MICRONAS

Application Note

HAL® 1002

Programming Guide

Edition March 6, 2018
APN000128_001EN

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Release Note: **Change bars indicate significant changes to the previous edition.**

1. General Information

1.1. Certification

The TDK-Micronas GmbH fulfills the requirements of the international automotive standard ISO/TS 16949 and is certified according to ISO 9001:2000. This ISO standard is a worldwide accepted quality standard.

1.2. Support

We advise you to register on https://service.micronas.com in order to obtain access to the workgroups for our various product families. Here you are able to get support by opening a support ticket in the customer support system. Additionally, once registered, you will receive notifications on software and Application Notes updates.

You are also able to contact the TDK-Micronas Support (product.support@micronas.com) in case of questions or problems.

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2. Definition of Programming Pulses

The sensor is addressed by modulating a serial telegram on the supply voltage. The sensor answers with a serial telegram on the output pin.

The bits in the serial telegram have different bit times for the V_{SUP}-line and the output. The bit time for the V_{SUP}-line is defined by the length of the Sync Bit at the beginning of each telegram. The bit time for the output is defined by the Acknowledge Bit.

A logical “0” is coded as no voltage change within the bit time. A logical “1” is coded as a voltage change between 50% and 80% of the bit time (0.5 < tp1/tp0 < 0.8). After each bit, a voltage level change occurs.

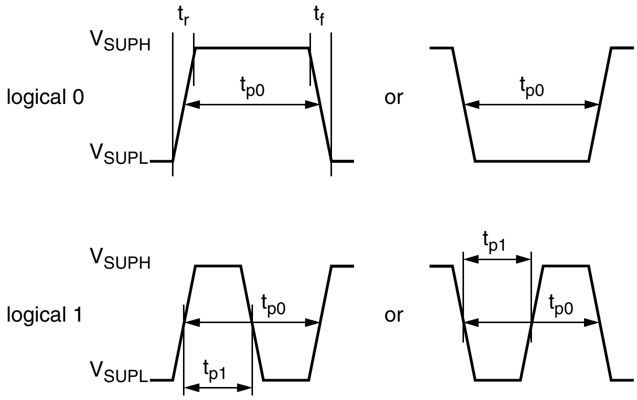

Fig. 2–1: Definition of logical 0 and 1 bit.
(See Table 3–1 for definitions of the parameters.)

3. Definition of the Telegram

Each telegram starts with the Sync bit (logical 0), followed by 3 bits for the Command (COM), the Command Parity bit (CP), 4 bits for the Address (ADR), and the Address Parity bit (AP).

There are 4 kinds of telegrams:

– Write a register (see Fig. 3–2)
The AP Bit is followed by 14 Data Bits (DAT) and the Data Parity Bit (DP). If the telegram is valid and the command has been processed, the sensor answers with an Acknowledge Bit (logical 0) on the output.

– Read a register (see Fig. 3–3)
After evaluating this command, the sensor answers with the Acknowledge Bit, 14 Data Bits, and the Data Parity Bit on the output.

– Programming the EEPROM cells (see Fig. 3–4)
After evaluating this command, the sensor answers with the Acknowledge Bit. After the delay time t_w, the supply voltage rises up to the programming voltage.

– Activate a sensor (see Fig. 3–5)
If more than one sensor is connected to the supply line, selection can be done by first deactivating all sensors. The output of all sensors have to be pulled to ground. With an Activate pulse on the appropriate output pin, an individual sensor can be selected. All following commands will only be accepted from the activated sensor.

