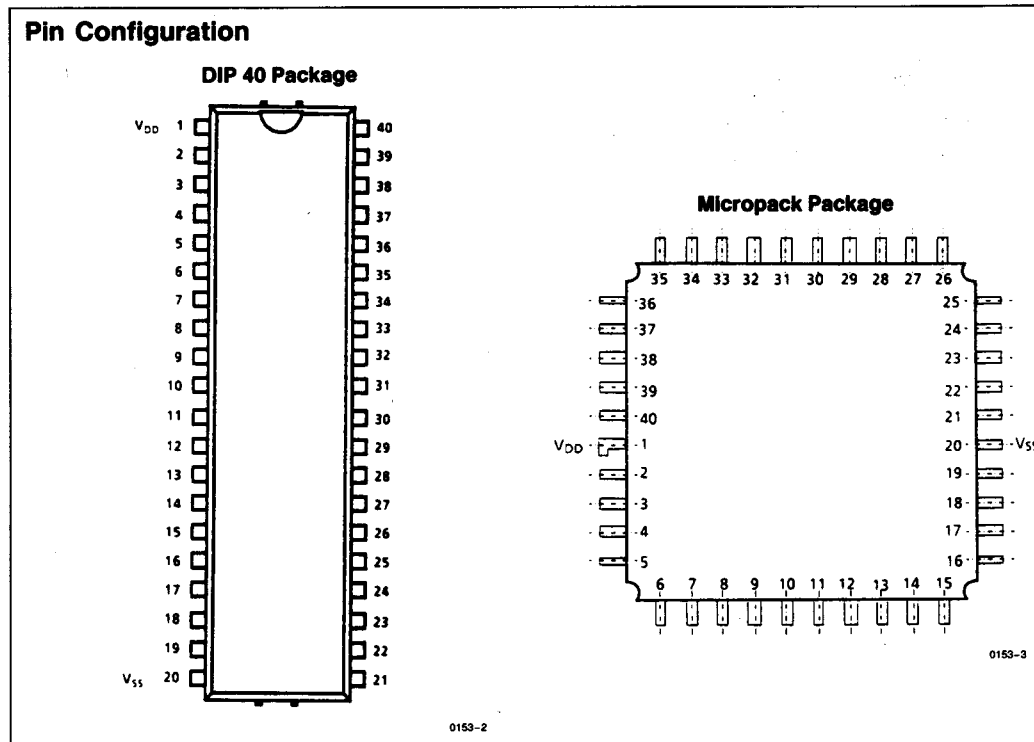


SLE 5001, SLE 5002 Universal IR Locking System



The CMOS components SLE 5001 and SLE 5002 are designed as transmitter and receiver for a universally applicable locking system. This system has been developed to minimize external components, offer maximum security and provide high user comfort.

By using a micropack package for the transmitter, it is possible to reduce its dimensions to the size of mechanical keys.

The data from the transmitter to the receiver is transferred by means of infrared light. Depending on the hardware periphery, the data can also be transferred via RF or ultrasound.

By pressing a key for a short time (approximately 100 μ s) the door locking system is triggered on or off. For application in vehicles as remote controlled central power locking systems the following additional features are possible:

Control of glove compartment, sun roof, windows, trunk and driver seat as well as rear mirror position.

The information flow from the transmitter to the receiver is based on a code scrambling technique. When synchronized, this method offers the user a high level of security.

Description of System

Depending on the configuration of several optional inputs and the peripheral hardware of the SLE 5001/5002, the following operating modes are available.

- Locking system with uni-directional synchronization and hardwired matrix as basic code memory
- Locking system with uni-directional synchronization and E²PROM SDE 2506 as basic code memory
- Locking system with dialog synchronization and hardwired matrix as basic code memory
- Locking system with dialog synchronization and E²PROM SDE 2506 as basic code memory

Code Replacement

A new code is used for each opening/locking process. After receiving a valid code, the lock is automatically set to the next code to be transmitted by the key. As a result, the code received a moment ago by the lock causes all previous codes to become ineffective, including secretly recorded codes.

The code sequence differs for each key/lock combination. The code sequence is mathematically derived from a number, characteristic for the combination in question, that is, from a "basic code". In principle, this method corresponds to the configuration of key notches and tumblers in mechanical systems. The "basic code" is stored in a hardwired matrix or in a non-volatile E²PROM.

