

# C-Dias Current Measuring Module

## 3 x current measuring inputs 0 – 5 A AC

**CAI 031**

The CAI 031 current measuring module is used to measure current in a 220 V – 600 V power supply.

To insulate from the power source, an external current transformer must be used that transforms the measured current to a max. of 5 A AC.



## Technical Data

### CPU

|                        |  |
|------------------------|--|
| Description            | ATMEGA32-16A1                          |
| Architecture           | 8-bit AVR (Advanced RISC Architecture) |
| Program memory (Flash) | 32 Kbytes                              |
| Data memory (SRAM)     | 2 Kbytes                               |
| Firmware (EEPROM)      | 1 Kbytes                               |

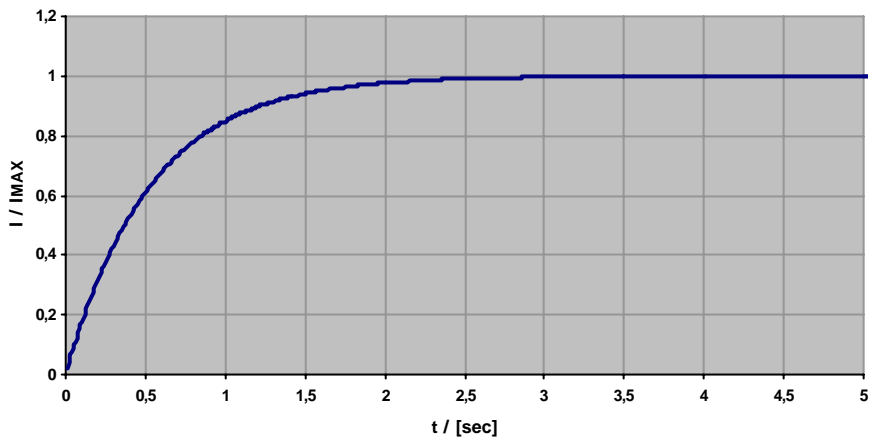
### Dual Port Static RAM

|                    |         |
|--------------------|---------|
| Description        | CY7C131 |
| Data memory (SRAM) | 1 kByte |

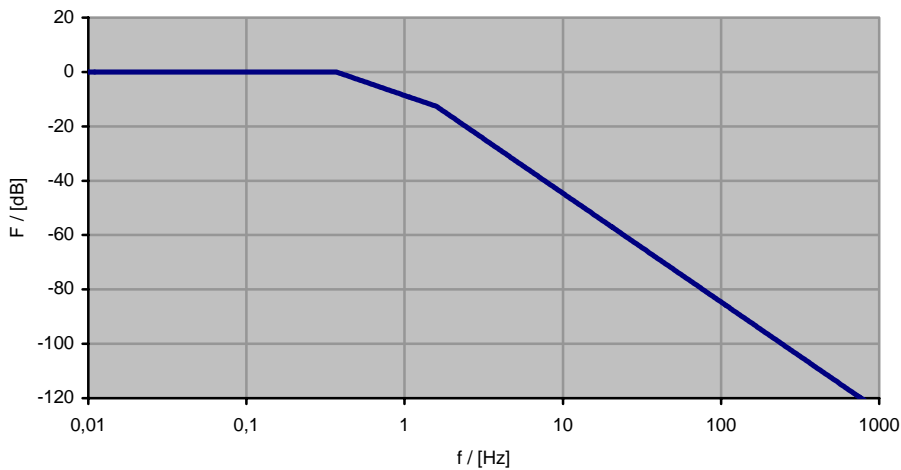
## Analog channel specifications

|  |                                     |                    |
|--|-------------------------------------|--------------------|
| Number of channels                       | 3                                   |                    |
| Measurement range                        | 0 – 5 A AC                          |                    |
| Measurement process                      | Average value measurement           |                    |
| Signal form                              | Sine                                |                    |
| Frequency                                | 50 Hz                               |                    |
| Measurement values                       | 0 – 255 Digits (8-bit)              |                    |
| Resolution                               | 19.6 mA AC / Digit                  |                    |
| Conversion time per channel              | ≤1ms                                |                    |
| Input filter                             | Typically 500 ms                    | Low pass 2. system |
| Precision of analog channel measurements | ±1,5 % of maximum measurement value |                    |
| Measurement resistance                   | 22 mΩ                               |                    |

