# Safety Technique

## SAFEMASTER M Multi-Function Safety System Diagnostic Module for CANopen
## BG 5551

**CANopen**

**DOLD**



0272625

0056708

- For transmitting the status information from the control unit and the input modules, e.g. input and error states, start button and safety output assignments, to a control system or bus-capable display
- Galvanic separation
- Adjustment of transmission via rotary switch
- LED indicators for operating voltage and status
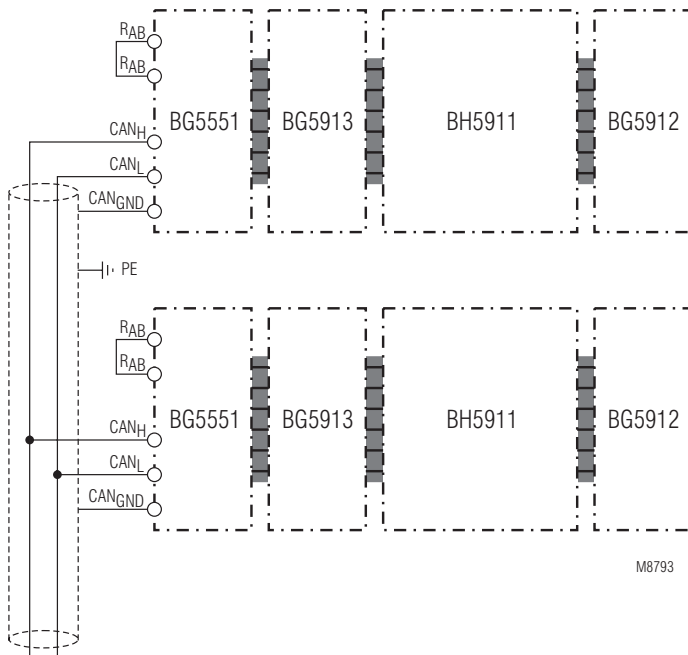- Width 22,5 mm

### Circuit Diagram



M8795

### Connection Example



M8793
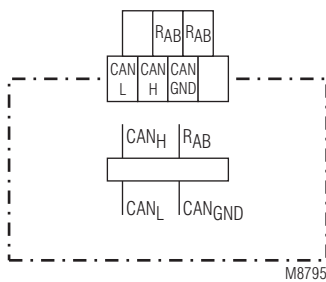
### Approvals and Markings

CE

### Applications

For connection to a CANopen network for visualizing the status of the multi-function safety system SAFEMASTER M.

### Indicators

| | |
|---|---|
| Green LED „on": | on when supply connected |
| Green LED „run": | Continuously on, when the diagnostic module is accessed by the bus, flashing, when a bus failure is detected |

### Device Connection

The diagnostic module is simply connected via flatcable instead of the left termination plug of the safety system. This connection is used for the power supply and for receiving the data to be evaluated.

The CANopen-Bus is connected via terminals $CAN_L$ und $CAN_H$. When the diagnostic module is physically installed at the end of the CAN Bus, the terminals $R_{AB}$ have to be bridged.

### Device Setting

The address (01 to 99) of the module in the CANopen system s set on the rotary switches $10^1$ and $10^0$.

The middle switch allows to set the data transmission rate. 20 Kbit, 125 Kbit, 500 Kbit or 1000 Kbit.

All other configurations is done by software, e.g. Pro CANopen. A configuration file is necessary which can be obtained on CD-Rom PN 5501. It is located in the folder CANopen/EDS.

Order reference: PN 5501, Article number: 0052860

**Attention:**

⚠️ Work on the device must be carried out by specialist personnel when the device is in a deenergized state.

All information contained in this list is technically correct at the time of going to print. We reserve the right to make technical improvements and modifications at any time.

