OMICRON

CMC 356

Reference Manual

Article Number VESD2003 - Version CMC356.AE.7 - Year: 2013

TABLE OF CONTENTS

Preface

The purpose of this reference manual is to familiarize users with the *CMC 356* test set and to show how to properly use it in various application areas.

The manual contains important tips on how to use the *CMC 356* safely, properly, and efficiently. Its purpose is to help you avoid danger, repair costs, and down time as well as to help maintain the reliability and life of the *CMC 356*.

This manual is to be supplemented by existing national safety standards for accident prevention and environmental protection.

The reference manual should always be available at the site where the *CMC 356* is used. It should be read by all personnel operating the test set.

Note: The OMICRON *Test Universe* software also installs a PDF version of this reference manual. It can directly be opened by a mouse-click from the help topic "User Manuals of OMICRON Test Universe".

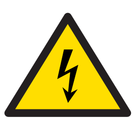
In addition to the reference manual and the applicable safety regulations in the country and at the site of operation, the usual technical procedures for safe and competent work should be heeded.

Note: This reference manual describes the *CMC 356* hardware - that is, the physical test set. In order to get familiar with the software for controlling and configuring the *CMC 356*, please refer to the software manuals and/or the OMICRON *Test Universe* Help.

For Your Safety Please Note

The CMC 356 test set can output life-hazardous voltages and currents.

Throughout the manual, this symbol indicates special safety-relevant notes/directions linked to the possibility of touching live voltages and/or currents. Please thoroughly read and follow those directions to avoid life-hazardous situations.



This symbol indicates potential hazards by electrical voltages/currents caused by, for example, wrong connections, short-circuits, technically inadequate or faulty equipment or by disregarding the safety notes of the following sections.

Safety Instructions

Before operating the *CMC 356* test set, carefully read the following safety instructions.

Only operate (or even turn on) the *CMC 356* after you have read this reference manual and fully understood the instructions herein.

The *CMC 356* may only be operated by trained personnel. Any maloperation can result in damage to property or persons.

Rules for Use

- The *CMC 356* should only be used when in a technically sound condition. Its use should be in accordance with the safety regulations for the specific job site and application. Always be aware of the dangers of the high voltages and currents associated with this equipment. Pay attention to the information provided in the reference manual and the software documentation.
- The *CMC 356* is exclusively intended for the application areas specified in section 1, "Designated Use" on page 11. The manufacturer/ distributors are not liable for damage resulting from unintended usage. The user alone assumes all responsibility and risk.
- The instructions provided in this reference manual and the associated software manuals are considered part of the rules governing proper usage.
- Do not open the *CMC 356* or remove any of its housing components.

Orderly Practices and Procedures

- The reference manual (or its "electronic PDF pendant", which is installed to your computer with the OMICRON Test Universe software) should always be available on site where the *CMC 356* is used.

  Note: The OMICRON *Test Universe* software also installs a PDF version of this reference manual. It can directly be opened by a mouse-click from the help topic "User Manuals of OMICRON Test Universe". The *Test Universe* Help can be launched by clicking **Help** on the *Start Page*.
- Personnel assigned to using the *CMC 356* must have read this reference manual and fully understood the instructions herein.
- Do not carry out any modifications, extensions or adaptations at the *CMC 356*.

Operator Qualifications

- Testing with the *CMC 356* should only be carried out by authorized and qualified personnel.
- Personnel receiving training, instruction, direction, or education on the *CMC 356* should remain under the constant supervision of an experienced operator while working with the equipment.

Safe Operation Procedures

- Follow the instructions in sections 3.2 and 3.4 that describe the safe use of the connecting cables and how to set the *CMC 356* into operation.
- The *CMC 356* must only be used from a power outlet that has a protective earth.
- Do not block the access to safety-relevant test set components like the main power switch or the power cord. In cases of an emergency, these components need free and quick access.
- Do not connect any of the front panel VOLTAGE/CURRENT OUTPUTS 1 ... 3 or VOLTAGE OUTPUT 4, respectively, to protective earth. The N sockets, however, may be connected to protective earth.
- When connecting to the banana plug sockets, only use cables with 4 mm/0.16 " safety banana connectors and plastic housing. Always insert plugs completely.
- Before connecting and disconnecting test objects, verify that all outputs have been turned off. Never connect or disconnect a test object while the outputs are active.
- When disconnecting power supply cables or test leads, always start from the device feeding the power or signal.
- All sockets on the front panel are to be considered dangerous with working voltages up to 300 V_{rms}. Only use cables that meet these respective requirements to connect to the equipment.
- Red Signal Light ⚠:
  If the voltage on any of the four voltage outputs or on the "AUX DC" output exceeds 42 V, the associated signal light lights up.
- Do not insert objects (e.g., screwdrivers, etc.) into the sockets or into the ventilation slots.
- Do not operate the *CMC 356* under wet or moist conditions (condensation).

- Do not operate the *CMC 356* when explosive gas or vapors are present.
- Connect only external devices to the *CMC 356* interfaces "USB", “ETH”, "LL out" and "ext. Interf." that meet the requirements for SELV equipment (SELV = Safety Extra Low Voltage) according to EN 60950 or IEC 60950.
- For applications drawing DC current: The load may not exceed 3 mH because of dangerous feedback current.
- When setting up the *CMC 356*, make sure that the air slots on the back, top, and bottom of the test set remain unobstructed.
- Voltages up to 1 kV can be present inside the *CMC 356*! Therefore, opening the *CMC 356* is only permitted by qualified experts either at the factory or at certified external repair centers.
- If the *CMC 356* is opened by the customer, all guarantees are invalidated.
- *CMC 356* Ethernet functionality (see section 5.2.2, "Ethernet Ports ETH1 and ETH2" on page 33):
  - It is a product of laser class 1 (EN 60825, IEC 60825).
  - Connect ETH1 **only** to Ethernet ports.
- If the *CMC 356* seems to be functioning improperly, please contact the OMICRON Technical Support (see section "OMICRON Service Centers" on page 85).

Changing the Power Fuse

- Unplug the power cord between the test set and the power source.
- The fuse is located at the back of the test set.
- Fuse type: **T12.5 AH 250 V** (wire fuse 5 × 20 mm).

  For safety reasons please use only fuse types recommended by the manufacturer. Refer to 6.1, "Main Power Supply" on page 39 for more information.

1 Designated Use

The *CMC 356* is a computer-controlled test set for the testing of:

- protection relays
- transducers
- energy meters
- PQ (power quality) analyzers.

In addition to the test functions, optional high-performance measurement functions [0 Hz (DC) ... 10 kHz] for ten analog inputs are available.

The *CMC 356* is part of the OMICRON *Test Universe* which, in addition to the physical test set, consists of a test software for a computer with Windows[1] operating system, and, when needed, external voltage and/or current amplifiers, GPS or IRIG-B synchronization units or other accessories.

Features of the ***CMC 356*****:**

- Output of test quantities:
  - 4 × voltage
  - two galvanically separated three-phase current outputs.
- Capability of protection testing with IEC 61850 devices.
- Control of external amplifiers through the low-level interface (6 additional test signals with a standard test set at LL out 1-6; six more test signals with the **LLO-2** (**l**ow **l**evel **o**utputs 7-12) option.
- Supply of DC voltages to the test object.
- Output of binary signals.
- Capture of binary signals and counter impulses.
- Option ELT-1:
  Measurement and analysis of DC and AC voltages and currents by means of a clip-on probe (refer to section 6.10, "Option ELT-1" on page 68) or a measurement shunt.

Any other use of the *CMC 356* is considered improper and may result in damage to property or persons.

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1 Windows is a US registered trademark of Microsoft Corporation.

2 Introduction

The *CMC 356* is a part of the OMICRON *Test Universe* which, in addition to the physical test set, consists of a test software for a computer with Microsoft Windows operating system, and, when needed, external voltage and/or current amplifiers, GPS or IRIG-B synchronization units or other accessories.

This reference manual describes the hardware of the *CMC 356*. The configuration and control of the *CMC 356* is carried out by the test software of the OMICRON *Test Universe*. For more detailed information, please read the user manuals and the OMICRON *Test Universe* Help.

Note: The OMICRON *Test Universe* software also installs a PDF version of this reference manual. It can directly be opened by a mouse-click from the *Test Universe* Help topic "User Manuals".

2.1 Options Available for the CMC 356 Test Set

The following options are available for the *CMC 356* test set:

- **ELT-1**

  This hardware option enables:

  - Measurement of analog signals using the combined BINARY / ANALOG INPUT sockets.
  - High-precision measurement of DC signals using the ANALOG DC INPUT sockets.

  For detailed information, please refer to section 6.10, "Option ELT-1" on page 68).

- **LLO-2** (**l**ow **l**evel **o**utputs 7-12)

  SELV interface connector holding two independent generator triples (SELV = Safety Extra Low Voltage). These six additional high accuracy analog signal sources can serve to either control an external amplifier or to directly provide small signal outputs.

  For more information please refer section 6.3.5, "Low Level Outputs "LL out" for External Amplifiers" on page 52.

- **FL-6**

  In a number of countries (e.g., Japan), the export of multiphase generators able to output steady signals with a frequency between 600 Hz and 2000 Hz is not permitted.

  The **FL-6** option constraints the maximum fundamental frequency that the test set can generate to 599 Hz. Test sets with the FL-6 option can therefore be exported without any restrictions (refer to 6.3, "Outputs" on page 41).

3 Operating the CMC 356

Only operate (or even turn on) the *CMC 356* after you have read this reference manual and fully understood the instructions herein.

3.1 System Components

Before operating the *CMC 356* for the first time, use the packing list to verify that all components of the test system are available.

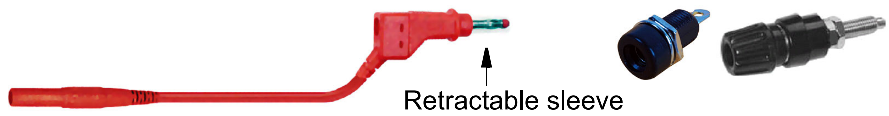
To set the *CMC 356* into operation you need the following components:

- *CMC 356* with (mains) power cable
- Connecting cable *CMC 356* ↔ PC
- Connecting cable *CMC 356* ↔ test object
- A computer equipped with the OMICRON *Test Universe* software.

3.2 Safe Use of the Connecting Cables

3.2.1 Test Lead Adapter for Non-Safety Sockets

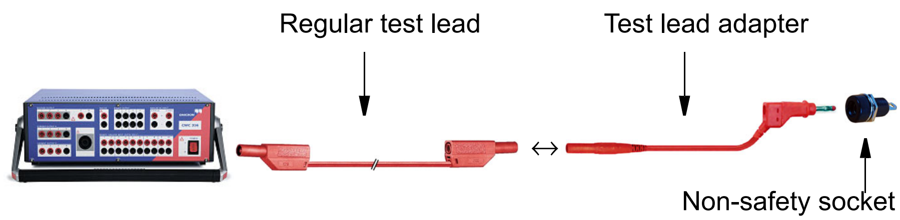
The optional CMC Wiring Accessory Package includes flexible test lead adapters of 5 cm/2 " length with a retractable sleeve (6 x black, 6 x red).



These test leads are to be used as **adapters**, only. They are intended to make the 4 mm/0.16 " banana plugs of the standard test leads fit into non-safety sockets (see illustration above).

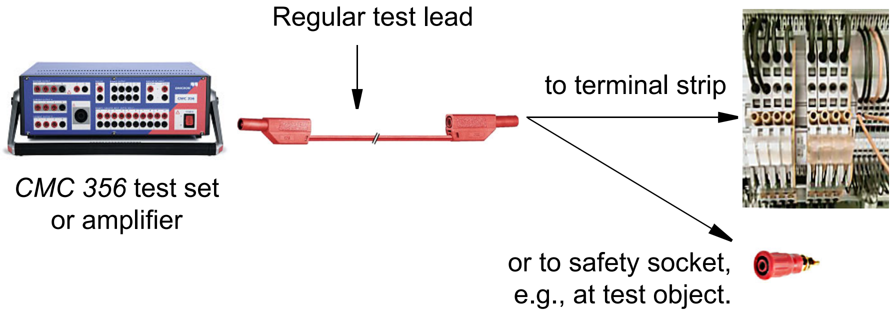
Never directly insert one of these retractable sleeves into a *CMC 356* output socket at the front of the test set. This does not comply with the designated purpose of these leads and is contrary to the safety regulations.

Plug **only the regular test leads** of 2.0 m/6 ft. length into the *CMC 356* output safety sockets.



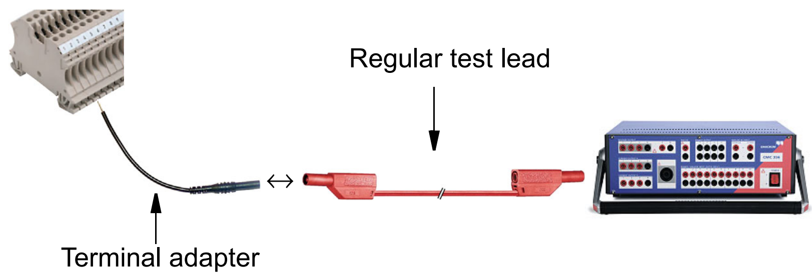
3.3 Regular Test Leads for Safety Sockets

Use the regular test leads of 2.0 m/6 ft. length to connect the *CMC 356* output to other safety sockets of, for example, amplifiers, test objects or to banana adapters in control cabinets.



3.3.1 Terminal adapters

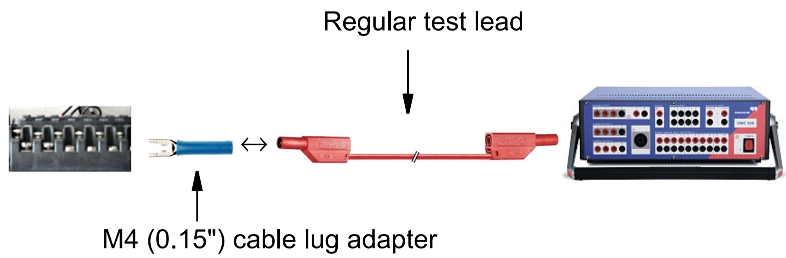
The optional CMC Wiring Accessory Package includes flexible terminal adapters to connect the regular test leads to screw-clamp terminals.



The terminal adapters have blank ends. Therefore, turn off the voltage before connecting these adapters. Always insert an adapter with its blank end into the terminal strip first, and fasten it before connecting it to a test lead.

3.3.2 M4 (0.15") Cable Lug Adapters

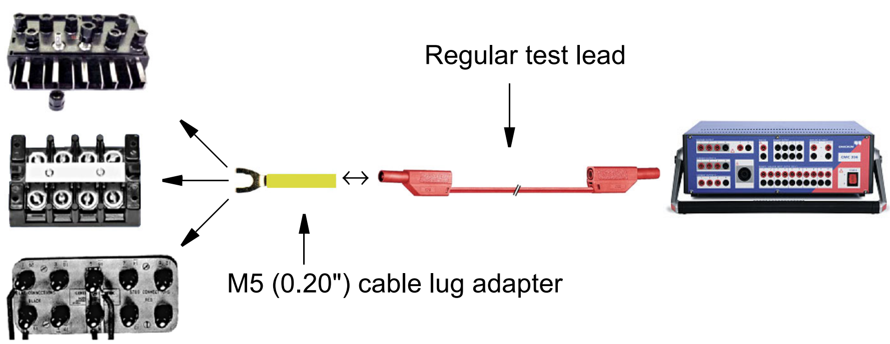
The optional CMC Wiring Accessory Package includes M4 (0.15") cable lug adapters to connect regular test leads to screw-clamp terminals of SEL/ABB/GE relays (and others).



The cable lugs have blank ends. Therefore, turn off the voltage before connecting such a lug. Always insert the cable lug with its blank end into the terminal strip first, and fasten it, before connecting it to a test lead.

3.3.3 M5 (0.20") Cable Lug Adapters

The optional CMC Wiring Accessory Package includes M5 (0.20") cable lug adapters to connect regular test leads to common and most widespread screw-clamp terminal types.



The cable lugs have blank ends. Therefore, turn off the voltage before connecting such a lug. Always insert the cable lug with its blank end into the terminal strip first, and fasten it, before connecting it to a test lead.

3.4 Starting the Test System

The following description assumes that the computer has been set up and that the test software for the OMICRON *Test Universe* has been installed.

At this point of time you may want to have a look at the **Getting Started with Test Universe** manual. This manual guides you through the first steps and actions with the *Test Universe* software. Learn

- how to associate a CMC test set with your computer and what to do if the association won't work
- about the *Test Universe Start Page*
- how to output voltages and currents with your CMC test set using the QuickCMC test module
- how to set up a test with **Test Object** and **Hardware Configuration**.

This manual is provided in PDF format. It is available on your hard disk after the installation of OMICRON *Test Universe*. To view the manual, start the *Test Universe* Help from the *Start Page* or any test module and navigate to the table of contents entry **User Manuals** (at the beginning of the table of contents). Click **Test Universe Software Manuals**. In this topic you find a direct link at "Getting Started". To view the manual, click the link.

This description refers both to the computer and to the *CMC 356*. It does not take into consideration any external devices. If the system is driven by external amplifiers, follow the instructions in section 7.5, "Operation with External Amplifiers" on page 101.

When setting up the *CMC 356*, make sure not to obstruct the ventilation slots.

Connecting the system components[1]:

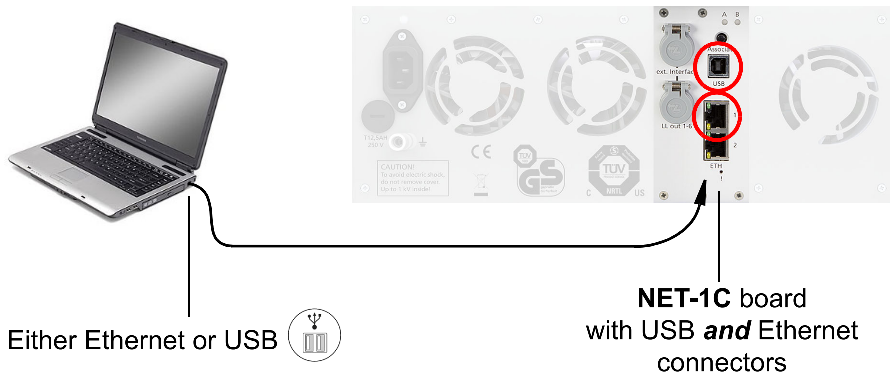


Figure 3-1:
Connecting the *CMC 356* to the computer

1. Connect the *CMC 356*:
   - from the Ethernet connector ETH1 at the CMC's rear side (available on NET-1, NET-1B & NET-1C board) to your computer's Ethernet port
   - or from the USB port of the CMC's **NET-1C** board to your computer's USB port

   For more information about the NET-1(x) boards, refer to section "Technical Data of the Communication Ports" on page 74.

   For instructions how to incorporate network-capable CMC test sets like the *CMC 356* into a computer network, refer to the **Getting Started with Test Universe** manual. To view the manual, start the *Test Universe* Help from the *Start Page* or any test module and navigate to the table of contents entry **User Manuals** (at the beginning of the table of contents). Click **Test Universe Software Manuals**. In this topic you find a direct link at "Getting Started". To view the manual, click the link.
2. Connect the *CMC 356* test set to the mains.
3. Turn on both devices.
4. Start the OMICRON *Test Universe* software.

   A comprehensive hardware test is carried out on the *CMC 356*. In the process, switching sounds from relays in the CMC test set can be heard. If any irregularities are determined during the course of this self-test, the software displays a corresponding error message on the PC monitor (refer to section 8, "Troubleshooting" on page 103).

[1] To ensure the required EMC compatibility, we strongly recommend to use the OMICRON-supplied cable, only.

4 SETUP AND FUNCTION

The computer-controlled OMICRON test system employs the concept of a functional division between the software running on the computer and the *CMC 356* hardware connected to the test object.

OMICRON *Test Universe* test software running on the computer

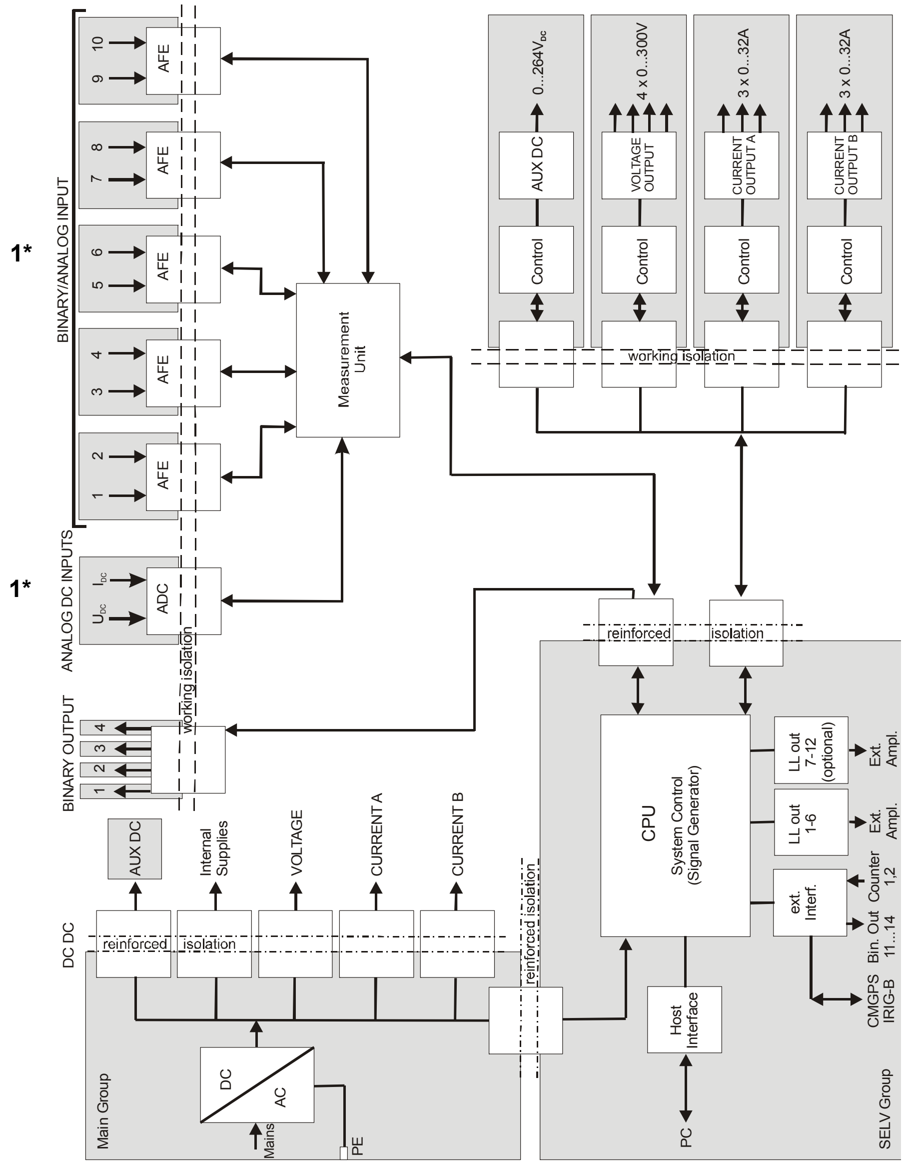
- controls the test signals
- processes measurement data
- creates reports
- generates data entries.

