DATA SHEET

PCF7931AS
Programmable Identification Transponder (PIT)

Product specification

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Philips Semiconductors

PHILIPS

CONTENTS

1 FEATURES

- Identification Transponder for use in contactless applications
- Programmable read only operation
- Non volatile memory of 1024 bits (768 bits user data, 256 bits control data)
- Periodically data read out during READ_MODE
- Data transmission and supply energy via RF link
- Write protection
- 7 byte password
- Operating/resonance frequency 125 kHz nominal
- 20 years non-volatile data retention
- 100 erase/write cycles per byte
- Extended temperature range –40°C to +85°C
- Assembled as plastic stick

2 GENERAL DESCRIPTION

The PCF7931AS is a “Programmable Identification Transponder” (PIT) which transmits data bidirectionally, in half duplex mode, between basestation and transponder.

Data are stored in the transponder in a non-volatile memory (EEPROM). The transponder requires no internal power supply; it derives its power from the magnetic component of the RF signal generated by the basestation. Data are transmitted by modulating the RF-signal.

The device has been specially designed for identification purposes where reprogramming of the identification code or storage of additional data is required, e.g. car immobilizer.

The EEPROM has a memory capacity of 128 bytes and is organized in eight blocks, each having 16 bytes. Capacity is split into six blocks (96 bytes) for programming/reading of user data and into two blocks (32 bytes) for control of the memory access.

The PCF7931AS contactless interface generates the power supply and system clock from the resonant circuit by inductive coupling to the basestation. The interface also demodulates data that are transmitted from the basestation to the PIT, and modulates the electromagnetic field for data transmission from PIT to station.

When the PIT enters an RF field the contactless interface generates a reset and then goes into READ_MODE. In this mode the PIT cyclically transmits all data blocks to the basestation.

Modulation and coding of data in READ_MODE (PIT to basestation) is carried out by Amplitude Key Shifting with Diphase Coding. As a result of the inductive coupling between the circuit and basestation antenna, the current in the antenna is also modulated, resulting in low level amplitude modulation.

3 ORDERING INFORMATION

EXTENDED TYPE NUMBER	IC VERSION	PACKAGE	DRAWING	TEMPERATURE RANGE (°C)
PCF7931AS/3851	V0	SOT385-1	SOT385BA3	–40 to +85

4 QUICK REFERENCE DATA

PARAMETER	VALUE	UNIT
Carrier frequency (nominal)	125	kHz
Magnetic flux density • read • program	 25 170	 μWb/m^2(min.) peak to peak μWb/m^2(typical) peak to peak
Data transmission mode	half-duplex	
Transfer rate • read • program	 1.95 0.98	 kbit/s kbit/s
Coding • read • program	 CDP (conditioned diphase) PPM (pulse position modulation)	
Modulation	ASK (amplitude shift keying)	
Memory size	128	byte
Memory organization	8 blocks	each 16 byte
Weight	0.427	g
Package dimensions	3 x 6 x 12	mm

Electro magnetic susceptibility	according to DIN 40839, part 4
Special features	• 7 byte password • blockwise write protection • user defined irreversible write protection

5 BLOCK DIAGRAM

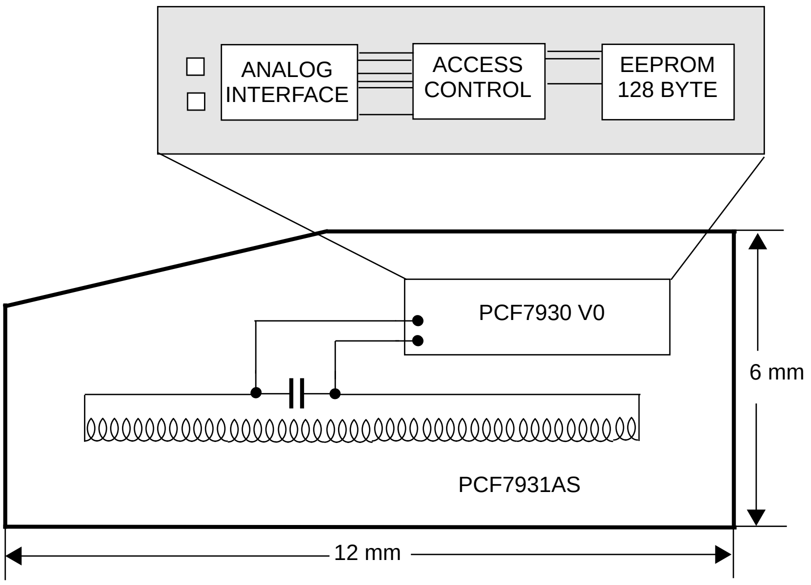


Fig.1 Blockdiagram transponder.

6 MODULE (STICK)

6.1 General Functional Description

The “Programmable Identification Transponder” (PIT) allows the contactless reading and programming of data into a memory. Data are transmitted bidirectionally in half duplex mode between basestation and the PIT. Data are stored in a non volatile memory (EEPROM). The PIT does not require any additional external power supply. It derives its power supply from the magnetic component of the RF-radiation which is generated by the basestation. Data are transmitted by modulating the RF-radiation.

The PIT has especially been designed for identification purposes where reprogramming of the identification code or storage of additional information is required. A block diagram of the system is given in Fig.2.

The PIT consists of a coil, a capacitor and the IC. On the IC the following functions are integrated:

- EEPROM: 128 byte non volatile memory (96 byte user, 32 byte control)
- CIF (contactless interface): power supply, clock recovery, data handling

The basestation generates an RF-field with a frequency of nominal 125 kHz. The PIT is synchronized on this “system clock”.

The two operating modes of the PIT are READ_MODE and PROGRAM_MODE. The PIT is switched between these two modes under control of the basestation.

The READ_MODE is entered, when the PIT senses a field with sufficient magnetic strength. Then the PIT transmits cyclically repeating the content of the EEPROM to the basestation.

To enter the PROGRAM_MODE, a programming pulse must be given from the basestation. Then data can be written bytewise or blockwise (16 bytes) into the EEPROM. If the PIT detects improper signal conditions during PROGRAM_MODE, it returns immediately back to READ_MODE. This avoids unintentional destruction of stored information.

The sequence of reading can be interrupted by a “soft reset”. With this “soft reset” the PIT can be forced to send data starting as if newly brought into the RF-field.

When returning from PROGRAM_MODE back to READ_MODE, a “read after write” procedure is initiated by default. Instead, a “soft reset” or the continuation of programming may be initiated from the basestation.

Several bytes of the memory are reserved for data protection and for memory access control. To prevent malicious or unintentional modification of stored information, password and block write protections can be set. If desired, the user can handle the protection bits so that some information is unalterable forever.

The user can store/alter the address range in the PIT for access control, so that only relevant information is read out. Furthermore, a “Sync-pattern” can be stored which clearly allows to identify the block number when data are read out of the PIT (the PIT does not provide the block number explicitly).

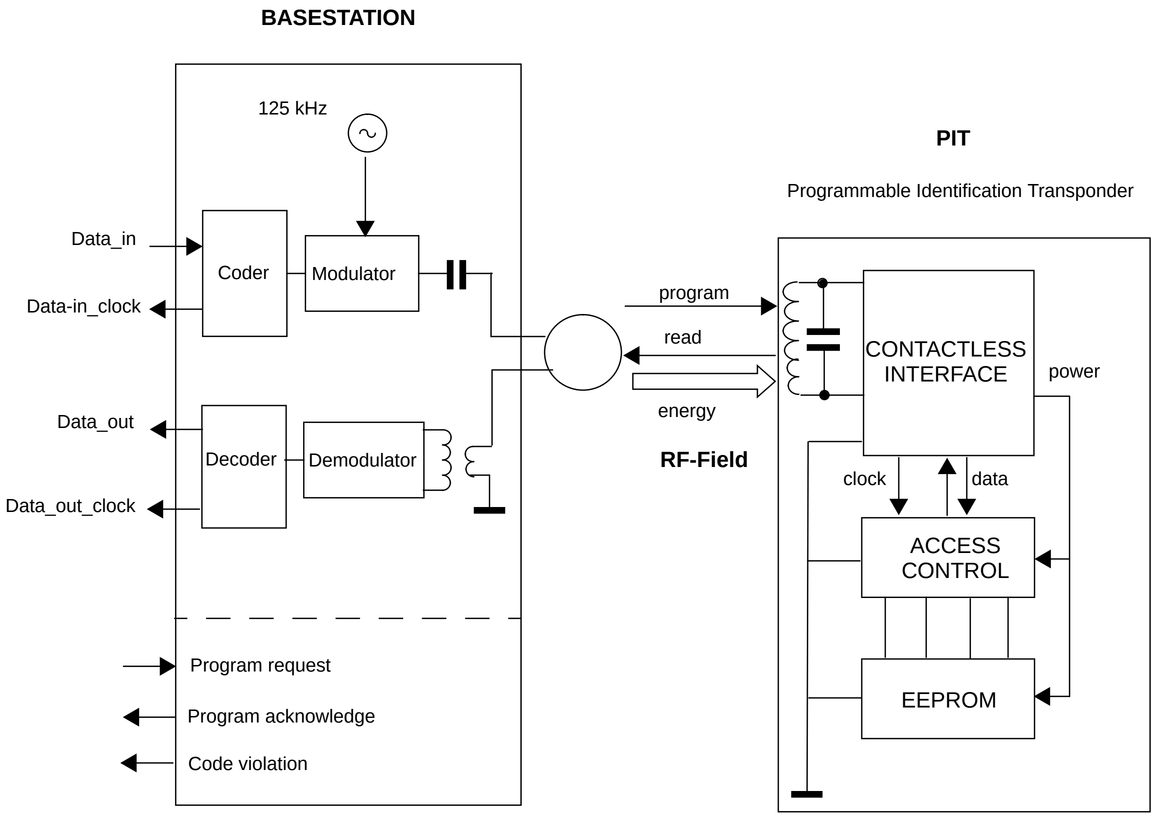


Fig.2 Transponder System Configuration.