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## Technical Data

### Input

| | |
|---|---|
| **Nominal voltage U$_N$:** | DC 24 V (power is supplied - by the SAFEMASTER M) |
| **Voltage range:** | |
| at max. 5% residual ripple: | 0.85 ... 1.15 U$_N$ |
| **Nominal consumption:** | max. 100 mA |

**CANopen interface**

| | |
|---|---|
| Transmission medium: | Twisted, shielded two-wire line |
| Transmission optionally: | 20 Kbit/s |
| | 125 Kbit/s |
| | 500 Kbit/s |
| | 1 Mbit/s |
| Maximum length: | 2500 m at 20 Kbit/s |
| | 500 m at 125 Kbit/s |
| | 90 m at 500 Kbit/s |
| | 15 m at 1 Mbit/s |

The screen of the bus cable has to be connected to the terminal CAN$_{GND}$ of all diagnostic modules and at one point also to PE (see connection example).

### General Data

| | |
|---|---|
| **Nominal mode of operation:** | Continuous operation |
| Temperature range: | $\pm$ 0 ... + 50° C |
| | At an operating temperature of 50 °C the modules must be mounted with a distance of 3 - 5 mm. |

**EMC**

| | | |
|---|---|---|
| HF irradiation: | 10 V / m | IEC 61 000-4-3 |
| Fast transients | | |
| on supply line A1-A2: | 2 kV | IEC 61 000-4-4 |
| on signal and control lines: | 2 kV | IEC 61 000-4-4 |

## Technical Data

| | | |
|---|---|---|
| Surge voltage between supply lines: | 1 kV | IEC 61 000-4-5 |
| between supply line and ground: | 2 kV | IEC 61 000-4-5 |
| HF wire guided: | 10 V | IEC 61 000-4-6 |
| Interference suppression: | Grenzwert Klasse B | EN 55 011 |

**Degree of protection**

| | | |
|---|---|---|
| Housing: | IP 20 | IEC/EN 60 529 |
| Terminals: | IP 20 | IEC/EN 60 529 |
| Housing: | Thermoplastic with V0 behaviour according to UL subject 94 | |
| **Vibration resistance:** | Amplitude 0.35 mm | |
| | frequency 10 ... 55 Hz | IEC/EN 60068-2-6 |

**Resistance to shock**

| | | |
|---|---|---|
| Acceleration: | 10 g | |
| Impulse length: | 16 ms | |
| Number of shocks: | 1000 per axis on 3 axes | |
| **Climate resistance:** | 0 / 050 / 04 | IEC/EN 60 068-1 |
| **Terminal designation:** | EN 50 005 | |
| **Wire connection:** | 1 x 2.5 mm$^2$ stranded wire with sleeve or 1 x 4 mm$^2$ solid or 2 x 1.5 mm$^2$ stranded wire with sleeve DIN 46 228-1/-2/-3/-4 | |
| **Wire fixing:** | Terminal screws M3,5, box terminals with wire protection | |
| **Mounting:** | on DIN rail | IEC/EN 60 715 |
| **Weight:** | 135 g | |

### Dimensions

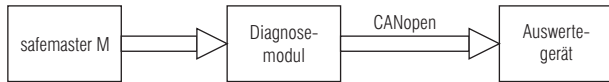| | |
|---|---|
| **Breite x Höhe x Tiefe** | 22.5 x 84 x 121 mm |

### Standard Type

BG 5551   DC 24 V   50 / 60 Hz
Article number:                0056708

## Information on System Diagnostics



Flow of information to evaluate data

M8807

## Information Structure

The diagnostic module delivers depending on the configuration a package of max. 28 information bytes. These are 7 Bytes for the control unit, and 7 Bytes each for the 3 possible input modules. Each byte has 8 information bits (Bit 0 ... Bit 7). The tables below „Structure of Diagnostic Information" show the assignment of each byte.
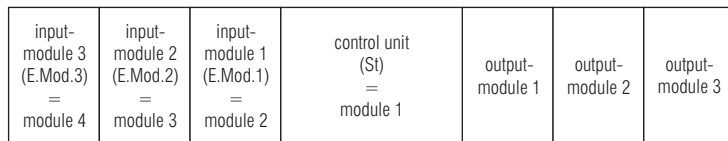