The *CMC 356* test set

- creates test signals (currents, voltages, binary signals)
- measures the reaction (analog and binary) from the test object
- supplies DC-current to test objects.

4.1 Block Diagram

Figure 4-1:
Main block diagram of the *CMC 356*



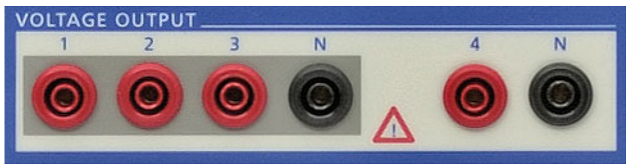
1* Note regarding the hardware option ELT-1:
The hardware option ELT-1 enables the measurement of analog signals using the *CMC 356*. In the standard configuration (*CMC 356* without option ELT-1), the inputs BINARY/ANALOG INPUT 1 - 10 can only be used as binary inputs, and DC inputs are not available.

The block schematic diagram in figure 4-1 shows all externally accessible signals with gray shading. Every gray area represents a galvanic group that is isolated from all of the other galvanic groups.

The power connection ("power supply group") and the connections for “SELV group” (SELV = Safety Extra Low Voltage) are available on the back of the test set. All other gray shaded groups are available on the front of the test set. The safety relevant isolated circuits (power ↔ SELV, power ↔ front plate, and front plate ↔ SELV) are marked as "reinforced isolation" in the block diagram.

4.1.1 Voltage Output (Voltage Amplifier)

Figure 4-2:
Voltage amplifier
(voltage outputs)



The four voltage outputs have a common neutral N and are galvanically separated from all other outputs of the *CMC 356*. The two black sockets labeled "N" are galvanically connected with one another.

The voltage amplifier and the current amplifiers are linear amplifiers with DC coupling. The voltage outputs work in two ranges:

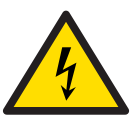
- Range 1: 4 x 0 ... 150 V
- Range 2: 4 x 0 ... 300 V

Protecting the Voltage Outputs

All voltage outputs are protected for open circuits, L-N short-circuits, and overload. Should the heat sink overheat, a thermal switch turns off all outputs.

Overload Warning Flagged in the Software

When a voltage output is overloaded, a corresponding warning is displayed in the user interface of the test software of the OMICRON *Test Universe*.



Do not connect any of the VOLTAGE OUTPUTS 1 ... 3 or VOLTAGE OUTPUT 4, respectively, to protective earth. The N sockets, however, may be connected to protective earth.

4.1.2 Current Output (Current Amplifier)

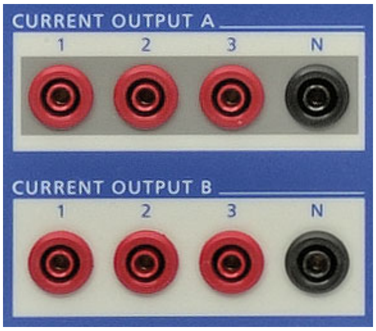


Figure 4-3:
CMC 356 current outputs groups A & B

CURRENT OUTPUT A

CURRENT OUTPUT B

Two galvanically separated three-phase current outputs, each with their own neutral (N).

Each output is galvanically separated from all other connections of the *CMC 356*.

The current amplifiers are implemented as switched mode amplifiers with DC coupling. With this technology it is possible to achieve high power density in a very compact structure. The DC coupling enables a precise reproduction of transients or DC offsets.

Protecting the Current Outputs

All current outputs are protected for open circuits, short-circuits, and overload. If the heat sink overheats, a thermo switch turns off all outputs. The output sockets are internally protected against currents > 45 A_{peak} (32 A_{rms}; the *CMC 356* switches off with the error message "current on neutral too high").

In non-operative state, relay contacts (as illustrated in figure 5-3) protect the current amplifier from external power by shortening the outputs to N.

Caution: If there is an in-feed from an external source, the current outputs can be damaged or destroyed.

Overload Warning Flagged in the Software

When a current output is overloaded, a corresponding warning is displayed in the user interface of the test software of the OMICRON *Test Universe.*

Please see also section 7.1, "Safety Instructions for High Current Output" on page 93.

4.1.3 Binary / Analog Input (Binary Inputs 1 - 10)

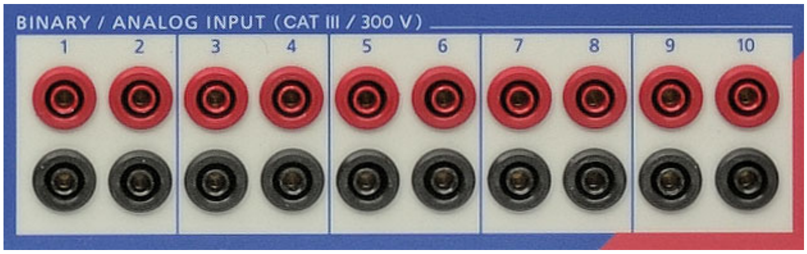


Figure 4-4:
Binary/analog inputs 1 - 10

The ten binary inputs are divided into five groups of two, each group galvanically separated from the others. If the hardware option ELT-1 is installed, all inputs can be configured individually by the software as binary or analog measurement inputs (refer to section 6.10, "Option ELT-1" on page 68).

The input signals are monitored with a time resolution of 100 µs and then evaluated in the CPU.

The binary inputs are configured from the Hardware Configuration module of the OMICRON *Test Universe* software. When doing so, it can be specified whether the contacts are potential-sensitive or not. When the contacts are potential-sensitive, the expected nominal voltage and pick-up threshold can be set for each binary input.

Moreover, the binary inputs 1 – 10 can be used as counter inputs for input frequencies up to 3 kHz.

More detailed information about the configuration of the binary inputs can be found in the OMICRON *Test Universe* Help.

4.1.4 Binary Output

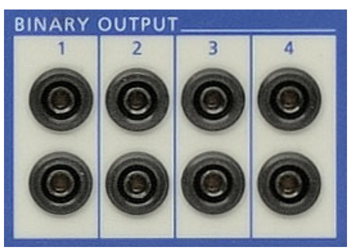


Figure 4-5:
Binary outputs

Four binary outputs are available for use as potential-free relay contacts.

More detailed information about the configuration of the binary outputs can be found in the OMICRON *Test Universe* Help.

4.1.5 AUX DC (DC Power for Test Objects)

Figure 4-6:
DC power for test objects (AUX DC)

Test objects that require an auxiliary DC voltage can be fed from the AUX DC output.

The DC voltage that is applied over the AUX DC output can vary from 0 to 264 Volts and is configured using the software.

The AUX DC output is galvanically separated from all other outputs.

The power-up default

By means of the test tool *AuxDC* you can set a so-called power-up default. When the test set is powered-up the next time, the auxiliary DC output is automatically set to this default value. This default value applies until it is deliberately changed again.

Setting a power-up default value means, that immediately after the test set is switched on, this voltage is applied to the auxiliary DC voltage output, regardless whether a computer is connected to it or not.

Caution: The selected voltage can be life-threatening!

Consider storing a power-up default voltage of higher than 0 V a potential danger to future users that may connect other devices to this CMC test set.

We strongly recommend to always set the default value to 0 V before storing the device, or to otherwise attach a warning label to the device housing, such as "*This unit outputs an AuxDC voltage of ___V immediately after powering-up*".

If the voltage on the "AUX DC" output exceeds 42 V, the associated signal light lights up.

More information about the configuration of the AUX DC supply can be found in the OMICRON *Test Universe AuxDC* Help.

4.1.6 CPU

The *CMC 356* CPU (**C**entral **P**rocessing **U**nit) carries out the following tasks:

- Communication with the computer or a network via USB or Ethernet.
- Digital signal generation for all outputs of the test set (including control signals for external amplifiers).
- Generation of a high-accuracy central clock signal with synchronization options using either the *CMGPS 588 or* the *CMGPS* synchronization unit, or the *CMIRIG-B* interface box as time source.
- Monitoring and control of all systems, including external amplifiers, if applicable.

4.1.7 Power Supplies (DC-DC)

An AC/DC converter generates the required DC voltage from 85 to 264 V_{AC} supply voltage (see section 6.1) and ensures adequate EMC filtering.

The power supply to the different modules, that each are part of their own galvanic groups, are implemented using DC-DC converters with reinforced insulation.

4.2 Signal Generation

The generation of sine wave signals with high amplitude and phase accuracy is required in order to achieve output signals with the specified accuracy.

In order to fulfill the requirement for phase-coupled signal sources, signal generation is digitally implemented.

For this, the *CMC 356* employs a high-performance digital signal processor (DSP).

With digital signal generation the system is very flexible. An exact correction of the amplitude, offset, and phase can be carried out in a digital manner through the use of device-specific parameters (i.e., gain, offset, and null phase angle on every channel).

The digital correction assures the best possible long-term drift behavior.

In addition to sine waves, any other periodic or transient signal can be generated.

4.2.1 Accuracy and Signal Quality

The *CMC 356* is a very precise test set with excellent long-term and temperature drift behavior.

To achieve this accuracy, the philosophy was not only to solve signal generation digitally, but also to implement the distribution of signals to the various modules using digital methods. In doing so, the goal of galvanic separation of the individual generator groups was also achieved without loss of accuracy.

In achieving the amplitude accuracy, the drift behavior (temperature and long-term) is of major importance in the voltage references, the digital-analog converters (DAC), the accurate voltage dividers in the voltage amplifiers, and the current shunts in the current amplifiers.

The actual (typical) data is in general about a factor of 3 better than the guaranteed data.

The associated exact measurement media are required for the assurance of the accuracy in the production. The measurement media used by OMICRON are regularly calibrated by an accredited calibration institute so that tracing to international standards can be assured.

5 Connections and Interfaces

5.1 Front Panel Connections

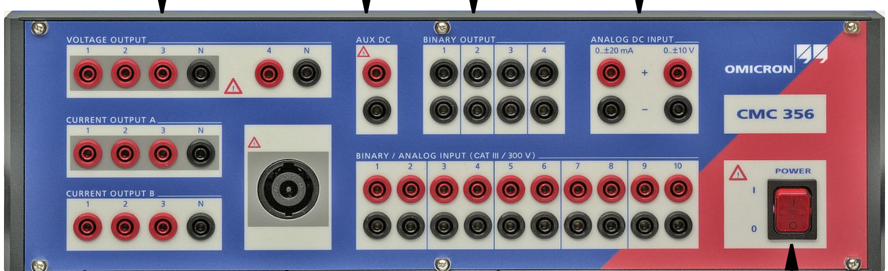
Figure 5-1:
Front view of the *CMC 356*

AUX DC
Output voltage in 3 ranges from 0 - 264 V; used to supply power to test objects.

VOLTAGE OUTPUT
4 x 300 V_{rms} output of the internal voltage amplifier; outputs 1 - 3 also applied to the generator combination socket.

BINARY OUTPUT
Four potential-free relay contacts.

ANALOG DC INPUT (with option ELT-1 only)
0 - ±1 mA / 0 - ±20 mA:
DC current inputs.
0 - ±10 V:
DC voltage inputs.



Power Switch

Generator combination socket
8-pole combination socket for VOLTAGE OUTPUT 1-3 and CURRENT OUTPUT A (up to 3 × 25 A max.).

Warning indication:
Dangerous Voltage!

At least one of the output voltages exceeds 42 V.

BINARY / ANALOG INPUT
10 binary inputs in 5 galvanically separated groups.

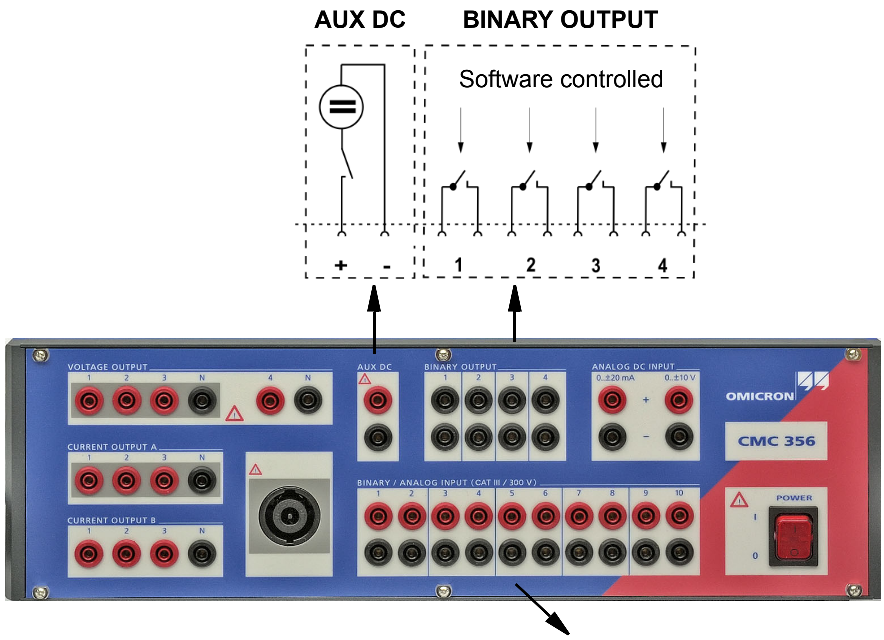
Hardware option ELT-1:
The inputs can be configured as analog measurement inputs. Without option ELT-1 only binary inputs are available.

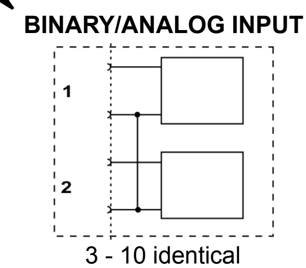
CURRENT OUTPUT

Group A: 3 x32 A_{rms} output of the internal current amplifier; also applied to the generator combination socket.

Group B: 3 x32 A_{rms} output of the internal current amplifier.

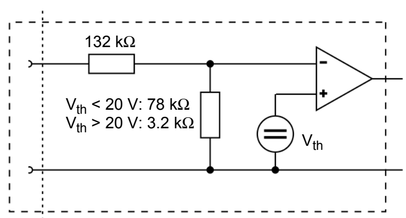
Figure 5-2:
Simplified circuit diagrams of binary inputs and outputs (*CMC 356* standard, without option ELT-1 installed)



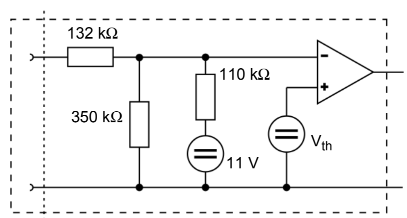


Each binary input can be configured individually for wet or dry operation.

Two inputs (1 + 2, 3 + 4, ...) are one potential group. The inputs grouped in one potential group share a common ground.



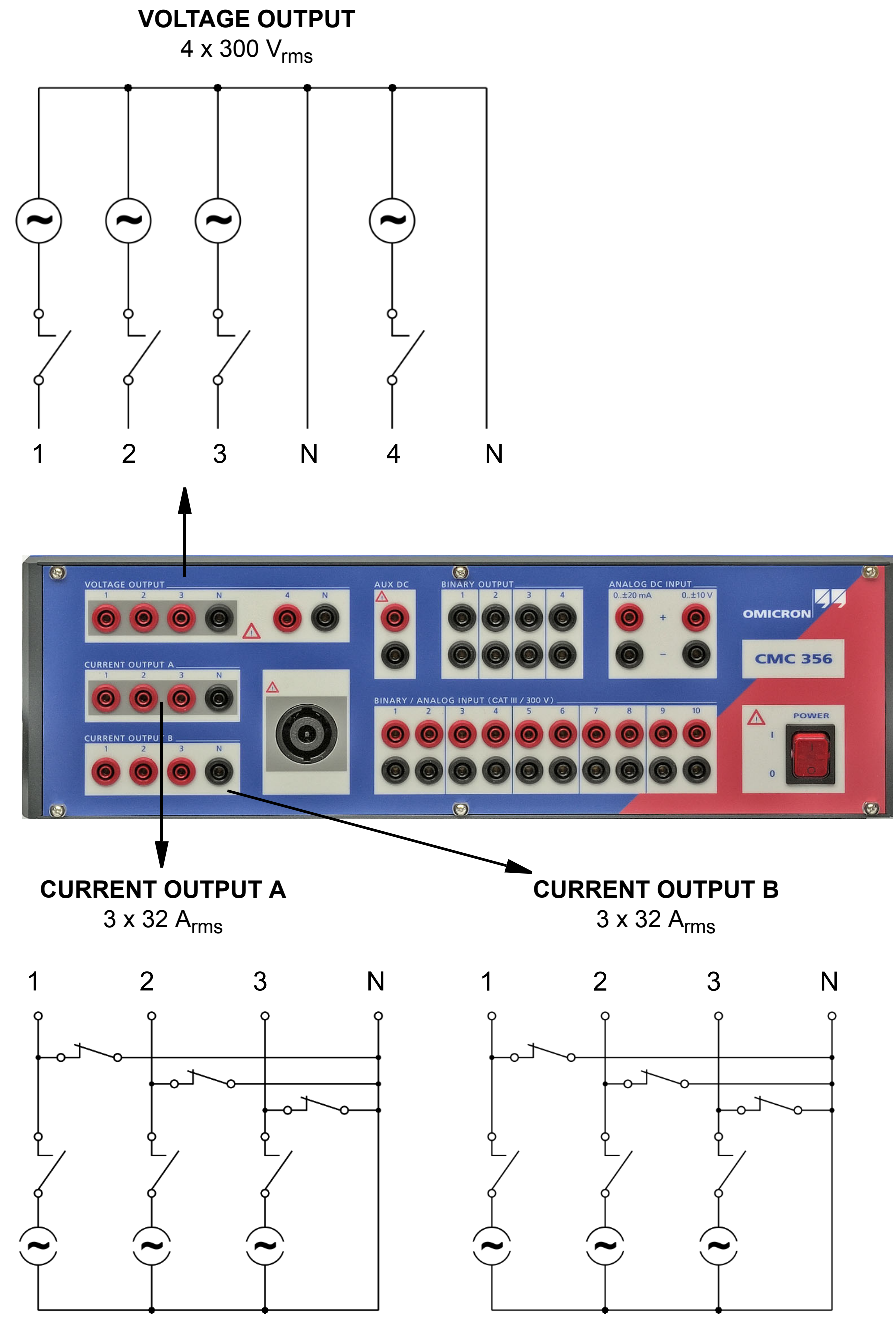
Circuit diagram of a binary input with programmable threshold voltage (wet operation)



Circuit diagram of a binary input for potential-free operation (dry)

Note: For simplified circuit diagrams of the inputs BINARY/ANALOG INPUTS and ANALOG DC INPUT of the *CMC 356* with hardware option ELT-1 installed, please refer to Figure 6-19 on page 73.

Figure 5-3:
Simplified diagrams of current and voltage outputs

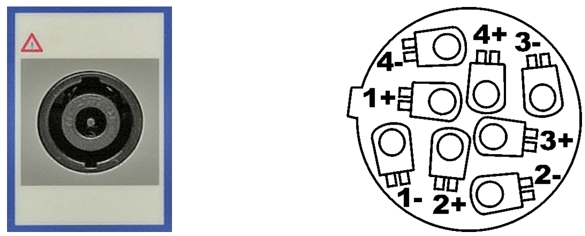


In non-operative state, relay contacts (as illustrated in figure 5-3) protect the current amplifier from external power by shortening the outputs to N.

5.1.1 Generator Combination Socket for VOLTAGE OUTPUT and CURRENT OUTPUT

The combination socket CURRENT OUTPUT / VOLTAGE OUTPUT simplifies the connection of test objects to the *CMC 356*. The three voltage outputs (VOLTAGE OUTPUT 1-3) as well as the CURRENT OUTPUT A are wired to the combination socket (refer to table 5-1 on page 31).

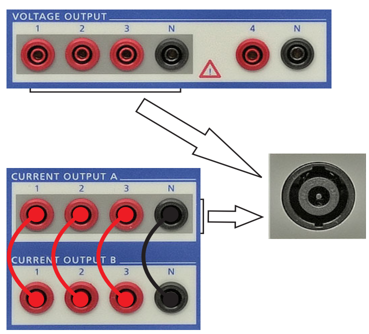
Figure 5-4: Generator combination socket



Front view

View onto the connector from the rear cable wiring side

Figure 5-5: CURRENT OUTPUT A and B wired to the combination socket



The combination socket can also be used to connect to CURRENT OUTPUT A and B (wired in parallel).

WARNING:
The connections on the socket are dangerous when the test set is turned on.   Follow the safety information provided at the beginning of this manual when connecting the generator combination sockets.   If a dangerous voltage (greater than 42 V) is applied to the socket, a warning indicator lights above the socket.   For currents greater than 25 A, the test object (load) should be exclusively connected to the 4 mm/0.16 " banana sockets and not on the generator connection socket.

Table 5-1:
Pin layout

Pin	Signal
1-	VOLTAGE N
2-	VOLTAGE 3
3-	VOLTAGE 2
4-	VOLTAGE 1
1+	CURRENT A 1
2+	CURRENT A N
3+	CURRENT A 3
4+	CURRENT A 2

Note: If using negative sequence phase rotation, swap the connectors VOLTAGE 2 and VOLTAGE 3 as well as CURRENT 2 and CURRENT 3.

