MICRONAS

Application Note

Software Boards

TDK SPI Programmer V1.x

User Manual

3D HAL® Technology

master HAL® Technology

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1. General Information

The hardware and software description in this document is valid for the **TDK SPI Programmer V1.x.**

The TDK SPI Programmer V1.x can be ordered via the TDK-Micronas Customer Service or via distributors. Ordering code: 99900053.

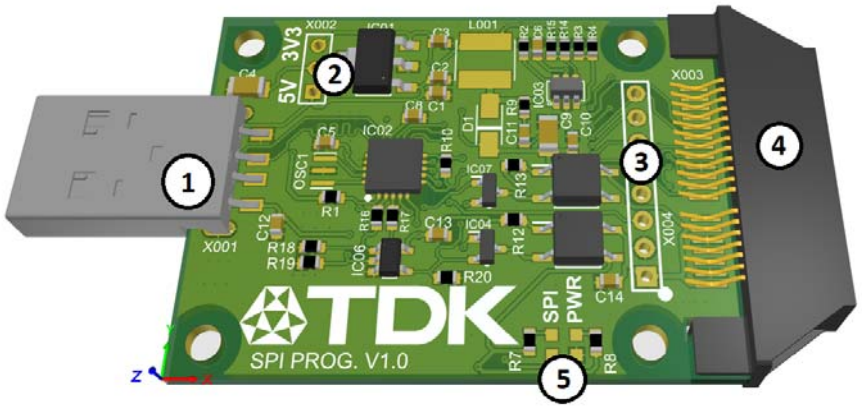

Fig. 1–1: TDK SPI Programmer V1.x

	TDK SPI Programmer V1.x	Function
1	USB Type A	Communication with host computer
2	Board Power Selector	Select between 5 V and 3.3 V to power the board IC and Output Voltage
3	Pin header	Pin header pads of 2.54 mm pitch for sensor communication
4	Mini Edge card socket	40 pin mini edge card socket for sensor communication
5	Indicator LEDs	Power (PWR) and SPI status LEDs

1.1. Certification

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

1.2. Support

We kindly ask you to register on https://service.micronas.com to obtain access to the workgroups for our various product families. You can request for support by opening a support ticket.

TDK-Micronas GmbH - Application Engineering

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D-79108 Freiburg im Breisgau

1.3. Introduction

The TDK SPI Programmer V1.x is a compact and user-friendly programming tool that enables SPI communication via USB (full-speed 2.0 compliant). It features a USB-to-SPI converter with GPIO pins.

The TDK SPI Programmer V1.x can communicate with up to six SPI sensors via the SPI interface acting as a master and supports communication speeds up to 12 MHz. It is designed to supply SPI peripherals with 3.3 V, 5 V or 8.3 V and uses a communication voltage of 3.3 V or 5V. Two LEDs are installed on the board to indicate the presence of power and active SPI communications.

It can be used with TDK sensors that support programming over SPI. A LabVIEW™ user interface is provided to enable the user to communicate with the board. This allows the implementation of specific PC software for engineering purposes.

The TDK SPI Programmer V1.x is intended to be used in laboratories for engineering purposes. It is based on the Microchip MCP2210. Experienced developers could use this together with the PCB layout to adapt the board functions to their needs. These functionalities are beyond the scope of this document. Due to the open construction of the tool, it is the user's responsibility to take any and all appropriate precautions with regard to safe and proper handling and use.

Note: The TDK SPI Programmer V1.x is not recommended for production.

1.3.1. Supported Sensors

The TDK SPI Programmer V1.x supports the Hall and TMR based sensors listed in Table 1–1.