6.2 Limiting values

All values are in accordance with the Absolute Maximum Rating System (IEC 134).

PARAMETER	MIN.	MAX.	UNIT
operating temperature range	–40	85	°C
storage temperature range	–55	125	°C
magnetic flux density (resistivity against magnetic pulses)		0.2	Wb/m^2
vibration • 10 – 2000 Hz • 3-axis • IEC 68-2-6, Test Fc		10	g
shock • 3-axis • IEC 68-2-6, Test Ea		1500	g

6.3 Electrical Characteristics

T_{amb} = –40°C to +85°C

SYMBOL	PARAMETER	CONDITION	MIN.	MAX.	UNIT
f_{RES}	operating/resonance frequency	measured contactless transponder inactive, Note 1	121.9	128.1	kHz
B_W	bandwidth	measured contactless transponder inactive, Note 2	2.3		kHz
B_{THR}	magnetic field strength threshold in READ_MODE (peak to peak)	$f_{CARRIER}$ = 125 kHz	25		µWB/m^2
B_{READ}	field absorption in READ_MODE (peak to peak)	$f_{CARRIER}$ = 125 kHz B_{FIELD} = 100 µWb/m^2	4		µWB/m^2
M_{IPRG}	modulation index in PROGRAM_MODE	$f_{CARRIER}$ = 125 kHz B_{FIELD} = 170 µWb/m^2 damping value preset to 200 T_{amb} = –17°C to +27°C	95		%
t_{RESET}	reset time			20	ms
t_{CPU}	Carrier Power-Up rise time	$f_{CARRIER}$ = 125 kHz, see Note 3		4	ms

Notes

1. Measured contactless with network analyzer HP4194A using 150 mV amplitude.
2. Measured contactless with network analyzer HP4194A using 150 mV amplitude (45°C phase criterion).
3. The Carrier Power-Up rise time is the time required to establish a carrier magnetic flux density of B_{THR}, see Figure 3. For proper device operation the Carrier Power-up rise time must not exceed the specified value. B_{THR} is the minimum magnetic flux density required for transponder read operation.

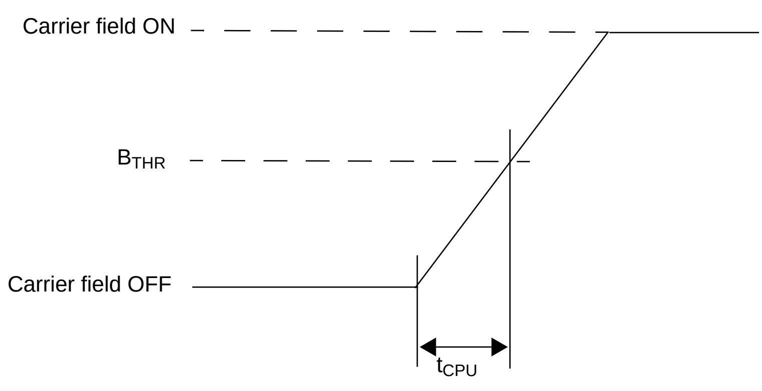


Fig.3 Definition of the Carrier Power-Up rise time.

SYMBOL	PARAMETER	CONDITION	MIN	MAX	UNIT
$N_{E/W}$	erase/write cycles per byte	T_A = +22°C to +70°C	100		
t_S	data retention time	T_A = +22°C	20		years

6.4 READ_MODE

6.4.1 MEASURING SETUP

In Fig.4 is showing the testing setup for measuring the threshold and the field absorption of the transponder. In Fig.5 the dimensioning of the coil parameters is given.

The magnetic flux density has to be adjusted (without transponder) by measuring the voltage over both (serial connected) sensing coils.

The voltage induced into the two serial connected sensing coils is proportional to the magnetic flux:

$1V_{pp}$ is equivalent to 8.9 µWb/m^2

The transponder has to be placed in the center of the Helmholtz arrangement. The transponder starts modulating the magnetic field.

Two different values of the magnetic flux density B will be applied to the transponder in order to verify the following physical characteristics:

- **Minimum power B_{THR}**
  - Modulation of the transponder at a minimum value of B, ensuring that the threshold of minimum required energy for operating the transponder is surpassed.
- **Minimum modulation depth B_{READ}**
  - Modulation of the transponder at the typical value of B, ensuring that the transponder modulation is in saturation. The minimum value of absorption of the transponder at this value of B is given in Section 6.3.
  - The difference of the voltages between sensing coils and reference coils ($V_{sense} - V_{reference}$) is proportional to the magnetic flux density absorbed by the transponder. The proportional factor is as given above (8.9 µWb/m^2/V_{pp}). A typical oscillogram is given in Fig.6.

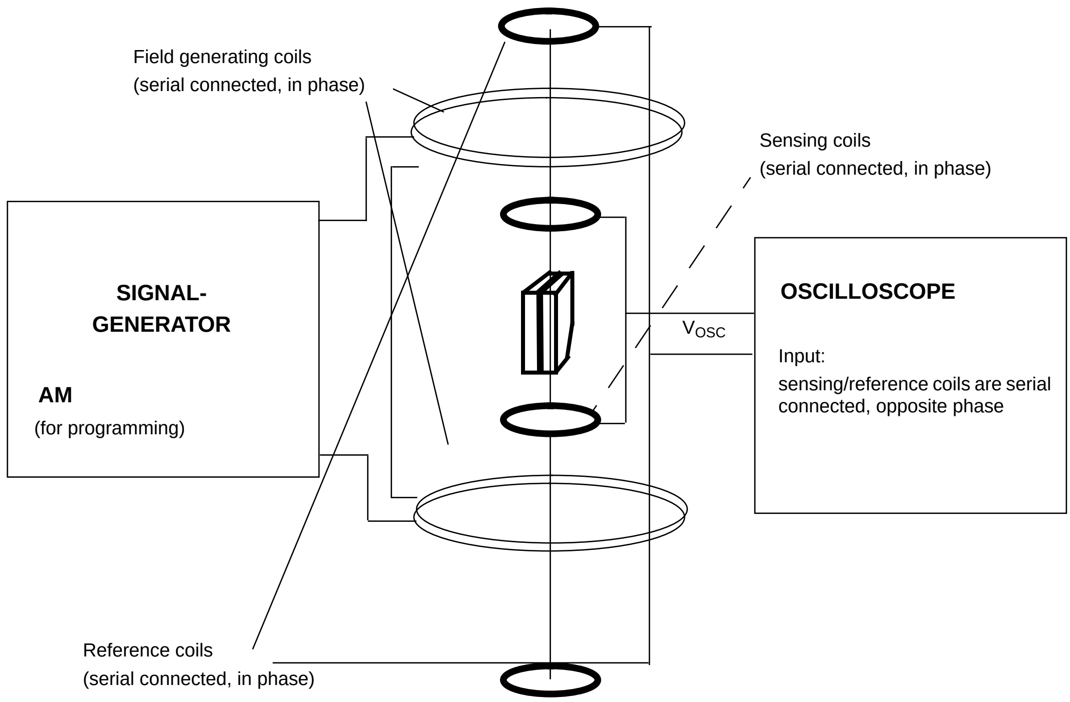


Fig.4 General testing set-up.