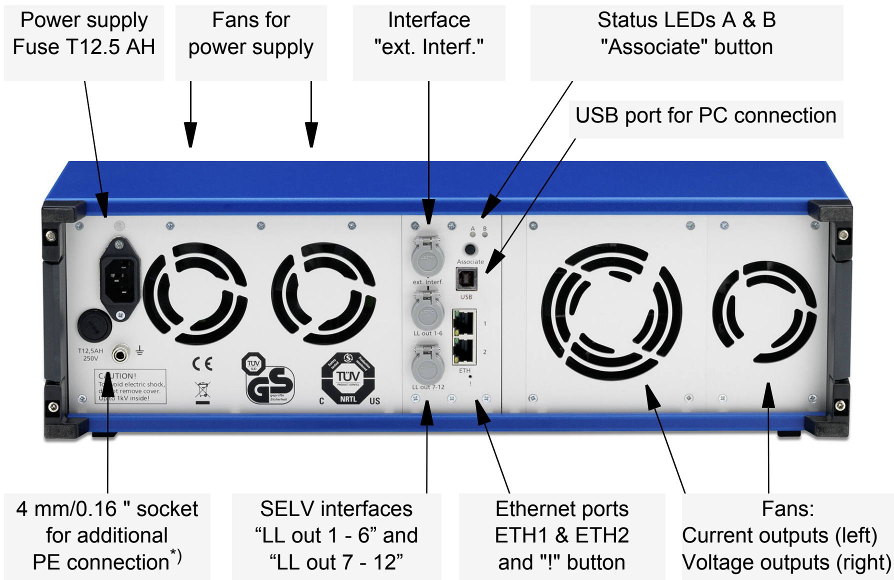
Table 5-2:
Manufacturer ordering information

Description of the generator combination socket	
Description	SPEAKON LINE 8-pole
Article Number	NL8FC
Manufacturer	Neutrik (www.neutrik.com)

You can order the plug for generator combination socket directly from OMICRON.

5.2 Connections on the Back Panel

Figure 5-6:
Rear view of *CMC 356*



*) For example to connect to low resistance grounding bars.

☞ The SELV interface LL out 7 - 12 is optional. Please refer to section 6.11, "Option LLO-2 (Low Level Outputs)" on page 91.

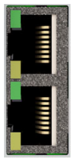
5.2.1 USB Port

The test set’s standard interface **NET-1C** board holds a **USB** port to connect the *CMC 356* to your computer. To ensure the required EMC compatibility, we strongly recommend to use the OMICRON-supplied cable, only.

☞ Note that a *Test Universe* software of version 3.0 (or later) plus the matching CMC firmware is required for the USB port to work.

For the technical data of the USB port, refer to 6.5.1, "The NET-1C Board" on page 63.

5.2.2 Ethernet Ports ETH1 and ETH2



The **NET-1C** board's two PoE (**P**ower **o**ver **E**thernet) ports ETH1 and ETH2 are standard 10/100Base-TX (twisted pair) Ethernet ports. They support auto crossing (auto MDI/MDIX). This means you can use a standard cable or a cross-over Ethernet patch cable.

Note: If your Ethernet ports ETH1 and ETH2 look different, i.e., ETH2 is the connector version of Fast Ethernet over optical fiber, you have a NET-1 board installed in your test set. Refer to chapter 6.5, "Technical Data of the Communication Ports" on page 63 for further information.

Since the CMC test set can be controlled over a network, any distance between the controlling computer and the test set is possible. This enables direct remote control of the CMC test set, e.g., for end-to-end testing.

The Ethernet ports also provide the basis for the processing of substation protocols according to the IEC 61850 standard. They allow flexible configurations, e.g., for separation of data traffic from different network segments or segregation of substation protocol data and test set control commands.

The green LED indicates a link connection to a PC or a network. The yellow LED indicates active traffic (receiving or transmitting) on the cable.

For detailed technical data about the Ethernet ports, please refer to section 6.5, "Technical Data of the Communication Ports" on page 63.

5.2.3 ! Button

The **!** button enables you to recover from unsuccessful software image downloads or other emergency situations. To start a new software image download, press the **!** button with a pointed tool or a paper clip while powering-up the CMC. In that case, the test set will not start as usual but wait for a new software image download.

5.2.4 Associate Button

The Associate button has the following functions:

- **Association with controlling computer**

  An Ethernet communication port enables you to communicate with any CMC available on the network. This may lead to dangerous situations where a user accidentally connects to a device located on a desk of somebody else, emitting unsafe voltages and endangering the person working there.

To prevent such a situation, a special mechanism is integrated into the CMC test set that allows only “authorized” clients to control the test set. By using the **Associate** button, the test set is registered for use with a specific host computer.

The test set will issue voltages and currents only when it is associated to the client requesting this. The association process can be initiated by the *Test Set Association and Configuration* tool or by the OMICRON *Device Browser*. For more details about this process, refer to the Help of the according tool.

For the association the Ethernet hardware address (MAC) of the controlling computer is remembered. Consequently, if the network interface on the computer has changed, the CMC test set has to be associated whenever the MAC address changes.

- **Reset IP Configuration**

  If the **Associate** button is pressed while powering up the CMC test set, the IP configuration of the network interfaces is reset to factory default, which is DHCP/AutoIP for both network interfaces. It may be necessary to reset the IP configuration in this way to recover from settings with conflicting static IP addresses.

5.2.5 Status LED A, B

The status LED A and B are of interest in case of troubleshooting.

A: yellow status LED

- A lit yellow LED indicates that the test set is ready to be controlled by a computer. The hardware checks in the test set are finished, and the test set is properly connected to a computer or a network.
- The LED is off when the test set is waiting for an "emergency software image download". This is the case when pressing the **!** button while powering-up the CMC test set.

B: green LED

If the yellow LED A is off, the green LED B signals the following conditions:

- LED B blinks slowly: CMC test set waits for the TFTP download (**T**rivial **F**ile **T**ransfer **P**rotocol) of a software image.
- LED B is lit: The TFTP download of the software image is in progress.
- LED B blinks quickly: The computer writes, e.g., the software image to the flash memory of the CMC test set. Do not turn off the CMC test set as long as the writing is in progress.

5.2.6 Ethernet / Network Settings

General

The OMICRON *Test Universe* software running on your the computer communicates with the CMC test set via a network connection. Therefore it is possible to either have the CMC directly connected to the computer's network plug by a cable or to have the CMC and the controlling computer connected to a computer network.

Both network ports can be used equally, and both network ports have link LEDs (green) and traffic LEDs (yellow flashing) to check the physical connectivity and proper cabling.

IP Configuration

For the CMC test set to communicate with the controlling computer and the OMICRON *Test Universe* software, TCP/IP is used. The IP parameters are set by either the *Test Set Association and Configuration* tool or the OMICRON *Device Browser*.

The CMC test set can either be set to static IP addresses or use DHCP (**D**ynamic **H**ost **C**onfiguration **P**rotocol) and AutoIP/APIPA (**A**utomatic **P**rivate **IP A**ddressing).

Additionally, there is a special DHCP server integrated in the CMC test set to serve IP addresses only for that computer the OMICRON *Test Universe* software is running on. Note that this will only take place when there is no DHCP server in the network. If there is a DHCP server in the network, the DHCP feature of the CMC test set remains inactive.

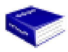
If the IP settings conflict with IP settings of other devices in the network, it is possible to reset the test set to factory defaults (DHCP and AutoIP) by pressing the **Associate** button at the rear of the test set while powering up the test set.

Security / Firewall Settings

To automatically detect and set the IP configuration of CMC test sets in the network, IP multicasts are used by the *Test Universe* software. Therefore, the firewall program has to be configured to allow communication with the CMC test sets. For the Microsoft Windows Firewall in Windows XP SP2 (or later), Windows 7 or Windows 8 the configuration of the firewall is done automatically during installation of the OMICRON *Test Universe*.

For instructions how to incorporate network-capable CMC test sets like the *CMC 356* into a computer network, refer to the **The First Steps to Get Started** chapter of the **Getting Started with Test Universe** manual.

Network Troubleshooting



For a complete list of ports and settings that are needed for the communication please refer to the **Troubleshooting** chapter of the **Getting Started with Test Universe** manual, subsection **Firewall Configuration**.

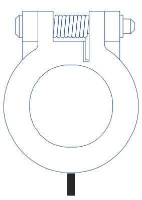
The **Getting Started with Test Universe** manual is available as PDF on your hard disk at *installation folder*\Test Universe\Doc. For languages other than English, language specific subfolders exist.

To view the manual, start the *Test Universe* Help from the *Start Page* or any test module and navigate to the table of contents entry **User Manuals** (at the beginning of the table of contents). Click **Test Universe Software Manuals**. In this topic you find a direct link at "Getting Started". To view the manual, click the link.

5.2.7 SELV Interfaces

All inputs and outputs to the SELV group (SELV = Safety Extra Low Voltage) reference to a common neutral that is internally connected to the protective earth (GND) of the housing.

5.2.7.1 External Interface ("ext. Interf.")



ext. Interf.

The SELV interface connector "ext. Interf." holds four additional transistor **binary outputs** (Bin. out 11 - 14). Unlike regular relay outputs, Bin. out 11 - 14 are bounce-free binary outputs (small signals) and have a minimal reaction time.

In addition, two high frequency **counter inputs** for up to 100 kHz are available for the testing of energy meters.

For more detailed information please refer to the technical data section 6.3.6, "Low-Level Binary Outputs ("ext. Interf.")" on page 54.

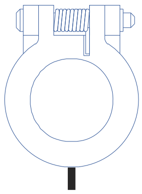
Meter Testing

For energy meter test applications, the "ext. Interf." grants easy connectivity.

Synchronization

Via the "ext. Interf.", the *CMC 356* time base can be GPS- and IRIG-B-synchronized. Depending on the synchronization method of your choice, use either the *CMGPS* synchronization unit or the *CMIRIG-B* interface box.

5.2.7.2 LL out 1-6 (Low Level Outputs 1-6)



LL out 1 - 6

The SELV interface connector "LL out 1 - 6" holds two independent generator triples. These six high accuracy analog signal sources can serve to either control an external amplifier or to directly provide small signal outputs.

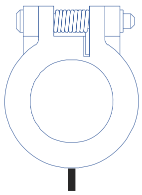
In addition, a serial digital interface is available that transmits control and monitor functions between the *CMC 356* and the external amplifiers. Supported devices are *CMA 156*, *CMA 56*[1], *CMS 156*, *CMS 251*[1] and *CMS 252*[1].

The low level outputs are short-circuit-proof and continually monitored for overload.

Connect the external amplifier to the *CMC 356* low level outputs. Use the connecting cable that was supplied with the amplifier.

For more detailed information please refer to the technical data section 6.3.5, "Low Level Outputs "LL out" for External Amplifiers" on page 52.

5.2.7.3 LL out 7-12 (Low Level Outputs 7-12) - Option "LLO-2"



LL out 7 - 12

The SELV interface connector "LL out 7 - 12" is optionally available for the *CMC 356* test set.

The outputs 7-12 extend the low level outputs 1-6 by two more independent generator triples. Outputs 7-12 are technically identical to outputs 1-6 as described above.

For more detailed information please refer to the technical data section 6.11, "Option LLO-2 (Low Level Outputs)" on page 91.

Overload Warning Flagged in the Software

When a low level output is overloaded, a corresponding warning message appears on the user interface of the OMICRON *Test Universe* software.

1 These products are not available anymore.

6 Technical Data

Guaranteed Values:

- General:

  The values are valid for the period of one year after factory calibration, within 23 °C ± 5 °C at nominal value and after a warm-up time greater than 25 min.

- Guaranteed values from the generator outputs:

  The values are valid in the frequency range from 10 to 100 Hz unless specified otherwise. Given maximum phase errors are related to the voltage amplifier outputs.

- Accuracy data for analog outputs are valid in the frequency range from 0 to 100 Hz unless specified otherwise.
- The given input/output accuracy values relate to the range limit value (% of range limit value).

6.1 Main Power Supply

Table 6-1:
Power supply data

Main Power Supply	
Connection	Connector according to IEC 60320
Voltage, single phase nominal voltage operational range	 100 - 240 V_{AC} 85 ... 264 V_{AC}
Power fuse	T 12.5 AH 250 V (5 x 20 mm) "Schurter", order number 0001.2515
Nominal current[1]	at < 170 V: 12 A max. at > 170 V: 10 A max.
Frequency nominal frequency operational range	 50/60 Hz 45 ... 65 Hz
Overvoltage category	II

1 Refer to section 6.3.4, "Operational Limits in Conjunction with Mains Supply" on page 51.

6.2 Insulation Coordination

Table 6-2:
Insulation coordination

Insulation Coordination	
Overvoltage category	II
Pollution degree	2 (except for Binary Inputs)
Insulation of function groups on front panel to ground (GND)[1]	- Basic insulation with maximum voltage of 600 V_{rms} to ground - Clearance: > 3 mm (0.12 ") - Creepage: > 6 mm (0.24 ") - Test voltage: 2200 V_{rms}
Insulation of functional groups on front panel from each other	- Working insulation - Clearance: > 1 mm (0.04 ") - Creepage: > 1 mm (0.04 ") - Test voltage: 1500 VDC
Measurement category (BINARY / ANALOG INPUTS)	- CAT III / 300 V_{rms} - CAT IV / 150 V_{rms}

[1] Functional groups on *CMC 356* front panel:
VOLTAGE OUTPUT, CURRENT OUTPUT (A, B), AUX DC, BINARY OUTPUT, BINARY / ANALOG INPUT, ANALOG DC INPUT

6.3 Outputs

For block diagrams of the available generator outputs, please refer to section 4.1, "Block Diagram" on page 20.

Table 6-3:
Analog current, voltage, and LL outputs.

General Generator Outputs Data (analog current and voltage outputs, outputs "LL out")	
Frequency ranges[1] sinusoidal signals[2] harmonics / interharmonics[3] transient signals	 10 … 1000 Hz 10 … 3000 Hz DC … 3.1 kHz
Frequency resolution	< 5 μHz
Frequency accuracy	± 0.5 ppm
Frequency drift	± 1 ppm
Bandwidth (–3 dB)	3.1 kHz
Phase range φ	- 360° to + 360°
Phase resolution	0.001°
Synchronized operation	Generator outputs can be synchronized to a reference input signal on binary/analog input 10 (range: 40 … 70 Hz).
Temperature drift	0.0025 %/°C

[1] If you purchased the option **FL-6**, the maximum output frequency is constrained to **599 Hz**.
[2] Amplitude derating for current outputs at frequencies above 380 Hz.
[3] Signals above 1 kHz are only supported in selected *Test Universe* modules and are only available on the voltage outputs and the low level outputs.

All voltages and current generators can independently be configured with respect to amplitude, phase angle, and frequency.

All outputs are monitored. Overload conditions result in a message displayed on the PC.

6.3.1 Extended Frequency Range

In selected *Test Universe* modules (e.g., *Harmonics* and *PQ Signal Generator*) the *CMC 356* supports a mode for generating stationary signals up to 3 kHz on the voltage outputs and the low-level outputs. This mode corrects the phase and gain errors of the output filter. The 3 dB bandwidth of this filter limits the amplitude at 3 kHz to about 70 % of the maximum range value. The application of the extended frequency range is the generation of harmonics and interharmonics.

Table 6-4:
Extended frequency range (1 - 3 kHz)

Extended Frequency Range (1 - 3 kHz)		
	Typical	Guaranteed
Low Level Outputs[1]		
Phase error	< 0.25 °	< 1 °
Amplitude error	< 0.25 %	< 1 %
Voltage Amplifier		
Phase error	< 0.25 °	< 1 °
Amplitude error	< 0.25 %	< 1 %

[1] No extended frequency range support for external amplifiers.

6.3.2 Current Outputs

Table 6-5:
Outputs of current groups A and B

Current Outputs[1] (Groups A and B)		
Output currents		
6-phase AC (L-N)	6 x 0 ... 32 A (Group A and B)	
3-phase AC (L-N)	3 x 0 ... 64 A (Group A + B parallel)	
2-phase AC (L-L)[2, 3]	2 x 0 ... 32 A (Group A and B)	
1-phase AC (L-L)[2, 3]	1 x 0 ... 64 A (Group A + B parallel)	
1-phase AC (L-L-L-L)[2, 3]	1 x 0 ... 32 A (Group A + B in series)	
2-phase AC (LL-LN)[2]	2 x 0 ... 64 A (Group A and B)	
1-phase AC (LL-LN)[2]	1 x 0 ... 128 A (Group A + B parallel)	
DC (LL-LN)[2]	1 x 0 ... ±180 A (Group A + B parallel)	
Power[7]	Typical	Guaranteed
6-phase AC (L-N)	6 x 430 VA at 25 A	6 x 250 W at 20 A
3-phase AC (L-N)	3 x 860 VA at 50 A	3 x 500 W at 40 A
2-phase AC (L-L)[2, 3]	2 x 870 VA at 25 A	2 x 550 W at 20 A
1-phase AC (L-L)[2, 3]	1 x 1740 VA at 50 A	1 x 1100 W at 40 A
1-phase AC (L-L-L-L)[2, 3]	1 x 1740 VA at 25 A	1 x 1100 W at 20 A
2-phase AC (LL-LN)[2]	2 x 500 VA at 40 A	2 x 350 W at 40 A
1-phase AC (LL-LN)[2]	1 x 1000 VA at 80 A	1 x 700 W at 80 A
DC (LL-LN)[2]	1 x 1400 W at ±80 A	1 x 1000 W at ±80 A
Accuracy	Typical	Guaranteed
$R_{load} \leq 0.5\ \Omega$	Error < 0.05 % rd.[4] + 0.02% of rg.	Error < 0.15 % of rd. + 0.05% of rg.
$R_{load} > 0.5\ \Omega$	Error < 0.1 % of rg.	Error < 0.3 % of rg.
Harmonic distortion (THD+N)[5,6]	0.05 %	< 0.15 %
Phase error[5]	0.05 °	< 0.2 °
DC offset current	< 3 mA	< 10 mA
Resolution	1 mA, 2 mA (2 phases parallel), ...	
Frequency range[8]	0 … 1000 Hz	
Trigger on overload	Timer accuracy error < 1 ms	
Short-circuit protection	Unlimited	
Open-circuit protection	Open outputs (open-circuit) permitted	
Connection	4 mm/0.16 " banana connectors, amplifier connection socket[9] (OUTPUT A only)	
Insulation	Reinforced insulation of power supply and all SELV interfaces	

Footnotes:

1. Data for three-phase systems are valid for symmetric conditions (0 °, 120 °, 240 °) unless specified otherwise.
2. For wiring of single-phase modes see chapter 7, "Increasing the Output Power, Operating Modes" on page 93.
3. Single-phase mode (in phase opposition).
4. rd. = reading; rg. = range, whereat *n* % of rg. means: *n* % of upper range value.
5. Valid for sinusoidal signals at 50/60 Hz and $R_{load} \leq 0.5\ \Omega$.
6. Values at 20 kHz measurement bandwidth, nominal value, and nominal load.
7. Guaranteed data at 230 V mains for ohmic loads (PF=1); typical data for inductive loads. Refer to section 6.3.4, "Operational Limits in Conjunction with Mains Supply" on page 51.
8. Current amplitude derating at frequencies above 380 Hz (see figure 6-4).
9. For currents > 25 A, connect test object only to the 4 mm/0.16 " banana connections and not to the generator combination socket.

Figure 6-1:
Guaranteed output power per phase of a group and when groups A and B are connected in parallel (active power values in W are guaranteed; apparent power values in VA are typical values)

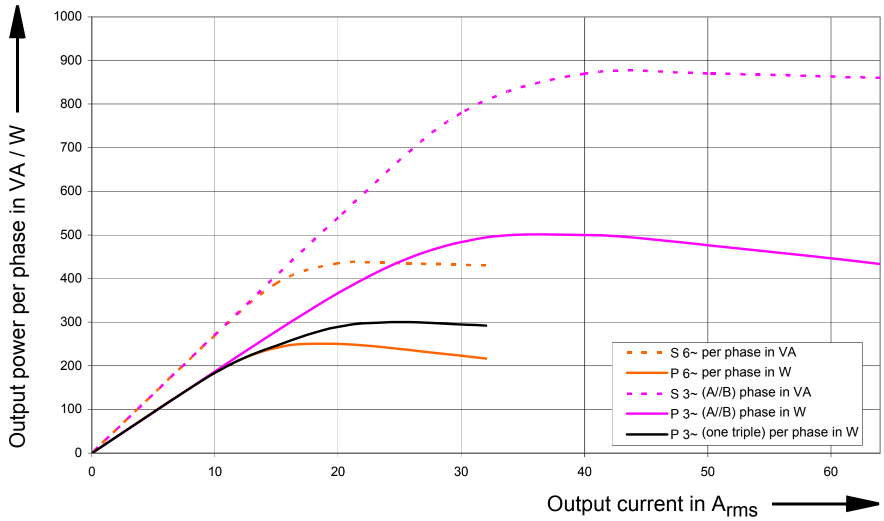
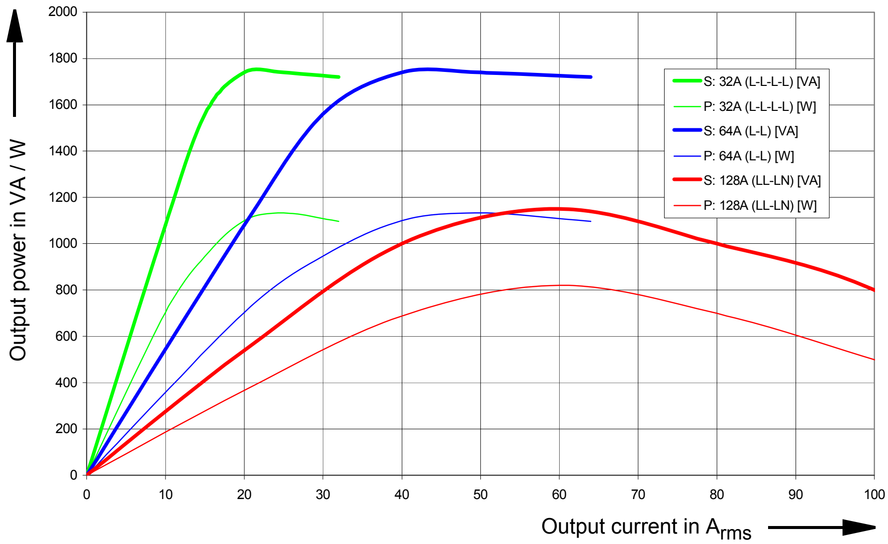
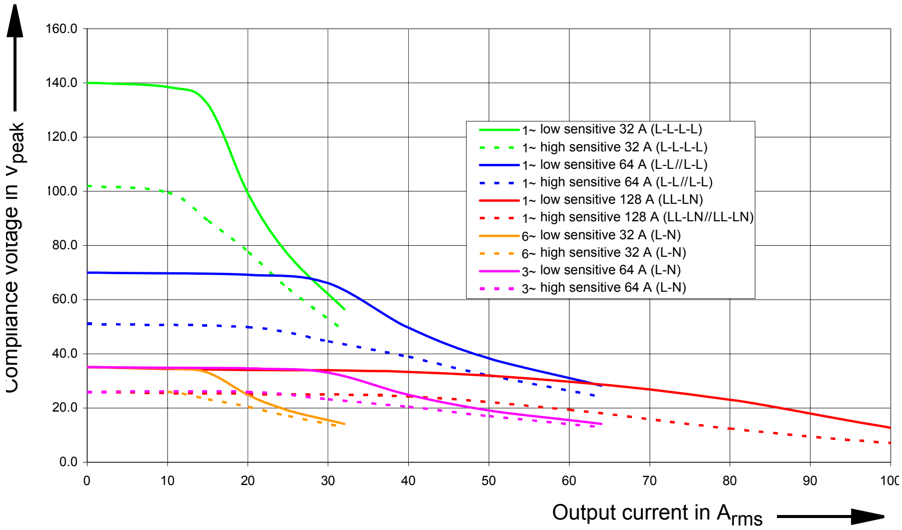


Figure 6-2:
Guaranteed single phase output power curves (active power values in W are guaranteed; apparent power values in VA are typical values)



For additional information refer to section 7.2, "Single-Phase Operation of the CMC 356" on page 94.