Table 1–1: Supported sensors

Sensor	Mode	Description
HALL		
HAL / HAR 3900	8	Hall based 3D position sensor with SPI interface
CUR 4000	8	Hall based magnetic flux sensor for current sensing-applications with SPI interface
TMR		
CUR 42xy	8	Tunnel Magneto Resistance (TMR) based magnetic flux sensor for current sensing applications with SENT/ SPI output
TAD 2141	8	Single-die Tunnel Magneto Resistance (TMR) based angle sensor with Encoder/ Switch/ PWM output
TAD4140	8	Dual-die Tunnel Magneto Resistance (TMR) based angle sensor with Encoder/ Switch/ PWM output

For detailed information on the listed sensors, please refer to the corresponding sensor Data Sheets and sensor documentation.

1.3.2. Sensor-Specific PC Software

TDK-Micronas GmbH provides easy-to-use PC software (LabVIEW™) for each supported sensor, which can be downloaded from the TDK-Micronas Service Portal upon registration (https://service.micronas.com).

1.4. Block Diagram of the TDK SPI Programmer V1.x

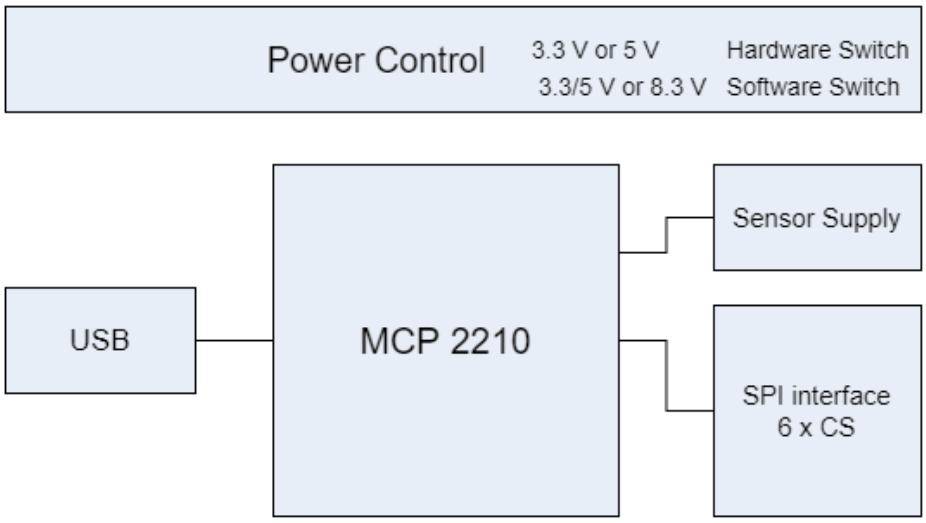


Fig. 1–2: TDK SPI Programmer V1.x block diagram

2. Getting Started

2.1. TDK SPI Programmer V1.x Installation

The TDK SPI Programmer V1.x user interface is accessed by a Windows installation wizard which includes the LabVIEW™ runtime engine, the MCP2210 dynamic link library (.dll) file and a LabVIEW™ based user interface. No further driver installation is needed. The installer is found on the TDK-Micronas service portal (https://service.micronas.com). The user interface can be used to send individual commands to the TDK SPI Programmer V1.x or can be integrated to a custom LabVIEW™ project.

Note: When using a supported TDK-Micronas Programming Environment the necessary files are already included.

2.2. First Steps

2.2.1. Connect TDK SPI Programmer V1.x

- Ensure the power jumper (X002) is connected across the desired voltage level
- Connect TDK SPI Programmer V1.x via the USB to the host computer
- The PWR LED should illuminate
- Open the TDK-SPI_Programmer.vi

2.2.2. Check Communication with PC and Sensor

Connect a supported TDK sensor to the socket of a supported extension board.

Note: For the first communication check it is recommended to use the LabVIEW Programming Environment software provided by TDK-Micronas for the specific sensor.

Alternatively:

- initiate the TDK SPI Programmer V1.x using the “sm8” command (see Section 5 on page 15).
- switch V_{S_SUP} on using the “vho1” command (see Section 6 on page 18).
- set board mode using “spisw<N>” for the appropriate sensor.
- try to read out a register (see Section 7 on page 19).