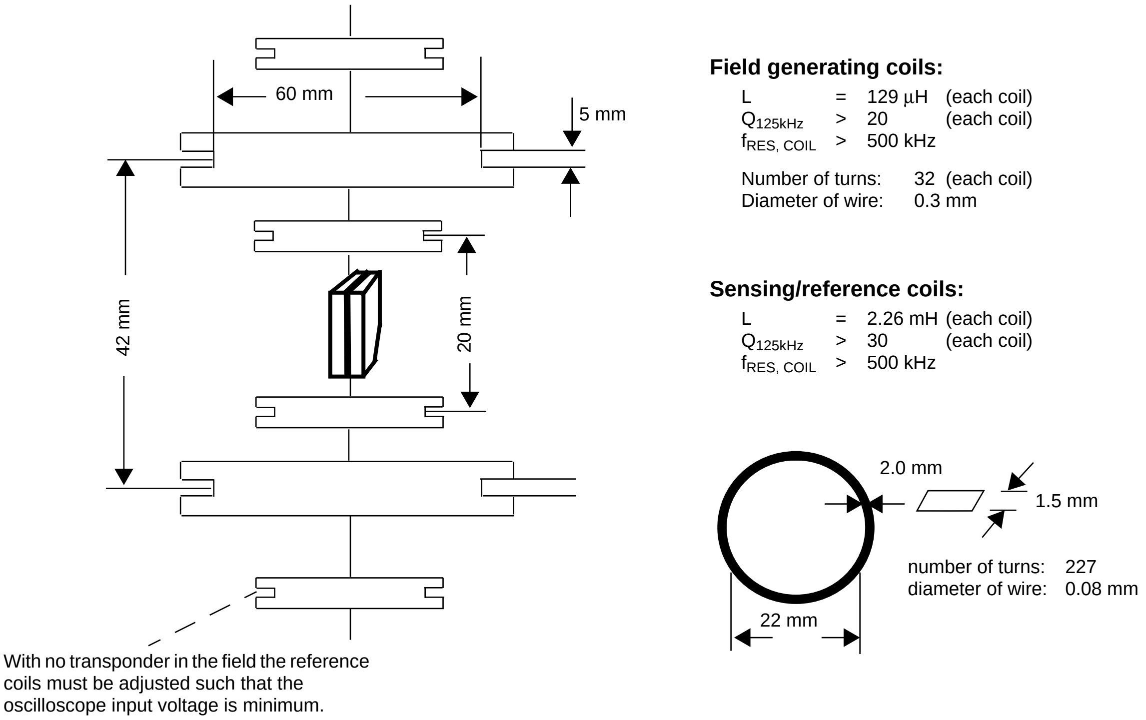


Fig.5 Coil parameters.

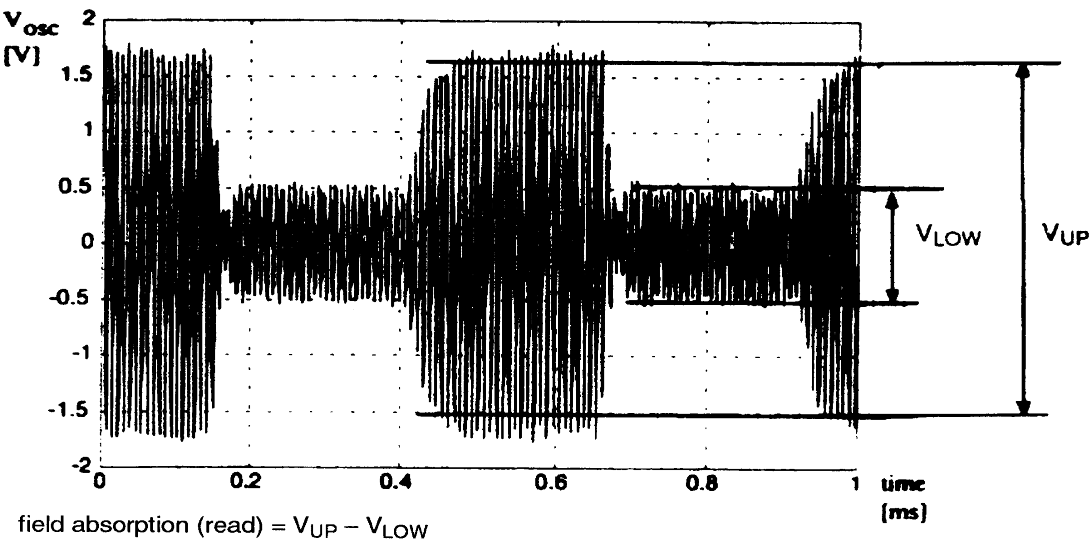


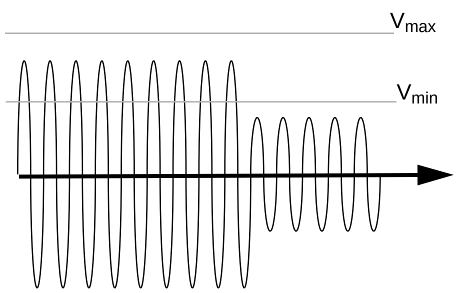
Fig.6 Modulation caused by transponder.

6.5 PROGRAM_MODE

The modulation index for programming the transponder is measured using the setup described in Section 6.4. The reference coils are not needed.

The magnetic flux density and the modulation index of the AM signal generator has to be adjusted according to the values given in Section 6.3. The definition of the modulation index is given in Fig.7.

The transponder has to be placed in the middle of the Helmholtz arrangement. Programming is successful over the specified temperature range.



Modulation index MI_{PRG} is given by:

$$MI_{PRG} = \frac{Vmax - Vmin}{Vmax + Vmin}$$

Fig.7 Definition of modulation index.

6.6 Mechanical Characteristic

The transponder is sealed in epoxy resin moulding compound. The outline of the package is given in Fig.8. The designation of the package is SOT385-1. The position of the coil is given in Figure 9.

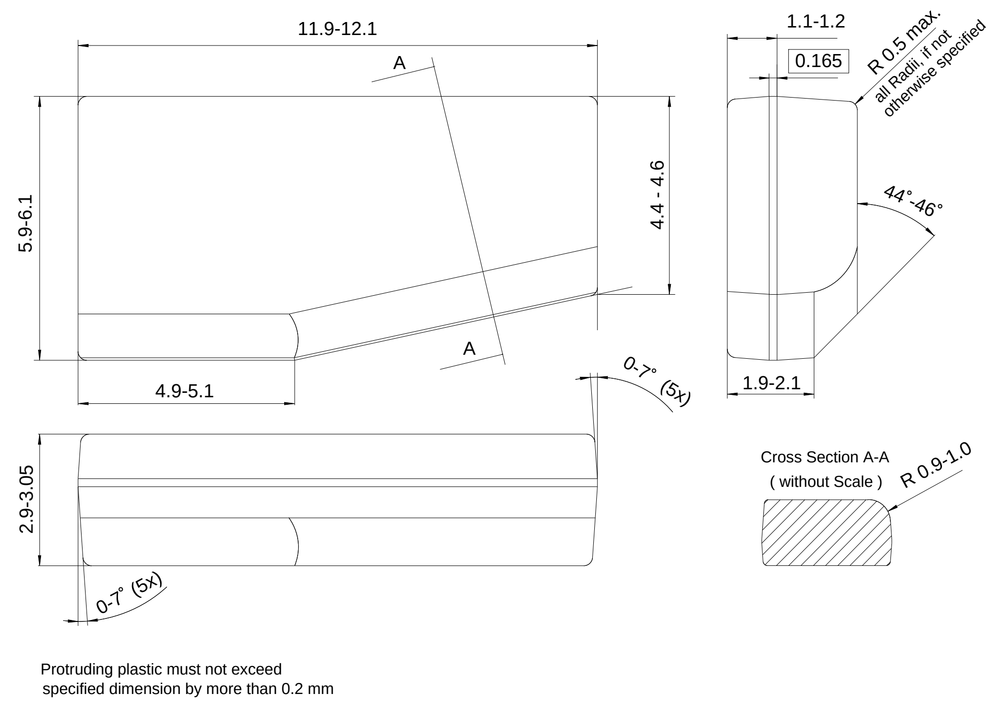


Fig.8 Package outlines SOT385-1.

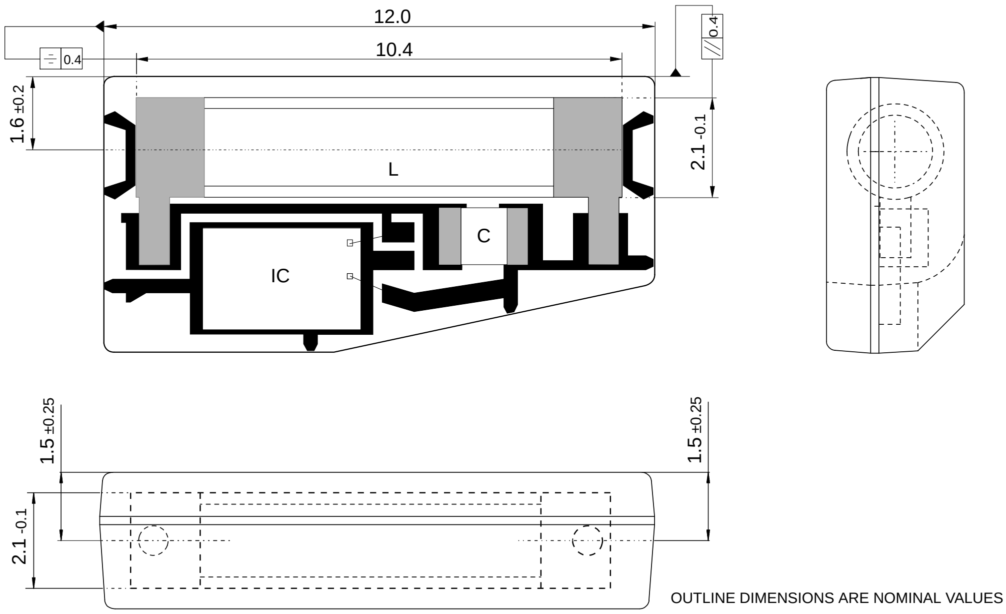


Fig.9 Coil position; layout SOT385BA3.

