

# MS 021

## MS SHOE ELECTRONICS

**PUBLISHER: SIGMATEK GMBH & Co KG**  
**A-5112 LAMPRECHTSHAUSEN**  
**TEL.: 06274/4321**  
**FAX: 06274/4321-18**  
**EMAIL: OFFICE@SIGMATEK.AT**  
**WWW.SIGMATEK-AUTOMATION.COM**

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## Shoe Electronics

## MS 021

This component has:

- 2-channel evaluation of pressure and speed (with MS 041)
- control option for vibration motor (on MS 041)
- monitored control of an ultrasound emitter
- 2.4 GHz wireless system



The ultrasound output is required for the operator positioning (shoe), the **sensor evaluation** for detecting the triggering pattern and the transmission path for communication with the machine electronics (MS 012).

To use the MS 021 module in an application, an MS 012 and Safety CPU module that regulates the synchronized communication with the safety modules using safe bus telegrams is also required. This also includes

- processing the safe application and
- the distribution of configuration data to remote safety modules.
- **the integrated Li-Ion battery is charged using the MS 052**

# Contents

- 1 Basic Safety Guidelines..... 4**
  - 1.1 General Safety Information..... 4
  - 1.2 Further Safety Guidelines ..... 5
  - 1.3 General Requirements ..... 6
  
- 2 Safety Conformity ..... 8**
  - 2.1 Functional Safety Standards ..... 8
  - 2.2 Safety-Relevant Parameters ..... 8
  
- 3 Delivery Condition..... 9**
  
- 4 Installation ..... 9**
  
- 5 System Architecture ..... 10**
  
- 6 Technical Data ..... 11**
  - 6.1 ADXL Interface Specifications..... 11
  - 6.2 FSR Interface Specifications ..... 11
  - 6.3 Vibration Motor Interface Specifications..... 12
  - 6.4 Configuration Interface Specifications..... 12
  - 6.5 Electrical Requirements..... 12
    - 6.5.1 Environmental Conditions ..... 13
    - 6.5.2 Miscellaneous ..... 13
  
- 7 Guidelines for Handling the Battery ..... 14**

**8 Safety Guidelines for Handling Li-Ion Batteries \*)..... 15**  
    **8.1 Battery Data Sheet ..... 17**

**9 Mechanical Dimensions..... 18**

**10 Connector Layout..... 19**

**11 FCC Statement..... 21**

# 1 Basic Safety Guidelines

## 1.1 General Safety Information

If the safety guidelines are not followed, danger to personnel can arise that could lead to serious injury or in worst cases, death. In less serious cases, systems and equipment can be damaged.

The following symbols identify the individual risks as well as the degree of seriousness; their respective meanings are briefly explained. You should therefore familiarize yourself with the safety symbols and their meanings to prevent dangers and risks.

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### DANGER



### DANGER

Identifies an immediate danger with high risk, which can lead to immediate death or serious injury if not avoided.

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### WARNING!



### WARNING!

Identifies a possible danger with a mid-level risk, which can lead to death or (serious) injury if not avoided.

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### CAUTION



### CAUTION

Identifies a low risk danger, which can lead to injury or property damage if not avoided.

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## 1.2 Further Safety Guidelines

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Warning, dangerous electrical voltage

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Hot surface warning

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Danger for ESD-sensitive components

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This symbol identifies important or additional information regarding the operation of the safety modules.

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## 1.3 General Requirements

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### Technical Documentation



This technical documentation is a component of this product.

- This document must be accessible in the vicinity of the machine, since it contains important instructions.
  - The technical documentation should be included in the sale, rental or transfer of the product.
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### Acceptance of Safety Guidelines



Before handling the product to which this documentation belongs, the operating instructions and safety guidelines must be read. SIGMATEK GmbH & Co KG accepts no liability for damages resulting from non-compliance with the safety guidelines or the relevant regulations

Acceptance of the safety guidelines and the explanations in this document, as well as the Safety System handbook are a basic requirement for proper use. Therefore, read this operating manual thoroughly and familiarize yourself with each of them in detail.

More information on standards and regulations etc. can be found in the system handbook

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### Qualified Personnel



Installation, assembly, programming and initial start-up, operation, maintenance and decommissioning of control and automation technology products in general, as well as safety-related products especially, can only be performed by qualified personnel.