3. TDK SPI Programmer V1.x Configuration

The description of the different status LEDs of the TDK SPI Programmer V1.x is shown in Table 3–2.

Table 3–2: LEDs description

LED Name	Function
PWR	On when power is connected to the board
SPI	Blinking when SPI interface is busy

Power Select Jumper (X002)

The board is equipped with a jumper which allows the user to select between two voltage levels to power the MCP2210 and consequently the voltage of the SPI communication. The voltage level can be switched between 3.3 V and 5 V.

Mini Edge Card Socket

The Mini edge card socket on the TDK SPI Programmer V1.x offers SPI interface and power to the sensors. Depending on the sensor type, up to six sensors can be connected to the TDK SPI Programmer V1.x

The Mini edge card socket (part no. MEC1-120-02-F-D-EM2) connects to the supported TDK-Micronas extension boards. The pinout of the socket is described in Table 3–3.

Table 3–3: Pin description of Mini Edge Card Socket

Pin No.	Description
1 & 2	V_{S_SUP}
3 & 4	Common GND
5 - 8	NC
9 & 10	Common GND
11 & 12	V_{S_SUP}
13 - 18	NC
19	CLK
20	MOSI
21	MISO
22	CS0
23	CLK
24	Common GND
25	CS1

Table 3–3: Pin description of Mini Edge Card Socket

Pin No.	Description
26	MOSI
27	Common GND
28	MISO
29	CS3
30	CS2
31	CS5
32	CS4
33 - 40	NC

Pin Header Connector

The TDK SPI Programmer V1.x includes empty 2.54 mm through hole pads where the user can solder a 8x1 pin header connector in cases where a supported mini edge card connector is not available.

The pin header connector allows connection to up to three sensors. The pin description of the pin header connector on the TDK SPI Programmer V1.x is shown in Table 3–4.

Table 3–4: Pin description of Pin Header Connector

Pin No.	Description
1	V_{S_SUP}
2	Common GND
3	CLK
4	MISO
5	MOSI
6	CS0
7	CS1
8	CS2

4. Specification

4.1. Recommended Wiring

The compact design of the TDK SPI Programmer V1.x allows direct connection to the host computer through the USB type A connector. Moreover a direct connection to the sensor is established through supported TDK-Micronas extension boards via the mini edge card socket. Therefore no additional wires are required.

In case the sensor setup is further away from the host computer, the user can use a standard USB type A male to female extension cable or use wiring to connect the sensor to the pin header of the TDK SPI Programmer V1.x It is recommended to connect the user's application to the TDK SPI Programmer V1.x using shielded wires.

To minimize the risk of electromagnetic disturbances, the cable must be as short as possible.

Note: Especially in noisy environments close to power switches and electromagnetic actuators, EMI-compliant layout of the wiring is mandatory.

For recommended cable parameters, please refer to Table 4–5.

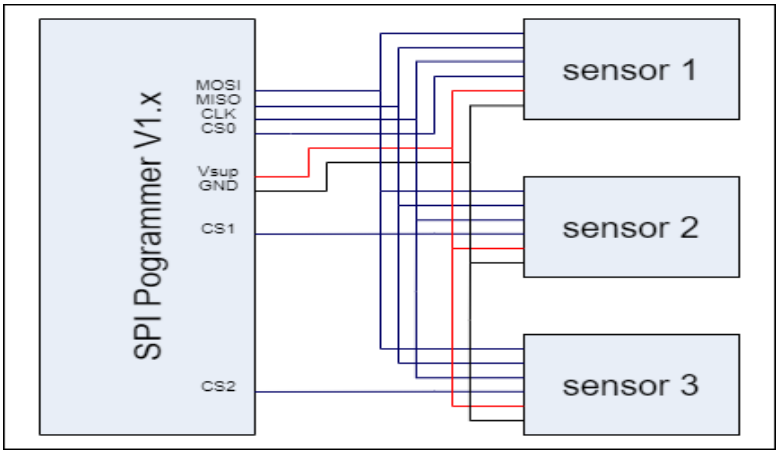


Fig. 4–3: TDK SPI Programmer V1.x Pin Header wiring

4.2. Maintenance

TDK SPI Programmer V1.x maintenance or repair should not be carried out by the customer. In case of any problems or defects, please contact your supplier.