Programming of the "Basic Code" and "Key Number"

a) With a Hardwired Matrix

Each matrix, both in the transmitter and receiver, must have the same knots. Minimum is one knot. Each matrix input may have only one knot (electrical connection).

b) With EEPROM SDE 2506

For programming the EEPROM a programming device is necessary for sending the data and the cycle. With this device it is possible to program the EEPROM. A description of this device is available.

In addition, a sample and hold range "N" = 9 has been defined to the effect that the lock does not only accept the actual code but also a number "N" of successively transmitted codes. This means that 8 successive codes can be transmitted without influencing synchronization. The synchronization established between a lock and each key fitting this lock must be ensured independent of all other invalid keys which fit the lock. Five different keys for one lock are possible. To this end, the status of the code sequence of each key fitting the lock is stored in the lock. Each key has been assigned with a number which is transmitted together with the code.

Depending on the hardware periphery and the level of security required, there are two possibilities of recovering lost synchronization. For both methods synchronization is initiated by depressing the transmit key for approximately 5 seconds. During this time 9 pulses are sent out at the output "Monitor-LED".

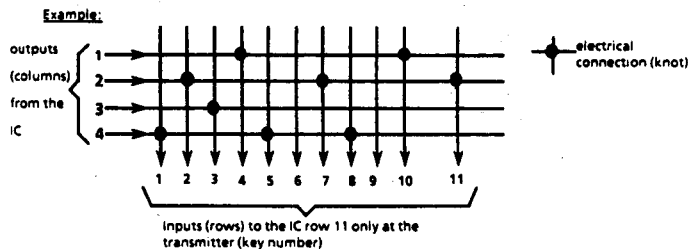
a) Uni-Directional Method

This method uses the "basic code" as the only fixed common characteristic for the lock/key combination. Synchronization is reestablished by deriving a "reset code" from the basic code. However, in view of secret recording (electronic wax impression) this method is not without risk since the reset code forms a sequence with the next code which opens the lock.

b) Dialog Method

This type of synchronization provides the user with a high level of security. However, an additional transmitter/receiver is required. Although their low output power requires the user to move closer to the lock,

Example:



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this inconvenience is alleviated by the fact that this type of synchronization is rarely necessary (e.g., when changing batteries).

Synchronization Process

Initially, the key should be located close to the lock (several cm). The dialog begins when the key transmits an initiation code to the lock. The lock acknowledges the code with a random number which is linked to the basic code in the lock and key. The key transmits the resulting identification number to the lock where the number is compared to the one computed by the lock. If the two numbers correspond, the lock is activated, reestablishing synchronization.

Since the key has to accurately acknowledge the particular random number transmitted at that moment by the lock, it cannot be activated by secretly recorded dialogs. It can be seen, the dialog method constitutes a high level of security which cannot be attained with the uni-directional method. Anyone attempting to misuse the opening/locking system is faced with the difficulty of solving the "basic code" and an unknown, complicated mathematical law.

Transmitter (Key)

The basic version of the transmitter comprises the SLE 5001, a basic code memory and an IR transmit stage with the IR transmitter diode SFH 484.

An additional IR receiver (with limited output power) is required for dialog synchronization. For monitoring the function 3 pulses are sent out on the output "Monitor-LED".

Receiver (Lock)

The receiver comprises the SLE 5002, the IR pre-amplifier TDE 4061 and a low-power IR receiver for dialog synchronization.

The basic code is stored in either a hardwired matrix or in the E²PROM SDE 2506.

Following outputs (active low) are available:

- | | |
|-----------------------------|-----------------------------------|
| 1 × Close | } Duration Approx.
1.2 seconds |
| 1 × Open | |
| 5 × Key No. (1, 2, 3, 4, 5) | |
| 1 × Trigger Pulse | Duration: 20 ms,
Delay: 20 ms |

1 × Error Indicator (Blink Signal):

- a) Data line low (short circuit against ground); intermitted 4 blink signals with 0.5 seconds duration and 4 seconds break.
- b) More than one knot in a hardwired matrix input of the receiver occurs a constant blink signal with a break of 1 second.
- c) More than one knot in a hardwired matrix input of the transmitter occurs a constant signal 4 periods long like a).