Qualified personnel in this context are people, who have completed training or have trained under supervision of qualified personnel and have been authorized to operate and maintain safety-related equipment, systems and facilities in compliance with the strict guidelines and standards of safety technology.

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## Designated Use



The Safety modules are designed for use in safety-oriented applications and meet the required conditions for safety operation in compliance with Performancelevel e (PL e), in accordance with EN ISO 13849-1 and SIL 3 or SIL CL 3 in accordance with EN 62061.

For your own safety and the safety of others, use safety modules for their designated purpose. Correct EMC installation as well as proper transport and storage are also included under designated use.

Non-designated use consists of

- any change made to the safety modules of any kind.
  - the use of damaged safety modules.
  - the use of the safety module outside of the instructions described in this handbook.
  - the use of the safety module outside of the technical data described in this handbook.
- 

## Operator Due Diligence



The operator must ensure that

- the Safety modules are to be used for their designated purpose only.
- the Safety modules are to be operated in error-free, fully functional condition only.
- only sufficiently qualified and authorized personnel operate the Safety modules.

the documentation is complete and in readable condition and available at the site of operation.

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## 2 Safety Conformity

### 2.1 Functional Safety Standards

SIL 3 or SIL CL 3 according to 62061  
PL e, Cat. 4 according to 13849

### 2.2 Safety-Relevant Parameters

Machine electronics	Safety Parameters
MS 021	$2.69 \cdot 10^{-09}h$
	871 years

### 3 Delivery Condition

The individual SIGMATEK Safety components are delivered in specific hard and software configurations. Any change of this configuration, which exceeds the options specified in this documentation, is not authorized and invalidates the warranty from SIGMATEK GmbH & Co KG.

### 4 Installation

Before assembling, disassembling or wiring the MagicShoe system, the entire system must be placed in a safe, voltage-free condition.

The MS 021 shoe electronics is powered by an integrated 3.7 V Li-Ion battery. This is before initial start-up with the MS 052 charging station provided.

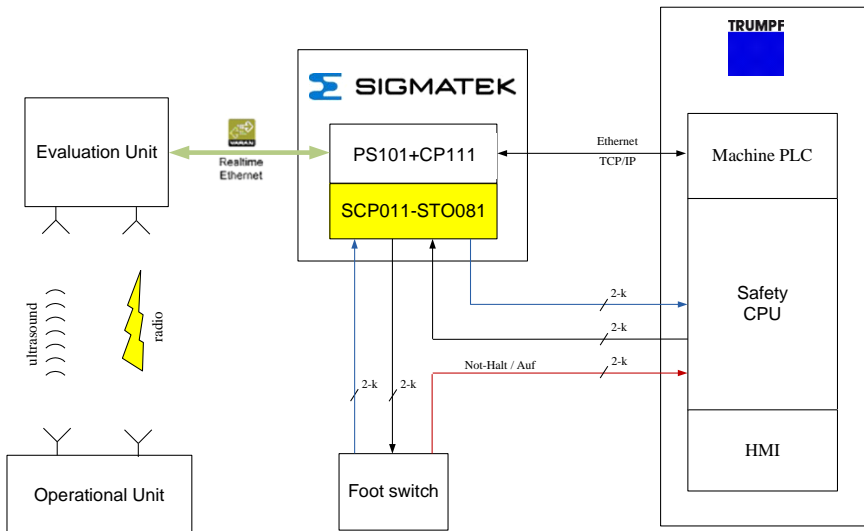


Fig 1: System architecture

## 5 System Architecture

For the system architecture of the safety-related MagicShoe control as shown above, a PS 101, CP 111, Safety CPU of type SCP 111 as well as an STO 081, the MS 012 evaluation unit and the operator-side components (shoe) MS 021, MS 031, MS 041 and MS 061 are required. A dangerous situation can therefore only occur in such a configuration.

After configuration, the safety-related application is located in the Safety CPU and is operational depending on the CP 111. The CP 111 is also needed to establish the communication between the Safety CPU and the design tool (SafetyDesigner). The PS 101 is required to supply all S-DIAS components and cannot be removed.

With a valid configuration file on an SD card, the Safety CPU can also be configured independently of the design tool (SafetyDesigner). More information can be found in the chapter "Using the microSD card". With regard to the configuration using the design tool, the SafetyDesign handbook must be consulted.