WARNING: Do not modify any part of the TDK SPI Programmer V1.x Otherwise, the TDK SPI Programmer V1.x may be damaged, causing programming to the sensors to be inadequate and rendering the sensors unreliable.

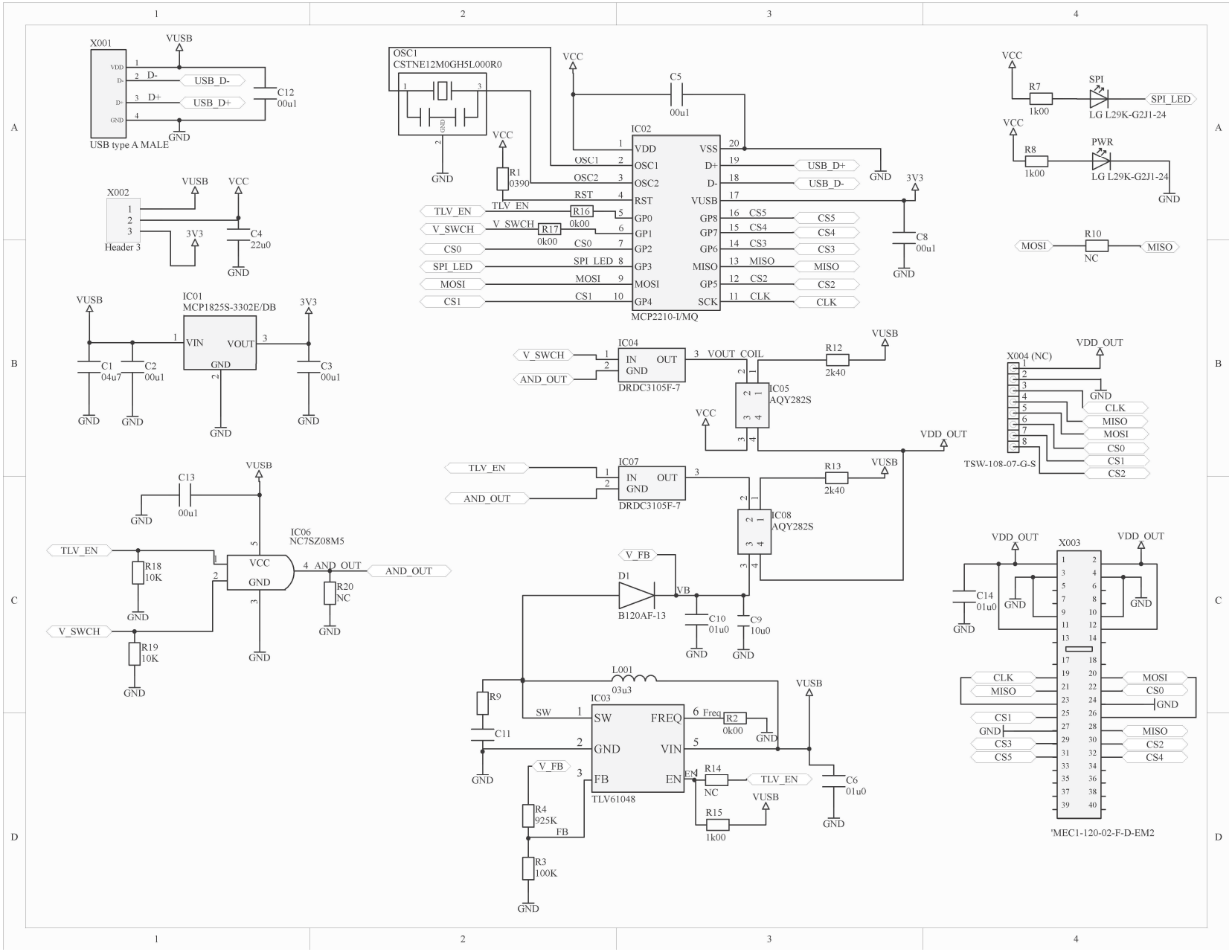
4.3. Characteristics

All voltages are referenced to GND.