7 FUNCTIONAL DESCRIPTION OF THE IC

7.1 Memory organization and access

The EEPROM provides a memory capacity of 128 bytes. It is organized in 8 blocks, each block consisting of 16 bytes. This capacity is split into 6 blocks (= 96 bytes) for programming/reading of user data and into 2 blocks (= 32 bytes) for the control of the memory access. The memory organization is given in Figures 10 and 11.

The access to the memory depends on the mode of operation: PROGRAM_MODE or READ_MODE. If the PIT is in PROGRAM_MODE, data can be programmed bytewise or blockwise with auto increment. During READ_MODE the EEPROM is cyclically read out.

Block 0 and block 1 store information for access control. The intention of these blocks is to provide some flexibility for different applications in terms of data security and access to relevant information. The following access procedures can be performed.

7.1.1 PASSWORD/PAC

The password is 56 bits long. If the password check is enabled (PAC = logical 1), data sent to the PIT are checked for correctness of the password. In case of failure, programming is inhibited and the transponder returns to READ_MODE. In READ_MODE the password is superseded by logical 0. If the password check is disabled (PAC = logical 0), the password is readable (not superseded).

7.1.2 PROTECTION

Each block (excluding block 1) of the user data can be protected separately against programming by setting the block write protection (BWP = logical 1). This implies, that if block 0 is write protected, the bits of this block can never be changed. The special effect of this protection is, that information stored in any write protected block can never be altered. It is frozen. With this feature the user memory is split into changeable and unchangeable address ranges.

Block 1 is executed from write protection.

7.1.3 SYNC-PATTERN

In these 8 bytes any kind of data can be stored. The purpose of this feature is, that if RB1 is enabled, the Sync-pattern is always the first information that is transmitted from the PIT to the basestation. Therefore the Sync-pattern should be programmed with a pattern, which allows the basestation to detect the blockposition unambiguously.

7.1.4 SELECTION

First and last block to be transmitted from PIT to the basestation are given by RFB and RLB. Starting with RFB the last block will be reached by modulo counting. So the value of RFB may be higher than that one of RLB. In this case the PIT wraps around from block 7 to block 0. In case when block 1 is enabled (RB1 = logical 1), block 1 is always sent before RFB.

All information sent to or received from the PIT (addresses and data) is transmitted with the lowest bitposition first.

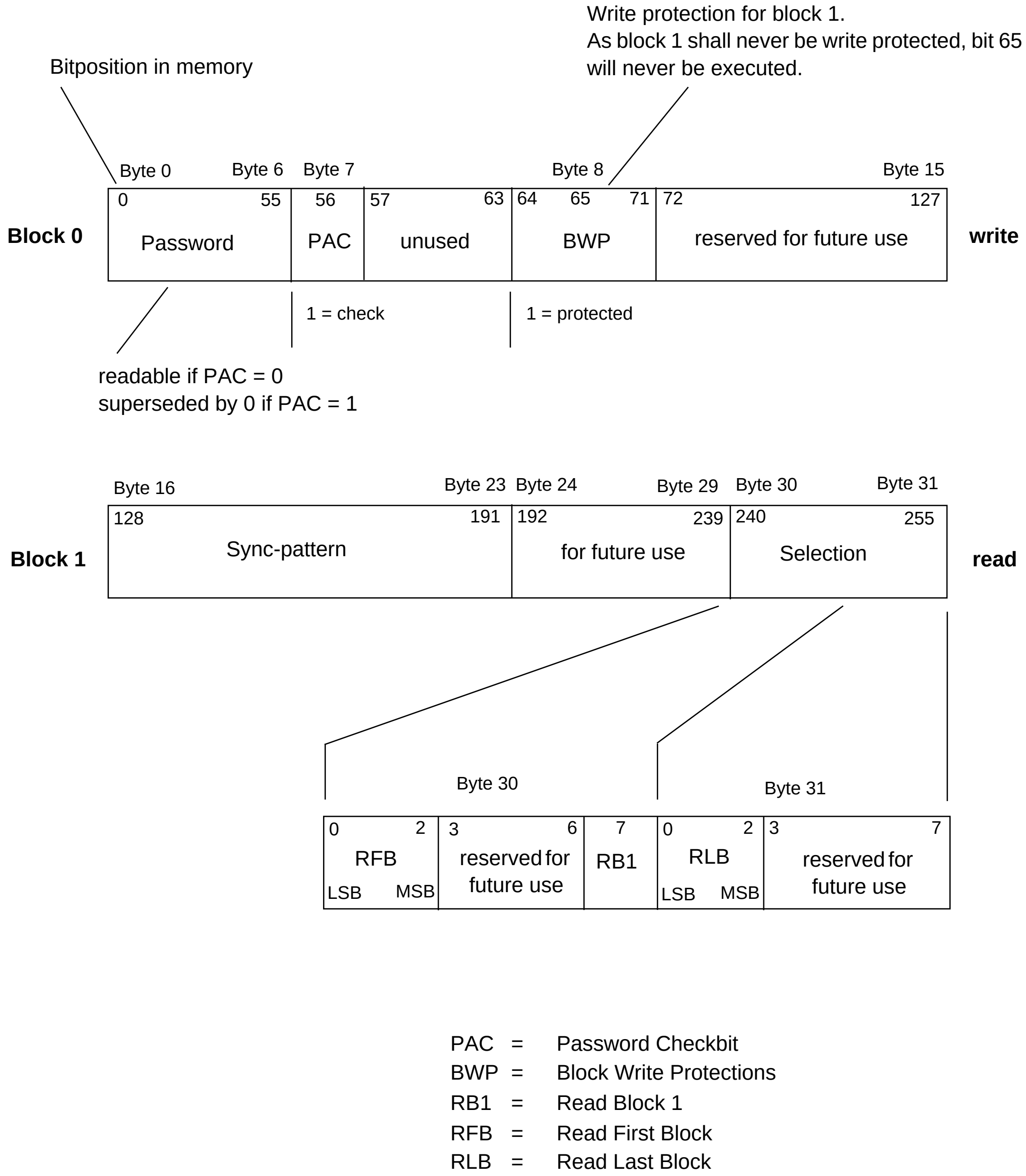


Fig.10 Memory organization: Memory Access Control, 32 bytes.

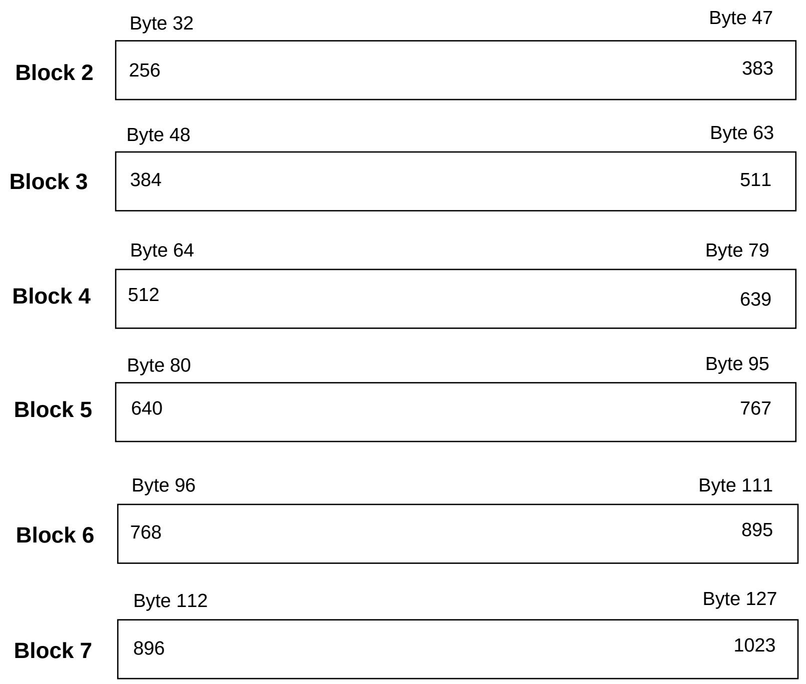


Fig.11 Memory organization: User Memory, 96 bytes.

7.2 Contactless Interface

The Contactless Interface (CIF) generates power supply and system clock from the received signal in the resonance circuit. The interface further demodulates data that are transmitted from the basestation to the PIT and modulates the electromagnetic field for data transmission from the PIT to the basestation. In detail the CIF provides the following functions:

7.2.1 SUPPLY VOLTAGE

A bridge rectifier together with a voltage stabilizer provides a constant supply voltage for the IC.

7.2.2 RESET

When the supply voltage is below a threshold voltage, a reset signal forces the IC into initial conditions. Immediately after reset the PIT goes into READ_MODE.

7.2.3 SYSTEM CLOCK

The CIF recovers the system clock from the RF-field as given from the basestation. The IC works correctly with frequencies in the range from 60 kHz to 150 kHz.