Description of the Data Transfer

(Figure 2)

One full IR transmit cycle comprises 4 bytes and 4 synchronization pulses. Each byte is preceded by a synchronization pulse. The transmitted byte is stored during the delay time (1.5 ms) following each byte transfer. The individual data bits are modulated with a carrier frequency of 125 kHz and transmitted as infrared light pulses by a transmit diode (SFH 484). Each data bit consists of 12 IR pulses of 2.4 μs duration and has a peak current of approximately 2A. Since the next bit will be transmitted after approximately 1.5 ms, the resulting maximum peak current is approximately 38 mA ($12 \times 2.4 \mu\text{s} / 1500 \mu\text{s} \times 2000 \text{ mA}$). The bit transmission is ended with a logic "0". Under worst case conditions (all bits "1") a battery of 2 mA ($12 \times 2.4 \mu\text{s} \times 2000 \text{ mA} \times 36$) is required for transmitting a 4 byte data word.

The infrared pulses emitted by the transmit diode are converted into current pulses by the IR receive diode SFH 205. The IR pre-amplifier amplifies and demodulates the received signal. Figure 3 shows a possible discrete solution for this purpose.

However the application of the TDE 4061 provides the highest level of integration. The demodulator is integrated, and the TDE 4061 can be connected directly to the receiver SLE 5002.

The processed data word is forwarded to the receiver in the lock and compared to the valid code in the sample and hold (9) range. If the data word and the stored code correspond, the lock is either open end or locked.

Absolute Maximum Ratings*

Ambient Temperature -40°C to +85°C
 Storage Temperature -55°C to +125°C
 Supply Voltage V_{DD} 0V to +7V
 Power Consumption 1W
 Input/Output Voltages -0.8V to $V_{DD} + 0.8V$

*Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Operating Specifications

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage	V_{DD}	$V_{SS} = 0V, 2.5V \text{ to } 6V$				
Current Consumption	I_{DD}	3 MHz, 5V	3.1	1.4	3.75	mA
		1 MHz, 5V				
		500 kHz, 5V	0.7			
		$V_{SS} \leq V_{IL} \leq 0.4V$ $4.8V \leq V_{IH} \leq V_{DD}$			0.9	mA
Standby	I_{DDs}	$V_{DD} = 5V$ $V_{SS} \leq V_{IL} \leq 0.4V$ $4.8V \leq V_{IH} \leq V_{DD}$		1	2	μA
Input Level Low	V_{IL}		-0.5		0.75	V
Input Level High	V_{IH}		$0.7 \times V_{DD}$		$V_{DD} + 0.5$	V
Output Level Low	V_{OL}	$I_{OL} = 1.0 \text{ mA}$			0.45	V
Output Level High	V_{OH}	$I_{OH} = -1.0 \text{ mA}$	$0.75 \times V_{DD}$			V