Table 4–5: TDK SPI Programmer V1.x board characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{Sup}	Output supply voltage	3.3	–	8.4	V
I_{S_load}	Output load current	–	–	500	mA

4.4. TDK SPI Programmer V1.x Schematic



5. Functions

5.1. USB Interface

The TDK SPI Programmer V1.x provides communication to the host computer using the human interface device (HID) protocol. Hence, communication from the host computer to the sensor is possible. The TDK SPI Programmer V1.x provides this communication in combination with the Programming Environments of the sensors listed in Table 1–1. In cases where the user needs to establish communication to a sensor without the use of the Programming Environments, they can use the TDK SPI Programmer V1.x LabVIEW™ user interface for command-by-command operation.

Note: This document uses the following symbolization:
"==>" to denote the commands being sent by the PC to the TDK SPI Programmer V1.x
"<==" to denote the response sent by the TDK SPI Programmer V1.x

5.1.1. LabVIEW™ User Interface

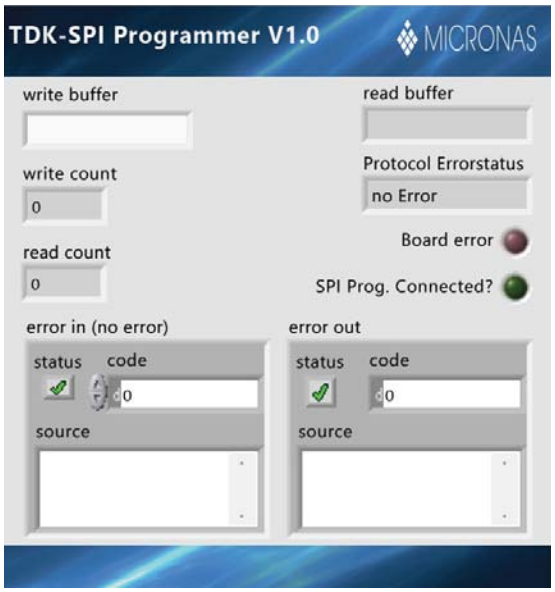


Fig. 5–4: TDK SPI Programmer V1.x LabVIEW™ user interface

The LabVIEW™ based user interface allows the user to communicate with the connected sensor, by sending commands to the TDK SPI Programmer V1.x and receiving a response when applicable.

The user should use the write buffer string to type in the appropriate commands. By running the VI once, the instruction is sent to the TDK SPI Programmer V1.x and a response is available in the read buffer string. All the controls and indicators of the user interface are described in Table 5–6.

Table 5–6: LabVIEW™ user interface description

Instrument Name	Type	Function
write buffer	control	command input string
read buffer	indicator	TDK SPI Programmer V1.x response string
write count	indicator	number of characters of the command
read count	indicator	number of characters of the response
Protocol Error Status	indicator	Status bit decoding
TDK SPI prog. Connected	indicator	Status of TDK SPI Programmer V1.x
Board Error	indicator	TDK SPI Programmer V1.x error indicator
error in	control	Error cluster used if VI is part of a project
error out	indicator	Error cluster indicating LabVIEW™ errors

5.1.2. Definition of the Write Buffer

The write buffer string is of variable length. There are basically two types of commands:

1. Configuration of the TDK SPI Programmer V1.x

Example: to request firmware version from the TDK SPI Programmer V1.x
command ==> ?v

2. Communication with the connected sensor device.

Example: to read data from the sensor.
command ==> xxr08

5.1.3. Definition of the Read Buffer

Based on the write buffer string (command) the read buffer string (response) consists of a status character followed by ':' and varying number of data characters (minimum 5) and a line feed (LF).