7.2.4 MODULATION/CODING

The communication between basestation and PIT operates half duplex. In both directions (PROGRAM_MODE, READ_MODE) different modulating/coding techniques are used. In PROGRAM_MODE the CIF is able to detect transmission errors. Modulator/Coder and Demodulator/ Decoder are part of the CIF.

7.2.5 LOGIC

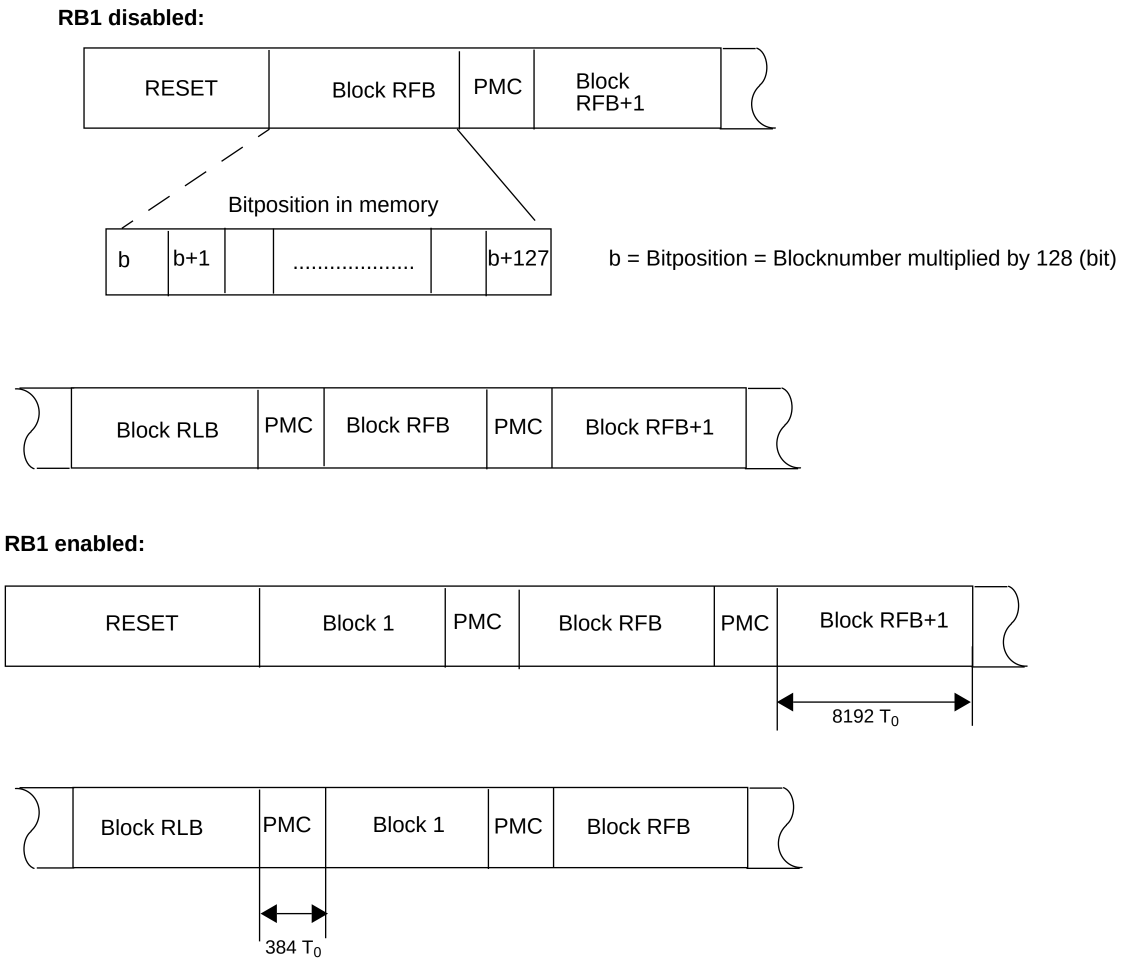
Sequential/Combinatorial logic for programming/reading and the evaluation of password, protection, selection and PROGRAM_MODE_CHECK.

7.3 Data Transmission from transponder to basestation (READ_MODE).

When the PIT enters a RF-field with sufficient strength, the CIF generates a reset and then goes into READ_MODE. In this mode the PIT cyclically repeating transmits the contents of internal memory between RFB and RLB to the basestation. If RB1 is enabled, block1 is always sent before each occurrence of block RFB.

Modulation and coding of data in READ_MODE is done by Amplitude Shift Keying with Diphase Coding (ASK-CDP). The ASK is realized by alternatingly clipping the voltage of the resonance circuit to two different levels. These levels are switched according to the value of the CDP coded data stream. The switching of clipping levels modulates the current of the resonance circuit. Due to the inductive coupling between resonance circuit and the antenna of the basestation, the current in the antenna is also modulated, resulting in a binary level amplitude modulation.

In order to unambiguously detect the beginning of a sequence transmitted from the PIT to the basestation, the first transmitted CDP coded databit always starts with the lower clipping level. Figure 12 shows the block sequence in READ_MODE. Figure 13 shows the coding of the data sent to the basestation.



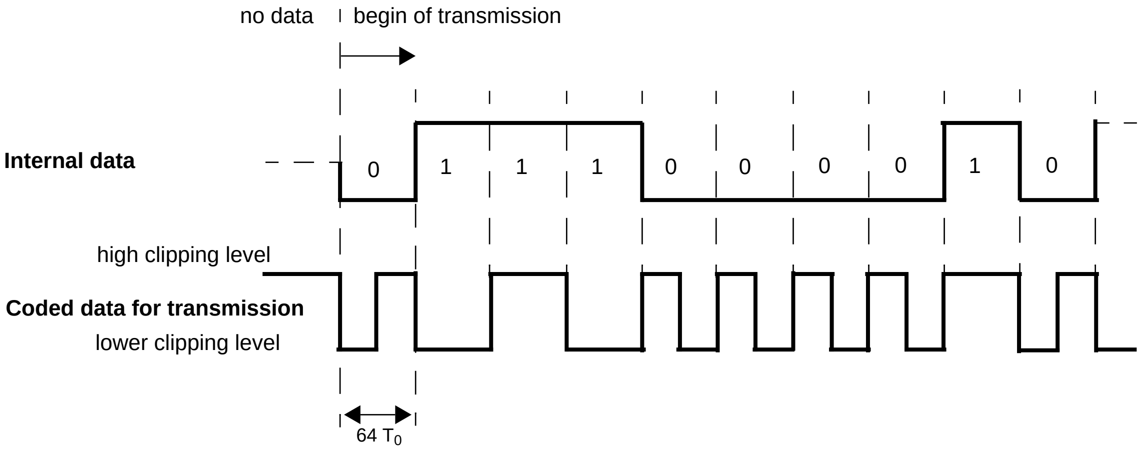
Note:

T_0 = Carrier Period Time (1/125 kHz nominal)

PMC = PROGRAM_MODE_CHECK
all PMCs without programming pulse from
basestation (READ_MODE)

Fig.12 READ_MODE.

Data	Coded
1	Change of state after full bitframe read (64 T_0)
2	Two changes of state after half bitframe read (32 T_0) each



Note:

First bit of a block always starts with lower clipping level

T_0 = Carrier Period Time (1/125 kHz nominal)

Fig.13 CDP coded signal.

7.4 Switching between read and program (PROGRAM_MODE_CHECK)

Between all blocks transmitted from the PIT to the basestation, a short time interval with no data transfer occurs, before the transmission of the next block is started. During this interval the PIT can be switched into PROGRAM_MODE. Therefore this interval is named PROGRAM_MODE_CHECK.

The basestation recognizes the PROGRAM_MODE_CHECK by a special pattern sent from the PIT.

The PROGRAM_MODE is entered/continued when the basestation sends a pulse of 3 T_0 during PROGRAM_MODE_CHECK and when there is sufficient field strength (power check). The PIT leaves the PROGRAM_MODE, when no pulse or pulse of 6 T_0 (“soft reset”) is given. When no pulse is given, the PIT first sends the last programmed block (read after write) followed by the PROGRAM_MODE_CHECK and continues then as after reset.

In case of “read after write” that block is transmitted in which the latest programming took place. This is also valid if the last programmed block is not in the range specified by RFB and RLB. The PIT then continues as after reset. Figure 14 shows the timing of the PROGRAM_MODE_CHECK.