Figure 6-3:
Typical compliance voltage (50/60 Hz)



The high and low sensitive curves in figure 6-3 correspond to the overload detection sensitivity settings in the *Test Universe* software. The low sensitive curves show the maximum available peak compliance voltage, which is mainly relevant for testing primary and electromechanical relays.

Figure 6-4:
Current derating at high frequencies for sinusoidal signals

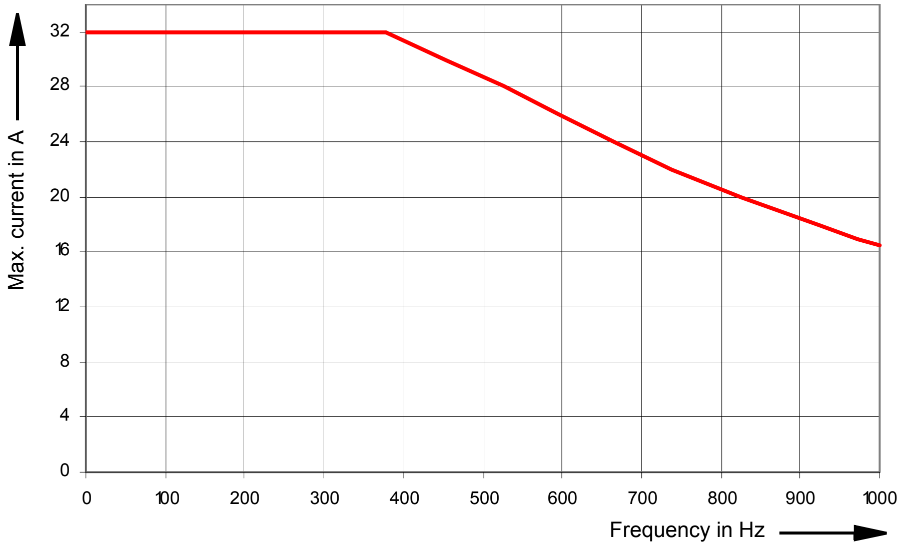


Figure 6-5:
Typical continuous output current and output power at 23 °C;
single-phase mode

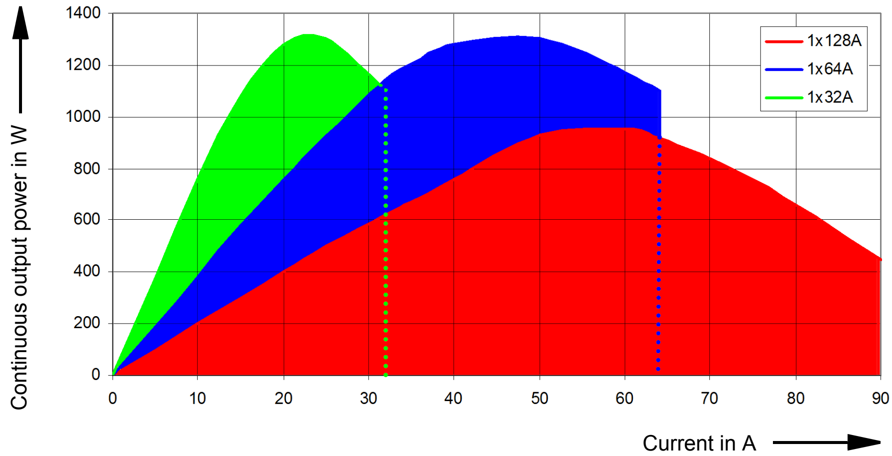
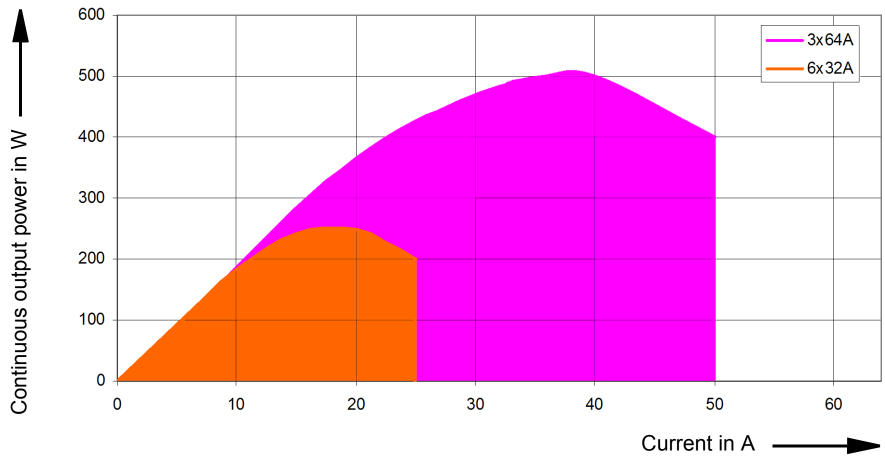


Figure 6-6:
Typical continuous output current and output power at 23 °C;
three- and six-phase mode



The continuous operating range is given by the area below the curves in the figure 6-5 and 6-6 above.

If you don't require more than 64 A, we recommend to use the 1 x 64 A configuration rather than the 128 A one because the 1 x 64 A configuration provides more continuous output power.

Due to the large number of operating modes, it is not possible to give universally applicable curves for the discontinuous mode. However, the examples given below can be used instead to gain feeling for the possible output durations (t1 is the possible duration of a cold device).

Table 6-6:
Typical duty cycles for operation at ambient temperature of 23 °C

6 x 32 A (L-N)					
I [A]	P [W]	duty cycle	t1 [min]	ton [s]	toff [s]
0 ... 25	0 ... 1200	100%	> 30	> 1800	-
26	1400	80%	7.5	80	20
29	1300	75%	6.0	60	20
32	1200	71%	3.5	50	20

3 x 64 A (L-N)					
I [A]	P [W]	duty cycle	t1 [min]	ton [s]	toff [s]
0 ... 50	0 ... 1200	100%	> 30	> 1800	-
52	1400	80%	7.5	80	20
58	1300	75%	6.0	60	20
64	1200	71%	3.5	50	20

1 x 128 A (LL-LN)					
I [A]	P [W]	duty cycle	t1 [min]	ton [s]	toff [s]
0 80	0 ... 700	100%	> 30.0	> 1800	0
100	450	60%	4.9	30	20
120	300	43%	2.6	15	20
128	200	38%	2.0	12	20

6.3.3 Voltage Outputs

Table 6-7:
CMC 356 voltage outputs

Footnotes:

1.a) V_{L4} (t) automatically calculated:
$V_{L4}=(V_{L1}+V_{L2}+V_{L3}) * C$
C: configurable constant from –4 to +4.

b) V_{L4} can be configured by software in frequency, phase, and amplitude.

2. Guaranteed data for ohmic loads, (PF=1). Refer to the accompanying figure of the output power curves.
Refer to section 6.3.4, "Operational Limits in Conjunction with Mains Supply" on page 51.

3. Data for three-phase systems are valid for symmetric conditions (0 °, 120 °, 240 °).

4. Data for four-phase systems are valid for symmetric conditions (0 °, 90 °, 180 °, 270 °).

5. rd. = reading; rg. = range, whereat *n* % of rg. means: *n* % of upper range value.

6. Valid for sinusoidal signals at 50/60 Hz.

7. 20 kHz measurement bandwidth, nominal value, and nominal load.

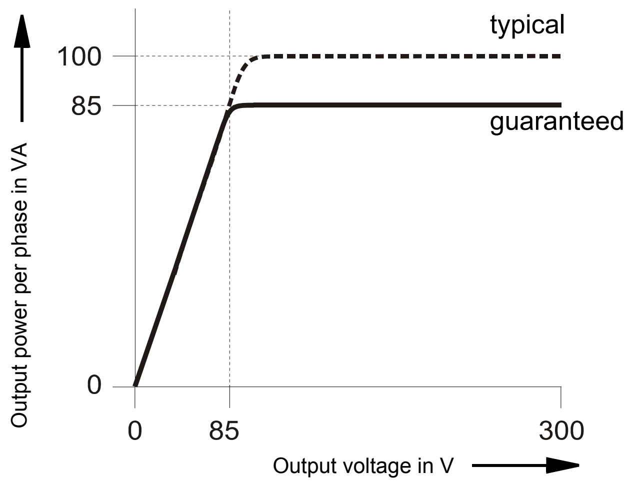
8. If you purchased the option **FL-6**, the maximum output frequency is constrained to **599 Hz**.

4 Voltage Outputs		
Output voltages 3-phase AC (L-N) 4-phase AC (L-N)[1] 1-phase AC (L-N) 1-phase AC (L-L) DC (L-N)	 3 x 0 ... 300 V 4 x 0 ... 300 V 1 x 0 ... 300 V 1 x 0 ... 600 V 4 x 0 ... ± 300 V	
Output power[2]	Typical	Guaranteed
3-phase AC[3] 4-phase AC[4] 1-phase AC (L-N) 1-phase AC (L-L) DC (L-N)	3 x 100 VA at 100 ... 300 V 4 x 75 VA at 100 ... 300 V 1 x 200 VA at 100 ... 300 V 1 x 275 VA at 200 ... 600 V 1 x 420 W at 300 VDC	3 x 85 VA at 85 ... 300 V 4 x 50 VA at 85 ... 300 V 1 x 150 VA at 75 ... 300 V 1 x 250 VA at 200... 600 V 1 x 360 W at 300 VDC
Accuracy	Error < 0.03 % of rd.[5] + 0.01 % of rg.	Error < 0.08 % of rd. + 0.02 % of rg.
Harmonic distortion (THD+N)[6, 7]	0.015 %	< 0.05 %
Phase error[6]	Typical 0.02 °	Guaranteed < 0.1 °
DC offset voltage	< 20 mV	< 100 mV
Voltage ranges	Range I: 0 ... 150 V Range II: 0 ... 300 V	
Resolution	Range I: 5 mV Range II: 10 mV	
Frequency ranges[8]	Sinusoidal signals harmonics/interharm.[9] transient signals	10 … 1000 Hz 10 … 3000 Hz DC … 3.1 kHz
Short-circuit protect.	Unlimited for L - N	
Connection	4 mm/0.16 " banana connectors; amplifier connection socket V_{L1}-V_{L3}	
Insulation	Reinforced insulation of power supply and all SELV interfaces	

9 Signals above 1 kHz are only supported in selected software modules and are only available on the voltage outputs and the low level outputs.

6.3.3.1 Power Diagram for Three-Phase Operation

Figure 6-7:
Power diagram for
three-phase operation



6.3.3.2 Power Diagram for Single-Phase Operation

Also refer to section 7.2.4, "Single-Phase Voltage" on page 97.

Figure 6-8:
Single-phase operation
L-N

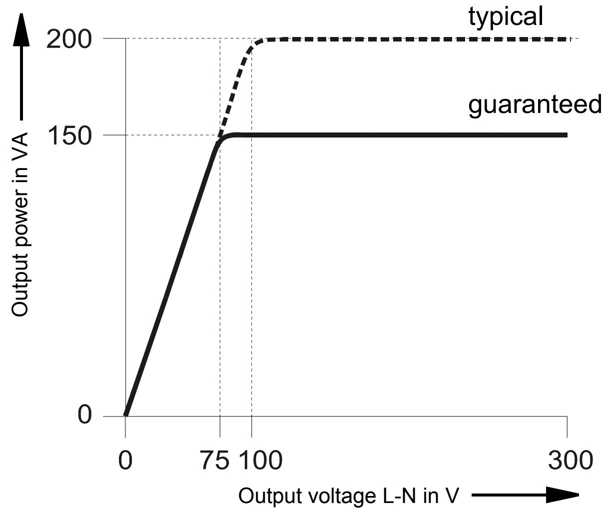
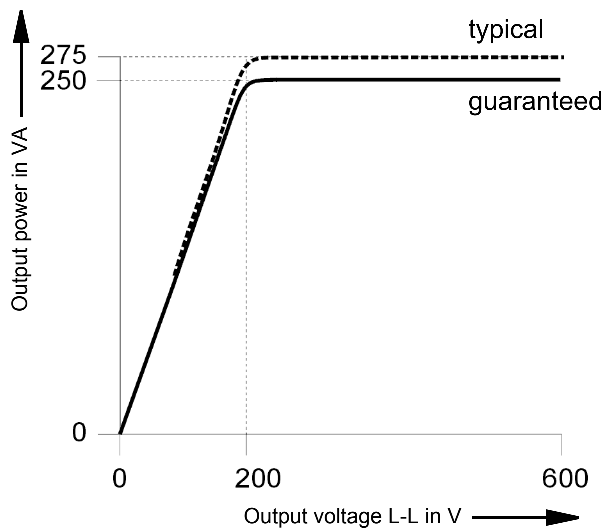


Figure 6-9:
Single-phase operation
L-L



6.3.4 Operational Limits in Conjunction with Mains Supply

Principally, the maximum output power of the *CMC 356* is limited by the mains input supply voltage.

For mains voltages of 115 V_{AC} or smaller, it is also possible to supply the *CMC 356* with two phases (L-L) instead of the normal phase-neutral (L-N) operation in order to increase the supply voltage (115 V * sqrt(3) = 200 V).

In order to limit the internal losses and to maximize the output power of the voltage amplifier, always set the maximum test object voltage to the minimum value possible for the test.

Beside the reduction of the available total output power of low line voltages, no other significant degradations in the technical data of the *CMC 356* occur.

Table 6-8:
Typical total output power at different mains voltages.

Mains voltage	**Current**	**Typical total output power**		
		Currents only	Currents	AUX DC & voltage
230V	6 x 15 A	1600 W	1190 W	+ 300 W
	6 x 25 A	1470 W	1060 W	+ 300 W
	6 x 32 A	1320 W	910 W	+ 300 W
115V[1]	6 x 15 A	1120 W	710 W	+ 300 W
	6 x 25 A	990 W	580 W	+ 300 W
	6 x 32 A	860 W	450 W	+ 300 W
100V[1]	6 x 15 A	910 W	500 W	+ 300 W
	6 x 25 A	790 W	380 W	+ 300 W
	6 x 32 A	670 W	260 W	+ 300 W

[1] After 15 min of continuous operation at full output power a duty cycle of 15 min on/15 min off is required at an ambient temperature of 25°C. This does not apply to the 6 x 32 A example because the output duration is limited by the current amplifier (see Chapter 6.3.2, "Current Outputs" on page 43 for more details).

6.3.5 Low Level Outputs "LL out" for External Amplifiers

Note: The low-level outputs "LL out 7 - 12" are only available, if the option *LLO-2* is installed.

Both SELV interface connectors "LL out 1 - 6" as well as the optional "LL out 7 - 12" (if applicable) hold two independent generator triples each. These six high accuracy analog signal sources per connector can serve to either control an external amplifier or to directly provide small signal outputs.

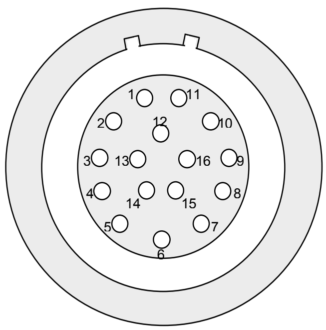
In addition, each SELV interface connector provides a serial digital interface (pins 8-16; see below) that transmits control and monitor functions between the *CMC 356* and the external amplifiers. Supported devices are the *CMA 156*, *CMA 56*[1], *CMS 156*, *CMS 251*[1] and *CMS 252*[1].

The low level outputs are short-circuit-proof and continually monitored for overload. They are separated through reinforced insulation from the power input and from the load outputs (SELV interface). They deliver calibrated signals in the range from 0 to 7 V_{eff} nominal (0 to ± 10 V_{peak}).

Both the selection of the particular amplifier as well as the specification of the range of the amplifier takes place in the *Test Universe* software.

Table 6-9:
Pin assignment of "LL out 1-6" (lower 16-pole Lemo socket); view onto the connector from the cable wiring side.

The pin assignment of "LL out 7-12" socket is identical.



Pin	Function LL out 1-6	Function LL out 7-12
1	LL out 1	LL out 7
2	LL out 2	LL out 8
3	LL out 3	LL out 9
4	Neutral (N) connected to GND	
5	LL out 4	LL out 10
6	LL out 5	LL out 11
7	LL out 6	LL out 12
8-16	For internal purposes	
Housing	Screen connection	

"LL out 1-3" and "LL out 4-6" (and optionally "LL out 7-9" and "LL out 10-12") each make up a selectable voltage or current triple.

[1] These products are not available anymore.

Table 6-10:
Data for SELV outputs "LL out"

6 Outputs "LL out 1 - 6" and 6 (optional) outputs "LL out 7 - 12"		
Output voltage range	0…±10 V_{peak}[1]	
Frequency range[2]	0 … 3000 Hz	
Output current	Max. 1 mA	
Resolution	< 250 µV	
Accuracy	Typical < 0.025 %	Guaranteed < 0.07 % for 1…10 V_{peak}
Harmonic distortion (THD+N)[3]	Typical < 0.015 %	Guaranteed < 0.05 %
Phase error[4]	Typical 0.02 °	Guaranteed < 0.1 °
DC offset voltage	Typical < 150 µV	Guaranteed < 1.5 mV
Unconventional CT/VT simulation	Linear or Rogowski[5] mode	
Overload indication	Yes	
Short-circuit protection	Unlimited to GND	
Insulation	Reinforced insulation to all other potential groups of the test equipment. GND is connected to protective earth (PE).	

1 Input OMICRON amplifier nominal: 0 ... 5 V_{rms}
2 If you purchased the option **FL-6**, the maximum output frequency is constrained to **599 Hz**.
3 Values at nominal voltage (10 V_{peak}), 50/60 Hz, and 20 kHz measurement bandwidth.
4 Valid for sinusoidal signals at 50/60 Hz.
5 When simulating Rogowski sensors, the output voltage is proportional to the derivative of the current with respect to time (di(t)/dt).

Table 6-11:
Ordering Information

Ordering Information	
Connector for two guide notches and pull relief (for "LL out")	FGB.2B.316.CLAD 72Z
Black anti-bend cable cover	GMA.2B.070 DN

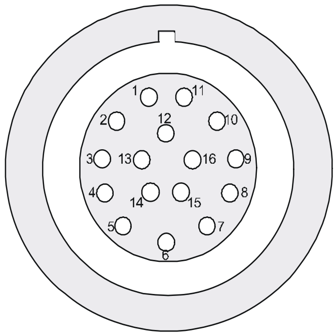
For a manufacturer description about the connection sockets "LL out" and "ext. Interf.", visit the Web site www.lemo.com.

6.3.6 Low-Level Binary Outputs ("ext. Interf.")

The SELV interface connector "ext. Interf." holds four additional transistor binary outputs (Bin. out 11 - 14). Unlike regular relay outputs, Bin. out 11 - 14 are bounce-free binary outputs (small signals) and have a minimal reaction time.

In addition, two high frequency counter inputs for up to 100 kHz are available for the testing of energy meters. They are described in section 6.4.2, "Counter Inputs 100 kHz (Low Level)" on page 61.

Figure 6-10:
Pin assignment of "ext. Interf." (upper 16-pole Lemo socket); view onto the connector from the cable wiring side



Pin	Function
Pin 1	Counter input 1
Pin 2	Counter input 2
Pin 3	Reserved
Pin 4	Neutral (N) connected to GND
Pin 5	Binary output 11
Pin 6	Binary output 12
Pin 7	Binary output 13
Pin 8	Binary output 14
Pin 9	Reserved
Housing	Screen connection

Table 6-12:
Data of the low-level binary outputs 11 - 14

4 Low-Level Transistor Binary Outputs (Bin. out 11 - 14)	
Type	Open-collector transistor outputs; external pull-up resistor
Switching voltage	Max. 15 V
Max. input voltage	±16 V
Switch current	Max. 5 mA (current limited); min. 100 μA
Actualization time	100 μs
Rise time	< 3 μs (V_{extern} = 5 V, R_{pullup} = 4.7 kΩ)
Connection	Connector "ext. Interf." (*CMC 356* rear side)
Insulation	Reinforced insulation to all other potential groups of the test equipment. GND is connected to protective earth (PE).