Example: <ST>:<Rn><Rn-1>....<R2><R1><R0> LF

ST (status character) = 0, if the command was successful.

ST != 0, in case of an error (see Table 5–7)

The Rx-characters contain the received data depending on the command (see Section 7).

5.1.4. Error Codes

Table 5–7: TDK SPI Programmer V1.x error codes

STATUS[3:0]	Description
0	No error
1	Reserved
2	Reserved
3	Invalid command for selected mode
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
A	Reserved
B	Reserved
C	Reserved
D	Data read error
E	Invalid command parameter
F	Invalid command

6. Board Configuration Commands

The board configuration commands shall be used to

– initialize the TDK SPI Programmer V1.x

– read the TDK SPI Programmer V1.x relative version information

– control the power supply V_{S_SUP} to the connected sensor.

Table 6–8: Configuration commands

Action	Command	Parameter	Remarks
Get firmware version	?v	Return value: 0:v<V3><V2><V1><V0> SPI-Prog. LF	V = firmware release version Example: ==> ?v <== 0:v1.00SPI-Prog.
Get TDK SPI Programmer V1.x hardware version[2)]	?hw	Return value: 0:HWv<V5><V4><V3><V2><V1><V0> LF	V = TDK SPI Programmer V1.x hardware version Example: ==> ?hwv <== 0:HWv1.0000
Initialization command	sm<N>	N = 8 Return value: <ST>:0000<N>LF[1)]	Initialize MCP2210 Configure GPIO pins default state
Get SPI frequency	?bt	Return Value: 0:0<F4><F3<F2><F1><F0>	F = Frequency in hexadecimal Example: 1 MHz = 1000 kHz ==> ?bt <== 0:003E8
Switch V_{S_SUP} on/ off	vho<X>	X = 0: Switch V_{S_SUP} off X = 1: Switch V_{S_SUP} on Return value: <ST>:0000X LF[1)]	Supply voltage on Example: ==> vho1 <== 0:00001 Supply voltage off Example: ==> vho0 <== 0:00000
Set voltage supply	svs<N>	N = 0: Set V_{S_SUP} voltage level to default N = 1: Set V_{S_SUP} voltage level to 8.3 V Return value: <ST>:0000<N>LF[1)]	The default voltage level is either 3.3 V or 5 V depending on the setting of the X002 jumper.
Select I/ O channel	ftses<N>	N = 1: sensor 1 N = 2: sensor 2 N = 3: sensor 3 N = 4: sensor 4 N = 5: sensor 5 N = 6: sensor 6 Return value: <ST>:00000<N> LF[1)]	Select the active sensor Example: ==> ftses1 <== 0:000001
1) <ST> TDK SPI Programmer V1.x status (see Table 5–7 on page 17 for details)			

7. Operation Mode

Operation Mode commands allow to setup and communicate with a sensor via SPI protocol. Detailed features and specifications are described in the respective sensor data sheet.

7.1. Configuration Commands

Table 7–9: TDK SPI Programmer V1.x configuration commands

Action	Command	Parameter	Remarks
Set board mode for respective sensor	spisw<N>	N = 0: HAL / HAR 3900, CUR 4000; board returns {Status, data and CRC} N = 1: TAD2141/4140 N = 2: reserved N = 3: CUR 42xy Return value: <ST>:000000 LF[1)]	Sensors using the SPI have different communication protocols. This command enables the board to communicate with the respective sensors.
Switch sensor to programming mode	pms	Return value: <ST>:000000 LF[1)]	This command switches HAL / HAR 3900 and CUR 4000 sensor from application to programming mode.
Switch sensor to programming mode	pgm	Return value: <ST>:000000 LF[1)]	This command switches TAD 2141 / 4140 and CUR 4235 sensors from application to listening mode
Set SPI clock frequency	spif<CLK>	CLK is a 4 digit hexadecimal number specifying SPI clock frequency in kHz. Return value: <ST>:000000 LF[1)]	TDK SPI Programmer V1.x can be configured with following SPI clock frequencies using this command 10, 20, 30 . . . . . 90 kHz 100, 200, 300 . . . . . 900 kHz 1000, 2000, 3000 . . . . . 10000 kHz Example: To set SPI clock frequency as 1 MHz 1 MHz = 1000 kHz 1000 = 0x03E8 ==> spif03E8 <== 0:000000
1) <ST> TDK SPI Programmer V1.x status (see Table 5–6 on page 16 for details)			