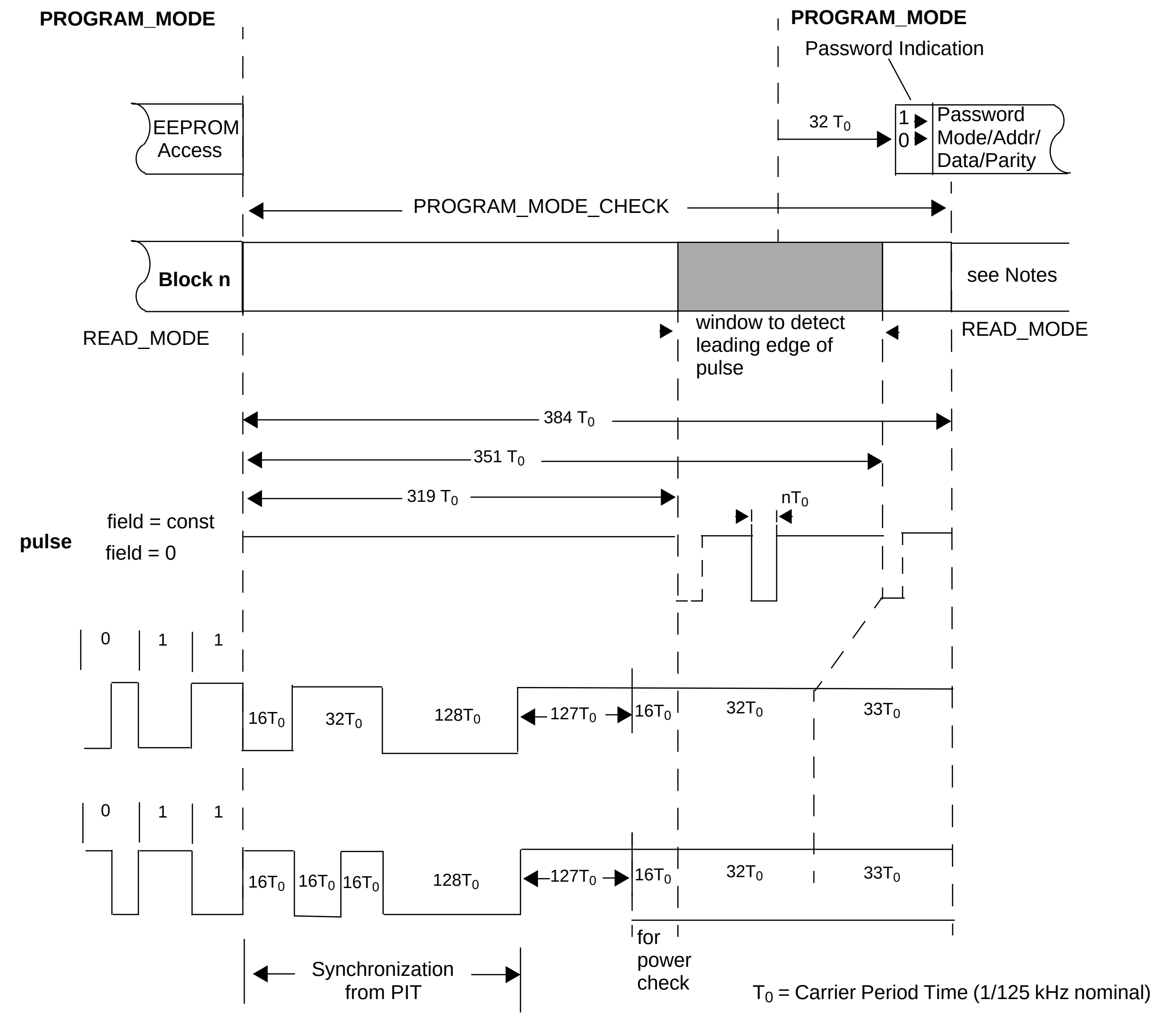


Fig.14 Timing conditions of PROGRAM_MODE_CHECK.

Notes to Figure 14

FROM	TO READ_MODE	TO PROGRAM-MODE
READ_MODE	if n = 0: block n + 1 if n = 6: soft-reset; see Note 1	n = 3
PROGRAM_MODE	if n = 0: last programmed block follow by MPC of which n = 0 is handles as n = 6 if n = 6: soft-reset; see Note 1	n = 3

Note

1. Soft-reset: PIT starts as if newly put into RF-field.

7.5 Data transmission from basestation to transponder (PROGRAMM_MODE)

After the PROGRAM_MODE_CHECK the PIT expects a password indication bit, signalling whether the basestation will send the password (= logical 1) or not (= logical 0). The PIT checks this bit against the PAC bit stored in block 0.Two possible conflicts might occur. They are resolved as follows:

PAC = logical 1 and password indication = logical 0
--> PIT returns immediately into READ_MODE

PAC = logical 0 and password indication = logical 1
--> PIT ignores password and programs (read after write) data that are received after the password

Password indication and (if indicated) password are sent only once, when the PIT is switched from READ_MODE to PROGRAM_MODE. Figures 15 and 14 show the transmission protocols for bytewise and blockwise programming, respectively. The password is followed by the mode_bit, block address, byte address, the data byte and a parity bit. The mode_bit indicates whether bytewise (= logical 0) or blockwise mode (= logical 1) is applied. With bytewise programming each byte of the memory can be directly accessed.

With blockwise programming only the blockaddress is given and the byteaddress is internally incremented. The parity bit (parity even) completes all bits from mode_bit on to an even number of logical 1's.

For finally storing the data byte into the EEPROM, a time of about 5 ms (at 125 kHz carrier frequency) is needed (EEPROM access). During this time the basestation is checking CDP coded modulation from the transponder. If no modulation is detected, proper programming of the PIT can be assumed. If the basestation detects modulation, the PIT has quit the PROGRAM_MODE caused by fauty operating conditions.

The PIT quits the PROGRAM_MODE of a byte under the following conditions:

- the power supply for programming is too low
- PAC = logical 1 and password indication = logical 0
- wrong password
- wrong parity bit
- attempt to write to a write-protected block
- detection of transmission error e.g. pulse position or pulse width incorrect

In each of these cases the PIT returns to READ_MODE, starting with the block as after reset.

Each bit of the password or address/data field is transmitted using pulse position modulation by reducing the amplitude of the field strength.

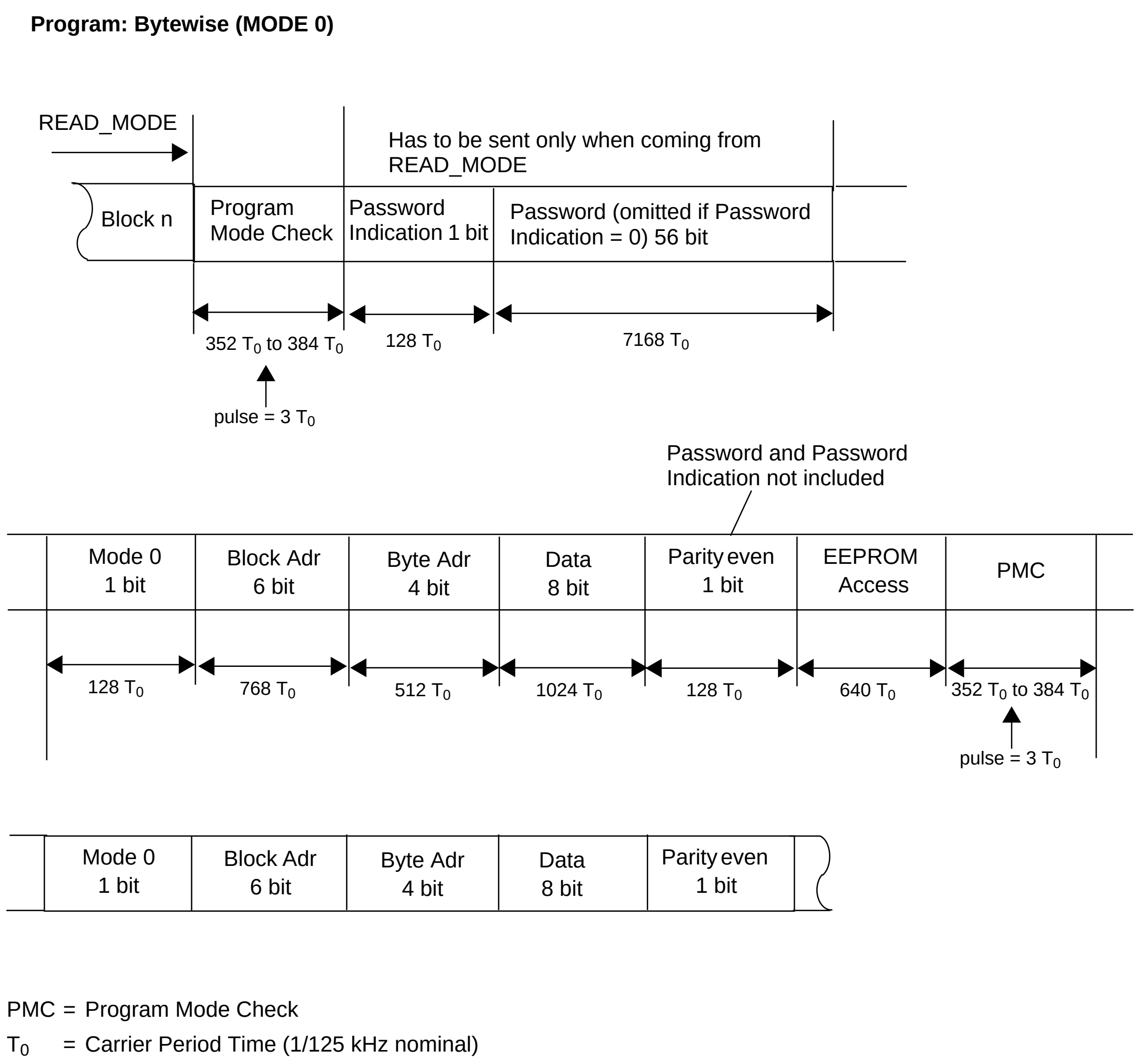
The PIT is not synchronized by the databit-pulses. It just counts periods of the carrier frequency from PMC onwards.