## 6 Technical Data

### 6.1 ADXL Interface Specifications

To evaluate the triggering pattern, the acceleration in the toe area of the shoe is recorded 3-dimensionally. The interface between the sensor and the evaluating CPU is made via SPI.

Because of the 2-channel principal, two acceleration sensors are used.

Number	2
Type	ADXL345 from analog device
Interface	SPI
Supply voltage	+3.3 V

### 6.2 FSR Interface Specifications

To evaluate the triggering pattern, active force is measured in the shoe (in the all area). The force-dependent resistance of the sensors is an analog measurement.

Because of the 2-channel principle, two force sensors are used.

Number	2
Type	FlexiForce A401 from Tekscan
Interface	analog resistance measurement
ADC resolution	12-bit

### 6.3 Vibration Motor Interface Specifications

The vibration motor is used as a feedback function. The turn-on time can be set via the software.

Number	1
Type	KOTL Z6DL2B0055211 (encapsulated)
Interface	switchable 3.3 V supply
Current consumption	typically 70 mA
Short circuit protection	internal current limit
Turn-on time	10 ms to 2.5 s in 10 ms increments

### 6.4 Configuration Interface Specifications

On the MS 031 docking station, the configuration memory is located and contains the operator-assigned (shoe) data, such as user name and the optimized limit data from the triggering pattern etc.

Number	1
Type	24LC16 (2k x 8)
Interface	I <sup>2</sup> C
Supply voltage	+3.3 V

### 6.5 Electrical Requirements

The supply for the MS 021 Safety module is provided with an integrated Li-Ion battery.

Rated supply voltage	+3.7 V DC	
Supply voltage range	maximum +3.0 V	maximum +4.2 V
Current consumption	typically 150 mA	
Battery used	1s1pCGA103450A-SNWC PHR3 from Sauseng	
Battery voltage	+3.0-4.2 V	
Battery capacity	1.950 mAh	
Operating time	At least 10 hours when fully charged	

### 6.5.1 Environmental Conditions

Operating temperature <sup>*)</sup>	-20 ... +50 °C within 1 week -20 ... +45 °C within 1 week -20 ... +40 °C within 6 week -20 ... +35 °C within 1 week	
Operating temperature	-5 ... +30 °C	
Humidity	0-85 %, non-condensing	
EMC stability	in accordance with EN 61000-6-2: Noise immunity (industrial area) EN 61000-6-4: noise emission increased requirements in accordance with IEC 62061	
Vibration tolerance	EN 60068-2-6 EN 60721-3-7	2-9 Hz: amplitude 3.5 mm 9-200 Hz: 1 g (10 m/s <sup>2</sup> ) 200-500 Hz: 4g (40 m/s <sup>2</sup> )
Shock resistance	EN 60068-2-27 EN 61131-2	15 g
Protection type	EN 60529 Protection type through unplugged housing - factory condition IP20 Protection type connected with MS 031 - operating condition <sup>1</sup> : IP34	

<sup>\*)</sup> Since the function occurs through a chemical reaction in the battery, it is considered a chemical product. As such, the battery performance will decrease over time. Even if it is placed unused in storage over a long period of time. In addition, various conditions of use such as charging, discharging, ambient temperature, etc. will reduce the lifespan of the battery or the device in which the battery is used can be damage be electrolyte leakage.

### 6.5.2 Miscellaneous

Article number	01-810-021
Hardware version	2.x

<sup>1</sup> The specified IP-protection type applies in connected condition with the MS 031 for the MS 021 only!

## 7 Guidelines for Handling the Battery

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1. The battery is delivered installed in the MS 021 Safety module and can only be used for its intended purpose. In addition, it cannot be opened, disassembled or modified in any way.
  2. The same safety regulations for the batter itself also apply to the MS 021 Safety module.
  3. The battery can be charged by trained personnel only and with the charging unit provided by SIGMATEK GmbH & Co KG. The Safety module can only be disconnected and connected for the purpose of charging. Thereby, it is important to ensure that no short-circuits or undesired contact with conductive materials can occur at the battery connections.
  4. The Safety module cannot be exposed to impacts, mechanical or thermal stresses, or moisture.
  5. Safety modules that are damaged, deformed or show unallowed mechanical or thermal stress, or exposure to moisture must be exchanged.
  6. Safety modules must be disposed of in accordance with the valid national guidelines and specifications.
  7. SIGMATEK GmbH & Co KG is not liable for damage caused by the improper use of the Safety module.
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## 8 Safety Guidelines for Handling Li-Ion Batteries \*)

### (1) Disassembly of battery packs and cells

Never disassemble the battery pack and cell. If disassembled cell, generated gas may irritate throats and the negative electrode plates may be heated and ignited. If disassembled battery pack, safety protection circuit may cause breaking and not operated safety system for charge and discharge. May cause heating, igniting and breaking of cell.