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### Electrical Requirements

| C-DIAS-Bus supply                                | +5 V and +24 V |       |
|--|----------------|-------|
| Current consumption or C-DIAS-Bus (+5 V supply)  | 35 mA          | 50 mA |
| Current consumption or C-DIAS-Bus (+24 V supply) | 35 mA          | 50 mA |

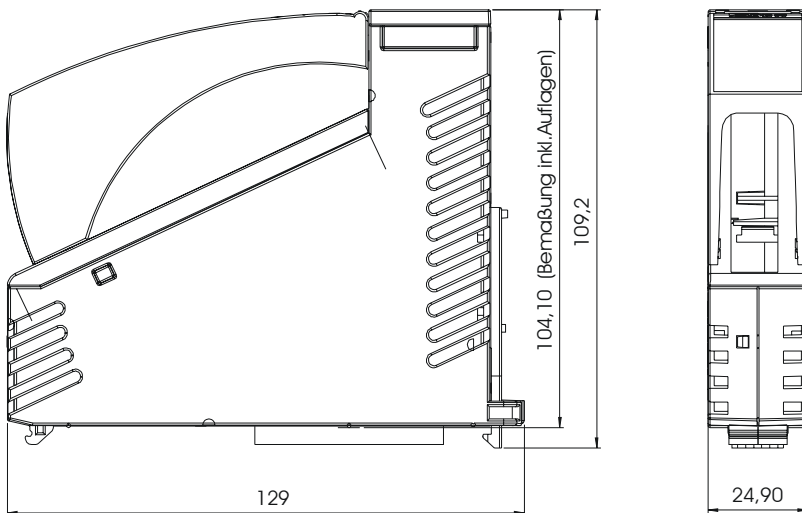
### Miscellaneous

|                  |            |
|------------------|------------|
| Article number   | 12-009-031 |
| Hardware version | 1.x        |

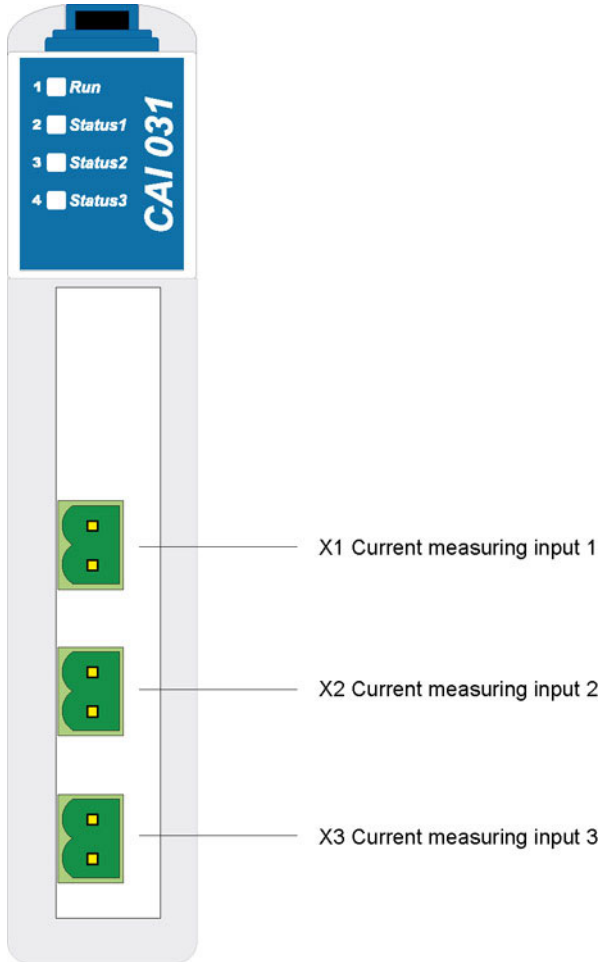
**Environmental conditions**

|                       |                                     |                      |
|-----------------------|-------------------------------------|----------------------|
| Storage temperature   | -20 – +85 °C                        |                      |
| Operating temperature | 0 – +60 °C                          |                      |
| Humidity              | 0 – 95 %, Uncondensed               |                      |
| EMV stability         | EN 61000-6-2:2001 (industrial area) |                      |
| Shock resistance      | EN 60068-2-27                       | 150 m/s <sup>2</sup> |
| Protection            | EN 60529                            | IP 20                |