Attention: See also Chapter 9 “Anomaly Notes (Version V0)”, Note 2 and Note 3.

7.6 Synchronization from PIT

In order to unambiguously detect the PROGRAM_MODE_CHECK (PMC) the PIT provides a unique timing to the basestation, when the PMC interval commences. It is recommended to assume synchronization when the 128 T_0 pulse is detected (see Fig.14).

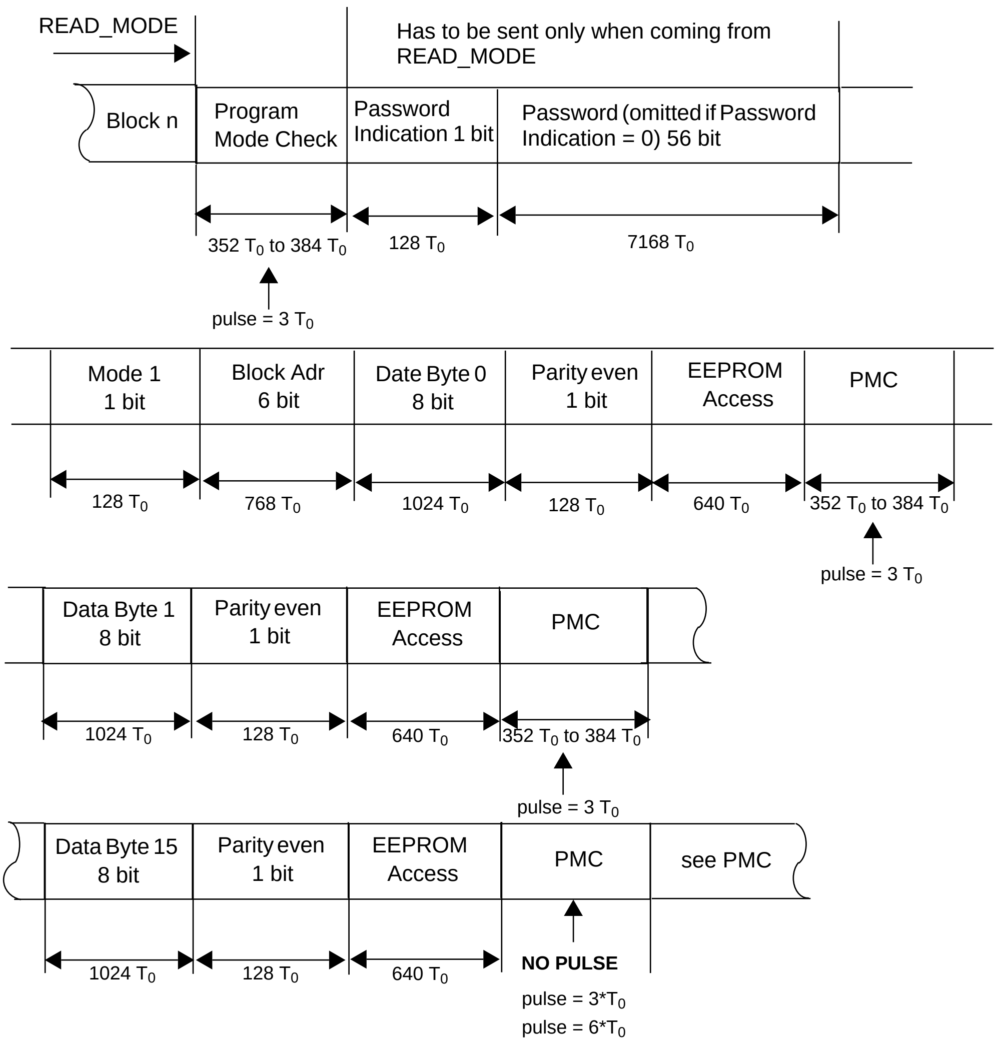
Due to the power check taking place in the second half of the PMC interval, a spurious modulation pulse may occur 303 T_0 after the PMC commences. Depending on the RF-signal strength the pulse length way vary from 16 T_0 to 81 T_0.



See also Notes to Figures 15 and 16, as well as Chapter 9 “Anomaly Notes (Version V0)”.

Fig.15 PROGRAM_MODE, bytewise.

Program: Bytewise (16 Byte, MODE 1)



T_0 = Carrier Period Time (1/125 kHz nominal)

See also Notes to Figures 15 and 16, as well as Chapter 9 “Anomaly Notes (Version V0)”.

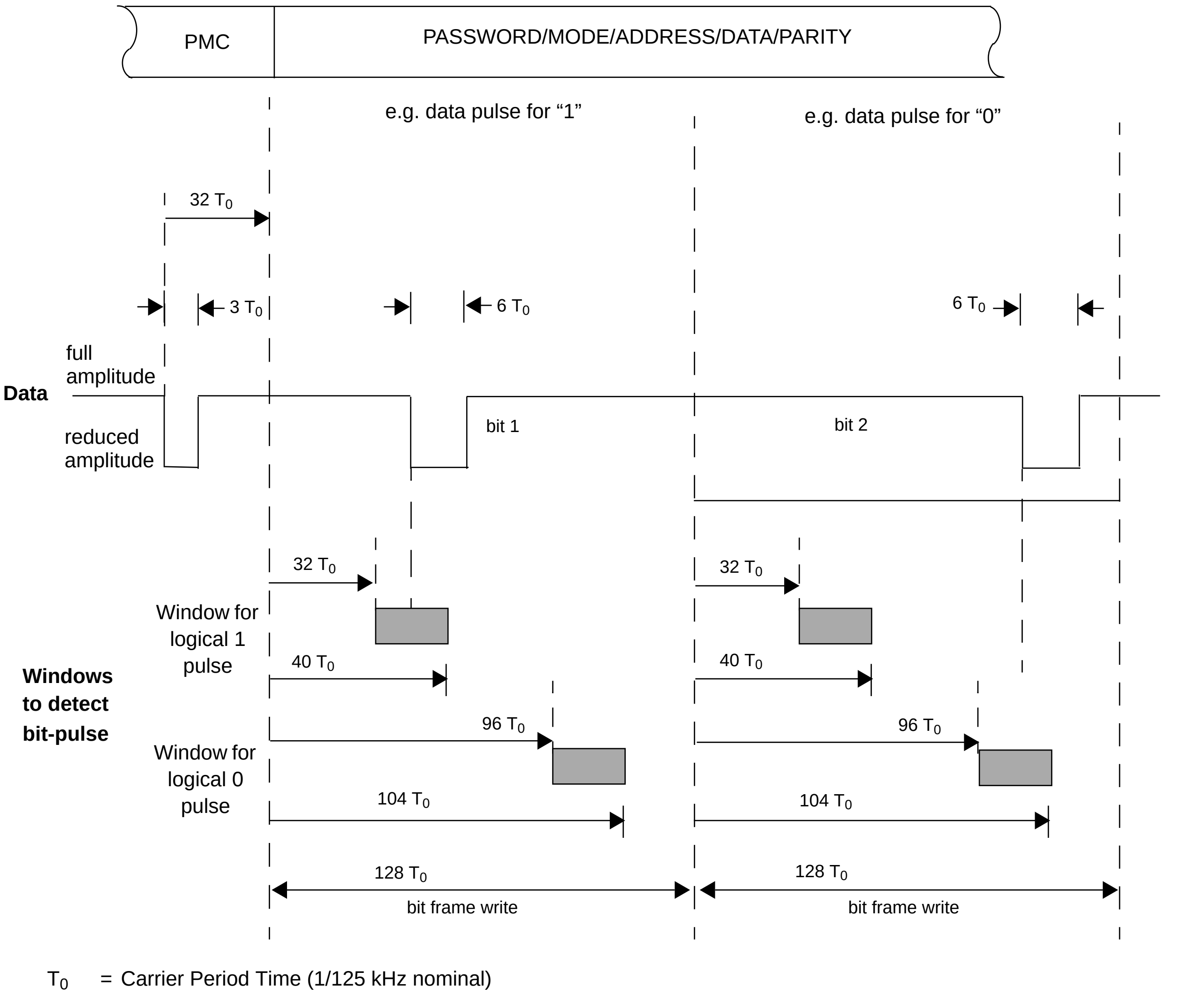
Fig.16 PROGRAM_MODE, blockwise.

7.6.1 NOTES TO FIGURES 15, 14

Bytewise and Blockwise programming can arbitrarily be appended without going in between into READ_MODE.

