

SIEMENS

SICAM BC

AI-5303/TIPS05

System Element Manual

Preface, Table of Contents

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Peripheral Element AI-5303/TIPS05

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**Note**

Please observe Notes and Warnings for your own safety in the Preface.

Disclaimer of Liability

Although we have carefully checked the contents of this publication for conformity with the hardware and software described, we cannot guarantee complete conformity since errors cannot be excluded. The information provided in this manual is checked at regular intervals and any corrections that might become necessary are included in the next releases. Any suggestions for improvement are welcome.

Subject to change without prior notice.

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Preface

This document is applicable to the following product(s):

- SICAM BC

Purpose of this manual

This manual describes the functioning of the system element AI-5303/TIPS05 (**T**ransformer **I**nput **P**reprocessing and **S**ynchronisation) and essentially contains

- Functional descriptions
- Technical Specifications
- Descriptions of interfaces to the process and other system elements
- Possible Configurations

Target Group

The document you are reading right now is addressed to users, who are in charge of the following engineering tasks:

- Conceptual activities, as for example design and configuration
- Creation of the assembly technical documentation using the designated engineering tools
- System parameterization and system diagnostic, using the designated engineering tools
- Technical system maintenance

Placement in the Information Landscape

Document	Item no.
SICAM BC System Manual	DC5-014-2
SICAM RTUs Common Functions Peripheral Elements according to IEC 60870-5-101/104	DC0-011-2

Notes on Safety

This manual does not constitute a complete catalog of all safety measures required for operating the equipment (module, device) in question because special operating conditions might require additional measures. However, it does contain notes that must be adhered to for your own personal safety and to avoid damage to property. These notes are highlighted with a warning triangle and different keywords indicating different degrees of danger.



Danger

means that death, serious bodily injury or considerable property damage **will** occur, if the appropriate precautionary measures are not carried out.



Warning

means that death, serious bodily injury or considerable property damage **can** occur, if the appropriate precautionary measures are not carried out.

Caution

means that minor bodily injury or property damage could occur, if the appropriate precautionary measures are not carried out.



Note

is important information about the product, the handling of the product or the respective part of the documentation, to which special attention is to be given.



Qualified Personnel

Commissioning and operation of the equipment (module, device) described in this manual must be performed by qualified personnel only. As used in the safety notes contained in this manual, qualified personnel are those persons who are authorized to commission, release, ground, and tag devices, systems, and electrical circuits in accordance with safety standards.

Use as Prescribed

The equipment (device, module) must not be used for any other purposes than those described in the Catalog and the Technical Description. If it is used together with third-party devices and components, these must be recommended or approved by Siemens.

Correct and safe operation of the product requires adequate transportation, storage, installation, and mounting as well as appropriate use and maintenance.

During operation of electrical equipment, it is unavoidable that certain parts of this equipment will carry dangerous voltages. Severe injury or damage to property can occur if the appropriate measures are not taken:

- Before making any connections at all, ground the equipment at the PE terminal.
- Hazardous voltages can be present on all switching components connected to the power supply.
- Even after the supply voltage has been disconnected, hazardous voltages can still be present in the equipment (capacitor storage).
- Equipment with current transformer circuits must not be operated while open.
- The limit values indicated in the manual or the operating instructions must not be exceeded; that also applies to testing and commissioning.

Consider obligatory the safety rules for the accomplishment of works at electrical plants:

1. Switch off electricity all-pole and on all sides!
 2. Ensure that electricity cannot be switched on again!
 3. Double check that no electrical current is flowing!
 4. Discharge, ground, short circuit!
 5. Cover or otherwise isolate components that are still electrically active!
-

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1 Introduction

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1.1 Application

The peripheral element AI-5303/TIPS05 is used in automation units of the system SICAM BC. It is deployed in the field of telecontrol and automation. The peripheral element is used for direct acquisition of transformer voltages and currents, and for the calculation of derived values.

System element type	Peripheral element
consists of	a module AI-5303 with firmware TIPS05
can be used in	SICAM BC
Engineering	SICAM TOOLBOX II with OPM II

1.2 Overview

Peripheral element for direct transformer input

- 3 current transformer inputs
 - Nominal current 6 A max. with 100% overrange
- 4 voltage transformer inputs
 - Nominal voltage 230 V max. with 50% overrange
- Nominal frequency 16 $\frac{2}{3}$, 50 or 60 Hz
- Calculation of the r.m.s. values
 - Currents
 - Phase and phase-to-phase voltages
- Calculation of
 - Frequency
 - Active and reactive power, and power factor
- Optional synchro-check
 - 2 1-pole relay outputs
 - Signal voltage 24 to 220 VDC, 400 VAC
- Acquisition and processing according to IEC 60870-5-101/104

1.3 Architecture

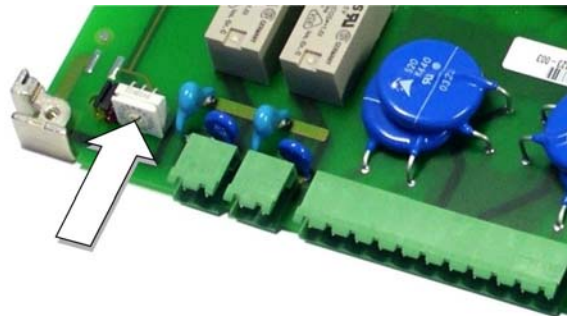
1.3.1 Mechanics

Module in double-euro format for equipping in a mounting rack.