module numbering of safemaster M

data block with 28 bytes of information with for each 8 bits
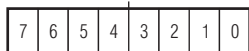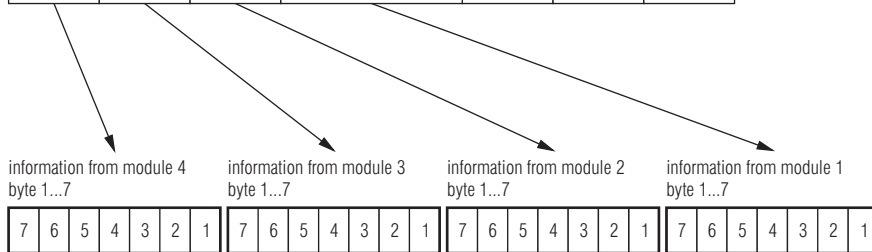
# Structure of Diagnostic Information

| Byte No. | CANopen designation | Module | Informationsbytes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| 1 | **Modul1 ModulNr** | St* | 0 | 0 | 0 | 0 = OK 1 = Systemfehler | Module number, if module available    0001 = Modul 1 | | | |
| | **Modul2 ModulNr** | E.Mod.1* | | | | | 0010 = Modul 2 | | | |
| | **Modul3 ModulNr** | E.Mod.2* | | | | | 0011 = Modul 3 | | | |
| | **Modul4 ModulNr** | E.Mod.3* | 0000 0000: Module not available or another module reports errors. In this case, all 7 bytes have the value 0000 0000. | | | | | | | |
| 2 | Modul1 assignements | St* | Which start button effects this module? | | | | Which output module does this module have an effect on? | | | |
| | Modul2 assignements | E.Mod.1* | 1 = T4 | 1 = T3 | 1 = T2 | 1 = T1 | 1 = output module 3 | 1 = output module 2 | 1 = output module 1 | 1 = Control unit |
| | Modul3 assignements | E.Mod.2* | | | | | | | | |
| | Modul4 assignements | E.Mod.3* | If bit 4 is set in the module number: system error code | | | | | | | |
| 3 | Modul1 input status | St* | Only if the button concerned is assigned to the control unit | | | | if T4 = start button: 0 | 0 | 1 = input S14 inaktive | 1 = input S12 inaktive |
| | | | 1 = T4 activated | 1 = T3 activated | 1 = T2 activated | 1 = T1 activated | if T4 = stop-button: 1 = Stop activated | | | |
| | Modul2 input status | E.Mod.1* | 1 = input S42 inactive | 1 = input S32 inactive | 1 = input S22 inactive | 1 = input S12 inactive | 1 = input S44 inactive | 1 = input S34 inactive | 1 = input S24 inactive | 1 = input S14 inactive |
| | Modul3 input status | E.Mod.2* | | | | | | | | |
| | Modul4 input status | E.Mod.3* | | | | | | | | |
| 4 | Modul1 output status | St* | 1 = output module 3 activated | 1 = output module 2 activated | 1 = output module 1 activated | 1 = safety outputs of control unit activated | 0 | Status of output 48 (error code) | 1 = activation of assigned output modules released (green LEDs left) | Status of yellow LED run 1 (error code) |
| | | | **Comment:** These bits show the activation signal, which is transmitted to the modules. In the case of delayed outputs, the progress of the delay time is not visible. | | | | | | | |
| | Modul2 input status | E.Mod.1* | 0 | 0 | 0 | 0 | | | | |
| | Modul3 input status | E.Mod.2* | | | | | | | | |
| | Modul4 input status | E.Mod.3* | | | | | | | | |
| 5 | Modul1 status byte 1 | St* | 1 = error on a safety output | 1 = release of assigned safety outputs enabled | 1 = waiting for activation of assigned start button (error has been eliminated) | 1 = short circuit on the inputs | Position of function switch (0000 bis 1001 for function 0 to 9) | | | |
| | Modul2 input status | E.Mod.1* | 1 = control unit reports errors (bit 4 or 7 of module status byte 1 set) | | | | | | | |
| | Modul3 input status | E.Mod.2* | | | | | | | | |
| | Modul4 input status | E.Mod.3* | | | | | | | | |
| | | | see comments below | | | | | | | |
| 6 | Modul1 status byte 2 | St* | The assignment of this byte depends on the function of the control unit or the respective input module (see the following pages) | | | | | | | |
| | Modul2 status byte 2 | E.Mod.1* | | | | | | | | |
| | Modul3 status byte 2 | E.Mod.2* | | | | | | | | |
| | Modul4 status byte 2 | E.Mod.3* | | | | | | | | |
| 7 | Modul1 starts and security outputs | St* | start button T4 activated | start button T3 activated | start button T2 activated | start button T1 activated | 1 = activation of output module 3 enabled | 1 = activation of output module 2 enabled | 1 = activation of output module 1 enabled | 1 = activation of safety outputs of Ct* enabled |
| | Modul2 starts and security outputs | E.Mod.1* | | | | | | | | |
| | Modul3 starts and security outputs | E.Mod.2* | | | | | | | | |
| | Modul4 starts and security outputs | E.Mod.3* | | | | | | | | |