7.2. Protocol Error Handling

In case of communication errors with the sensor, the TDK SPI Programmer V1.x indicates errors as listed in Table 5–7.

7.3. Sensor Communication Commands

For specific details about the SPI timing and instructions of each sensor, refer to the appropriate sensor documentation.

Table 7–10: TDK SPI Programmer V1.x sensor communication commands

Action	Command	Address	Data
Write data Sub-mode 0, (spisw0)	xxw<STR>	STR = <A1><A0><D3><D2><D1> <D0><CRC1><CRC0> Return value: <ST>:000000 LF[1)]	A = Address (2-digit hexadecimal number) D = Data (4-digit hexadecimal number) CRC = Checksum (2-digit hexadecimal number) Example: Write 0x0001 to address 0x49 ==> xxw49000137 <== 0:000000
Write data Sub-mode 1 (spisw1)	xxw<STR>	STR = <A1><A0><D3><D2><D1> <D0> Return value: <ST>:000000 LF[1)]	A = Address (2-digit hexadecimal number) D = Data (4-digit hexadecimal number) Example: Write 0x0001 to address 0x49 ==> xxw490001 <== 0:000000
Write data Sub-mode 3 (spisw3)	xxw<STR>	STR = <C1><C0><A1><A0><D3><D2><D1> <D0><CRC1><CRC0> Return value: <ST>:000000 LF[1)]	C = Command (2-digit hexadecimal number) A = Address (2-digit hexadecimal number) D = Data (4-digit hexadecimal number) CRC = Checksum (2-digit hexadecimal number) Example: Write 0x0001 to address 0x49 ==> xxw3349000137 <== 0:000000

Table 7–10: TDK SPI Programmer V1.x sensor communication commands, continued

Action	Command	Address	Data
Read data Sub-mode 0 (spisw0)	xxr<STR>	STR = <A1><A0> Return value: <ST>:<S1><S0><R3><R2><R1><R0><CRC1><CRC0>LF[1)] TDK SPI Programmer V1.x returns the received data bytes and CRC byte on the MISO line	A = Address (2-digit hexadecimal number) S = Status (2-digit hexadecimal number) R = Received data (4-digit hexadecimal number) CRC = Checksum (2-digit hexadecimal number) Example: Read address 0x49 ==> xxr49 <== 0:110001F3
Read data Sub-mode 1 (spisw1)	xxr<STR>	STR = <A1><A0> Return value: <ST>:<0><0><R3><R2><R1><R0>LF[1)]	A = Address (2-digit hexadecimal number) R = Received data (4-digit hexadecimal number) Example: Read address 0x49 ==> xxr49 <== 0:000001
Read data Sub-mode 3 (spisw3)	xxr<STR>	STR = <C1><C0><A1><A0><CRC1><CRC0> LF Return value: <ST>:<R3><R2><R1><R0><CRC1><CRC0> LF[1)] TDK SPI Programmer V1.x returns the received data bytes and CRC byte on the MISO line	C = Command (2-digit hexadecimal number) A = Address (2-digit hexadecimal number) CRC = Checksum (2-digit hexadecimal number) R = Received data (4-digit hexadecimal number) Example: Read address 0x49 ==> xxr3C4912 <== 0:0001F3
1) <ST> TDK SPI Programmer V1.x status (see Table 5–7 on page 17 for details)			

8. Document History

1. TDK SPI Programmer V1.x, Feb. 1, 2021; APN000177_001EN.
   First release of the application note.

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