1.3.2 Ax 1703 Peripheral Bus

The peripheral element is coupled to the basic system element via the Ax 1703 peripheral bus. The address of the peripheral element at the Ax 1703 peripheral bus is already specified during the assembly of the SICAM BC system.

This address can be changed afterwards also by a configuration change with the SICAM SICAM TOOLBOX II. This address is then to be set by means of the PBA switch (⇧) on the peripheral element.



2 Peripheral Element AI-5303/TIPS05

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2.1 Features and Functions

Acquisition Functions

- **Transformer currents**
 - Acquisition of currents through direct transformers, up to the 8th harmonic using of Fourier Analysis, signal scanning 128 times per period
 - Measuring range 1 A, 2 A, 5 A or 6 A (0.5...6 A) with 100% overrange and a resolution of 12 bits
 - Calculation of r.m.s. values by a digital signal processor
 - Revision
- **Transformer voltages**
 - Acquisition of voltages through direct transformers, up to the 8th harmonic using Fourier Analysis ^{*)}, signal scanning 128 times per period by means of Fourier Analysis
 - Wiring of phase voltages or phase-to-phase voltages to voltage inputs ^{*)}
 - Measuring range 230 V, 110 V or 110 V/ $\sqrt{3}$ (10...230 V) with 50% overrange and a resolution of 12 bits
 - Calculation of r.m.s. values by a digital signal processor
 - Messages of voltage transformer MCB's are considered
 - Revision
- **Frequency**
 - Acquisition of frequency using signal zero crossing of a selectable transformer input (voltage, current)
 - Failure strategy can use other transformer inputs
 - Measuring range
±5 Hz for selectable nominal frequencies of 16 $\frac{2}{3}$ Hz, 50 Hz, and 60 Hz, with a resolution of 1 mHz
 - Revision

^{*)} see "Dependency of Functions on the Assignment to Voltage Transformer Inputs"



Hint

The above mentioned functions are described in detail in the document *SICAM RTUs Common Functions Peripheral Elements according to IEC 60870-5-101/104*

^t **Telecontrol**

the function affects process information which is **spontaneously** transmitted

^a **Automation**

the function affects process information which is **periodically** transmitted

^c **Calculation**

the function affects process information which is used as input for the calculation of calculated (derived) values

Calculation Functions

- **Calculation of Values from Acquired Values in a processing grid of 40 ms**

- Current r.m.s. value $I1^{tac}, I2^{tc}, I3^{tc}$
- Phase voltage r.m.s. value $U1^{tac}, U2^{tc}, U3^{tc}$ 1)
- Phase-to-phase voltage r.m.s. value $U12^{tac}, U23^{tc}, U31^{tc}$ 1)
- Voltage r.m.s. value $U4^{tac}$ 1)
- Frequency instantaneous value tac
- Frequency mean value tc
- Frequency difference tac 1)
 - voltage $U4 \Leftrightarrow$ one phase voltage or phase-to-phase voltage

Voltage and current r.m.s. values undergo a linear (technological) adaption tac and are the base for calculating further values

- Zero current r.m.s. value $I0^t$
- Zero voltage r.m.s. value $U0^t$ 1)
- Active power $P1^{ta}, P2^t, P3^t$
 - 1-, 2- or 3-wattmeter method 1)
- Reactive power $Q1^{ta}, Q2^t, Q3^t$
 - 1-, 2- or 3-wattmeter method 1)
- Power factor $1^{ta}, 2^t, 3^t$
- Voltage difference r.m.s. value 1)
- Phase difference ta 1)

To calculated values the following functions are applied:

- Revision tac
- Smoothing t
- Format conversion t
 - Normalized, technologically scaled or short floating point
 - Suppression of zero range
- Change monitoring t
- Spontaneous transmission of changes t
- Periodical transmission of selected values a

1) see "Dependency of Functions on the Assignment to Voltage Transformer Inputs"



Hint

The above mentioned functions are described in detail in the document *SICAM RTUs Common Functions Peripheral Elements according to IEC 60870-5-101/104*

Dedicated Functions

- **Synchro-check** ¹⁾
 - Determines the synchrony of two systems
 - Messages of voltage transformer MCB's are considered
 - Cold load pickup (4 sets of parameters)
 - Connecting de-energized lines to the system is supported
 - Creates the signal *Synchrocheck OK* ^a

¹⁾ see "Dependency of Functions on the Assignment to Voltage Transformer Inputs"



Note

The above mentioned functions are described in detail in the document *SICAM RTUs Common Functions Peripheral Elements according to IEC 60870-5-101/104*

Output Functions

- **Output of messages or signals**
 - Output
 - of the message
 - of the signal *Synchrocheck OK* ¹⁾
 - of both, logically ANDed
 - of both, logically ORed
 - Periodical transmission of the message ^a

¹⁾ see "Dependency of Functions on the Assignment to Voltage Transformer Inputs"

2.2 Details Regarding Selected Functions

2.2.1 Calculation Functions

Dependency of Functions on the Assignment to Voltage Transformer Inputs

	Y U1-3 / Y U4	Y U1-3 / ΔU4	ΔU1-3 / Y U4	ΔU1-3 / ΔU4
Calculation of phase-to-phase voltages U12, U23, U31	✓	✓	-	-
Calculation of phase voltages U1, U2, U3	-	-	✓ ¹⁾	-
Calculation of the zero voltage U0	✓	✓	✓ ¹⁾	-
Calculation of the frequency difference	✓	✓	-	✓
Calculation of the voltage difference	✓	✓ ²⁾	-	✓
Calculation of the phase difference	✓	✓	-	✓
Synchro-check	✓	✓	-	✓
Calculation of power using 1-wattmeter method	✓	✓	-	-
Calculation of power using 2-wattmeter method	✓ ²⁾	✓ ²⁾	✓	✓
Calculation of power using 3-wattmeter method	✓	✓	-	-

¹⁾ only possible if to voltage input U4 a phase voltage of that system is assigned of which also the phase-to-phase voltages are acquired (reference point). The Synchro-check funktion is then not available.