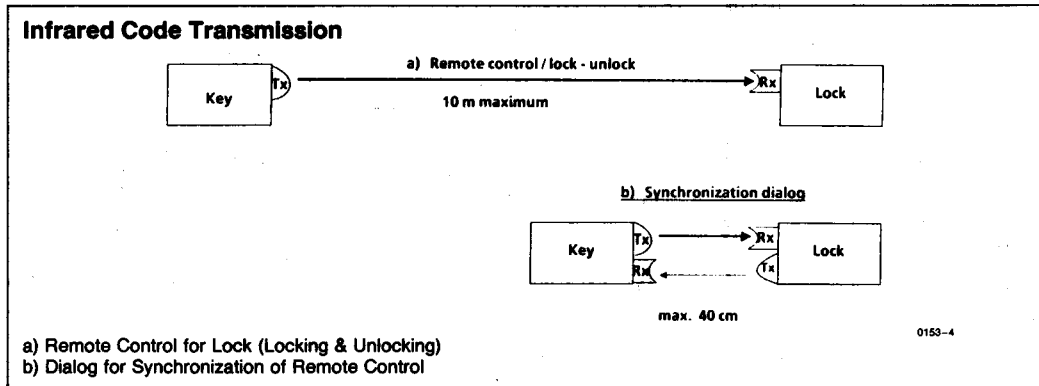


Figure 1

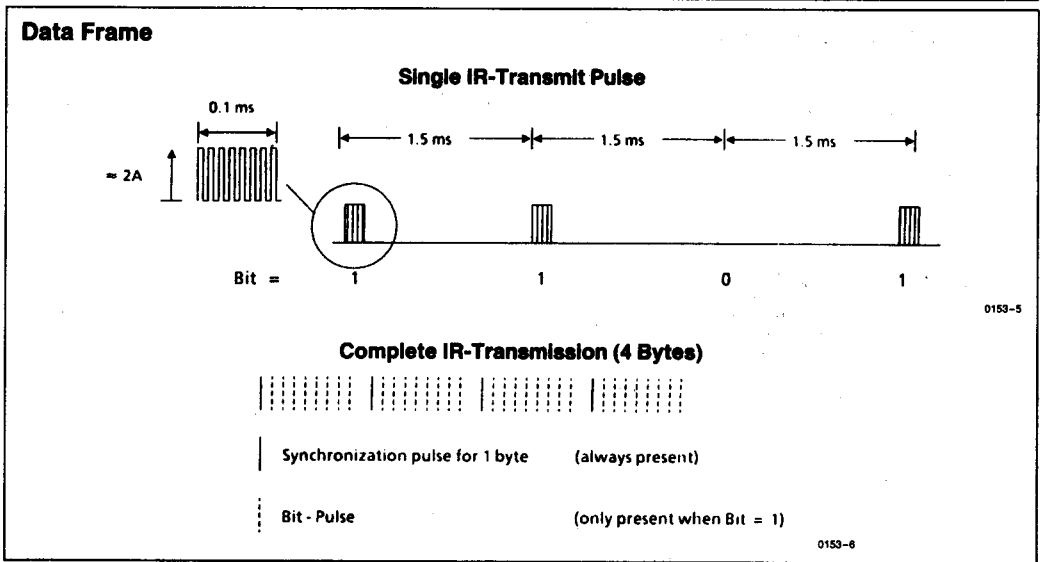


Figure 2

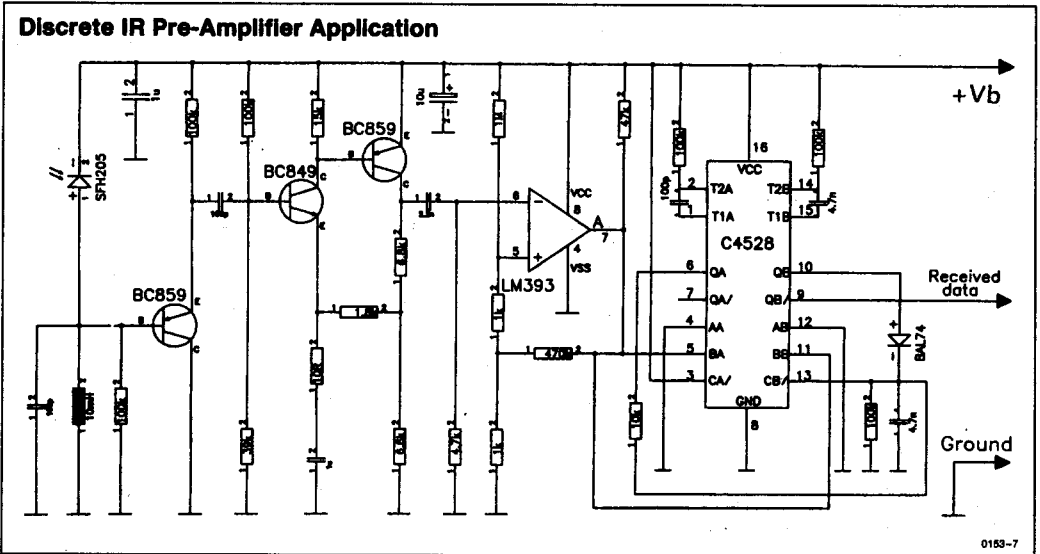
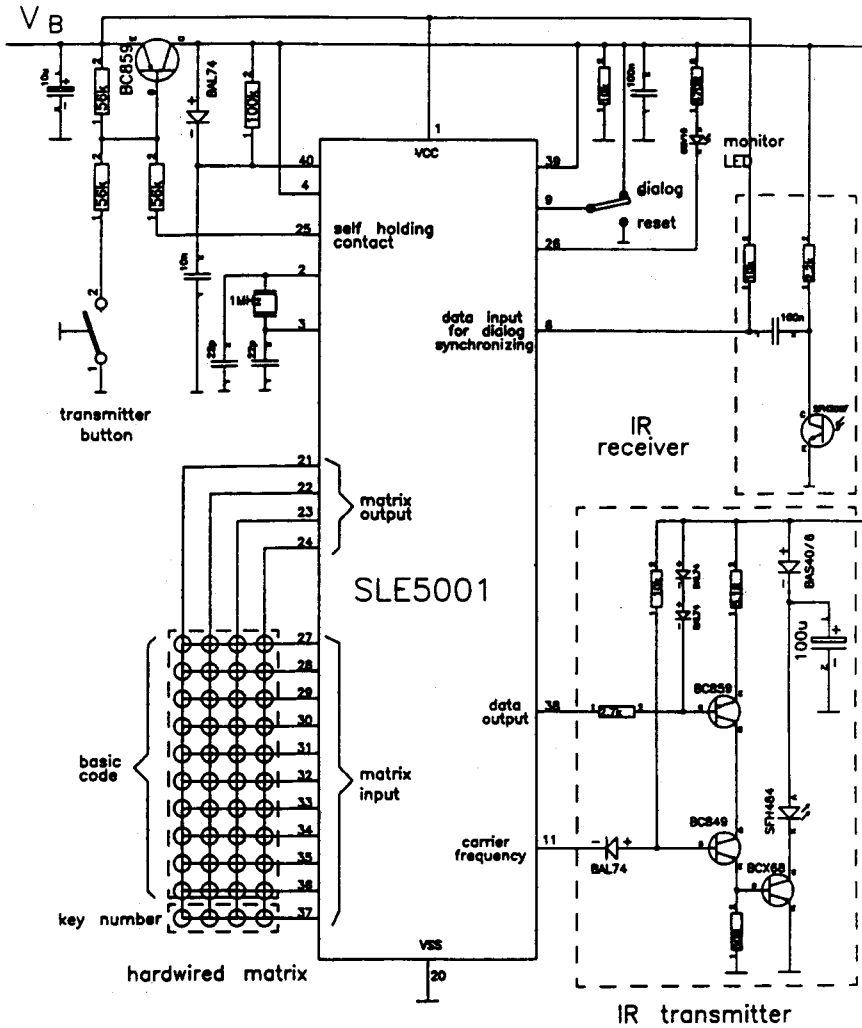