Table 3–1: Telegram parameters

Symbol	Parameter	Pin	Min.	Typ.	Max.	Unit	Remarks
V_{SUPL}	Supply Voltage for Low Level during Programming	1	5	5.6	6	V	
V_{SUPH}	Supply Voltage for High Level during Programming	1	6.8	8.0	8.5	V	
t_r	Rise time	1	–	–	0.05	ms	
t_f	Fall time	1	–	–	0.05	ms	
t_{p0}	Bit time on V_{SUP}	1	1.7	1.75	1.9	ms	t_{p0} is defined by the Sync Bit
t_{pOUT}	Bit time on output pin	3	2	3	4	ms	t_{pOUT} is defined by the Acknowledge Bit
t_{p1}	Duty-Cycle Change for logical 1	1, 3	50	65	80	%	% of t_{p0} or t_{pOUT}
$V_{SUPPROG}$	Supply Voltage for Programming the EEPROM	1	12.4	12.5	12.6	V	
t_{PROG}	Programming Time for EEPROM	1	95	100	105	ms	
t_{rp}	Rise time of programming voltage	1	0.2	0.5	1	ms	
t_{fp}	Fall time of programming voltage	1	0	–	1	ms	
t_w	Delay time of programming voltage after Acknowledge	1	0.5	0.7	1	ms	
V_{act}	Voltage for an Activate pulse	3	3	4	5	V	
t_{act}	Duration of an Activate pulse	3	0.05	0.1	0.2	ms	
$V_{OUT,deact}$	Output voltage after deactivate command	3	0	0.1	0.2	V	
t_{delay}	Time between the end of a read/write frame and the Acknowledge	3	0.7	–	1.2	ms	