²⁾ the calculation of phase-to-phase voltages must be enabled

Meaning of the columns:

Y U1-3 / Y U4 phase voltages assigned to U1, U2, U3 and U4

Y U1-3 / ΔU4 phase voltages assigned to U1, U2, U3 and phase-to-phase voltage assigned to U4

ΔU1-3 / Y U4 phase-to-phase voltages assigned to U1, U2, U3 and phase voltage assigned to U4

ΔU1-3 / ΔU4 phase-to-phase voltages assigned to U1, U2, U3 and U4

2.2.2 Synchro Check

The *Synchrocheck* function decides, whether the systems are synchronous, and, as the result, creates the signal *Synchrocheck OK*.

The signal *Synchrocheck OK* can

- Be logically ANDed or ORed with two items of periodical information and be output through both relays of the system element
- Be made available, as periodical information, to the application program of the [Open-/Closed-Loop Control Function](#)

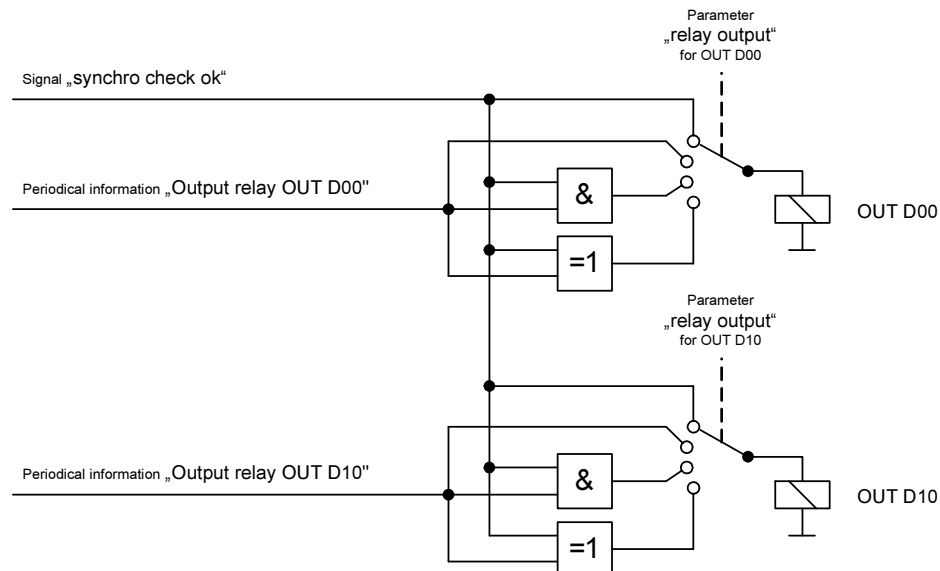
For project specific or market segment specific applications, the function *Synchrocheck* can help to accomplish:

- Providing an enable signal to an external automation equipment or to the application program of the [Open-/Closed-Loop Control Function](#)
- Support for switching-on a circuit breaker using DO-5212/PCCO55

2.2.3 Output of Binary Information or Signals

The firmware can trigger two relays. Via parameter is chosen whereby the respective relay is triggered. Optional by means of

- the function synchrocheck
- the function diagram
- the function synchrocheck, the function diagram (logically AND)
- the function synchrocheck, the function diagram (logically OR)



If the firmware is switched to revision, the relays are terminated.

Both relays are independent from each other. Each relay has two contacts, whereby the second is used for read back and thus a recognition of a welded contact is possible. If the read back signals an error on a relay, the relay output (for both relays) is closed by firmware, a relay selective diagnostic is set and possibly active outputs are terminated.

If a welded contact should separate independently (excluded in practice), this is not recognized.

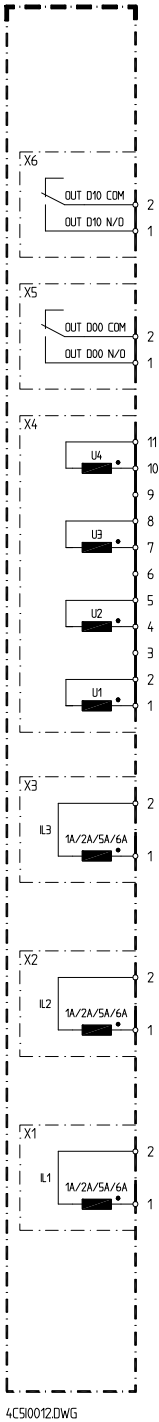
The firmware examines already during startup both relays for a welded contact.

If both relays are defective, in the diagnosis only relay 1 is indicated as defective.