Figure 3

Application Circuit with Hardwired Matrix as Basic Code Memory

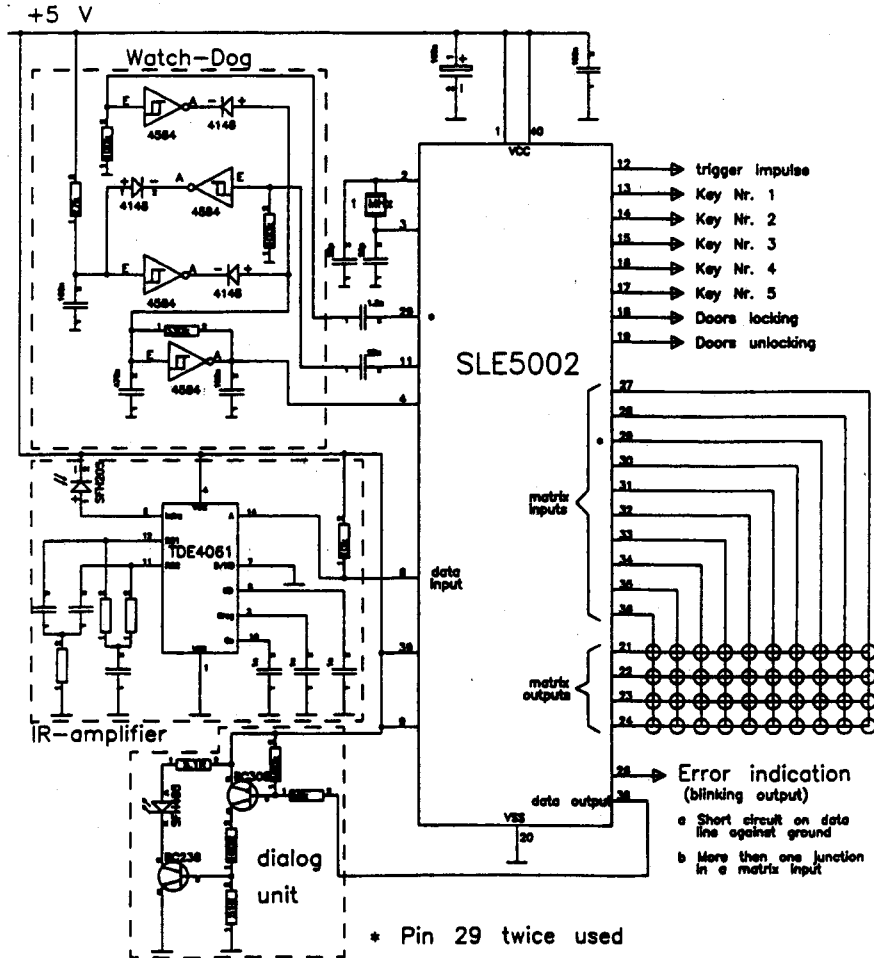


Transmitter (Key) SLE 5001

*The IR receiver can be omitted for uni-directional synchronization.
 Not used pin's remain unconnected.