**Comment:** Bit 7 and bit 4 of the **Modul x status byte 1** (Byte 5) are saved from the time when the error appears until when the module is restarted. DThe fact that the fault was corrected is indicated by bit 5 in the case of a manual start; and by bit 6 in the case of an automatic start. If these errors are detected in the control unit, the entire **SAFEMASTER M** system is locked. f the input modules are error-free in the „automatic start" mode, their bits 7 and 6 flash in the **status byte 1** (byte 12, 19 or 26) as well as their green LEDs until the error has been corrected in the control unit or in the safety outputs.

# Structure of Diagnostic Information
**Assignment of bytes 6 in the different modules of SAFEMASTER M**

**Control unit BH 5911:**

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Modul1 status byte 2 | 1 = start button activated for too long (>3s) | 1 = one of the assigned start buttons has been activated | 1 = emergency stop S14 activated | 1 = emergency stop S12 activated | 1 = error on output module 3 | 1 = error on output module 2 | 1 = error on output module 1 | 1 = error on the safety outputs of the Ct* |

**Comment 1:** All signals are saved from the time when the error is detected until the safety outputs are released for activation again. The fact that the error was corrected is indicated in **status byte 1** (byte 5), bits 5 and 6.

**Comment 2:** In the case of a 2-channel emergency stop, bits 5 and 4 change together. For more precise diagnostics of the input signals, byte 3 (status of the inputs) must be evaluated.

**Input module BG 5913.08/_0_ _ _**

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Modul2 status byte 2 Modul3 status byte 2 Modul4 status byte 2 | 1 = time error[2] | 1 = one of the assigned start buttons has been activated | 1 = one of the assigned simulation buttons has been activated | 0 (unused) | 1 = function group 4 of module does not grant release[1] | 1 = function group 3 of module does not grant release[1] | 1 = function group 2 of module does not grant release[1] | 1 = function group 1 of module does not grant release[1] |

**BComments:** Except for bit 6 and 5, all signals are saved from the time when the error is detected until the assigned safety outputs are released for activation again. The fact that the error was corrected is indicated in **status byte 1** (no. 19, 20 or 26), bits 5 and 6.

1) The numbers of the different function groups match the numbering of the safety functions in the application examples of the data sheet of input module BG 5913.08/_0_ _ _. If less than 4 functions are possible as a result of the input module setting (e.g. max. 2 with two-hand control type IIIC), the surplus bits are set to 0.