## Mechanical Dimensions



## Connector Layout



**X1 (PH-MSTBA2,5/2-G-5,08): Current measuring input 1**


| Pin | Function |
|-----|----------|
| 1   | Input 1+ |
| 2   | Input 1- |

**X2 (PH-MSTBA2,5/2-G-5,08): Current measuring input 2**


| Pin | Function |
|-----|----------|
| 1   | Input 2+ |
| 2   | Input 2- |

**X3 (PH-MSTBA2,5/2-G-5,08): Current measuring input 3**


| Pin | Function |
|-----|----------|
| 1   | Input 3+ |
| 2   | Input 3- |

**Applicable connectors**
**X1 – X3: Phoenix FKC2,5/2-ST5,08**

The complete C-Dias CKL 048 connector set is available from Sigmatek under the article number 12-600-048.

## Status Display



| LED Nr. | LED color | LED Status   | Meaning   |
|---------|-----------|--------------|---|
| 1       | Green     | LED on       | Run (module in operation)                                 |
| 2       | Red       | LED blinking | Status1 – Over current channel 1 ( $I > 5 \text{ A AC}$ ) |
| 3       | Red       | LED blinking | Status2 - Over current channel 2 ( $I > 5 \text{ A AC}$ ) |
| 4       | Red       | LED blinking | Status3 - Over current channel 3 ( $I > 5 \text{ A AC}$ ) |



## C-DIAS Communication

The operation parameters and analog values can be read over the C-DIAS bus. Up to 256 8-bit addresses can be allocated. Registers cannot be addressed since these are used by the CAI 031 internally.

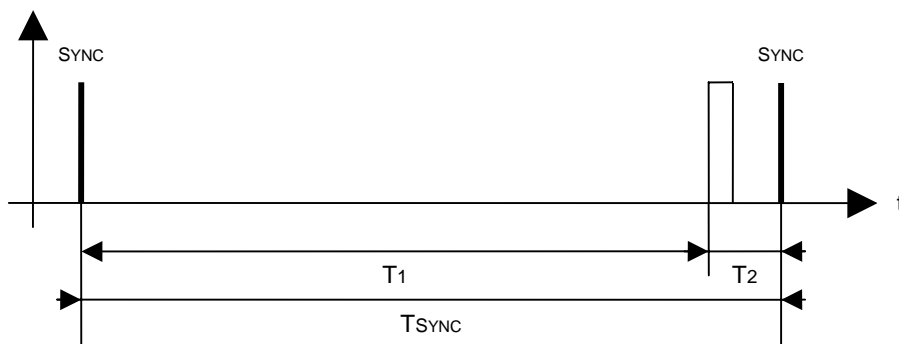
The raw measurements are converted to analog values in the ATMEGA32 directly using calibration data. The ATMEGA32 EEPROM can be read and written to over the C-DIAS bus.

With the built-in serial EEPROM (LASAL-EEProm), data can be read over the hardware.

## C-DIAS Bus Access

The C-DIAS should use synchronous access for the CAI 031 only. If the CAI is accessed asynchronously, the C-DIAS bus can be blocked for several microseconds. C-DIAS RDY = "0" can occur when the same DPRAM register is accessed by the ATMEG32 and the C-DIAS bus simultaneously!