Figure 6-11:
Circuit diagram of "ext. Interf." binary transistor outputs 11 - 14

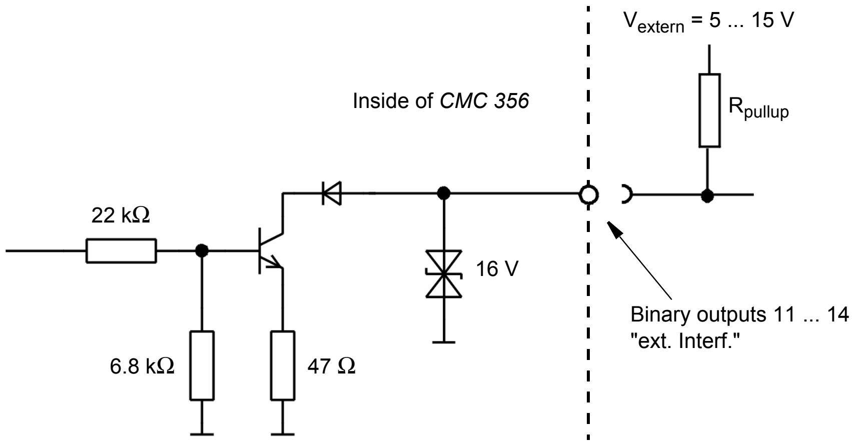


Table 6-13:
Ordering Information

Ordering Information	
Connector for one guide notch and pull relief (for "ext. Interf")	FGG.2B.316.CLAD 72Z
Black anti-bend cable cover	GMA.2B.070 DN

For a manufacturer description about the connection sockets "LL out" and "ext. Interf.", visit the Web site www.lemo.com.

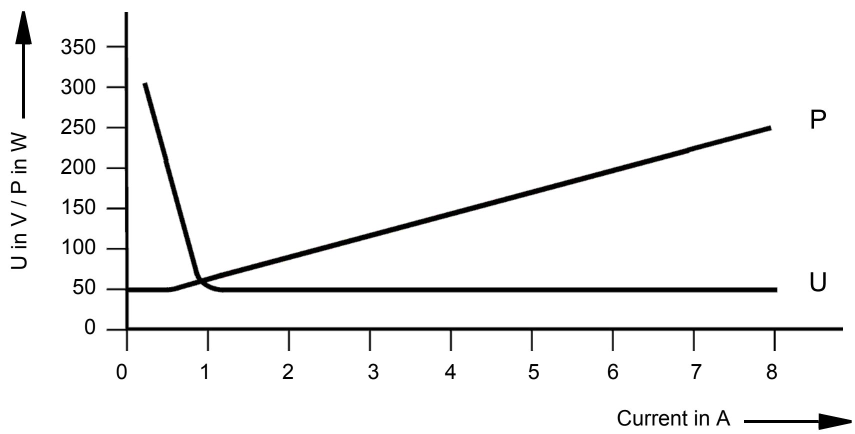
6.3.7 Binary Output Relays

Table 6-14:
Data of binary output relays

4 Binary Output Relays (Binary Outputs 1-4)	
Type	Potential-free contacts; software-controlled
AC loading	V_{max} 300 VAC; I_{max} 8 A; P_{max} 2000 VA
DC loading	V_{max} 300 VDC; I_{max} 8 A; P_{max} 50 W (refer to load limit curve)
Switch-on current	15 A (max. 4 s at 10 % duty-cycle)
Electrical lifetime	100 000 switching cycles at 230 V_{AC} / 8 A and ohmic load
Pickup time	Approx. 6 ms
Fall back time	Approx. 3 ms
Bounce time	Approx. 0.5 ms
Connection	4 mm/0.16 " banana sockets
Insulation	Reinforced insulation from all SELV interfaces and from power supply.

The accompanying diagram shows the load limit curve for DC voltages. For AC voltages, a maximum power of 2000 VA is achieved.

Figure 6-12:
Load limit curve for relays on the binary outputs with DC voltages



6.3.8 DC Supply (AUX DC)

Table 6-15:
DC Voltage supply
AUX DC

DC Supply (AUX DC)	
Voltage ranges	0 ... 66 V_{DC} (max. 0.8 A) 0 ... 132 V_{DC} (max 0.4 A) 0 ... 264 V_{DC} (max. 0.2 A)
Power	Max. 50 W
Accuracy[1]	Error: typical < 2 %, guaranteed < 5 %
Resolution	< 70 mV
Connection	4 mm/0.16 " banana sockets on front panel
Short-circuit protection	Yes
Overload indication	Yes
Insulation	Reinforced insulation from power supply and all SELV interfaces

[1] Percentage is with respect to each range's full-scale.

6.4 Inputs

6.4.1 Binary Inputs

Note: If option ELT-1 is installed, only the general binary input data given in the following Table 6-16 are valid. For detailed information about the option ELT-1, please refer to section 6.10, "Option ELT-1" on page 68.

Table 6-16: General data of binary inputs

General Data of Binary Inputs 1…10	
Number of binary inputs	10
Trigger criteria	Potential-free or DC-voltage compared to threshold voltage
Reaction time	Max. 220 µs
Sampling frequency	10 kHz
Time resolution	100 µs
Max. measuring time	Unlimited
Debounce time	0…25 ms (refer to page 60)
Deglitch time	0…25 ms (refer to page 60)
Counting function counter frequency pulse width	 3 kHz (per input) >150 µs (for high and low signals)
Configuration	Binary inputs can be configured. Refer to the OMICRON *Test Universe* Help.
Connection	4 mm/0.16 " banana sockets on the front panel
Insulation	5 galvanic insulated binary groups with each 2 inputs having its own GND. Operation insulation to the power outputs, DC inputs and between galvanically separated groups. Reinforced insulation from all SELV interfaces and from power supply.

Table 6-17:
Data for potential-sensing operation

Data for Potential-Sensing Operation		
Threshold voltage data per input range	Setting range	Resolution
Range I Range II	0...20V >20...300V	50mV 500mV
Max. input voltage	CAT III/ / 300 V_{rms} CAT IV / 150 V_{rms}	
Threshold voltage accuracy[1]	5% of rd. + 0.5% of rg.	
Threshold voltage hysteresis	Range I: typ. 60 mV Range II: typ. 900 mV	
Input impedance[2] Threshold 0...20V Threshold 20...300V	 210 kΩ 135 kΩ	

1 Applies to positive voltage signal edge; value shown in % of reading (rd.) + % of upper range value (rg.)

2 Refer to figure 5-2, "Simplified circuit diagrams of binary inputs and outputs (CMC 356 standard, without option ELT-1 installed)" on page 28.

Table 6-18:
Data for potential-free operation

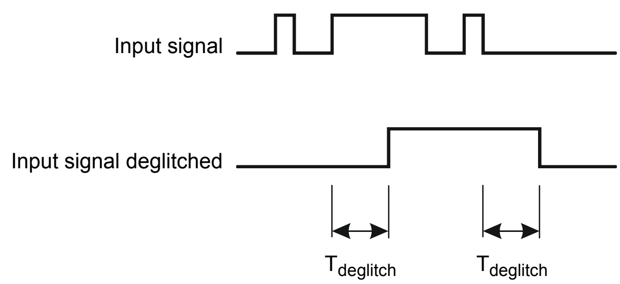
Data for Potential-Free Operation[1]	
Trigger criteria	Logical 0: R > 100 kΩ Logical 1: R < 10 kΩ
Input impedance	216 kΩ

1 Refer to figure 5-2, "Simplified circuit diagrams of binary inputs and outputs (CMC 356 standard, without option ELT-1 installed)" on page 28.

Deglitching input signals

In order to suppress short spurious pulses a deglitching algorithm could be configured. The deglitch process results in an additional dead time and introduces a signal delay. In order to be detected as a valid signal level, the level of an input signal must have a constant value at least during the deglitch time. The figure below illustrates the deglitch function.

Figure 6-13:
Signal curve, deglitching input signals



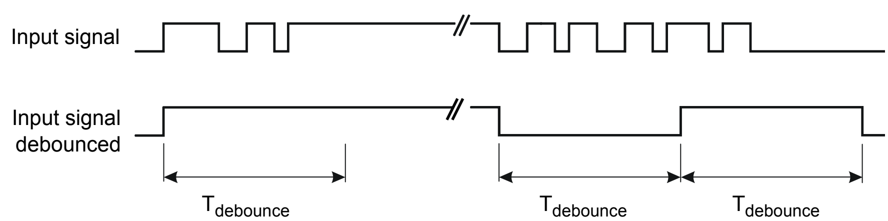
Debouncing input signals

For input signals with a bouncing characteristic, a debounce function can be configured. This means that the first change of the input signal causes the debounced input signal to be changed and then be kept on this signal value for the duration of the debounce time.

The debounce function is placed after the deglitch function described above and both are realized by the firmware of the *CMC 356* and are calculated in real time.

The figure below illustrates the debounce function. On the right-hand side of the figure, the debounce time is too short. As a result, the debounced signal rises to “high” once again, even while the input signal is still bouncing and does not drop to low level until the expiry of another period $T_{debounce}$.

Figure 6-14:
Signal curve, debounce input signals

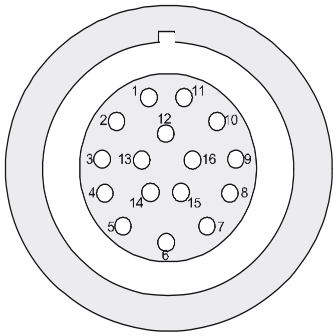


6.4.2 Counter Inputs 100 kHz (Low Level)

The SELV interface connector "ext. Interf." holds two high frequency counter inputs for up to 100 kHz are available for the testing of energy meters.

In addition, four transistor binary outputs (Bin. out 11 - 14) are available. They are described in section 6.3.6, "Low-Level Binary Outputs ("ext. Interf.")" on page 54.

Figure 6-15:
Pin assignment of "ext. Interf." (upper 16-pole Lemo socket); view onto the connector from the cable wiring side



Pin	Function
Pin 1	Counter input 1
Pin 2	Counter input 2
Pin 3	Reserved
Pin 4	Neutral (N) connected to GND
Pin 5	Binary output 11
Pin 6	Binary output 12
Pin 7	Binary output 13
Pin 8	Binary output 14
Pin 9	Reserved
Housing	Screen connection

Table 6-19:
Counter inputs 100 kHz

2 Counter Inputs	
Max. counter frequency	100 kHz
Pulse width	> 3 µs (high and low signal)
Switch threshold pos. edge neg. edge	 max. 8 V min. 4 V
Hysteresis	typ. 2 V
Rise & fall times	< 1 ms
Max. input voltage	± 30 V
Connection	Socket "ext. Interf." (rear *CMC 356*)
Insulation	Reinforced insulation to all other potential groups of the test equipment. GND is connected to protective earth (PE).

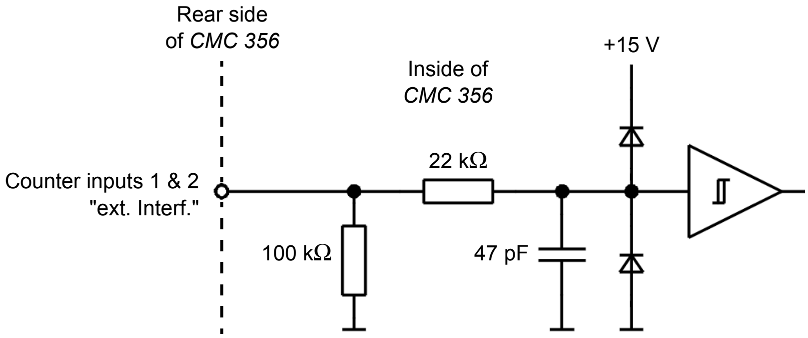


Figure 6-16:
Circuit diagram of
"ext. Interf." counter inputs
1 and 2

Table 6-20:
Ordering Information

Ordering Information	
Connector for one guide notch and pull relief (for "ext. Interf")	FGG.2B.316.CLAD 72Z
Black anti-bend cable cover	GMA.2B.070 DN

For a manufacturer description about the connection sockets "LL out 1-6" and "ext. Interf.", visit the Web site www.lemo.com.

6.5 Technical Data of the Communication Ports

The first versions of the *CMC 356* test sets were delivered with a **NET-1** board that contained two different Ethernet ports: **ETH1**, a10/100Base-TX Ethernet port and **ETH2**, a 100Base-FX (optical fiber) Ethernet port.

With the introduction of the front panel control device *CMControl*, the *CMC 356* test sets were then equipped with a **NET-1B** board that contained two identical 10/100Base-TX PoE (**P**ower **o**ver **E**thernet) Ethernet ports **ETH1** and **ETH2**.

Today, the standard interface is the **NET-1C** board that, in addition to **ETH1** and **ETH2**, provides an additional USB port.

CMC 356 test sets with **NET-1** board can be upgraded with the new **NET-1C** board to be able to communicate with the new *CMControl* and have Ethernet as well as USB access at the same time.

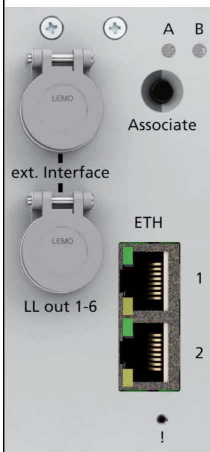
6.5.1 The NET-1C Board

Table 6-21: Technical data of the NET-1C communication ports USB and ETH1/ETH2

NET-1C: USB port and Ethernet ports ETH1/ETH2		
	USB type	USB 2.0 full speed up to 12 Mbit/s
	USB connector	USB type B
	USB cable	2 m USB 2.0 high speed type A-B
	ETH type	10/100Base-TX (10/100Mbit, twisted pair, auto-MDI/MDIX or auto-crossover)
	ETH connector	RJ45
	ETH cable type	LAN cable of category 5 (CAT5) or better
	ETH status indication	Green LED: physical link present Yellow LED: traffic on interface
	ETH **P**ower **o**ver **E**thernet (PoE)	IEEE 802.3af compliant. Port capability limited to one Class 1 (3.84 W) and one Class 2 (6.49 W) power device.

6.5.2 The NET-1B Board

Table 6-22:
Technical data of the NET-1B communication ports ETH1 and ETH2

<table>
<tr><th colspan="3">NET-1B: Ethernet ports ETH1/ETH2</th></tr>
<tr><td rowspan="5">
</td><td>Type</td><td>10/100Base-TX (10/100Mbit, twisted pair, auto-MDI/MDIX or auto-crossover)</td></tr>
<tr><td>Connector</td><td>RJ45</td></tr>
<tr><td>Cable type</td><td>LAN cable of category 5 (CAT5) or better</td></tr>
<tr><td>Status indication</td><td>Green LED: physical link present
Yellow LED: traffic on interface</td></tr>
<tr><td>Power over Ethernet (PoE)</td><td>IEEE 802.3af compliant.
Port capability limited to one Class 1 (3.84 W) and one Class 2 (6.49 W) power device.</td></tr>
</table>

6.5.3 The NET-1 Board

Table 6-23:
Technical data of the NET-1 communication port ETH1

<table>
<tr><th colspan="3">NET-1: Ethernet port ETH1</th></tr>
<tr><td rowspan="4">
</td><td>Type</td><td>10/100Base-TX (10/100Mbit, twisted pair, auto-MDI/MDIX or auto-crossover)</td></tr>
<tr><td>Connector</td><td>RJ45</td></tr>
<tr><td>Cable type</td><td>LAN cable of category 5 (CAT5) or better</td></tr>
<tr><td>Status indication</td><td>Green LED: physical link present
Yellow LED: traffic on interface</td></tr>
</table>

Table 6-24:
Technical data of the NET-1 communication port ETH2

NET-1: Ethernet port ETH2		
	Type	100Base-FX (100Mbit, fiber, duplex)
	Connector	MT-RJ
	Cable type	50/125 µm or 62.5/125 µm (duplex patch cable)
	Cable length	> 1 km (0.62 miles) possible
	Status idication	Green LED: physical link present Yellow LED: traffic on interface
		This is a product of Laser Class 1 (IEC 60825)

6.6 Environmental Conditions

6.6.1 Climate

Table 6-25:
Climate

Climate	
Operating temperature	0 ... +50 °C; above +30 °C a 50 % duty cycle may apply.
Storage and transportation	-25 … +70 °C
Max. altitude	2000 m
Humidity	5 … 95% relative humidity; no condensation
Climate	Tested according to IEC 60068-2-78

6.6.2 Shock and Vibration

Table 6-26:
Shock and vibration

Dynamics	
Vibration	Tested according to IEC 60068-2-6; frequency range 10 ... 150 Hz; acceleration 2 g continuous (20 m/s²); 10 cycles per axis
Shock	Tested according to IEC 60068-2-27; 15 g / 11 ms, half-sinusoid, each axis

6.7 Mechanical Data

Table 6-27:
Data regarding size and weight

Size, Weight and Protection	
Weight	16.8 kg (37 lbs)
Dimensions W x H x D (without handle)	450 x 145 x 390 mm (17.7 x 5.7 x 15.4 ")
Housing	IP20 according to EN 60529

6.8 Cleaning

To clean the *CMC 356*, use a cloth dampened with isopropanol alcohol or water. Prior to cleaning, always switch off the power switch and unplug the power cord from the mains.

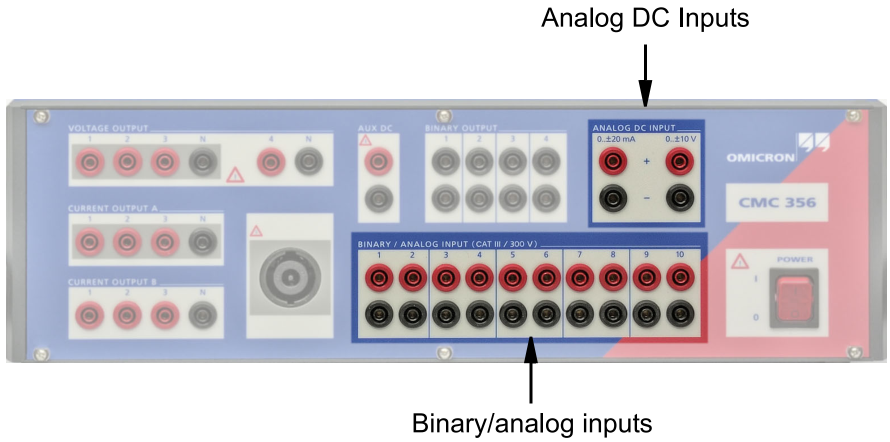
6.9 Safety Standards, Electromagnetic Compatibility (EMC) and Certificates

Table 6-28:
CE conformity, certified Safety Standards and EMC-compatibility

CE Conformity, Requirements	
The product adheres to the specifications of the guidelines of the council of the European Community for meeting the requirements of the member states regarding the electromagnetic compatibility (EMC) Directive 2004/108/EC and the low voltage Directive 2006/95/EC.	
EMC	
Emission Europe International USA	 EN 61326-1; EN 61000-6-4; EN 61000-3-2/3 IEC 61326-1; IEC 61000-6-4; IEC 61000-3-2/3 FCC Subpart B of Part 15 Class A
Immunity Europe International	 EN 61326-1; EN 61000-6-2; EN 61000-4-2/3/4/5/6/11 IEC 61326-1; IEC 61000-6-2; IEC 61000-4-2/3/4/5/6/11
Certified Safety Standards	
Europe	EN 61010-1 Insulation of PC and SELV interfaces complies with EN 60950-1
International USA Canada	IEC 61010-1 UL 61010-1 CAN/CSA-C22.2 No 61010-1-04
Certificate	Manufactured under an ISO9001 registered system

6.10 Option ELT-1

Figure 6-17: Binary/analog inputs and inputs for analog DC measurement



The ELT-1 option enables the *CMC 356* to measure analog signals:

- Analog DC inputs (+/-10V and either +/-1mA or +/-20mA) for basic transducer testing with the test module *QuickCMC*.
- Basic voltage and current measurements with up to three of the 10 analog measurement inputs (restricted *EnerLyzer* mode).

In addition, the *Test Universe* module *EnerLyzer* provides the following functionality:

- Simultaneous measurement of up to 10 voltages and/or currents.
- Evaluation of DC components (DC voltages or DC currents).
- Real-time indication of effective values (true RMS) for all measurement signals.
- Peak values indication (U_{peak}, I_{peak},...).
- Phase angles with reference to a given input signal.
- Real-time calculation of apparent, reactive, and active power (in any configuration).
- Frequency and spectrum indication (harmonic diagrams) of periodic signals.
- Capturing of transient input signals with different sampling rates.
- Different triggering options for transient signal capturing (basic triggers and power quality triggers).
- Trend Recording: Measurement of RMS current, RMS voltage, frequency, phase, active, apparent and reactive power and power factor over long periods of time (up to 4 million samples possible).

Using the *CMC 356* test set in combination with the *Test Universe* module *Transducer* enables advanced testing of multifunctional single-phase and three-phase electrical transducers with symmetrical or non-symmetrical operating characteristics.

The hardware option ELT-1 can either be ordered with the new test set or later as a factory upgrade (the *CMC 356* needs to be returned to OMICRON).

6.10.1 General Data

The actual capturing of the measurement values and the range switching for the channels takes place in the analog input stages AFE (**A**nalog **F**ront **E**nd). Each AFE is used by two input channels and galvanically separated from the other input stages.

The measured values are passed through an isolation amplifier to the "Measurement Unit" and digitized by an A/D converter. The further processing is done by a high-performance floating point digital signal processor (DSP).

As such, apparent power, reactive power, active power, etc., can be provided in real-time and transmitted to the PC.

The analog measurement inputs have five measurement ranges that can be configured individually in the test module *EnerLyzer*.

- 100 mV
- 1 V
- 10 V
- 100 V
- 600 V

These range limits refer to the respective rms values of sinusoidal input signals. The ranges 100 mV, 1 V, 10 V and 100 V can be overloaded approximately with 10 %.

Input impedance: 500 kOhm || 50 pF for all measurement ranges.

Overload protection: 600 Vrms (± 850 Vpeak) from reference potential N, from another input, or protective earth (GND).