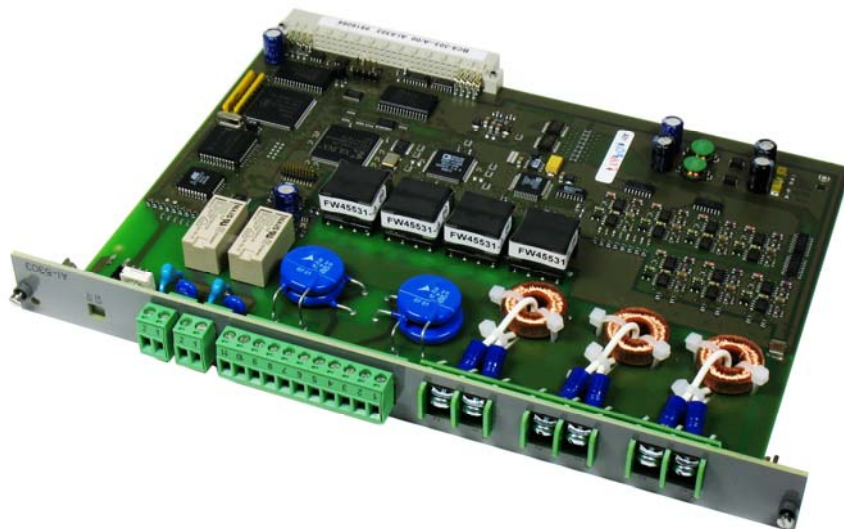
2.3 Engineering

For diagnosis, testing, parameter setting or documentation, the system element is supported by the engineering tools of SICAM TOOLBOX II. OPM II is required.

2.4 Block Diagram



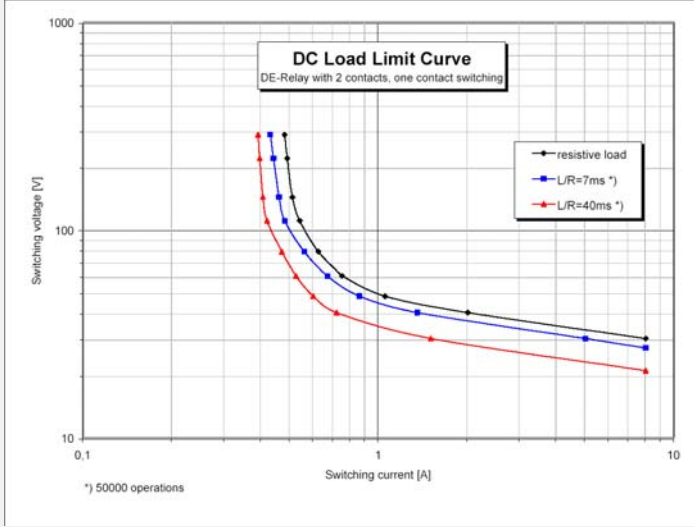
2.5 View



2.6 Technical Specifications

2.6.1 Module AI-5303

Processor and Memory	
Main Processor	80C251, 16 MHz
Program memory	PE-ROM 192 kByte
Main memory	RAM 52 kByte
Parameter memory	EEPROM 8 kByte
Signal processor	ADSP2185, 40 MHz
Memory	internal
Inputs for Transformer Currents	
3 current inputs (X1, X2, X3)	The current inputs are galvanically insulated by transformers, from each other, from the voltage inputs, and from logic circuits
Nominal current I_N	1A / 2A / 5A / 6A (settable)
Max. measurement current	200% I_N
Nominal frequency f_N	50 Hz, 60 Hz, 16.7 Hz (settable)
Resolution	12 Bit
Scanning	128 values per system period
Thermal withstand capability	25A continuously 500A 1s 1250A 1 half-period
Intrinsic consumption	< 0.1 VA at $I_N = 1$ A < 0.2 VA at $I_N = 5$ A
Inputs for Transformer Voltages	
4 voltage inputs (X4)	The voltage inputs are galvanically insulated by transformers, from each other, from the current inputs, and from logic circuits
Nominal voltage U_N	230V, 110V, $110V/\sqrt{3}$ (settable)
Max. measuring voltage	150% U_N
Nominal frequency f_N	50 Hz, 60 Hz, 16.7 Hz (settable)
Resolution	12 Bit
Scanning	128 values per system period
Thermal withstand capability	440V continuously
Intrinsic consumption	< 0.11VA at $U_N = 110V$ < 0.48VA at $U_N = 230V$ < 0.04VA at $U_N = 110V/\sqrt{3}$

Binary Outputs	
2 outputs (relay) (X5, X6)	<ul style="list-style-type: none"> • 2 contacts (make contact) each, 1-pole make, one contact is used for reading back the relay activation • Recognition of contact welding • The outputs are galvanically insulated from logic circuits and ground by monostable relays
Maximum output current	• 8 A AC or DC permanent
Maximum switching voltage	<ul style="list-style-type: none"> • 220 V DC + 5% • 400 V AC + 10%
Minimum number of switching cycles	<ul style="list-style-type: none"> • 10^5 AC 220 V (≤ 8 A) @ $\cos \varphi = 1$ • $5 \cdot 10^4$ DC according to DC Load Limit Curve
Minimum switching capacity	• 1 mW
Electric strength with open contacts	• 1.0 kV AC or DC for 1 min
Output circuits	≤ 220 V DC + 5% ≤ 400 V AC + 10% The circuits are operated by means of an external voltage.
Maximum switching capacity AC	400 V 2000 VA (≤ 8 A) @ $\cos \varphi = 1$
Maximum switching-on capacity DC	24 .. 30 V ≤ 8 A @ $L/R \leq 40$ ms 30 .. 220 V ≤ 240 W @ $L/R \leq 40$ ms
Breaking capacity DC	
Power supply	
Operating voltage	4,75 .. 5,25 VDC, typ. 2 W max. 2.5 W The voltage is picked off at the bus of mounting rack
Mechanics and Connectors	
Ax 1703 peripheral bus	Transmission rate 16 Mbps
Peripheral connector	Removable screw terminals Phoenix Contact MSTBT 2.5/x-ST-5.08 <ul style="list-style-type: none"> • 2x1 binary output X5, X6 1x 2-pin each
Peripheral terminals	Screw terminals for 6 mm ² <ul style="list-style-type: none"> • 3x1 transformer current X1, X2, X3 1x 2-pin each
Peripheral connector	Removable screw terminals Phoenix Contact MSTB 2.5/11-ST-5.08 <ul style="list-style-type: none"> • 4 transformer voltages X4 1x 11-pin
Dimensions	Double-euro format 233.4 x 160 mm, 4WU
Weight	Approx. 390 g