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Application Circuit with Hardwire Matrix as Basic Code Memory

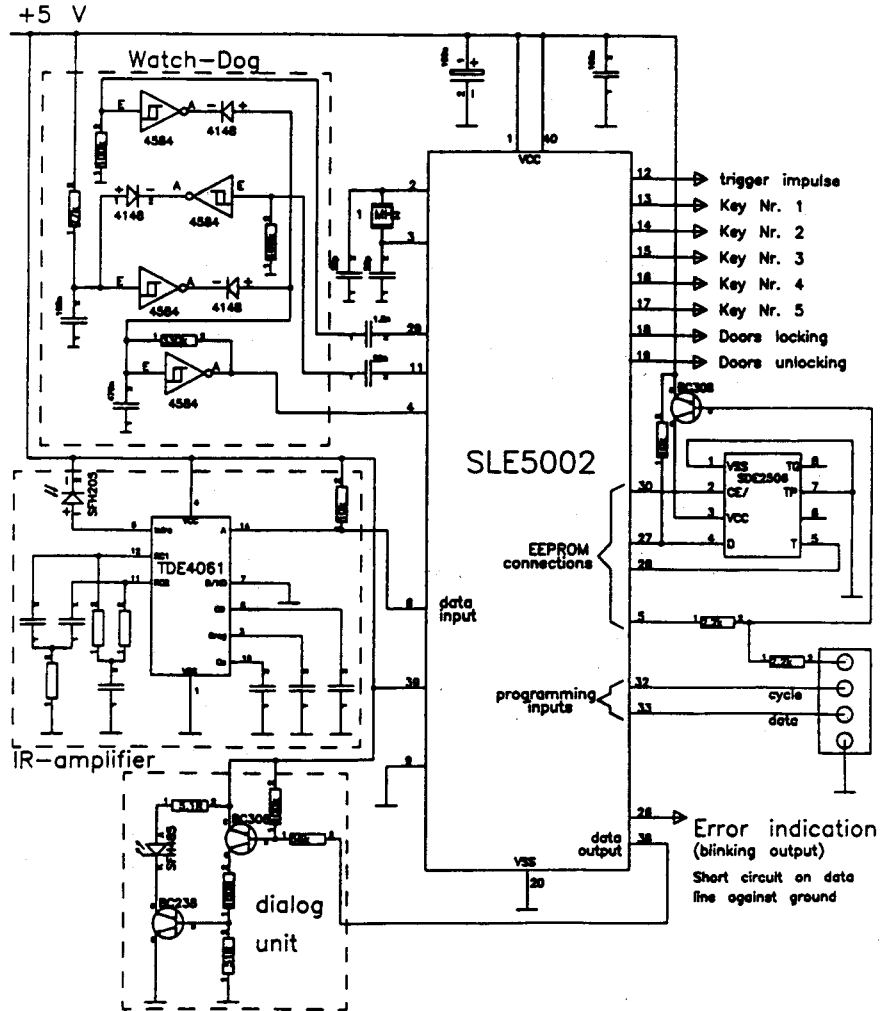


Receiver (Lock) SLE 5002

*Dialog-synchronization
 Dialog unit can be omitted for uni-directional synchronization.
 Not used pins remain unconnected.

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Application Circuitry with E2PROM as Basic Code Memory



Transmitter (Lock) SLE 5002

*The IR receiver can be omitted for uni-directional synchronization.
Not used pins remain unconnected.

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Ordering Information

Type	Function	Ordering Code	Package
SLE 5001	Transmitter	Q 67100-H 8532	DIP 40
SLE 5001 K	Transmitter	Q 67100-H 8533	Micropack
SLE 5001 W	Transmitter	Q 67100-H 8534	PLCC 44
SLE 5002	Receiver	Q 67100-H 8529	DIP 40
SLE 5002 K	Receiver	Q 67100-H 8530	Micropack
SLE 5002 W	Receiver	Q 67100-H 8531	PLCC 44