The sampling rate can be configured by software:

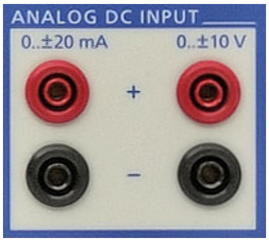
- 28.44 kHz
- 9.48 kHz
- 3.16 kHz

Four different operating modes are possible:

- Multimeter Mode (section 6.10.6)
- Harmonic Analysis (section 6.10.7)
- Transient Recording (section 6.10.8)
- Trend Recording (section 6.10.9)

6.10.2 Analog DC Input (V_{DC}, I_{DC})

Figure 6-18:
DC measurement unit
(analog inputs V_{DC}, I_{DC})



The measurement of analog DC signals has been implemented to enable the testing of transducers. The measurement unit consists of

- a highly accurate voltage reference,
- one ADC (**A**nalog **D**igital **C**onverter) for each input, and
- the respective input circuits (i.e., accurate voltage divider, shunt, filter).

The DC measurement unit measures the input signals V_{DC} and I_{DC} and performs the evaluation and forwarding of the measurement values.

Input I_{DC} has two measurement ranges: 0 … ± 20 mA and 0 … ± 1mA. The input is protected by a reversible input fuse. The inputs V_{DC} and I_{DC} reference a common neutral N. The DC measurement unit is galvanically isolated from all other connections on the front panel.

6.10.3 Accuracy of the Analog DC Input

Note: Exceeding the specified input values can damage the measurement inputs!

Table 6-29:
DC measurement input

DC Measurement Input IDC		
Measurement ranges	0 ... ±1 mA 0 ... ±20 mA	
Max. input current	600 mA	
Accuracy	Typical error < 0.003 % of rg.[1]	Guaranteed error < 0.02 % of rg.
Input impedance	Approx. 15 Ω	
Connection	4 mm/0.16 " banana connectors	
Insulation	Insulation to all other front panel connections. Reinforced insulation from all SELV interfaces and from power supply. Not galvanically isolated from V_{DC}.	

[1] rg. = range, whereat *n* % of rg. means: *n* % of upper range value.

Table 6-30:
DC voltage measurement input

DC Voltage Measurement Input VDC		
Measurement range	0…± 10 V	
Max. input voltage	± 11 V	
Input impedance	1 MΩ	
Max. input current	± 90 mA	
Accuracy	Typical error < 0.003 % of rg.	Guaranteed error < 0.02 % of rg.
Connection	4 mm/0.16 " banana connectors	
Insulation	Not galvanically isolated from I_{DC}	

6.10.4 Measuring Currents

Since the analog inputs of the *CMC 356* are voltage inputs, current measurement has to be performed using suitable active current clamps with voltage outputs or shunt resistors.

OMICRON offers the *C-PROBE1* as a suitable current clamp. The *C-PROBE1* is not included in the scope of delivery of option **ELT-1** and thus has to be ordered separately.

For further information, please contact OMICRON electronics (refer to section "OMICRON Service Centers" on page 109).

6.10.5 Accuracy of Binary/Analog Inputs with Option ELT-1

The technical data for the binary inputs change with the installation of option ELT-1.

Figure 6-19: Simplified diagrams of analog and binary inputs with option ELT-1 installed

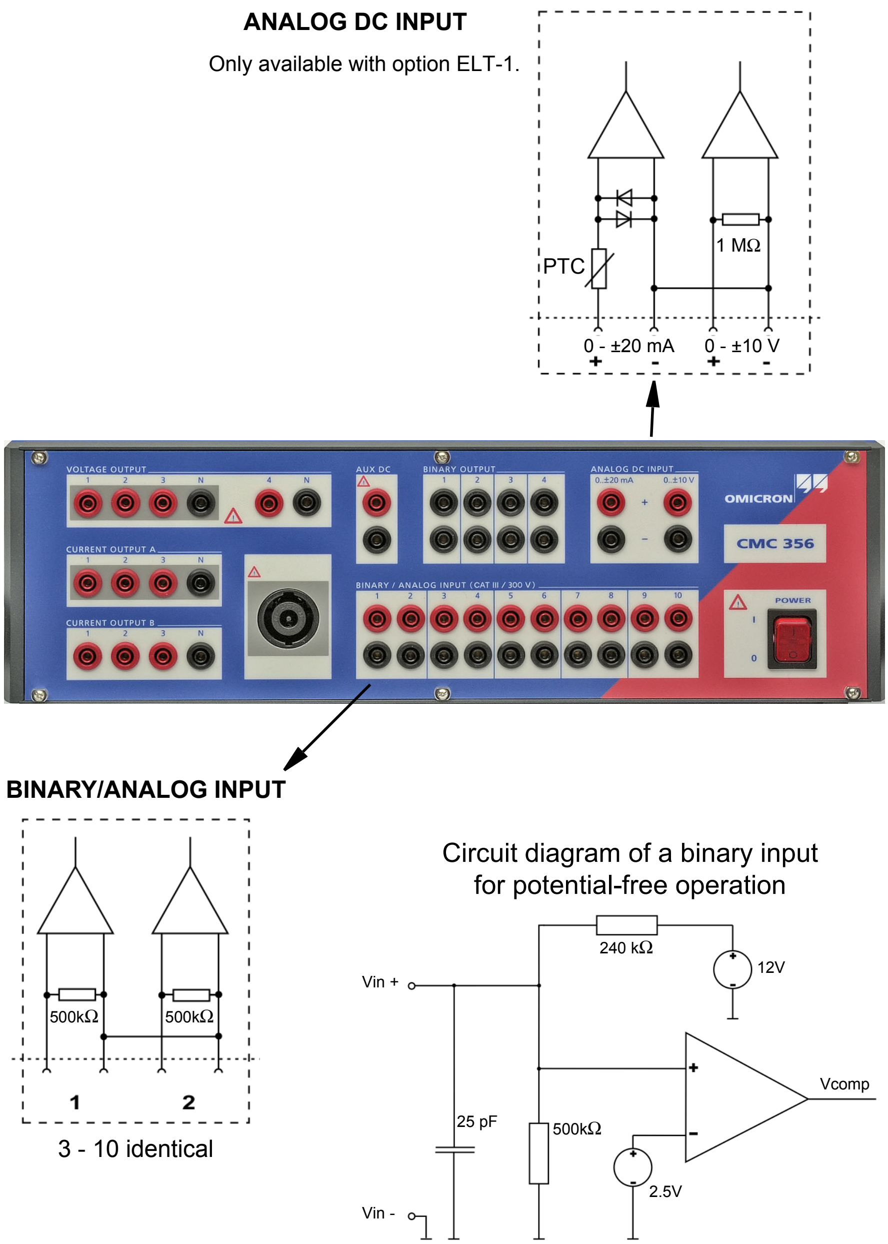


Table 6-31:
Data for potential-sensing operation

Data for Potential-Sensing Operation		
Threshold voltage data per input range	Setting range	Resolution
100 mV 1 V 10 V 100 V 600 V	± 100 mV ± 1 V ± 10 V ± 100 V ± 600 V	2 mV 20 mV 200 mV 2 V 20 V
Max. input voltage	CAT II / 600 V_{rms} (850 V_{pk}) CAT III/ / 300 V_{rms} CAT IV / 150 V_{rms}	
Threshold voltage accuracy[1] per range: 100 mV, 1 V, 10 V, 100 V, 600 V	Error: typical < 2 %, guaranteed < 4 % typical < 5 %, guaranteed < 10 %	
Threshold voltage hysteresis: 100 mV, 1 V, 10 V, 100 V, 600 V	Typical: 3.5% of range + 1.3% of setting 5.8% of range + 1.3% of setting	
Input impedance	500 kΩ (|| 50 pF)	

[1] Valid for positive voltage signal edge; percentage is shown in respect to each range's full-scale.

Table 6-32:
Data for potential-free operation

Data for Potential-Free Operation[1]	
Trigger criteria	Logical 0: R > 80 kΩ Logical 1: R < 40 kΩ
Input impedance	162 kΩ (|| 50 pF)

[1] Refer to figure 5-2, "Simplified circuit diagrams of binary inputs and outputs (CMC 356 standard, without option ELT-1 installed)" on page 28.

6.10.6 Multimeter Mode

This operating mode is designed for measuring steady-state signals (e.g., also non-sinusoidal shaped signals). Measurements such as rms values, phase angle, frequency, etc. can be performed.

The input signals are processed in real time without delay.

6.10.6.1 Accuracy of AC Measurements

Conditions: integration time 1 s, measurement signal sinusoidal, excitation 10 - 100 %, accuracy references the measurement full scale values.

Table 6-33:
Sampling rate 28.44 kHz; measurement range 600 V, 100 V, 10 V, 1 V

Frequency range	Accuracy	
	Typical	Guaranteed
DC	± 0.15%	± 0.40%
10 Hz ... 100 Hz	± 0.06%	± 0.15%
10 Hz ... 1 kHz	+ 0.06% / -0.11%	± 0.25%
10 Hz ... 10 kHz	+ 0.06% / -0.7%	± 1.1%

Table 6-34:
Sampling rate 28.44 kHz; measurement range 100 mV

Frequency range	Accuracy	
	Typical	Guaranteed
DC	± 0.15%	± 0.45%
10 Hz ... 100 Hz	± 0.1%	± 0.3%
10 Hz ... 1 kHz	+ 0.15% / -0.2%	± 0.5%
10 Hz ... 10 kHz	+ 0.15% / -1.0%	± 2%

Table 6-35:
Sampling rate 9.48 kHz 3.16 kHz; measurement range 600 V, 100 V, 10 V, 1 V

Frequency range	Accuracy	
	Typical	Guaranteed
DC	± 0.15%	± 0.45%
10 Hz ... 100 Hz	± 0.08%	± 0.2%
10 Hz ... 1 kHz	+ 0.1% / -0.3%	± 0.5%
10 Hz ... 4 kHz (sampling rate 9.48 kHz)	+ 0.1% / -0.5%	± 1.2%
10 Hz ... 1.4 kHz (sampling rate 3.16 kHz)	+ 0.1% / -0.5%	± 1.0%

Table 6-36:
Sampling rate 9.48 kHz 3.16 kHz; measurement range 100 mV

Frequency range	Accuracy	
	Typical	Guaranteed
DC	± 0.15%	± 0.5%
10 Hz ... 100 Hz	± 0.1%	± 0.35%
10 Hz ... 1 kHz	+ 0.15% / -0.35%	± 0.5%
10 Hz ... 4 kHz (sampling rate 9.48 kHz)	+ 0.15% / -0.6%	± 1.2%
10 Hz ... 1.4 kHz (sampling rate 3.16 kHz)	+ 0.15%/ -0.6%	± 1.2%

The accuracy data contains linearity, temperature, long-term drift, and frequency.

Figure 6-20:
Typical frequency response with a sampling rate of 28.44 kHz and an input voltage of 70 V[1]

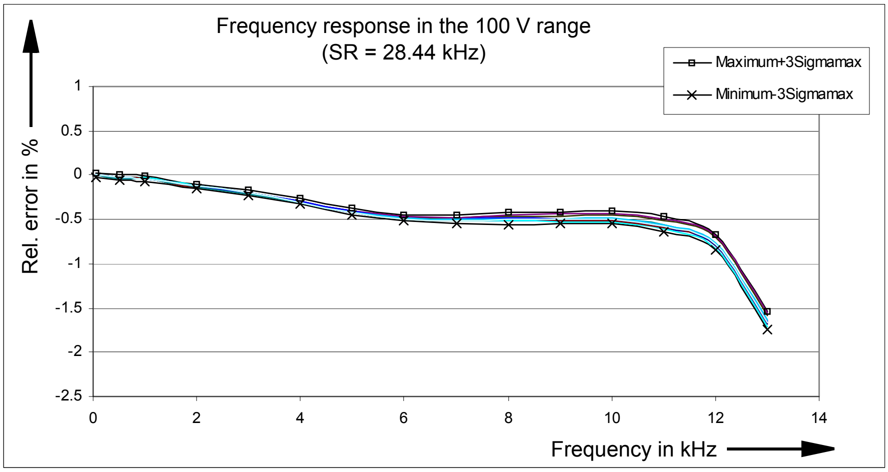
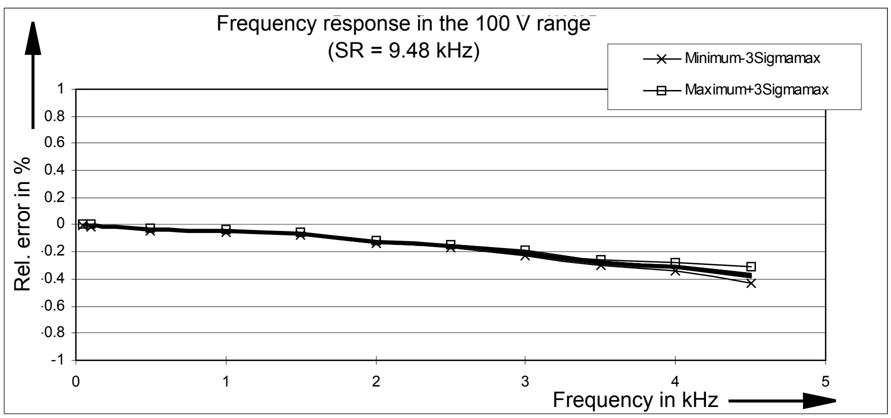


Figure 6-21:
Typical frequency response with a sampling rate of 9.48 kHz and an input voltage of 70 V[1]



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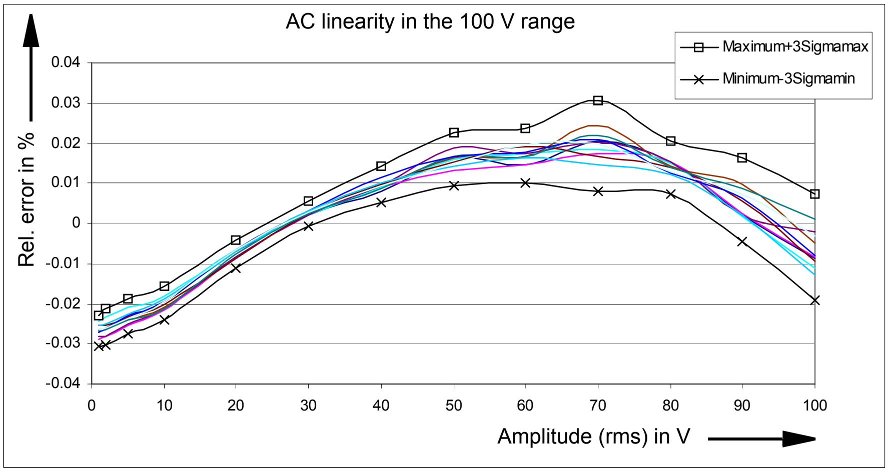
1 a) Relative error: $\frac{\text{Actual - Expected}}{\text{Full scale}} \times 100\ \%$

b) $3Sigma_{max}$ represents the maximum of the 3Sigma values of all 10 input channels. The $3Sigma_{max}$ value of an analog input are determined from 50 measurement values.

Figure 6-22:
Typical AC linear progression at 50 Hz and a sampling rate of 28.44 kHz[1]



6.10.6.2 Channel Cross-Talk

Conditions: sinusoidal form infeed on a channel without overload, AC measurement on neighboring channel, integration time 1 s.

Table 6-37:
Cross talk dampening

Measurement range	600 V	100 V	10 V	1 V	100 mV
Dampening in dB	80	105	95	120	120

Cross talk dampening on channels of the same potential groups in dB at f = 50 Hz

Table 6-38:
Cross talk dampening

Measurement range	600 V	100 V	10 V	1 V	100 mV
Dampening in dB	65	80	75	95	95

Cross talk dampening on channels of the same potential groups in dB at f = 500 Hz

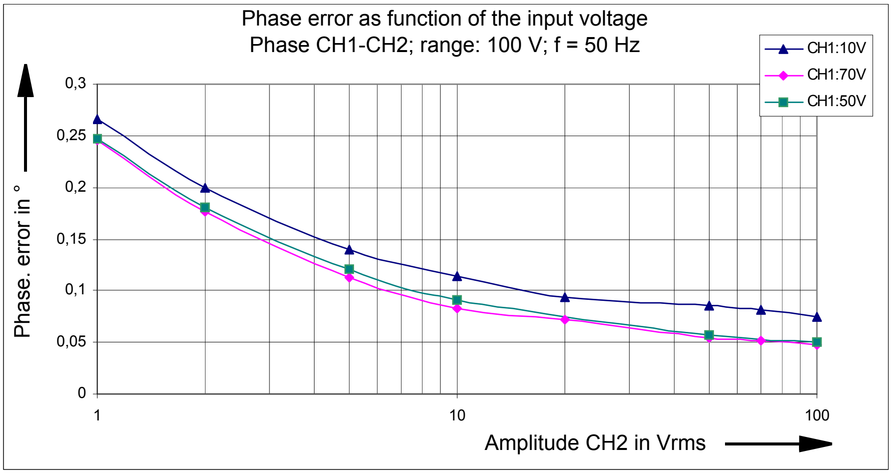
The cross-talk dampening on a neighboring channel of another potential group is greater than 120 dB in all measurement ranges (f = 50 Hz or 500 Hz).

[1] a) Relative error: $\frac{\text{Actual - Expected}}{\text{Full scale}} \times 100\ \%$

b) $3Sigma_{max}$ represents the maximum of the 3Sigma values of all 10 input channels. The $3Sigma_{max}$ value of an analog input are determined from 50 measurement values.

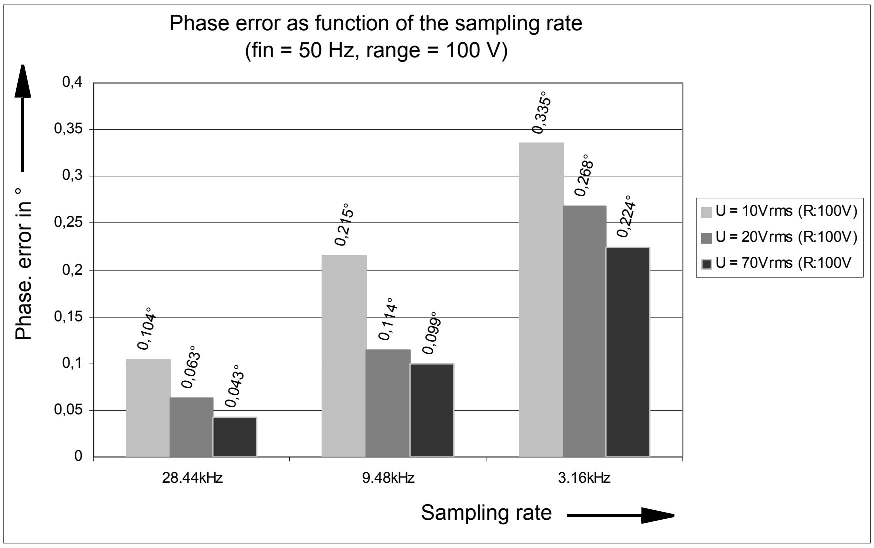
6.10.6.3 Accuracy of Phase Measurement

Figure 6-23:
Phase error as function of input voltage



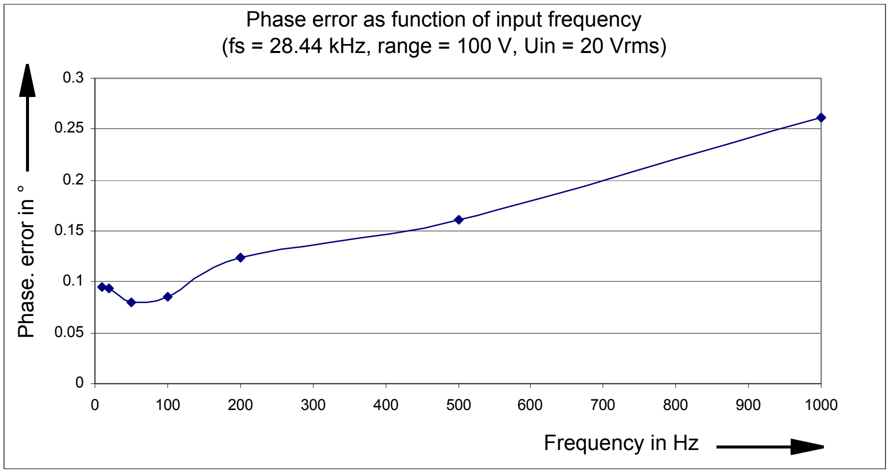
Conditions: integration time 1 s, measurement signal sinusoidal, measurement range 100 V, f = 50 Hz, sampling rate 28.44 kHz.

Figure 6-24:
Phase error as function of sampling rate



Conditions: integration time 1 s, measurement signal sinusoidal, f = 50 Hz, measurement range 100 V, both channels same excitation (20 V, 70 V).

Figure 6-25:
Typical phase error as function of the input frequency



Conditions: integration time 1 s, measurement signal sinusoidal, sampling rate = 28.44 kHz, measurement range 100 V, excitation on both channels 20 Vrms.

The maximum input frequency for the phase measurement depends on the sampling rate.

Table 6-39:
Sampling rate and input frequency range

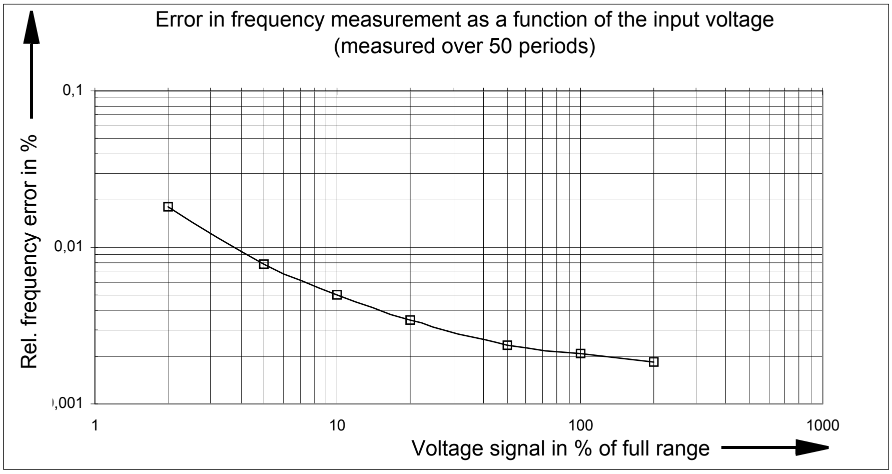
Sampling rate	Input frequency range
28.44 kHz	10 Hz ... 2.30 kHz
9.48 kHz	10 Hz ... 750 Hz
3.16 kHz	10 Hz ... 250 Hz

Note:

1. The measurement accuracy of phase can be improved by:
   - increasing the integration time
   - enabling the recursive averaging function
2. When measuring very small phase shifts (less than 0.2 °), the sign (positive or negative) of the measurement results can not be definitely determined. If this causes a problem, please refer to the phase measurement in the harmonic analysis.
3. For measuring phase, the input voltage should be greater than 5 % of full scale. An overload of the measurement channel does not negatively affect the obtainable accuracy.