2.6.2 Acquired and Calculated Values

Current R.M.S. Values		
Calculation of protection measured values	by means of Fourier analysis, up to the 8 th harmonic	
Accuracy under reference conditions	class 0.2	
Reference Values	Reference Conditions	
Ambient temperature	23°C ± 2°C	
Frequency	F _N ± 2%	
Input current	I _N ± 2%, Sine, form factor 1.1107	
Warm-up time	=15 minutes	
Other	DIN IEC 60688	
Parameter	Nominal Consumption Range	Additional Error through Parameter Effects in % ^{*)}
Ambient temperature	-25°C .. <u>23°C</u> .. 70°C	---
Curve form of the input current	Rectangular 1:1	2.5
	Sine phase control α=90°	2.5
Other	DIN IEC 60688	DIN IEC 60688

^{*)} error to be added to accuracy under reference conditions

Voltage R.M.S. Values		
Calculation (only if AI-5399 is equipped)	by means of Fourier analysis, up to the 8 th harmonic	
Accuracy under reference conditions	class 0.2	
Reference Values	Reference Conditions	
Ambient temperature	23°C ± 2°C	
Frequency	F _N ± 2%	
Input voltage	U _N ± 2%, Sine, form factor 1.1107	
Warm-up time	=15 minutes	
Other	DIN IEC 60688	
Parameter	Nominal Consumption Range	Additional Error through Parameter Effects in % ^{*)}
Ambient temperature	-25°C .. <u>23°C</u> .. 70°C	---
Curve form of the input voltage	Rectangular 1:1	1.5
	Sine phase control α=90°	2.5
Other	DIN IEC 60688	DIN IEC 60688

^{*)} error to be added to accuracy under reference conditions

Active and Reactive Power		
Calculation (only if AI-5399 is equipped)	by means of Fourier analysis, up to the 8 th harmonic	
Accuracy under reference conditions	class 0.5	
Reference Values		
Reference Conditions		
Ambient temperature	23°C ± 2°C	
Frequency	F _N ± 2%	
Input voltage	U _N ± 2%, Sine, form factor 1.1107	
Input current	I _N ± 2%, Sine, form factor 1.1107	
Warm-up time	=15 minutes	
Other	DIN IEC 60688	
Parameter	Nominal Consumption Range	Additional Error through Parameter Effects in % ^{*)}
Ambient temperature	-25°C .. <u>23°C</u> .. 70°C	---
Kurvenform des Eingangstromes	Rectangular 1:1	2.5
	Sine phase control α=90°	2.5
Other	DIN IEC 60688	DIN IEC 60688

^{*)} error to be added to accuracy under reference conditions

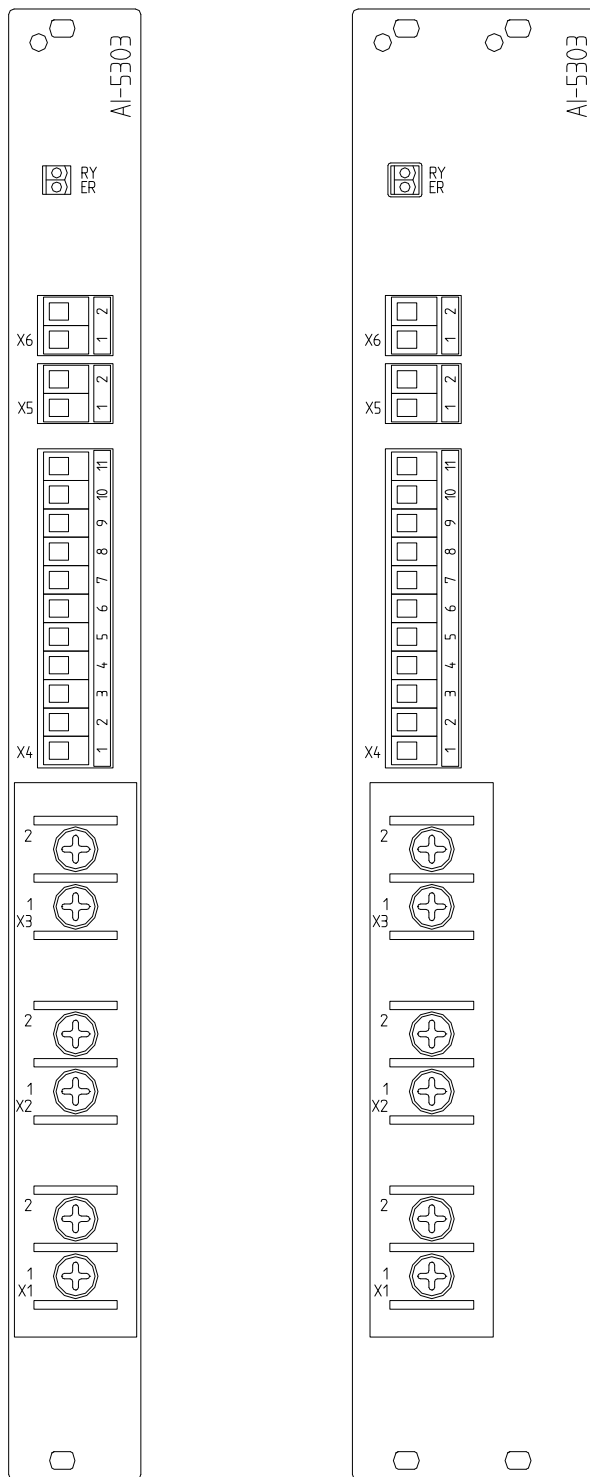
Phase Angel		
Calculation	by means of Fourier analysis FFT	
Accuracy under reference conditions	0.5°	
Reference Values		
Reference Conditions		
Ambient temperature	23°C ± 2°C	
Frequency	F _N ± 2%	
Input voltage	U _N ± 2%, Sine, form factor 1.1107	
Input current	I _N ± 2%, Sine, form factor 1.1107	
Warm-up time	=15 minutes	
Other	DIN IEC 60688	
Parameter	Nominal Consumption Range	Additional Error through Parameter Effects in % ^{*)}
Ambient temperature	-25°C .. <u>23°C</u> .. 70°C	---
Other	DIN IEC 60688	DIN IEC 60688