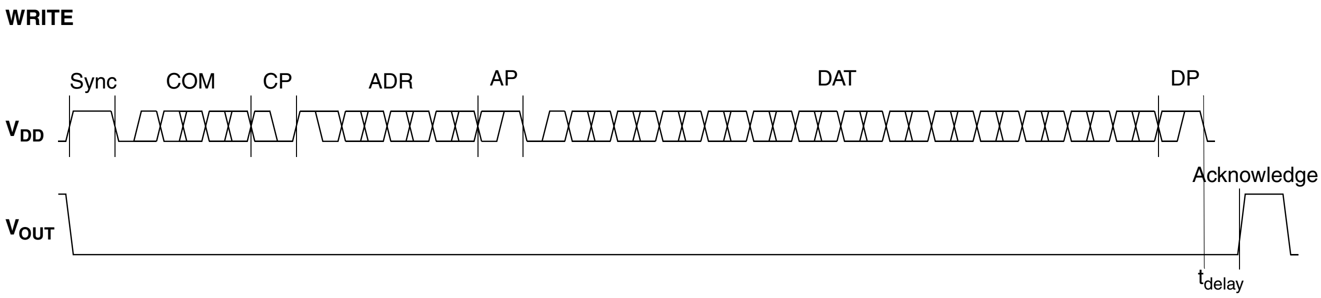

Fig. 3–2: Telegram for coding a Write command

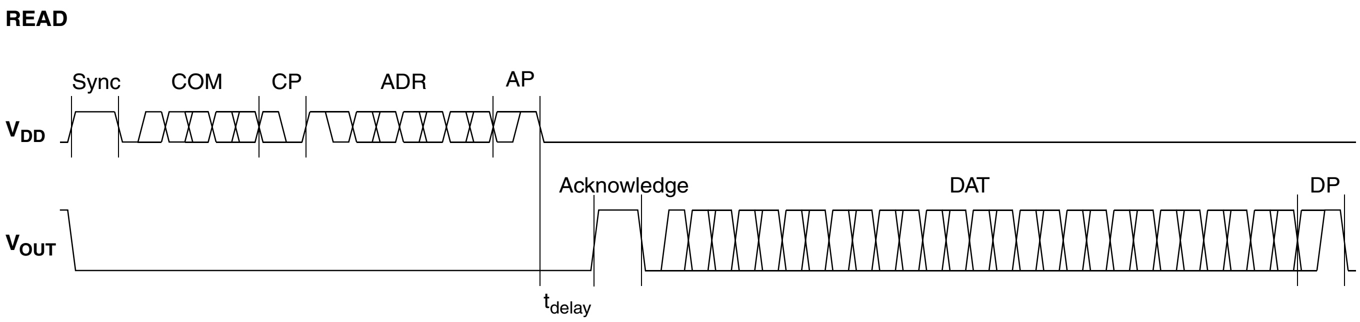

Fig. 3–3: Telegram for coding a Read command

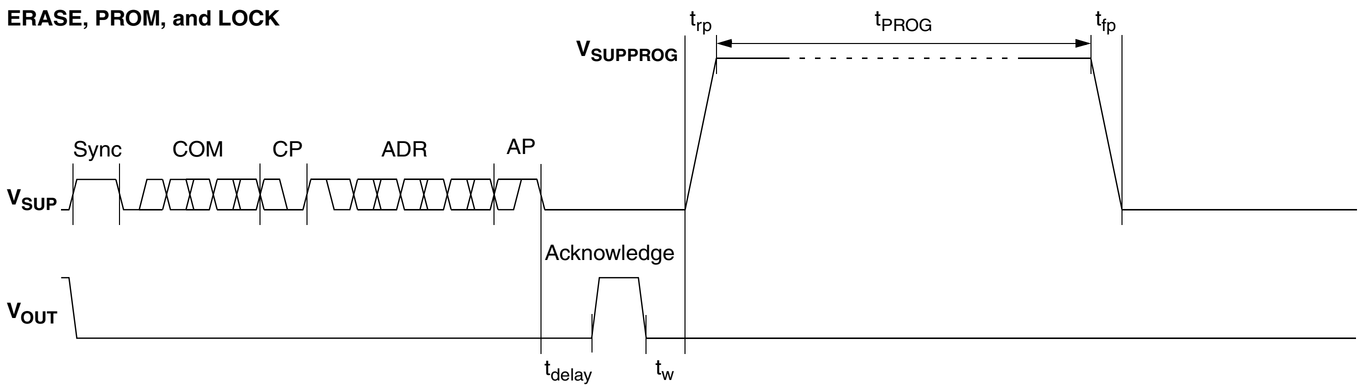

Fig. 3–4: Telegram for coding the EEPROM programming

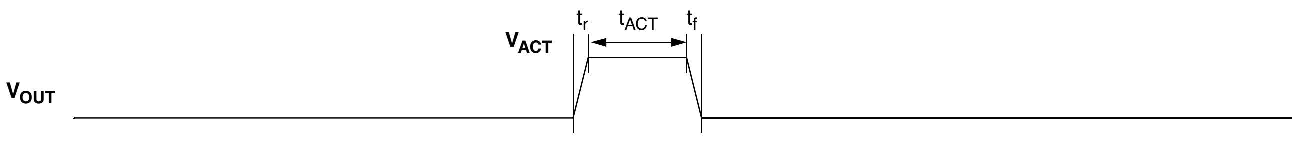

Fig. 3–5: Activate pulse

4. Telegram Codes

Sync Bit

Each telegram starts with the Sync Bit. This logical “0” pulse defines the exact timing for t_{p0}.

Command Bits (COM)

The Command code contains 3 bits and is a binary number. Table 6–2 shows the available commands and the corresponding codes for the HAL 1002.

Command Parity Bit (CP)

This parity bit is “1” if the number of zeros within the 3 Command Bits is uneven. The parity bit is “0”, if the number of zeros is even.

Address Bits (ADR)

The Address code contains 4 bits and is a binary number.

Address Parity Bit (AP)

This parity bit is “1” if the number of zeros within the 4 Address bits is uneven. The parity bit is “0” if the number of zeros is even.

Data Bits (DAT)

The 14 Data Bits contain the register information.

The registers use different number formats for the Data Bits.

In the Write command, the last bits are valid. If, for example, the TC register (10 bits) is written, only the last 10 bits are valid.

In the Read command, the first bits are valid. If, for example, the TC register (10 bits) is read, only the first 10 bits are valid.

Data Parity Bit (DP)

This parity bit is “1” if the number of zeros within the data bits is even. The parity bit is “0” if the number of zeros is uneven.

Acknowledge

After each telegram, the sensor answers with the Acknowledge signal on the output. This logical “0” pulse defines the exact timing for t_{pOUT}.

5. Number Formats

Binary number:

The most significant bit is given as first, the least significant bit as last digit.

Example: `101001` represents 41 decimal.

Signed binary number:

The first digit represents the sign of the following binary number (1 for negative, 0 for positive sign).