2) Time error is detected if the start or simulation buttons (>3s) are activated for too long. A time error message is also generated if two sensors of a function are not activated in the required time window (e.g. in the case of gates or two-hand controls).

**Input module BG 5913.08/_1_ _ _, BG 5913.08/_2_ _ _ and BG 5913.08/_3_ _ _**

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Modul2 status byte 2 Modul3 status byte 2 Modul4 status byte 2 | 1 = time error[2] | 1 = one of the assigned start buttons or simulation buttons has been activated | 0 (unused) | 0 (unused) | 1 = function group 4 of module does not grant release[1] | 1 = function group 3 of module does not grant release[1] | 1 = function group 2 of module does not grant release[1] | 1 = function group 1 of module does not grant release[1] |

**Comments:** Except for bit 6, all signals are saved from the time when the error is detected until the assigned safety outputs are released for activation again. The fact that the error was corrected is indicated in **status byte 1** (no. 19, 20 or 26), bits 5 and 6.

1) The numbers of the different function groups match the numbering of the safety functions in the applications examples of the data sheet from input module. If a function combination with two-hand type IIIC is set on the input module, only 3 function groups are available and bit 3 is then always 0.

2) Time error is detected if the start or simulation buttons (>3s) are activated for too long. A time error message is also generated if two sensors of a function are not activated in the required time window (e.g. in the case of gates or two-hand controls).

## Structure of Diagnostic Information
**Input module BG 5914.08/_0_ _ _, BH 5914.08/_1_ _ _ and BH 5914.08/_2_ _ _**

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Modul2 status byte 2 Modul3 status byte 2 Modul4 status byte 2 | 1 = start button activated for too long (>3s) | 1 = one of the assigned start buttons has been activated | 1 = emergency stop on S14, S24, S34 or S44 does not grant release[1] | Double contact error on S42 - S44[2] | 1 = emergency stop on S42 or S44 does not grant release[1] | 1 = emergency stop on S32 or S34 does not grant release[1] | 1 = emergency stop on S22 or S24 does not grant release[1] | 1 = emergency stop on S12 or S14 does not grant release[1] |

**Comments:** Except for bit 6, all signals are saved from the time when the error is detected until the assigned safety outputs are released for activation again. The fact that the error was corrected is indicated in **status byte 1** (no. 12, 19 or 26), bits 5 and 6.

1) The emergency stop function which actually prevented the release can only be recognized from the combination of bit 5 with the bits 0 to 3. The current status of the inputs is always visible in byte 10, 17 or 24 (status of the inputs).

2) Bit 4 is only set if S42 and S44 are set for 2-channels for the emergency stop function, and both signals do not match.

We have a safemaster M system with the following components:
- 1 control unit BH 5911.03/00MF0
- 1 output module BG 5912.04
- 1 diagnostic module BH 5552 for Profibus DP

The transmitted information from diagnostic module BH 5552 is to be used in order to observe how and why the outputs of output module 1 change.

The available diagnostic information of the control unit and its changes are shown here:

**1. Normal state**: Safety outputs are activated, all EMERGENCY STOP buttons are released

| | | Bit no. | 76543210 |
|---|---|---|---|
| Byte 1: Module number: | Hex: 01 | Bin: | 00000001 |
| Byte 2: Assignments: | Hex: 13 | Bin: | 00010011 |
| Byte 3: Status of inputs: | Hex: 00 | Bin: | 00000000 |
| Byte 4: Status of outputs: | Hex: 00 | Bin: | 00000000 |
| Byte 5: Status byte 1: | Hex: 45 | Bin: | 01000101 |
| Byte 6: Status byte 2: | Hex: 00 | Bin: | 00000000 |
| Byte 7: Start button and safety outputs: | Hex: 0B | Bin: | 00000011 |

Module number 01 with deleted bit 4 shows that the entire safemaster M system is working properly.
The set bits 0 to 3 of status byte 1 show that the function switch of the control unit (module1) is set to position "5". That means that the following mode of operation is set:

2 x 1 channel emergency stop, manual start, 4 start buttons

The set assignments in byte 2 shows you that the control unit is started by the start button 1 (bit 4), and it has an effect on its own outputs (bit 0) and the outputs of output module 1 (bit 1). Since no input module is available, the outputs of both modules must always have the same status.