^{*)} error to be added to accuracy under reference conditions

Frequency		
Calculation	Via the zero crossing of the signal to a current or voltage input	
Resolution	1mHz	
Accuracy under reference conditions	<ul style="list-style-type: none"> • 1 mHz for frequency mean value • 5 mHz for frequency instantaneous value 	
Accuracy at 10 % signal proportion at 25 Hz or higher harmonic	<ul style="list-style-type: none"> • 5 mHz for frequency mean value • 20 mHz for frequency instantaneous value 	
Reference Values		
Ambient temperature	23°C ± 2°C	
Frequency	$F_N \pm 2\%$	
Curve form on the used current or voltage input	I_N or U_N sinusoidal, any distortion, but without additional zero crossing	
Warm-up time	=15 minutes	
Other	DIN IEC 60688	
Parameter	Nominal Consumption Range	Additional Error through Parameter Effects in % ^{*)}
Ambient temperature	-25°C .. <u>23°C</u> .. 70°C	---
Other	DIN IEC 60688	DIN IEC 60688

^{*)} error to be added to accuracy under reference conditions

2.7 Front Panel



Variant used if module is installed
on slot 1 of SICAM BC/C

2.8 Pin Assignment

Screw terminals are used as peripheral connectors. They are assigned according to the following tables. The abbreviations which are used for the signals of the various pins are explained below.

X6:

pin	signal
2	OUT D10 COM
1	OUT D10 N/O

X3:

pin	signal
2	I3b
1	I3a

X5:

pin	signal
2	OUT D00 COM
1	OUT D00 N/O

X2:

pin	signal
2	I2b
1	I2a

X4:

pin	signal
11	U4b
10	U4a
9	N.C.
8	U3b
7	U3a
6	N.C.
5	U2b
4	U2a
3	N.C.
2	U1b
1	U1a

X1:

pin	signal
2	I1b
1	I1a

4CS0012.DWG

The abbreviations have the following meaning:

I1a ... I3a current input, terminal a (k)

I1b ... I3b current input, terminal b (l)