Example: `0101001` represents +41 decimal
`1101001` represents –41 decimal

Two's-complement number:

The first digit of positive numbers is "0", the rest of the number is a binary number. Negative numbers start with "1". In order to calculate the absolute value of the number, calculate the complement of the remaining digits and add "1".

Example: `0101001` represents +41 decimal
`1010111` represents –41 decimal

6. Programming Information

If the content of any register (except the lock register) has to be changed, first the desired value must be written into the corresponding RAM layer of the EEPROM cell. Before reading the register again, the register value must be permanently stored in the EEPROM.

Permanently storing a value in the EEPROM is done by first sending an ERASE command followed by a PROM command. **The address within the ERASE and PROM commands must be zero.** ERASE and PROM act on all registers in parallel.

If all HAL 1002 registers have to be changed, all writing commands can be sent consecutively, followed by an ERASE and a PROM command at the end.

During all communication sequences, the customer has to check if the communication with the sensor was successful. This means that the acknowledge and the parity bits sent by the sensor have to be checked by the customer. If the Micronas programmer board is used, the customer has to check the error flags sent from the programmer board.

Note: For production and qualification tests it is mandatory to set the LOCK bit after final adjustment and programming of the HAL 1002. The LOCK function is active after the next power-on of the sensor.
The success of the lock process shall be checked by attempting to read at least one sensor register after locking and/or by a check of the output voltage.
Electrostatic discharges (ESD) may disturb the programming pulses. Please take precautions against ESD.

6.1. Available Commands

Table 6–2: Available commands

Command	Code	Explanation
READ	2	read a register
WRITE	3	write a register
PROM	4	program all nonvolatile registers (except the lock bits)
ERASE	5	erase all nonvolatile registers (except the lock bits)

6.1.1. Acknowledge check (checkACK)

The logic used to detect the occurrence of the ACK is described in Fig. 6–6.

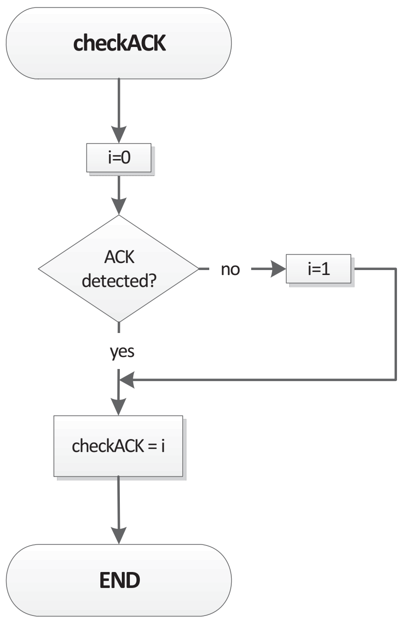

Fig. 6–6: Flowchart - checkACK

6.1.2. Read

An exemplary flowchart for a read-out is given in Table 6–7.

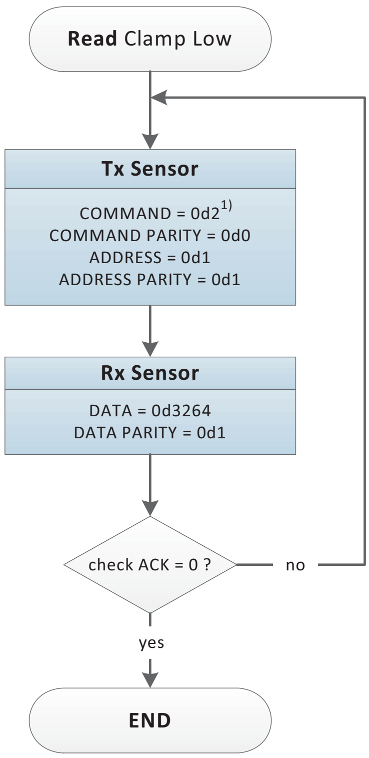

Fig. 6–7: Flowchart - read from address 1

1) 0d: stands for decimal value

6.1.3. Write

An exemplary flowchart for a write sequence is given in Table 6–8.