6.10.6.4 Accuracy of Frequency Measurement

Figure 6-26:
Error in the frequency measurement as a function of the input voltage



Conditions: integration time 1 s, measurement signal sinusoid.

The maximum input frequency for the frequency measurement depends on the sampling rate.

Table 6-40:
Sampling rate and input frequency range.

Sampling rate	Input frequency range
28.44 kHz	10 Hz ... 1500 Hz
9.48 kHz	5 Hz ... 500 Hz
3.16 kHz	5 Hz ... 150 Hz

Conditions: Excitation greater than 10 % from measurement full scale, duty cycle 50 %.

Note: With the harmonic analysis, input frequencies up to 3.4 kHz can be measured.

6.10.6.5 Accuracy of Power Measurement

General

The power is calculated from one current channel and one voltage channel:

Active power: $P = \frac{1}{T} * \int_0^T u(t) * i(t) dt$ [W]

Apparent power: $S = V_{rms} \times I_{rms}$ [VA]

Reactive power: $Q = \sqrt{S^2 - P^2} * \text{sign\_Q}$ [var]

$U_{rms} = \sqrt{\frac{1}{T} * \int_0^T u(t)^2 dt}$, $I_{rms} = \sqrt{\frac{1}{T} * \int_0^T i(t)^2 dt}$

Accuracies

Conditions: integration time 1s, measurement signal sinusoidal, excitation 10-100 %, accuracy references the apparent power, error of the current clamp is not taken into account.

Table 6-41: Sampling rates 28.44kHz 9.48kHz 3.16kHz

Frequency range	Power	Accuracy[1]	
AC		Typical	Guaranteed
10 Hz ... 100 Hz	S	± 0.3 %	± 0.7 %
	P	± 0.3 %	± 0.7 %
	Q	± 0.8 %	± 2 %

Table 6-42: Sampling rate 28.44kHz

Frequency range	Power	Accuracy[1]	
AC		Typical	Guaranteed
10 Hz ... 2.2 kHz	S	+ 0.3 % / - 1.2 %	± 2.5 %
	P	+ 0.3 % / - 1,2 %	± 2.5 %
	Q	+ 0.8 % / - 2.5 %	± 3.5 %

[1] Relative error: $\frac{\text{Actual - Expected}}{\text{Full scale}} \times 100\,\%$

S = Apparent power
P = Active power
Q = Reactive power

Table 6-43:
Sampling rate
9.48 kHz

Frequency range	Power	Accuracy[1]	
AC		Typical	Guaranteed
10 Hz ... 750 Hz	S	+ 0.3 % / - 0.7 %	± 1.8 %
10 Hz ... 750 Hz	P	+ 0.3 % / - 0.7 %	± 1.8 %
10 Hz ... 750 Hz	Q	+ 0.8 % / - 1.2 %	± 2.5 %

Table 6-44:
Sampling rate
3.16 kHz

Frequency range	Power	Accuracy[1]	
AC		Typical	Guaranteed
10 Hz ... 250 Hz	S	+ 0.3 % / - 0.5 %	± 1.3 %
10 Hz ... 250 Hz	P	+ 0.3 % / - 0.5 %	± 1.3 %
10 Hz ... 250 Hz	Q	+ 0.8 % / - 1 %	± 2.2 %

Table 6-45:
DC accuracy

	Power	Accuracy[1]	
DC		Typical	Guaranteed
	P, S	± 0.3 %	± 0.9 %

[1] Relative error: $\frac{\text{Actual - Expected}}{\text{Full scale}} \times 100\ \%$

S = Apparent power
P = Active power
Q = Reactive power

Note: The accuracy specifications include linearity, temperature, ageing drift, frequency and phase response.

Typical relative error as function of the excitation

Figure 6-27:
Typical error of the apparent power S as function of the excitation,
fs = 28.44 kHz, fin = 50 Hz

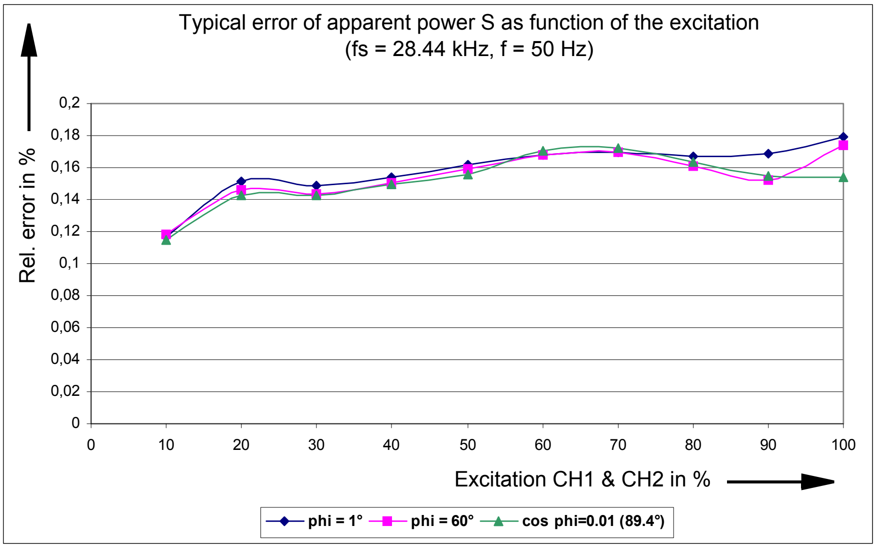


Figure 6-28:
Typical error of the active power P as a function of the excitation considering the apparent power,
fs = 28.44 kHz, fin = 50 Hz

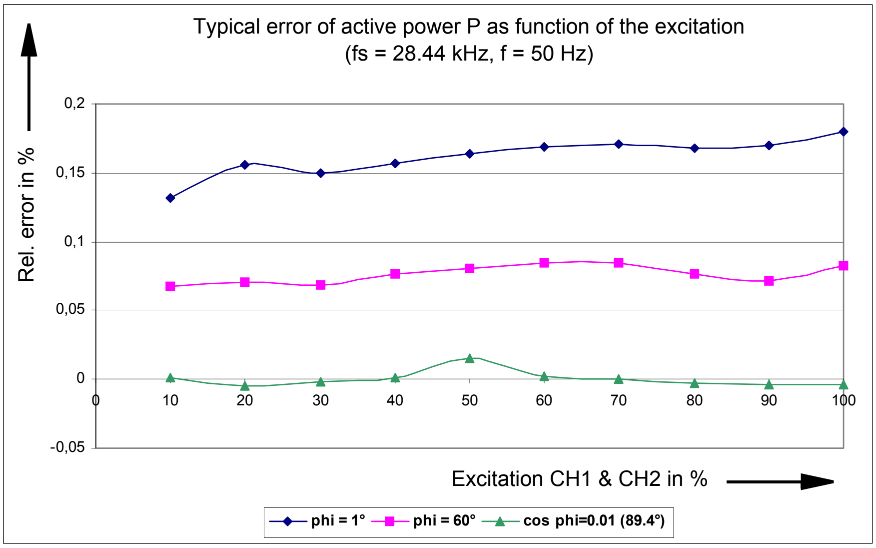
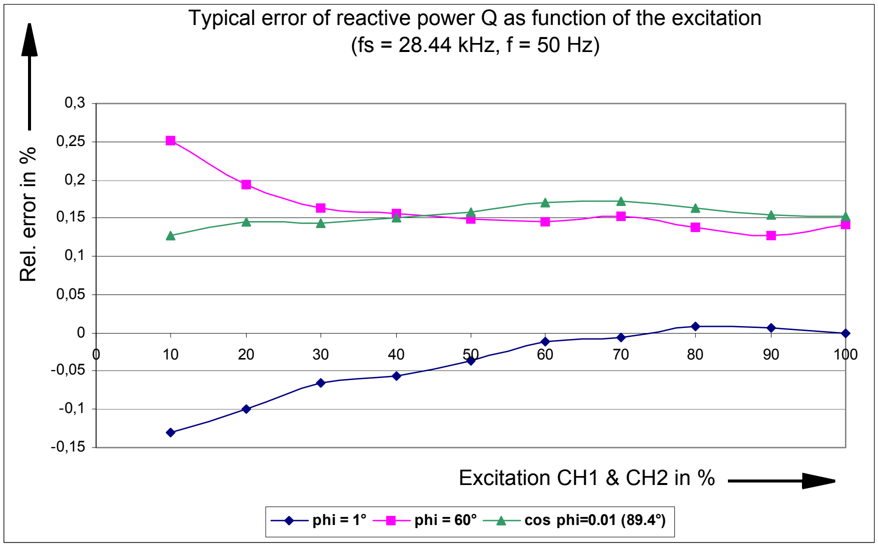
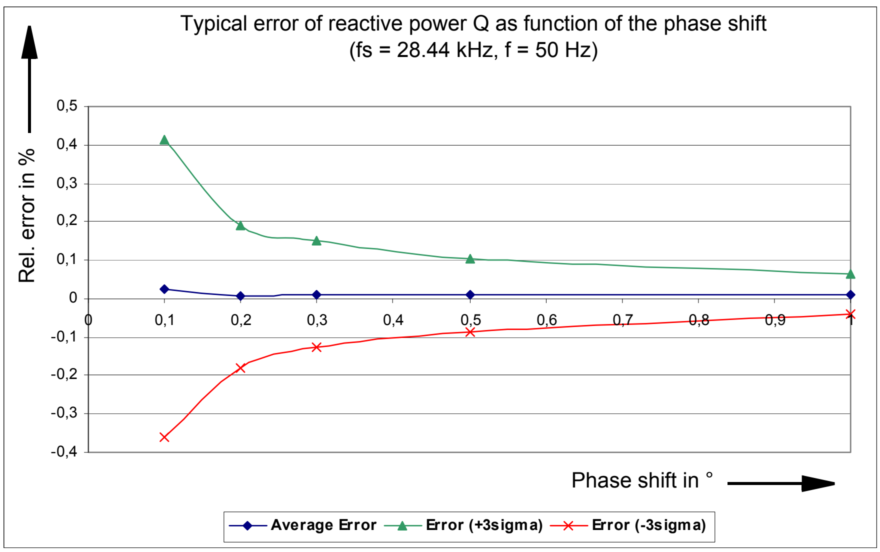


Figure 6-29:
Typical error of the reactive power Q as a function of the excitation, fs = 28.44 kHz, fin = 50 Hz



Conditions: integration time 1s, measurement signal sinusoid, sampling rate = 28.44 kHz, fin = 50 Hz

Figure 6-30:
Typical error[1] of the reactive power Q as a function of the phase shift considering the apparent power, fs = 28.44 kHz, fin = 50 Hz, excitation CH1 and CH2 = 70 %.



Conditions: integration time 1s, measurement signal sinusoidal, sampling rate = 28.44 kHz, both channels with same excitation 70 %

1 The 3Sigma values are determined from 50 measurement values.

Note:

- For very small phase shifts (< 0,3 °) and small excitation (< 10 %), too small integration time (< 1 s) or sampling rate 3.16 kHz, the sign of the reactive power cannot definitely be determined.
- The accuracy of the power measurement depends primarily on the accuracy of the current clamp.

6.10.7 Harmonic Analysis

This operating mode is designed for measuring stationary signals (e.g., not sinusoid shaped). The input signal is separated into fundamental and harmonic waves (Fourier Analysis).

The following items are measured:

- frequency of the fundamental wave
- amplitude of the fundamental and harmonic waves
- phase shifts between the fundamental and harmonic waves (also from the different channels)

The input signals are captured. Finally, the calculation of the measurement items is carried out. During this time, the input signal is not taken into consideration.

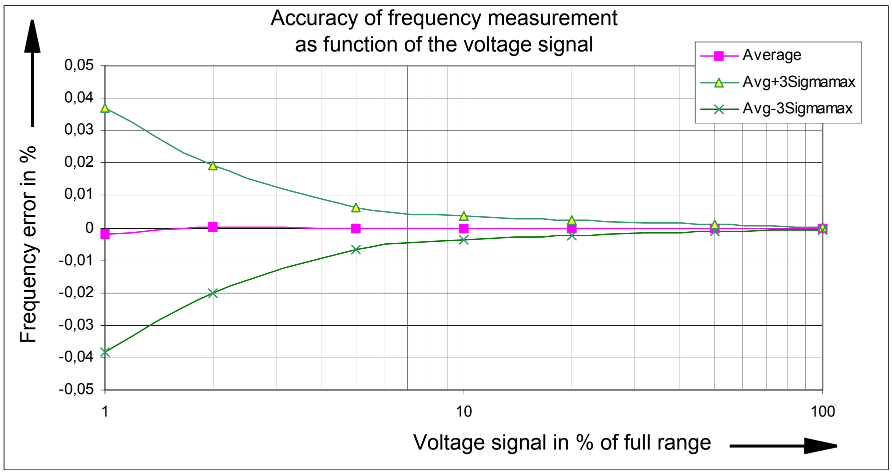
6.10.7.1 Accuracy of Frequency Measurement

The permitted input frequency range depends on the specified sampling rate:

Table 6-46:
Sampling rate and input frequency range

Sampling rate	Input frequency range
28.44 kHz	49 Hz ... 3400 Hz
9.48 kHz	17 Hz ... 1100 Hz
3.16 kHz	5 Hz ... 380 Hz

Figure 6-31:
Accuracy of frequency measurement as function of the voltage signal



Conditions: sampling rate 9.48 kHz, fin=20 Hz ... 1 kHz

Note: Through recursive averaging, the measurement uncertainty can be further reduced.

6.10.7.2 Accuracy of Amplitude Measurement

The measurement values are given as effective values (rms).

The permitted input frequency range for the fundamental wave depends on the specified sampling rate:

Table 6-47:
Sampling rate and input frequency range

Sampling rate	Input frequency range
28.44 kHz	100 Hz (= fmin) ... 3200 Hz
9.48 kHz	30 Hz (= fmin) ... 1000 Hz
3.6 kHz	10 Hz (= fmin) ... 350 Hz

Valid for fundamental and harmonic waves in specified frequency range; accuracy refers to full scale.

Table 6-48:
Sampling rate 28.44 kHz, measurement range 600 V, 100 V, 10 V, 1 V

Frequency range	Accuracy	
	Typical	Guaranteed
fmin ... 1 kHz	± 0.1 %	± 0.3 %
fmin ... 10 kHz	+ 0.1 % / - 0.7 %	± 1.1 %

Table 6-49:
Sampling rate 28.44 kHz, measurement range 100 mV

Frequency range	Accuracy	
	Typical	Guaranteed
fmin ... 1 kHz	± 0.2 %	± 0.5 %
fmin ... 10 kHz	+ 0.2 % / - 1.0 %	± 2.0 %

Table 6-50:
Sampling rate
9.48 kHz
3.16 kHz,
measurement range
600 V, 100 V, 10 V, 1 V

Frequency range	Accuracy	
	Typical	Guaranteed
fmin ... 100 Hz	± 0.1 %	± 0.3 %
fmin ... 1 kHz	+ 0.1 % / - 0.5 %	± 0.8 %
fmin ... 4 kHz (sampling rate = 9.48 kHz)	+ 0.1 % / - 0.8 %	±1.2 %
fmin ... 1.4 kHz (sampling rate = 3.16 kHz)	+ 0.1 % / - 0.8 %	±1.2 %

Table 6-51:
Sampling rate
9.48 kHz
3.16 kHz
measurement range
100 mV

Frequency range	Accuracy	
	Typical	Guaranteed
fmin ... 100 Hz	± 0.15 %	± 0.4 %
fmin ... 1 kHz	± 0.2 % / - 0.5 %	± 0.8 %
fmin ... 4 kHz (sampling rate = 9.48 kHz)	+ 0.2 % / - 1.0 %	± 1.5 %
fmin ... 1.4 kHz (sampling rate = 3.16 kHz)	+ 0.25 % / - 1.0 %	± 2.0 %

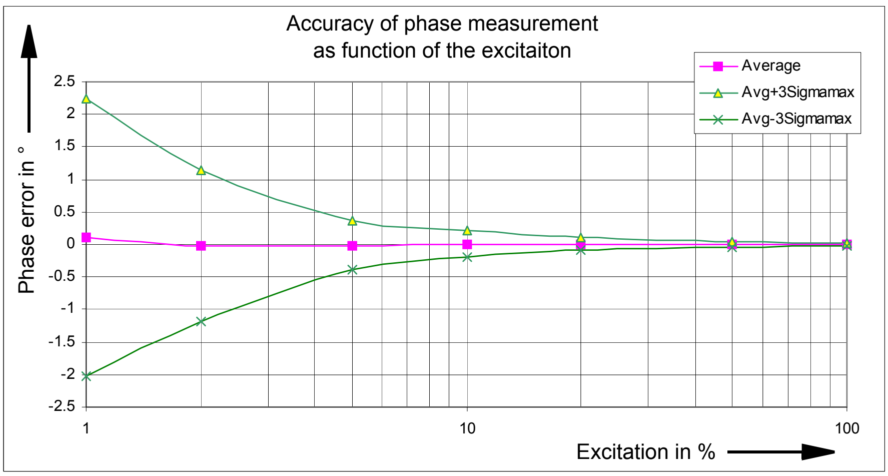
6.10.7.3 Accuracy of Phase Measurement

The permitted input frequency range for the fundamental wave depends on the specified sampling rate:

Table 6-52:
Sampling rate and input frequency range

Sampling rate	Input frequency range
28.44 kHz	100 Hz ... 3200 Hz
9.48 kHz	30 Hz ... 1000 Hz
3.16 kHz	10 Hz ... 350 Hz

Figure 6-32:
Accuracy of phase measurement as function of the excitation



Conditions: sampling rate 9.48 kHz, fin = 50 Hz.

Note: Through recursive averaging, the measurement uncertainty can be reduced further.

6.10.8 Transient Recording

In this operating mode, transient signals on up to 10 input channels can be recorded synchronously.

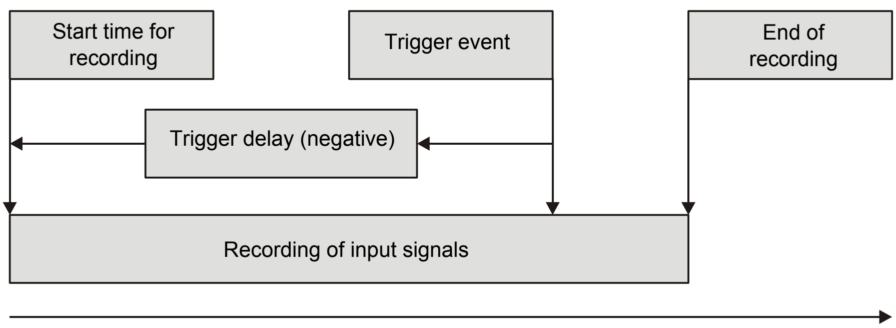
The recording starts whenever a pre-defined trigger condition is met. The selectable trigger conditions are:

- Trigger on threshold with positive or negative edge
- Combination of different power quality triggers (sag, swell, harmonic, frequency, frequency change, notch)

In addition, a time offset for the capture window relative to the trigger event can be specified. The trigger delay can be

- positive (recording begins after the trigger event)
- or negative (recording begins already before the trigger event).

Figure 6-33: Illustration of the relationship between trigger events, trigger delay, and recording time



Note: More details about triggering methods can be found in the OMICRON *Test Universe* Help and in the practical examples of the ELT-1 option.

The maximum length of the recording depends on the settings for the sample rate and the number of channels to be captured.

Table 6-53:
The maximum recording time depends on the number of active channels and the sampling frequency

Number of active channels	Maximum recording time [s] at fs = 28.4 kHz	Maximum recording time [s] at fs = 9.48 kHz	Maximum recording time [s] at fs = 3.16 kHz
1	35.16 s	105.47 s	316.41 s
2	17.58 s	52.73 s	158.20 s
3	11.72 s	35.16 s	105.47 s
4	8.79 s	26.37 s	79.10 s
5	7.03 s	21.09 s	63.28 s
6	5.86 s	17.58 s	52.73 s
7	5.02 s	15.07 s	45.20 s
8	4.40 s	13.18 s	39.55 s
9	3.91 s	11.72 s	35.15 s
10	3.52 s	10.55 s	31.64 s
11[1]	3.20 s	9.59 s	28.76 s

1 All binary inputs are stored as one channel.

Accuracy of the sampling value:

- measurement ranges 600 V, 100 V, 10 V, 1 V:
  ± 0.2 % typical
  ± 0.5 % guaranteed
- measurement range 100 mV:
  ± 0.3 % typical
  ± 0.6 % guaranteed

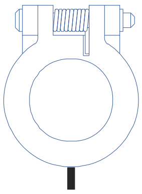
The accuracy data are full scale errors.

6.10.9 Trend Recording

In Trend Recording Mode, you can make a historical plot of various measurements over time. It is possible to measure RMS voltage, RMS current, phase, real, apparent and reactive power and the power factor.

The main view has a CTS Chart. Each selected measurement function appears in a separate diagram (i.e. all frequency measurements in the frequency diagram). RMS current and voltage appear in separate diagrams. Time is displayed in seconds on the x-axis. The diagram is scrolled from right-to-left as new data is recorded.

6.11 Option LLO-2 (Low Level Outputs)


LL out 7 - 12

The *LLO-2* option ("LL out 7 - 12") represents an additional SELV (SELV = Safety Extra Low Voltage) interface connector holding two independent generator triples. These six high accuracy analog signal sources can serve to either control an external amplifier or to directly provide small signal outputs.

The outputs 7-12 extend the low level outputs 1-6 ("LL out 1-6") by two more independent generator triples. Outputs 7-12 are technically identical to outputs 1-6.

For more information please refer section 6.3.5, "Low Level Outputs "LL out" for External Amplifiers" on page 52.