Synchronous access:



$T_{SYNC}$ ... Sync on CMB is settable (1 ms ... 5 ms)

$T_1$ ...  $T_{SYNC} - T_2$  ... time for synchronous C-DIAS access to the module

$T_2$ ... 50  $\mu$ s – access of CAI 031 to the DPRAM 50  $\mu$ s before the Sync pulse  
(Duration of access: approx. 15  $\mu$ s)

## CAI 031 Registers

### Overview

| Register | Description                                    | Address     |
|----------|--|-------------|
| STATUS   | Module status (operating status, error status) | 0x00        |
| DATA1    | Analog value channel1                          | 0x01        |
| DATA2    | Analog value channel2                          | 0x02        |
| DATA3    | Analog value channel3                          | 0x03        |
| ...      | ...  | ...         |
| RAW1     | Raw value channel1                             | 0x10 – 0x11 |
| RAW2     | Raw value channel2                             | 0x12 – 0x13 |
| RAW3     | Raw value channel3                             | 0x14 – 0x15 |
| ...      | ...  | ...         |
| CMD_ST   | Status for execution of instructions           | 0xF0        |
| EE_ADR   | EEPROM Address                                 | 0xF1        |
| EE_DATA  | EEPROM Data                                    | 0xF2        |
| ...      | ...  | ...         |
| VER      | Firmware version                               | 0xF4        |
| ...      | ...  | ...         |
| CMD      | Instruction register                           | 0xFE        |
| ...      | ...  | ...         |

## Status register – STATUS

| Bit           | 7 | 6 | 5 | 4        | 3       | 2       | 1       | 0   |
|---------------|---|---|---|----------|---------|---------|---------|-----|
| STATUS        | - | - | - | ADJ_DATA | STATUS3 | STATUS2 | STATUS1 | RUN |
| R/W           | R | R | R | R        | R       | R       | R       | R   |
| Initial Value | 0 | 0 | 0 | 0        | 0       | 0       | 0       | 0   |

- BIT 4 – ADJ\_DATA: Adjustment Data Bit**  
 When calibration data for the module is available, this bit is set.
- BIT 3 – STATUS3: Status Bit 3**  
 When a current surge is detected on channel 3 of the current measuring module, this bit is set.
- BIT 2 – STATUS2: Status Bit 2**  
 This bit is set when a current surge is detected on channel 2 ( $I > 5$  A AC) of the current measuring module.
- BIT 1 – STATUS1: Status Bit 1**  
 This bit is set when a current surge is detected on channel 1 ( $I > 5$  A AC) of the current measuring module.
- BIT 0 – RUN: Run Bit**  
 This bit is set when the module reaches operation mode.

### Data register - DATAx

| Bit           | 7            | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|--------------|---|---|---|---|---|---|---|
| DATAx         | DATAx [7..0] |   |   |   |   |   |   |   |
| R/W           | R            | R | R | R | R | R | R | R |
| Initial Value | 0            | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

8 Bit Analog value for Channelx  
x ... [1 ... 3]

### Data register - RAWx

| Bit           | 7           | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|-------------|---|---|---|---|---|---|---|
| RAWx          | RAWx [7..0] |   |   |   |   |   |   |   |
| RAWx          | RAWx [9..8] |   |   |   |   |   |   |   |
| R/W           | R           | R | R | R | R | R | R | R |
| Initial Value | 0           | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

10 Bit Analog raw value for Channelx  
x ... [1 ... 3]

### VER –Versions register

| Bit           | 7         | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|-----------|---|---|---|---|---|---|---|
| VER           | VER[7..0] |   |   |   |   |   |   |   |
| R/W           | R         | R | R | R | R | R | R | R |
| Initial Value | 0         | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

8 Bit Register for the version number of the Firmware

Example:

| VER  | Version |
|------|---------|
| 0x10 | V1.0    |
| 0x23 | V2.3    |

### Status register for executing instructions – CMD\_ST

| Bit           | 7   | 6   | 5   | 4   | 3   | 2   | 1   | 0      |
|---------------|-----|-----|-----|-----|-----|-----|-----|--------|
| CMD_ST        | -   | -   | -   | -   | -   | -   | -   | CMD_ST |
| R/W           | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W    |
| Initial Value | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0      |

- **BIT 0 – CMD\_ST: execution status**

If this bit is cleared, the module is processing an instruction. When set, the module is ready a new instruction.