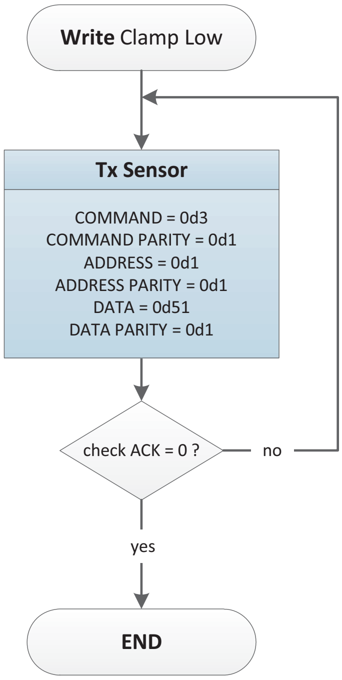

Fig. 6–8: Flowchart - write to address 1

6.1.4. ERASE and PROM

Exemplary flowcharts for Erase and Prom sequences are given in Fig. 6–9.

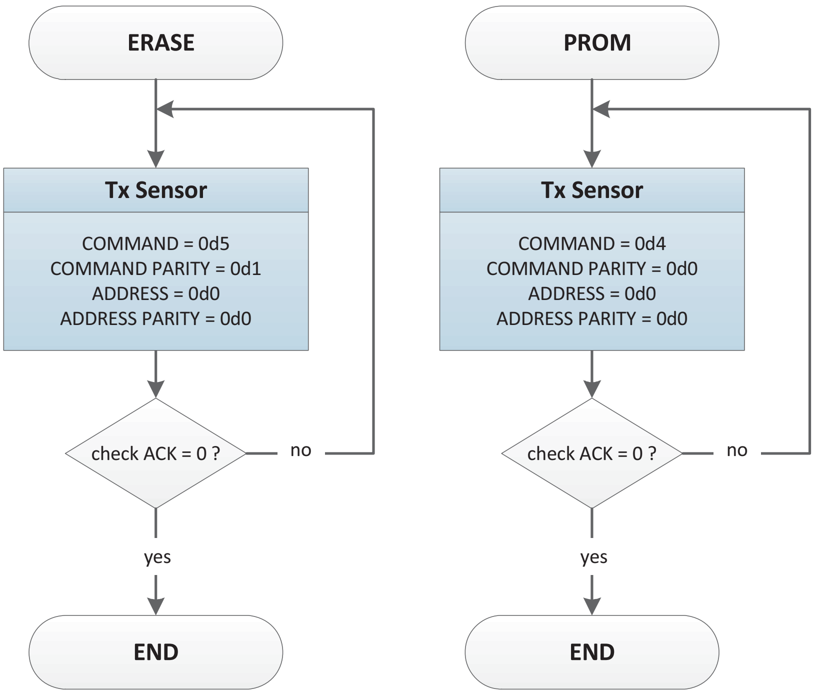

Fig. 6–9: Flowchart - write ERASE and PROM command

7. Application Note History

1. HAL 1002 Programming Guide, Jan. 20, 2014; APN000094_001EN. First release of the application note.
2. HAL 1002 Programming Guide, March 6, 2018; APN000094_002EN. Second release of the application note.

   Changes:

   - Programmable switch parallel tab in the software added

Note: The document has been converted into two separate documents due to internal formalities. New Documents:
APN000127_001EN HAL 1002 User Manual
APN000128_001EN HAL 1002 Programming Guide.

1. HAL 1002 Programming Guide, March 6, 2018; APN000128_01EN. First release of the application note.

   Major Changes:

– Section 1.2 (Support) updated
– Section 2, 3, 4, 5, 5.1., 5.1.1., 5.2., 5.2.5 and 6 removed
– Section 5.2.1. switched to Section 2. Definition of Programming Pulses
– Section 5.2.2. switched to Section 3. Definition of the Telegram
– Section 5.2.3 switched to Section 4. Telegram Codes
– Section 5.2.4. switched to Section 5. Number Formats
– Section 5.2.6. switched to Section 6. Programming Information
– Section 6.1, Section 6.1.1, Section 6.1.2, Section 6.1.3 and Section 6.1.4 added

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