7 Increasing the Output Power, Operating Modes

The *CMC 356* has a very large application diversity. The current outputs offer enough output power to test all electromechanical relays.

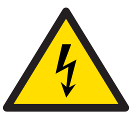
In particular, the *CMC 356* offers a variety of types of single-phase operation using its two galvanically separated three-phase current outputs with which the output power from the units can be significantly increased.

In cases when the current or the output power - or even the number of independent voltages or currents - is insufficient, it is possible to switch individual amplifier groups of the *CMC 356* in parallel or to connect external amplifiers (up to six independent additional channels) to the "LL out 1-6".

The option "LLO-2" extends the low level outputs by two more independent generator triples “LL out 7-12”; refer to section 6.11, "Option LLO-2 (Low Level Outputs)" on page 91.

The operating modes illustrated in the following sections can be set in the Hardware Configuration of the OMICRON *Test Universe* software.

7.1 Safety Instructions for High Current Output



Observe the following safety instructions when using the operating modes and connection methods described in this chapter.

- For currents greater than 25 A, the test object (load) should be exclusively connected to the 4 mm/0.16 " banana sockets and not to the generator combination socket.
- Since a current of 32 A flowing through a test lead (2 m/6 ft. of length, 2.5 mm^2) causes a loss of 15 ... 18 W, we recommend to use the connection methods shown in this chapter.
- When connecting current outputs in parallel, it has to be ensured that the test leads are only connected together immediately at the test object and that the test leads have sufficient diameter.
- At maximum amplitude of the 128 A mode, the cable losses can amount to 112 W for AC and 280 W for DC operation.
- At maximum amplitude of the 64 A mode, the cable losses can amount to 28 W for AC and 140 W for DC operation.

- For applications drawing DC current: The test object (load) should be exclusively non-inductive! Note that a load of, for example, 1 Henry can store 50 J (Joule) at 10 A DC for a long period of time. Electrical shocks with more than 350 mJ can be life-hazardous for the user.

7.2 Single-Phase Operation of the CMC 356

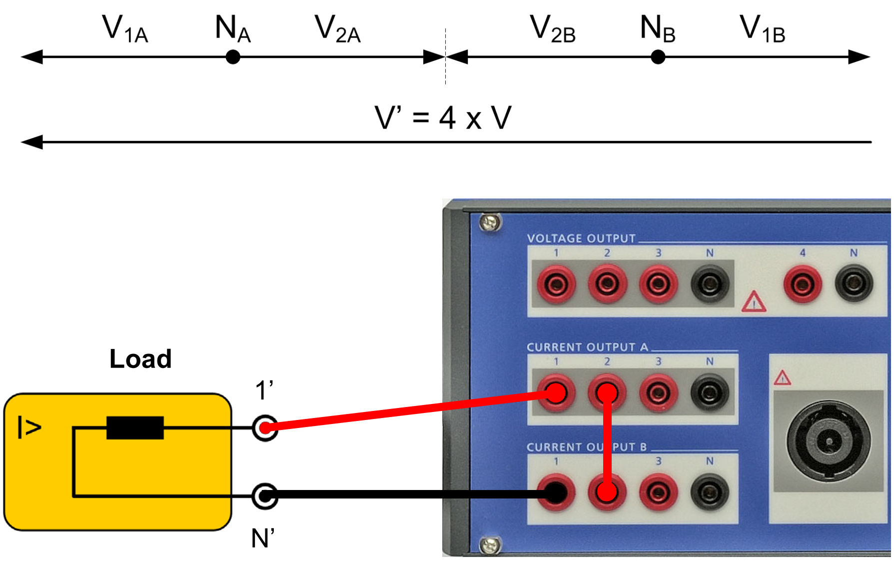
7.2.1 1 x 32 A High Burden Mode (L-L-L-L)

1 x 0 ... 32 A (±45 A_{DC}), max. 140 V_{peak}, 1 x 1740 VA at 25 A

Both amplifier groups CURRENT OUTPUT A and CURRENT OUTPUT B are connected in series. The currents 1 and 2 of a group are phase-opposite. This results in four times the compliance voltage of a single output.

Observe the safety instructions given in Section 7.1 on page 93 when using this operating mode.

Figure 7-1:
Single-phase operation,
1 x 32 A high burden mode



Refer to the output curves shown in the figures 6-1 through 6-5 in section 6.3.2, "Current Outputs" on page 43.

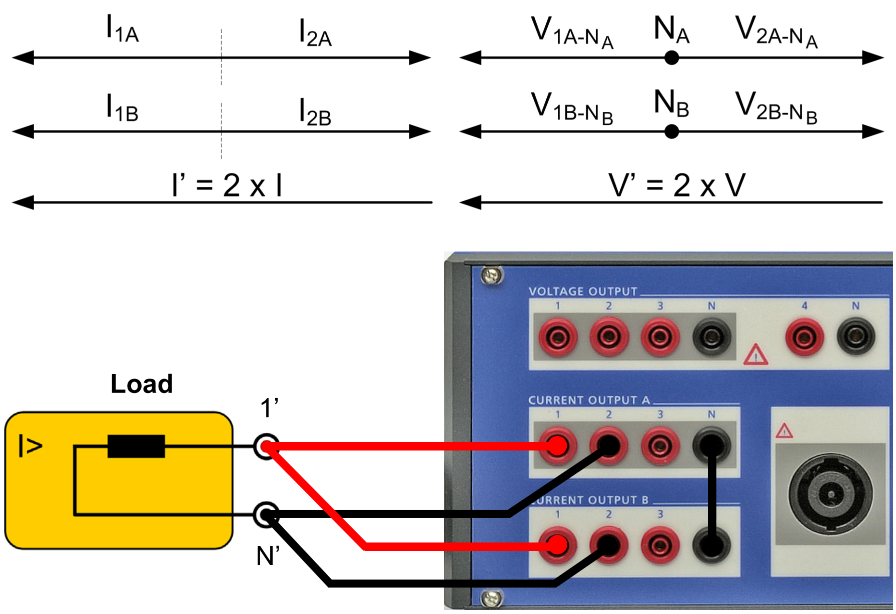
7.2.2 1 x 64 A High Burden and High Current Mode (L-L)

1 x 0 ... 64 A (±90 A_{DC}), max. 70 V_{peak}, 1 x 1740 VA at 50 A

The currents 1 and 2 of each group are phase-opposite. In addition, the groups A and B are connected in parallel.

Observe the safety instructions given in Section 7.1 on page 93 when using this operating mode.

Figure 7-2:
Single-phase operation,
1 x 64 A high burden and
high current mode



Refer to the output curves shown in the figures 6-1 through 6-5 in section 6.3.2, "Current Outputs" on page 43.

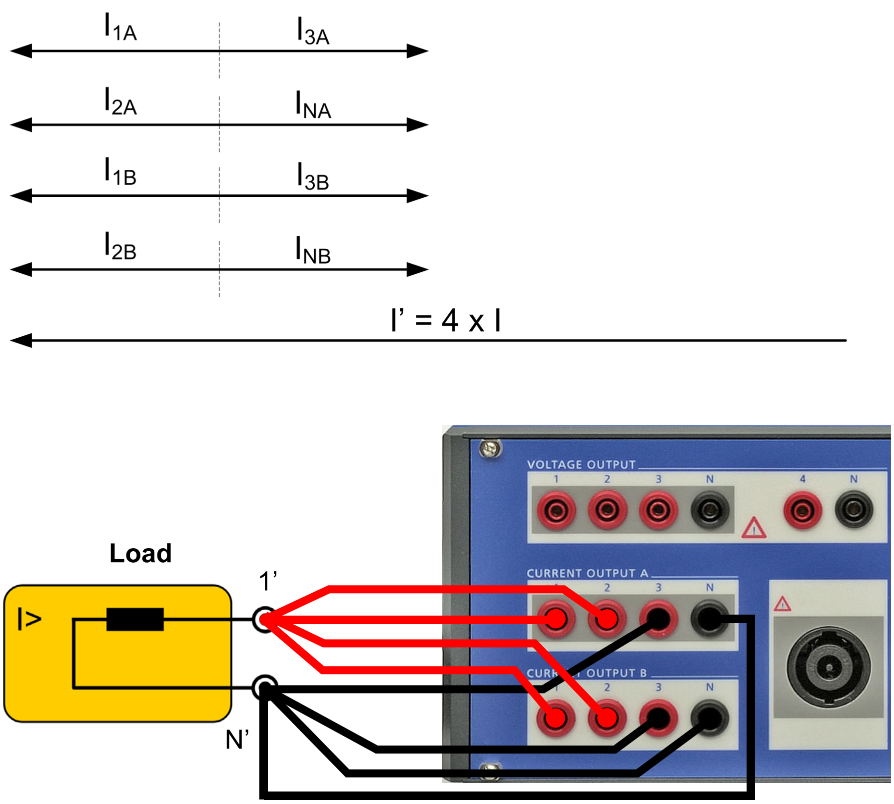
7.2.3 1 x 128 A High Current Mode (LL-LN)

1 x 0 ... 128 A (±180 A_{DC}), max. 35 V_{peak}, 1 x 1000 VA at 80 A

Since the current over the N socket is limited to 32 A_{rms} (45 A_{DC}), the third phase is used to support the N socket. The currents 1, 2 of groups A and B are connected in parallel.

Observe the safety instructions given in Section 7.1 on page 93 when using this operating mode.

Figure 7-3:
Single-phase operation,
1 x 128 A high current
mode

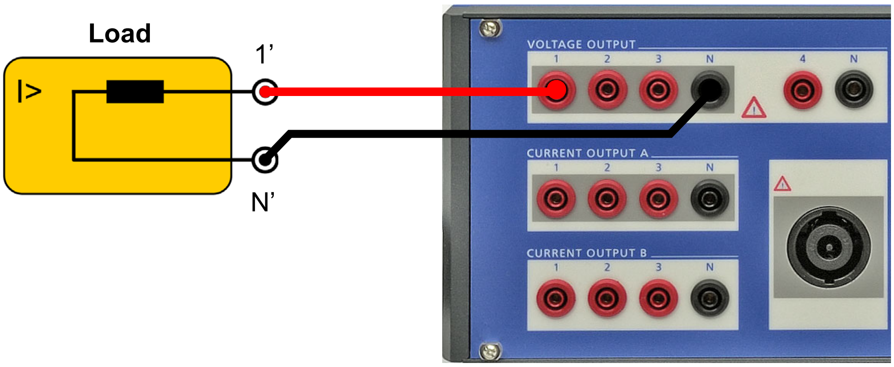


Refer to the output curves shown in the figures 6-1 through 6-5 in section 6.3.2, "Current Outputs" on page 43.

7.2.4 Single-Phase Voltage

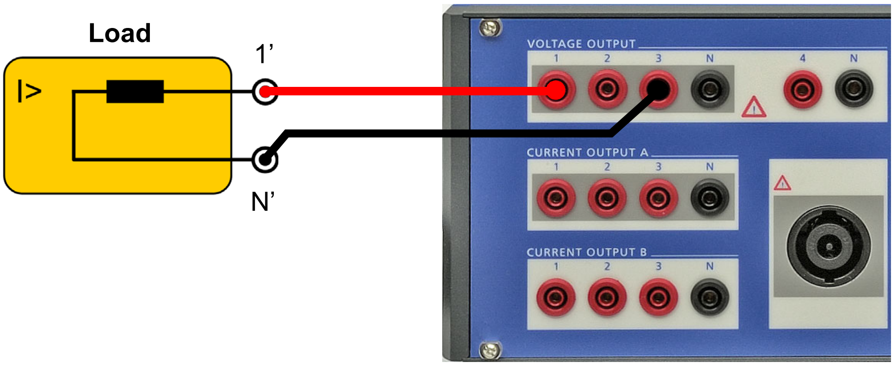
1 x 0 ... 300 V, 1 x 200 VA [100 ... 300 V] typical

Figure 7-4:
Single-phase operation of the voltage system (L-N)



1 x 0 ... 600 V, 1 x 275 VA [200 ... 600 V] typical

Figure 7-5:
Single-phase operation of the voltage system
(L-L phase opposition)



Refer to the output curves shown in the figures 6-8 through 6-9 in section 6.3.3, "Voltage Outputs" on page 48.

Note: Never connect N' or any other phase to GND (PE). This can cause life-hazardous situations to persons and damage to property.

7.3 Two-Phase Operation

For some applications it is beneficial to have two independent currents, each higher than 32 A_{rms}, or a higher compliance voltage available.

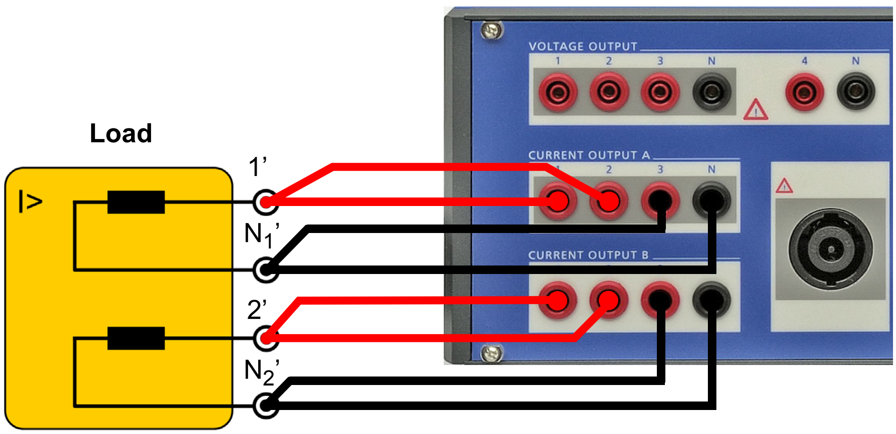
7.3.1 2 x 64 A High Current Mode (LL-LN)

2 x 0 ... 64 A (±90 A_{DC}), max. 35 V_{peak}, 2 x 500 VA at 40 A

Since the current over the N socket is limited to 32 A_{rms} (45 A_{DC}), the third phase is used to support the N socket.

Observe the safety instructions given in Section 7.1 on page 93 when using this operating mode.

Figure 7-6:
Two-phase operation,
2 x 64 A high current mode



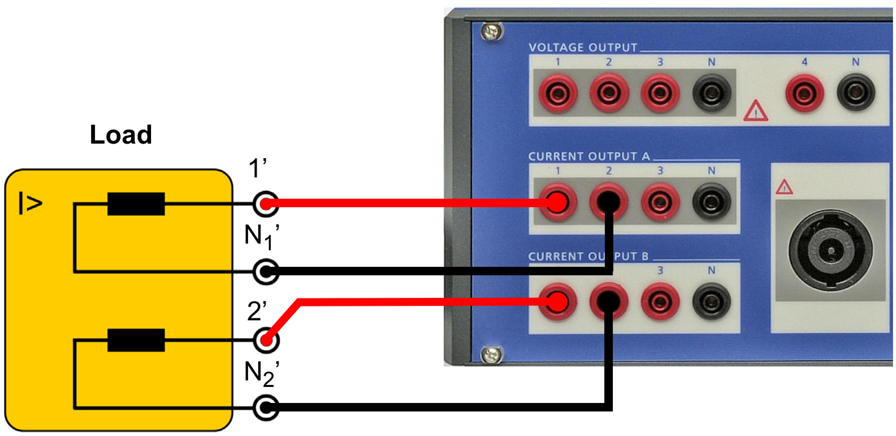
7.3.2 2 x 32 A High Burden Mode (L-L)

2 x 0 ... 32 A (±45 A_{DC}), max. 70 V_{peak}, 2 x 870 VA at 25 A

The currents 1 and 2 of each group are phase-opposite.

Observe the safety instructions given in Section 7.1 on page 93 when using this operating mode.

Figure 7-7:
Two-phase operation
2 x 32 A high burden mode



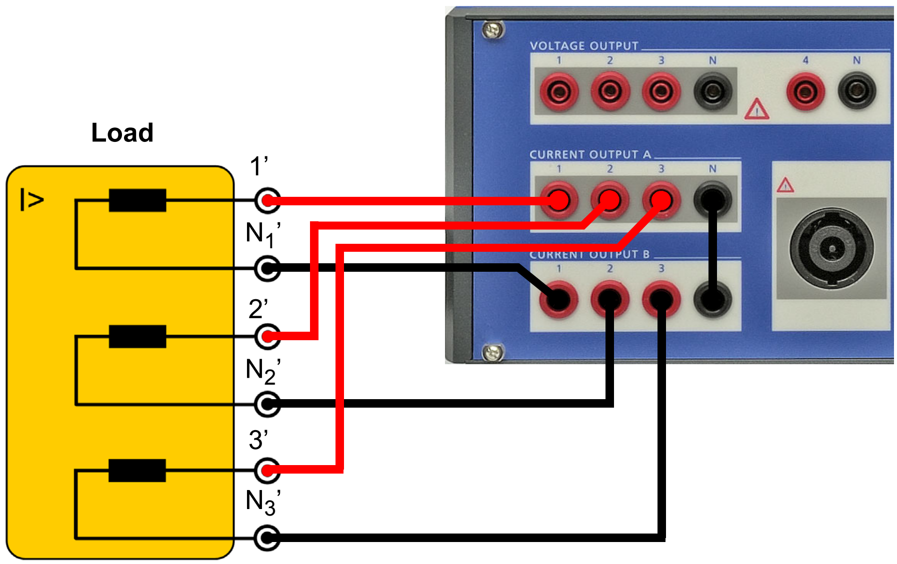
7.4 Three-Phase Current Mode with High Burden

3 x 0 ... 32 A (±45 A_{DC}), max. 70 V_{peak}, 3 x 860 VA at 25 A

For loads with three separate phases it is possible to double the available compliance voltage. However, this configuration does not make sense, if a common N connector is required! **Do not** connect N1, N2 and N3 to each other!

Observe the safety instructions given in Section 7.1 on page 93 when using this operating mode.

Figure 7-8:
Three-phase operation



7.5 Operation with External Amplifiers

The connections "LL out 1-6" offer a large variety of extension possibilities. They enable the connection of external amplifiers in order to increase the number of independent voltage or current channels and thus provide the possibility to realize additional applications the *CMC 356* alone cannot cover.

Each LL output socket ("LL out 1-6" and the optional "LL out 7-12") can connect up to four external amplifiers with six independent channels.

The following configurations are possible:

- 9 × 25 A_{rms} / 70 VA for differential relays in three galvanically separated current triples with *CMC 356* + *CMA 156.*
- 6 × 250 V / 75 VA for the synchronization in two galvanically separated voltage triples with *CMC 356* + *CMS 156.*

For a complete overview of the supported configurations of the *CMC 356* and CMA/S amplifiers see the OMICRON *Test Universe* Help, topic **Hardware Configuration**.

8 Troubleshooting

8.1 Troubleshooting Guide

In case of operational problems with the *CMC 356* proceed as follows:

1. Consult the reference manual or the *Test Universe* Help.
2. Check whether the malfunction is reproducible and document it.
3. Try to isolate the malfunction by using another computer, test set or connecting cable, if available.
4. Note the exact wording of any error message or unexpected conditions.
5. If you contact the OMICRON technical support, please attach:
   - your company name as well as a phone number and e-mail address
   - the serial number of your test set
   - information about your computer: Manufacturer, type, memory, installed printers, operating system (and language) and the installed version and language of the OMICRON *Test Universe* software.
   - screenshots or the exact wording of possible error messages.
6. If you call the OMICRON hotline, please have your computer and test set available and be prepared to repeat the steps that caused the problem.

To speed up the support, please attach the following diagnostic log files:

- **Communication log file**

  This file records any communication between the *CMC 356* and the computer. To send the log file to the OMICRON technical support:

  1. Close all other applications.
  2. From the *Test Universe* Start Page, select **Calibration & Diagnosis…** and then **Logfile**.
  3. Select **Logging on (Detailed)** in the **Edit** menu and minimize the window.
  4. Start the test module and reproduce the malfunction.
  5. Go back to the log file and select **Send** in the **File** menu to submit the log file via e-mail to the OMICRON technical support.

- **Hardware check log file**

  Each time a test module starts, an internal hardware self-check is performed. The results of this test are stored in the hwcheck.log file.

  To open the log file, select **Calibration & Diagnosis…** and then **Hardware Check** from the *Test Universe* Start Page.

8.2 Potential Errors, Possible Causes, Remedies

Some potential disruptions that may occur while operating the *CMC 356* are listed below. Try to eliminate them by applying the remedies proposed here.

Table 8-1: Troubleshooting the *CMC 356*

Error	Possible causes	Remedies
Power switch does not light up after turning on the *CMC 356* test set.	There is no power to the test set.	Check the power supply and assure that it supplies power to the test set.
	The fuse of the test set is blown	Unplug the power cord from the power source! Replace the fuse: T 12.5 AH 250 V (5 x 20 mm).
	Malfunction of internal test set components	Please contact the OMICRON technical support (refer to section "OMICRON Service Centers" on page 109).
The following message appears in the status line: "WARNING: Broken ground connection! Immediately turn off the test set! Resuming the operation can result in hazard to life and is done at your own risk."	Ground-wire connection to the *CMC 356* is broken or the test set is powered by an earth-free power supply. **Note:** Never connect the *CMC 356* to an isolating transformer.	Check the ground connection. Ground the housing of the test set separately using the PE connection socket (on the back panel of the test set).

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The OMICRON Bootloader software includes software parts developed by:

- Intel Corporation (IXP400 SW Release version 2.3)
- Intrinsyc Software (Intrinsyc Bootloader)
- Swedish Institute of Computer Science, Adam Dunkels (lwIP TCP/IP stack)
- Mark Adler (puff - decompress the deflate data format)
- Jean-loup Gailly and Mark Adler ("zlib" general purpose compression library)

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IXP400 SW Release version 2.3

Intrinsyc Bootloader

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lwIP TCP/IP stack

Author: Adam Dunkels <adam@sics.se>

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puff (Mark Adler)

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zlib (Jean-loup Gailly and Mark Adler)

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The data format used by the zlib library is described by RFCs (Request for Comments) 1950 to 1952 in the files ftp://ds.internic.net/rfc/rfc1950.txt (zlib format), rfc1951.txt (deflate format) and rfc1952.txt (gzip format).

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INDEX

Numerics

A

B

C

D

E

F

G

H

I

L

M

N

O

P

R

S

T

U

V

W