### (2) External short circuit of the battery pack

Do not externally short-circuit the battery pack. If externally short-circuited, the battery pack may be heated, ignited or broken.

### (3) Throwing the battery pack of into fire

If battery pack thrown into the fire, the battery pack may be ignited or broken.

### (4) Throwing the battery pack of into water

If thrown battery pack into water, safety protection circuit may cause breaking and may be not operated safety system for charge and discharge. May cause heating, igniting and breaking. Oxygen and hydrogen may be generated by electrolysis of water, and the sealing part may be corroded and leaking may occur.

### (5) Soldering/heating of the battery pack

Do not solder to terminal of battery pack. Safety protection circuit may cause breaking and may be not operated safety system for charge and discharge. May cause heating, igniting and breaking. If heat up battery pack over 90°C, plastic parts may be melting and cell may be leaking and may cause heating, igniting and breaking by short-circuit internally.

### (6) incorrect inserting / wrong polarity of connector / tearing cable

Do not connect/insert battery pack + - reversely. In some machines, battery pack may be short-circuited externally, causing heat, ignition and breakage. Do not tear at battery pack cable, this may cause damage and breaking of the safety protection circuit and may be not operated safety system for charge and discharge. Internal short-circuit may occur too. Both items may cause heating, igniting and breaking.

### (7) Mounting to units

Do not mount in close structures. Combustibles released from cells in operating the safety mechanism may take fire by sparks generated by the motor, switches, etc. Take notice to immediately release combustibles from the units. Day of issue: 15.04.2011 5/9

### (8) Overcharge, inverse charge, in high current

Do not charge in higher currents than specified. Do not over-charge or inverse-charge. Gas may be quickly generated inside the cell, causing ignition or breakage. Charging by chargers not matching the battery pack requirements may cause heating, igniting and breaking.

**(9) Use in other usage**

Do not use battery pack to other units or in other usage. Specification difference may damage battery pack or break units.

**(10) Deformation**

If battery pack are deformed by applying pressure, etc., the sealing part may be deformed, causing leakage, or internal short circuit may cause heating, igniting or breaking.

**(11) Plural use**

Please use battery pack as only single one without any plural series or parallel connection.

**(12) Markering and information in the application guideline**

Make sure that the label always remain on the battery pack. The information printed on the label have to be visible during handling the battery pack. Make sure that there will be the following information in the application guideline concerning the battery pack named:

- i) Li-Ion Rechargeable Batteries for (*application name*)
- ii) Use the charger approved by manufacturer (*charger name*)
- iii) Do not heat or throw the battery pack of in fire. Do not charge and leave the battery pack at the high temperature.
- iv) Do not deform, short-circuit, disassemble or modify the battery pack
- v) Do not allow the battery to be immersed in or wetted with water or sea water
- vi) Do not subject the battery pack to a strong impact or throw it
- vii) Do not cut, squeeze, tear at the cables of the battery pack
- viii) Do not carry or store the battery pack together with material which have sharp edges or is electrical conductive in the same custody
- ix) Not letting (+) terminal come in contact with (-) terminal or metal The above items may cause heat, fire and explosion Day of issue: 15.04.2011 6/9



Non-compliance with these safety guidelines can lead to serious to personnel, system and the environment through fire and explosion.