1. If the PIT expects a password (PAC = logical 1) and Password Indication = logical 0 --> PIT goes immediately into READ_MODE.
2. If the PIT expects no password (PAC = logical 0) and Password Indication = logical 1 --> PIT ignores password and programs data that are received after the password.
3. In case of faulty conditions during PROGRAM_MODE --> PIT goes immediately into READ_MODE and starts as after reset.
4. Blockwise programming can be stopped before the last byte of the block is reached by either sending no pulse or a "soft reset" pulse during PMC --> PIT goes into READ_MODE as defined by Program _Mode_Check (see Fig.14).

The transmission time of a bit is a 128 clock cycles of the carrier frequency. The logical value of the data bits are defined by the time window during which they occur. The falling edge of the pulse must be within this window. The pulselength must be 6 T_0. If pulses are detected outside these windows or if more one pulse occurs within one bit frame, the PIT switches to READ_MODE.



T_0 = Carrier Period Time (1/125 kHz nominal)

Fig.17 Transmission of databits (PROGRAM_MODE).

8 STRUCTURE OF CIRCUIT

8.1 Functional diagram

The functional diagram of the PIT is shown in Fig.18. The IC has the following functional units:

- Rectifier
- Voltage clamp
- CDP data clamp
- Clock generator
- Demodulator
- Control logic + EEPROM
- Damping circuitry
- Charge pump
- Power-on reset

8.1.1 RECTIFIER

The incoming signal received on coil A and coil B is symmetrically rectified by a bridge rectifier and flattened by a load capacitor.

8.1.2 VOLTAGE CLAMP CIRCUIT

The clamp has to serve two purposes:

- Over voltage protection
- Supply voltage regulation

8.1.3 CDP DATA CLAMP

The clamp has to serve:

- Modulation of the output data onto the RF amplitude

8.1.4 CLOCK GENERATOR

The clock for the operation of the full control logic is derived from the incoming RF signal by amplification.

8.1.5 DEMODULATOR

The demodulator detects the incoming signal in the modulated and non demodulated case, respectively and synchronizes it to the system clock.

8.1.6 CONTROL LOGIC + EEPROM

The control logic handles the transmission protocol and controls the EEPROM-access.

8.1.7 DAMPING CIRCUIT

When the PIT is in PROGRAM_MODE an additional damping becomes active.

The damping values is programmed during manufacturing. In most cases the value of D200 is appropriate, it is set by default.

8.1.8 CHARGE PUMP

The charge pump generates the programming voltage for the EEPROM cells.

8.1.9 POWER-ON RESET

The Power-on reset generates an internal Power-on clear signal (POC), if the voltage between coil A and coil B is below the power on reset threshold voltage (see Fig.18). Increasing the voltage above that value causes release of the circuit and starts an initialization phase before entering the first EP/PMC.

For proper device operation the Carrier Power-Up rise time, t_{CPU} must not exceed the specified value, see Section 6.3 “Electrical Characteristics”.

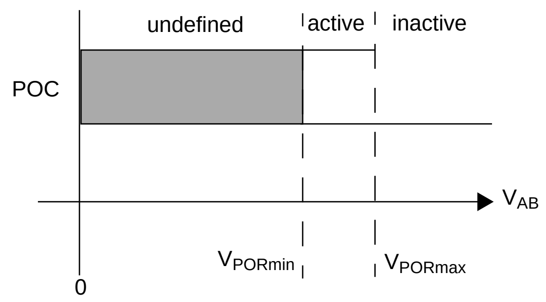


Fig.18 Power-on clear signal.

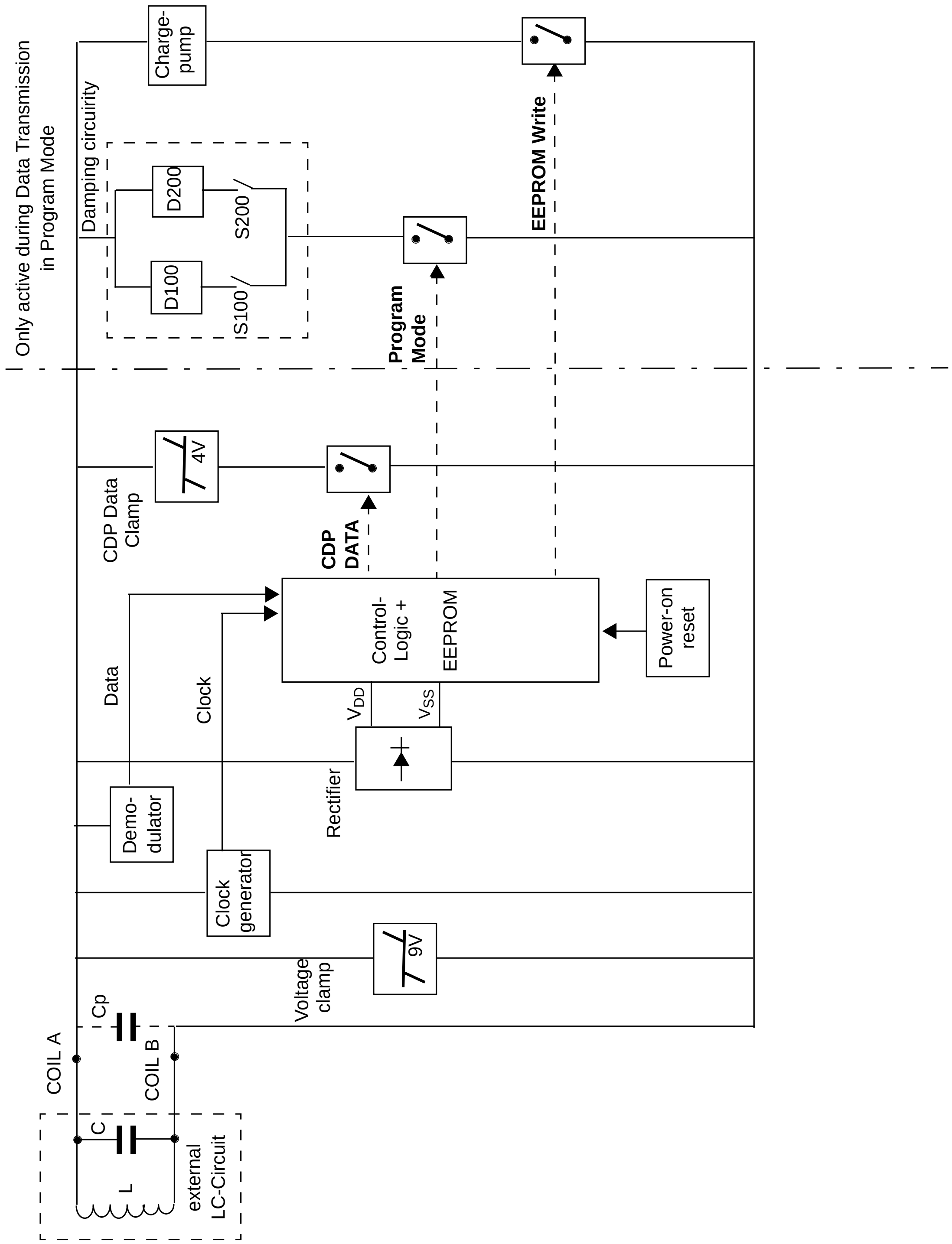


Fig.19 Functional diagram.

9 ANOMALY NOTES (VERSION V0)

Note 1 Programming of the PCF7931AS is only possible in the temperature range T = +22 °C to +85 °C.

Note 2 If the sequence of bytes is written into the PIT memory in blockwise mode, a byte address offset may be added to the correct start address in two cases:

- using password transmission the address offset results in seven bytes
- immediately after a bytewise programming the resulting address offset results in the byte address + one.

This is due to a missing reset of the write position after the password (A) / byte (B) being transmitted.

A blockwise programming of data should always be preceded by a read operation. Having switched to program mode the data block can be programmed correctly and can then be followed by any bytewise program operations.

Note 3 While in PROGRAM_MODE a spurious carrier modulation may occur during the EEPROM access interval. This modulation shall not be regarded as CDP modulation thus is not an indication that the PROGRAM_MODE failed. The spurious modulation may occurs during the first 300 T_0 and last 280 T_0 of the EEPROM access interval (see Fig.20).

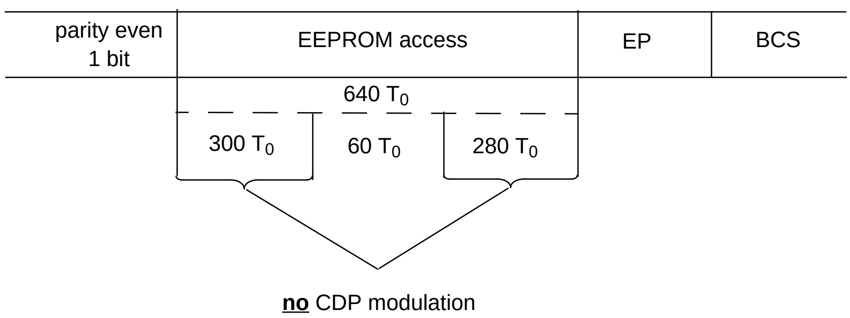


Fig.20 EEPROM access timing during successful PROGRAM_EEPROM sequence.

10 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 sections 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.	

11 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so on their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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