U1a ... U4a voltage input, terminal a

U1b ... U4b voltage input, terminal b

OUT D00_N/O 1. relay synchro check, normally open contact

OUT D00_COM 1. relay synchro check, common contact

OUT D10_N/O 2. relay synchro check, normally open contact

OUT D10_COM 2. relay synchro check, common contact

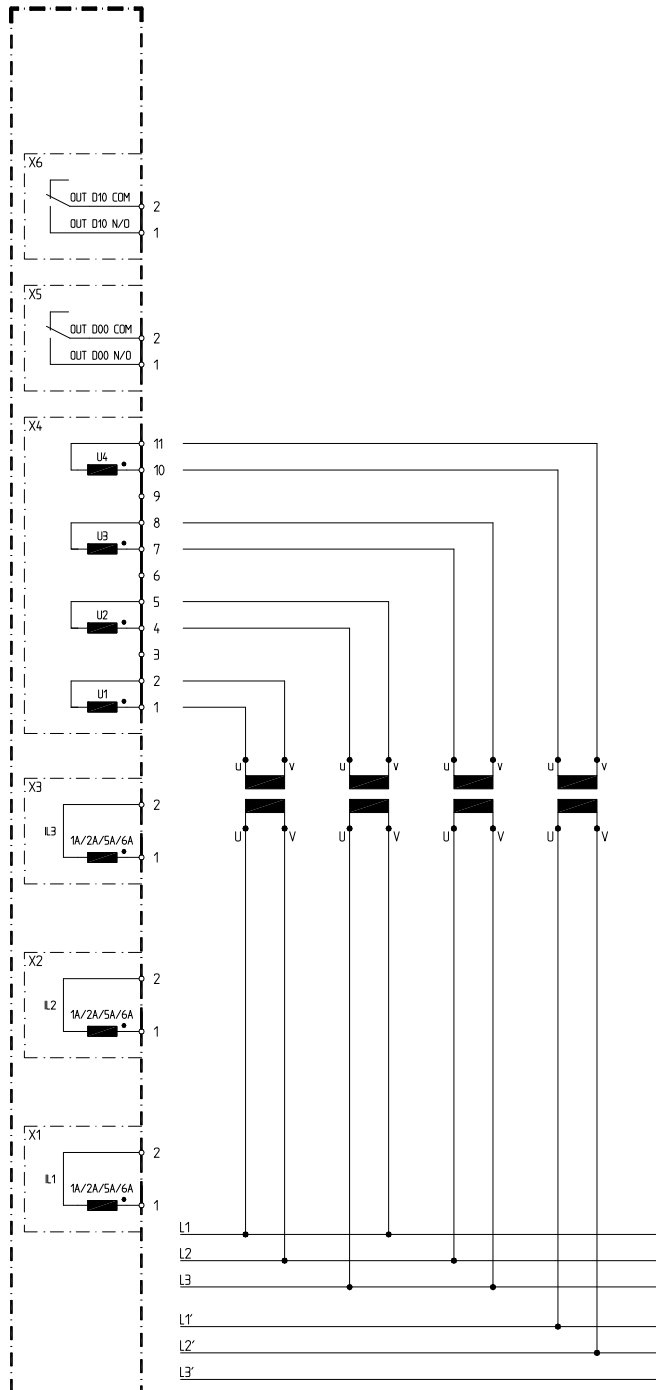
N.C. not used

4CS1012.DWG

2.9 External Circuit Elements

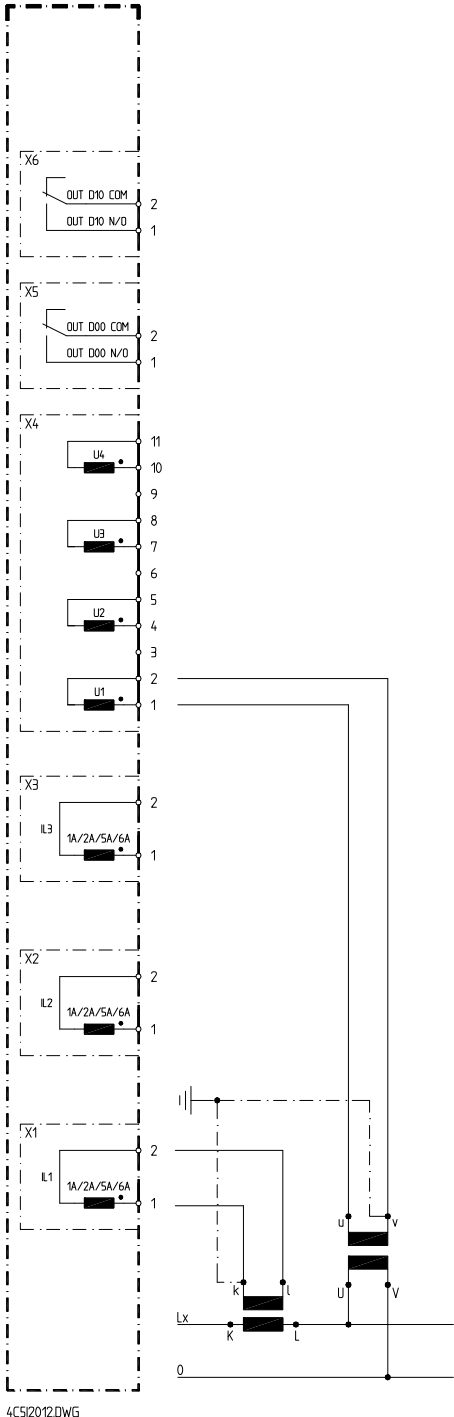
2.9.1 Circuitry with Phase-to-Phase Voltages

Connection via three respectively four voltage transformers.