### EEPROM Address register – EE\_ADR

| Bit           | 7             | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
|---------------|---------------|-----|-----|-----|-----|-----|-----|-----|
| EE_ADR        | EE_ADR [7..0] |     |     |     |     |     |     |     |
| R/W           | R/W           | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Initial Value | 0             | 0   | 0   | 0   | 0   | 0   | 0   | 0   |

8-Bit Register for the EEPROM Address

### EEPROM data register – EE\_DAT

| Bit           | 7             | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
|---------------|---------------|-----|-----|-----|-----|-----|-----|-----|
| EE_DAT        | EE_DAT [7..0] |     |     |     |     |     |     |     |
| R/W           | R/W           | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Initial Value | 0             | 0   | 0   | 0   | 0   | 0   | 0   | 0   |

8-Bit Register for EEPROM Data

## Instruction register. - CMD

|               |           |     |     |     |     |     |     |     |
|---------------|-----------|-----|-----|-----|-----|-----|-----|-----|
| Bit           | 7         | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
| CMD           | CMD[7..0] |     |     |     |     |     |     |     |
| R/W           | R/W       | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Initial Value | 0         | 0   | 0   | 0   | 0   | 0   | 0   | 0   |

## Instruction table

| CMD  | Instruction  |
|------|--|
| 0xF1 | Write data (EE_DAT) to the EEPROM Address (EE_ADR) |
| 0xF2 | Read EEPROM Address (EE_ADR)                       |

## Executing instructions

### EEPROM Write Byte command:

- Clear status bit command (CMD\_ST)
- Write EEPROM Address to address register (EE\_ADR)
- Write EEPROM Data to data register (EE\_DAT)
- Write EEPROM command (0xF1) to instruction register (CMD)
- Set command status bit (CMD\_ST) by the module after instruction is processed.

### EEPROM Read Byte command:

- Clear status bit command (CMD\_ST)
- Write EEPROM Address to address register (EE\_ADR)
- Write EEPROM command (0xF1) to instruction register (CMD)
- Set command status bit (CMD\_ST) by the module after instruction is processed.
- Read EEPROM Data from the data register (EE\_DAT)

When processing instructions, the above sequence must be followed!

## Data in the LASAL and ATMEGA32 EEPROMs

For the hardware calibration, the calibration values for offset, multiplier and divisor are determined at the manufacturer. These values are stored in the LASAL and ATMEGA32 EEPROMs found in the C-DIAS current measuring module.

### Module data (Organized by byte)

| Address   | Data | Description                    |
|-----------|------|--------------------------------|
| \$00      | \$xx | Check sum                      |
| \$01      | 123  | Identification                 |
| \$02      | 5    | Module group 5 = CAI           |
| \$03      | 13   | Module variant 13 = CAI031     |
| \$04      | 3    | Number of channels (3 x AI)    |
| \$05      | \$10 | Hardware version \$10 = HW 1.0 |
| \$06-\$3F | \$FF | FILL                           |
| \$10      |      | Serial number                  |

### AI calibration data (organized by word)

|           |        |  |
|-----------|--------|--|
| \$40      | \$xxxx | Check sum                                  |
| \$42      | 12345  | Identification                             |
| \$44      | 10     | Length of the following data block in WORD |
| \$46      | 3      | Number of channels                         |
| \$48      | \$xxxx | AI1 Offset current input1 (0 – 5 A AC)     |
| \$4A      | \$03FF | AI1 multiplier                             |
| \$4C      | \$xxxx | AI1 Divisor                                |
| \$4E      | \$xxxx | AI2 Offset – current input2 (0 – 5 A AC)   |
| \$50      | \$03FF | AI2 multiplier                             |
| \$52      | \$xxxx | AI2 Divisor                                |
| \$54      | \$xxxx | AI3 Offset – current input3 (0 – 5 A AC)   |
| \$56      | \$03FF | AI3 multiplier                             |
| \$58      | \$xxxx | AI3 Divisor                                |
| \$5A-\$FF | \$FFFF | FILL                                       |