The set bit 6 in status byte 1 means the control unit grants the release for setting the safety outputs which are assigned to it. The fact that the outputs are actually set can be seen in byte 4.

**2. Emergency stop button on S12 activated**

| | | Bit no. | 76543210 |
|---|---|---|---|
| Byte 1: Module number: | Hex: 01 | Bin: | 00000001 |
| Byte 2: Assignments: | Hex: 13 | Bin: | 00010011 |
| Byte 3: Status of inputs: | Hex: 01 | Bin: | 0000000**1** |
| Byte 4: Status of outputs: | Hex: 0x | Bin: | 00**000x0x**x = flash |
| Byte 5: Status byte 1: | Hex: 05 | Bin: | 0**0**000101 |
| Byte 6: Status byte 2: | Hex: 10 | Bin: | 000**1**0000 |
| Byte 7: Start button and safety outputs: | Hex: 00 | Bin: | 000000**00** |

Bit 6 in status byte 1 shows that the control unit does not release the safety outputs which are assigned to it.
The reason for this is indicatedby bit 0 in byte 3 (input S12 inactive) and by bit 4 in status byte 2 (emergency stop activated). The set bit 4 in byte 6 is saved until the release is granted again.
Byte 4 signals that the outputs have actually dropped out (bit 4 and 5) and the output 48 (bit 2) as well as the LED run 1 (bit 0) flash.

**3. Emergency stop button is unlocked again**

| | | Bit no. | 76543210 |
|---|---|---|---|
| Byte 1: Module number: | Hex: 01 | Bin: | 00000001 |
| Byte 2: Assignments: | Hex: 13 | Bin: | 00010011 |
| Byte 3: Status of inputs: | Hex: **00** | Bin: | 0000000**0** |
| Byte 4: Status of outputs: | Hex: 0x | Bin: | 00000x0x |
| Byte 5: Status byte 1: | Hex: **25** | Bin: | 00**1**00101 |
| Byte 6: Status byte 2: | Hex: 10 | Bin: | 00010000 |
| Byte 7: Start button and safety outputs: | Hex: 00 | Bin: | 00000000 |

Since all inputs are in quiescent state again, only the status bytes 1 and 2 as well as byte 4 (status of outputs) still indicate that safemaster M was switched off. However, the saved bit 4 in status byte 2 still shows the reason for switch-off.

**4. Start button T1 is activated**

| | | Bit no. | 76543210 |
|---|---|---|---|
| Byte 1: Module number: | Hex: 01 | Bin: | 00000001 |
| Byte 2: Assignments: | Hex: 13 | Bin: | 00010011 |
| Byte 3: Status of inputs: | Hex: **01** | Bin: | 000**1**0000 |
| Byte 4: Status of outputs: | Hex: **00** | Bin: | 000000**00** |
| Byte 5: Status byte 1: | Hex: **05** | Bin: | 00100101 |
| Byte 6: Status byte 2: | Hex: **00** | Bin: | 000**0**0000 |
| Byte 7: Start button and safety outputs: | Hex: 00 | Bin: | 00000000 |

If the start button was activated properly (< 3 s), the system returns to the normal state described under section 1. If the start button is activated for too long (> 3 s), bit 7 would signal in byte 6.

**Comment:**
If a system was already put into operation, it is often sufficient just to evaluate status bytes 1 and 2.
Depending on the depth and degree of detail of the diagnostics, e.g. in the case of troubleshooting when placing the system into operation, the other bytes can also be included if required.

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