2.9.2 Circuitry for 1-Wattmeter method

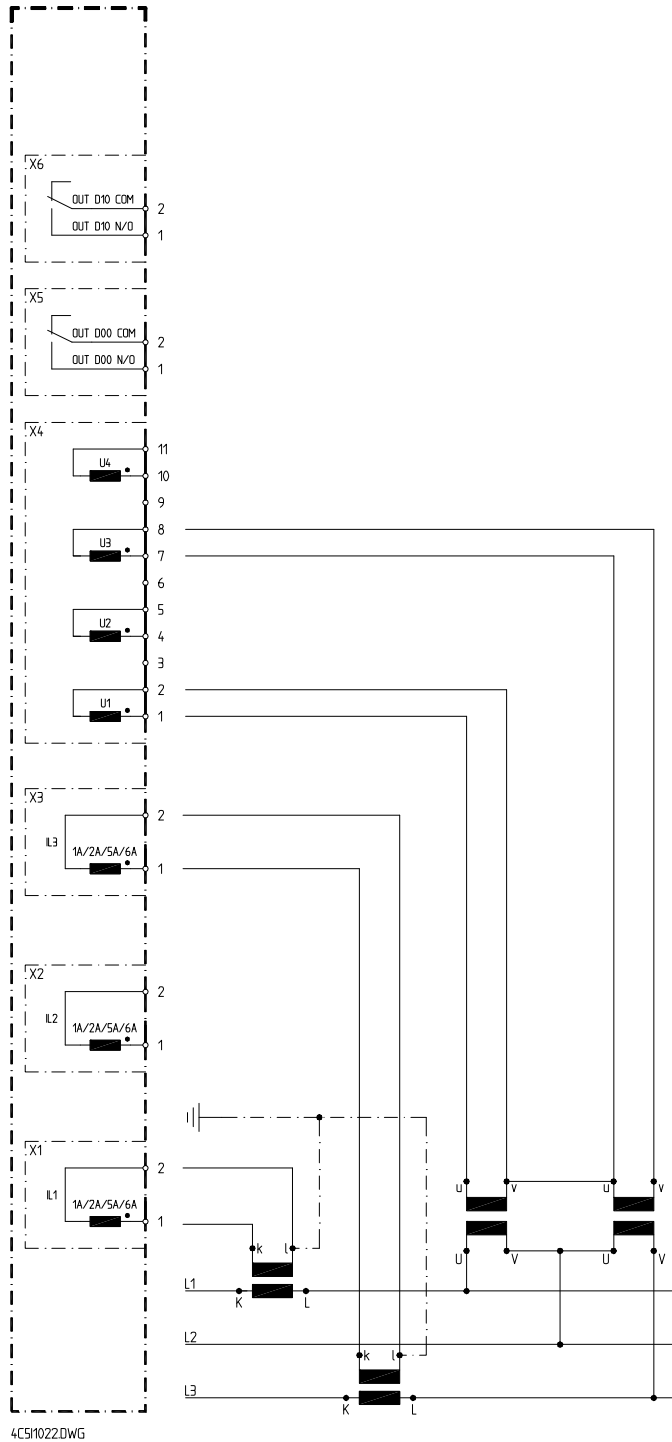
Measurement on single phase alternating current, connection over a current and a voltage -transformer.



An AI-5303/TIPS05 system element can also be used for single-phase measurement in three different feeders (or components) of the same three-phase current system. In this case the same wiring principle is used in each feeder. Then the power calculation takes place 3 times according to the 1-wattmeter method.

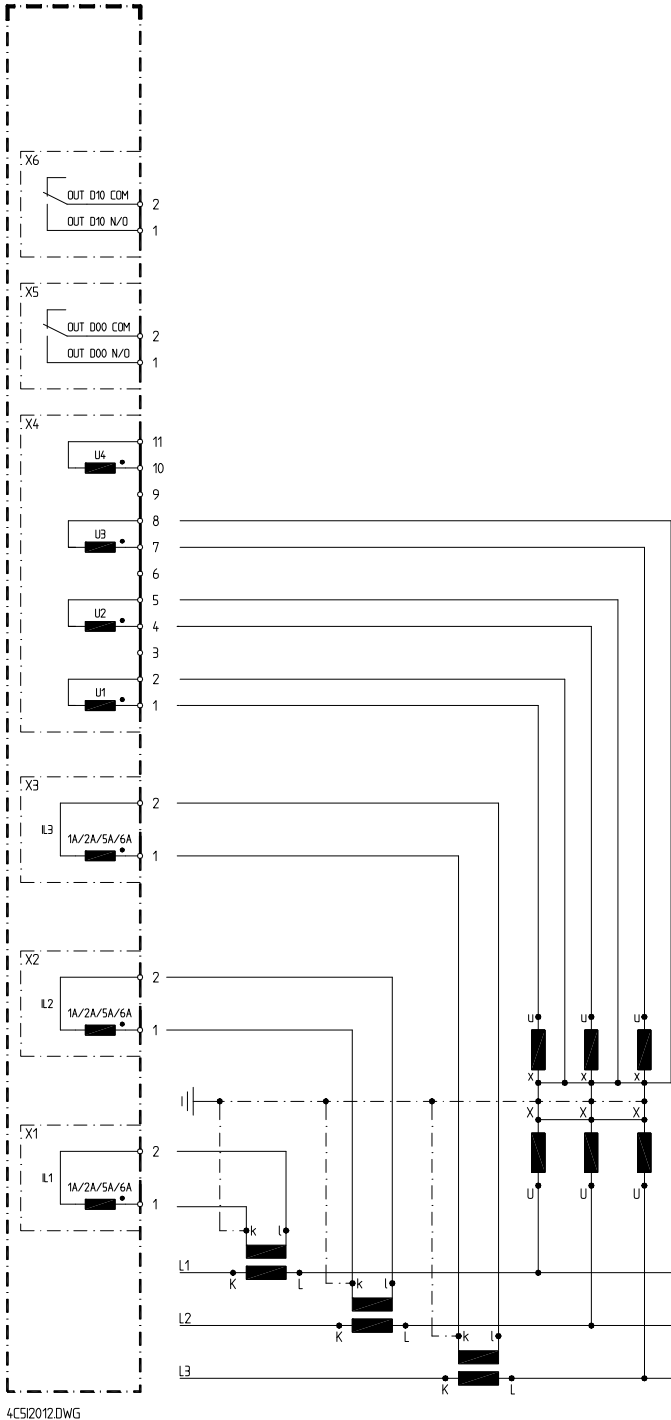
2.9.3 Circuitry for 2-Wattmeter method

Measurement in three-phase current system (unequally loaded), connection over two current and voltage - transformers.



2.9.4 Circuitry for 3-Wattmeter method

Measurement in three-phase current system, connection over three current transformer and three unipolar isolated voltage transformers.



A Order Information

Contents

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A.1 System Element



Designation	Item Number/MLFB
AI-5303/TIPS05 Direct Transformer Input (4x220 V, 3x 6 A)	BC5-303 6MF10130FD030AA0