\*) Text based on the document AKKU\_Lagerung & Transport.doc

## 8.1 Battery Data Sheet

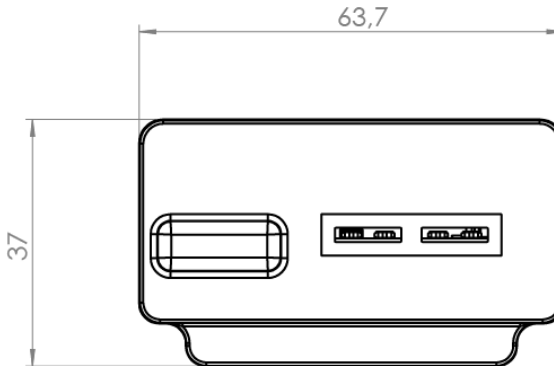
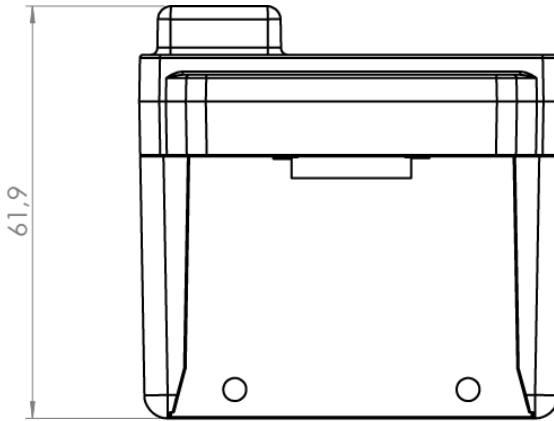
### Data for pack

Nominal Voltage		3,7V	4,2V-3,0V
Nominal capacity		1.950mAh	typical
Used cell in Pack		1x	Panasonic CGA-103450A
internal resistance pack		180mOhm	170 - 220 mOhm
Max charge voltage		4,2V	
Charge current	standard	370mA	0°C < T < 45°C
	rapid	1.300mA	10°C < T < 45°C
Discharge	standard	370mA	-20°C < T < 60°C
	max.cont.	1.600mA	-20°C < T < 45°C
	max.peak	1.730mA	-20°C < T < 45°C
Short circuit current		≈20A	<500μs
NTC		10 kOhm	Tolerance 5%; B-value 25°C/85°C = 3980K
Connector	JST	PHR-3	Pin 1 : GND    black
			Pin 2: NTC    yellow
			Pin 3: PLUS    red
Cable length		60 mm	±5mm
Weight		43g	±2,5g
Lithium content		0,555g	7,215 Wh

### Limitations by Safety Unit (SU)

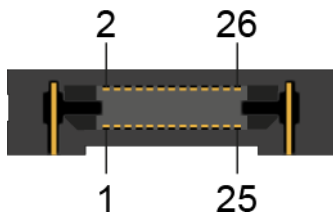
over voltage	cut off	4,3V	±25mV
	release	4,05V	±100mV
under voltage	cut off	2,25V	±100mV
	release	3,0V	2,250V – 3,450V
Current limit 1 by SU		1.600mA	continuous ( typical)
Current limit 2 by SU		>1.730mA	<150ms ( typical)
Current limit 3 by SU		<14A	<4ms ( typical)
Power consumption	active	12,5μA	-0/+7,5μA
	sleep	1,5μA	-0/+1,0μA
ESD Protection		no	

## 9 Mechanical Dimensions



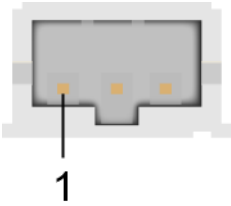
## 10 Connector Layout

### X3: Docking Plug Samtec\_ERF8-013-S-D-RA



Pin	Function
1	DC-IN (Charger)
2	DC-IN (Charger)
3	BATT+
4	BATT+
5	GND
6	BATT-NTC
7	3V3
8	GND
9	EEPROM SDA
10	ADXL1_CLK
11	EEPROM SCL
12	ADXL1_SDI
13	ADXL2_CLK
14	ADXL1_SDO
15	ADXL2_SDI
16	ADXL1_/CE
17	ADXL2_SDO
18	XGND
19	ADXL2_/CE
20	Pressure sensor FSR1
21	Pressure sensor XGND
22	Pressure sensor FSR2
23	Vibration +Motor_on
24	Ultrasound GND
25	Vibration motor GND
26	Ultrasound Chirp_EXT

### X1: Battery Connector JST S3B-PH-SM4-TB



Pin	Function
1	GND
2	BATT-NTC
3	BATT+

### J1, J2: JTAG Programming Connector (Internal)



Pin	Function
1	TDI
2	TMS
3	TCK
4	/TRST
5	TDO
6	/uC-Reset
7	+3.3 V
8	GND

## 11 FCC Statement

### FCC ID: 2ACQNAMM002

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

#### Section 15.21 Information to user

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### Section 15.105 (b)

Note: This equipment has been tested and found to comply with the Limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television Reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

## Documentation Changes

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Change date	Affected page(s)	Chapter	Note