ARCO 400

Technical Data

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1 Technical data

ARCO 400 is calibrated at + 23 °C (+ 73.4 °F). All guaranteed specified values are valid for the period of one year after factory calibration and within a temperature range of 23 °C ± 5 °C (73.4 °F ± 9°F) at nominal value after a warm-up phase of more than 25 minutes.

1.1 Control

1.1.1 Technical data of the communication ports

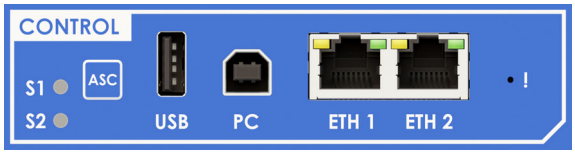
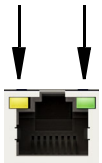


Figure 2-1: *ARCO 400* Communication ports

Two USB ports and Ethernet ports ETH1/ETH2		
USB	USB type	USB 2.0 high speed up to 480 Mbit/s
	USB connector	USB type A (for future use of USB peripherals)
	Output current	500 mA max.
PC	USB type	USB 2.0 high speed up to 480 Mbit/s; USB 1.1 compatible
	USB connector	USB type B
	USB cable	USB 2.0 high speed type A-B, 2 m/6 ft
ETH 1 ETH 2	ETH type	10/100/1000Base-TX[1] (twisted pair, auto-MDI/MDIX or auto-crossover)
	ETH connector	RJ45
	ETH cable type	LAN cable of category 5 (CAT5) or better[2]
	ETH port status LED 	Depending on the ETH type of your interface board's counterpart, the status LED's behavior varies. Physical link established, port active: Mbit/s — Active LED ON 10 — yellow 100 — green 1000 — yellow + green If there is traffic via an ETH port, the active LEDs start blinking.
	ETH Power over Ethernet (PoE)	IEEE 802.3af compliant. Port capability limited to 2 x Class 3 (12.95 W) power devices.

1. 10 Base = 10 Mbit/s transfer rate; 100 Base = 100 Mbit/s transfer rate; 1000 Base = 1000 Mbit/s transfer rate
2. Shielded LAN cable required.

1.1.2 Clock accuracy

All signals that are generated or measured by *ARCO 400* are referenced to a common time base that is specified as follows:

Clock accuracy	
Clock performance	Stratum 3 (ANSI/T1.101-1987)
Frequency drift (over time)	
24 hours	< ± 0.37 ppm (± 0.000037 %)
20 years	< ± 4.60 ppm (± 0.00046 %)
Frequency drift (over temperature range)	< ± 0.28 ppm (± 0.000028 %)
Frequency resolution (signal generation)	< 5 µHz

1.1.3 Synchronization accuracy

The specifications below refer to the internal time base. For the accuracy values of outputs and inputs in reference to absolute time, you need to add the error of the respective channel.

Synchronization accuracy	
IEEE 1588	
Offset (UTC)	Error < 100 ns[1]
Pulling range	± 100 ppm (± 0.01 %)

1. Depends on the PTP master clock accuracy.

1.2 Current output specifications

General current output specifications	
Number of outputs	3
Ranges	
Range I	0 ... 1.25 A
Range II	0 ... 12.5 A
Range III	0 ... 8 V (for more details refer to section “Low level output specifications” on page 13)
Frequency Range	0 ... 599 Hz
Configurations (AC)	
L-N	3 x 1.25 A
L-N	3 x 12.5 A
L-N	3 x 8 V
Configurations (DC)	
L-N	3 x ± 1.25 A
L-N	3 x ± 12.5 A
L-N	3 x ± 11.3 V
Connection	Test interface
Potential group	Test interface; see section "Isolation coordination diagram" on page 17.

The amplifier is fully protected against short and open circuit. The outputs are shorted when they are not in operation.

1.2.1 Signal quality of current output

	Typical	Guaranteed (1 year)
AC accuracy [1]		
50/60 Hz	Error < 0.04 % of rd. + 0.01 % of rg.	Error < 0.08 % of rd. + 0.02 % of rg.
≤ 100 Hz	Error < 0.08 % of rd. + 0.02 % of rg.	Error < 0.15 % of rd. + 0.05 % of rg.
≤ 250 Hz	Error < 0.48 % of rd. + 0.02 % of rg.	Error < 0.95 % of rd. + 0.05 % of rg.
≤ 599 Hz	Error < 1.48 % of rd. + 0.02 % of rg.	Error < 2.45 % of rd. + 0.05 % of rg.
Phase error to V_{a1} [1, 2]		
50/60 Hz	< 0.05°	< 0.10°
≤ 599 Hz	< 0.25°	
Phasor error to UTC [1]		
50/60 Hz	< 0.05°	< 0.20°
THD+N at 50/60 Hz (bandwidth = 20 kHz)	< 0.10 %	< 0.25 %
DC offset		
Range I	< 100 µA	< 300 µA
Range II	< 1 mA	< 3 mA
DC resolution		
Range I	< 100 µA	
Range II	< 1 mA	
Temperature drift		
+ 20 °C … + 50 °C (+ 68 °F ... + 122 °F)	< 25 ppm/K	< 50 ppm/K
- 10 °C ... + 20 °C (+ 14 °F ... + 68 °F)	< 50 ppm/K	< 100 ppm/K

1. Load impedance $|Z_l| \leq 0.5\ \Omega$ in 12.5 A range and $\leq 1\ \Omega$ in 1.25 A range. For higher load impedances consider the influence of the output impedance.
2. The phase error refers to the first voltage output.

1.2.2 Performance data of current output

The performance test values below apply to the following test conditions:

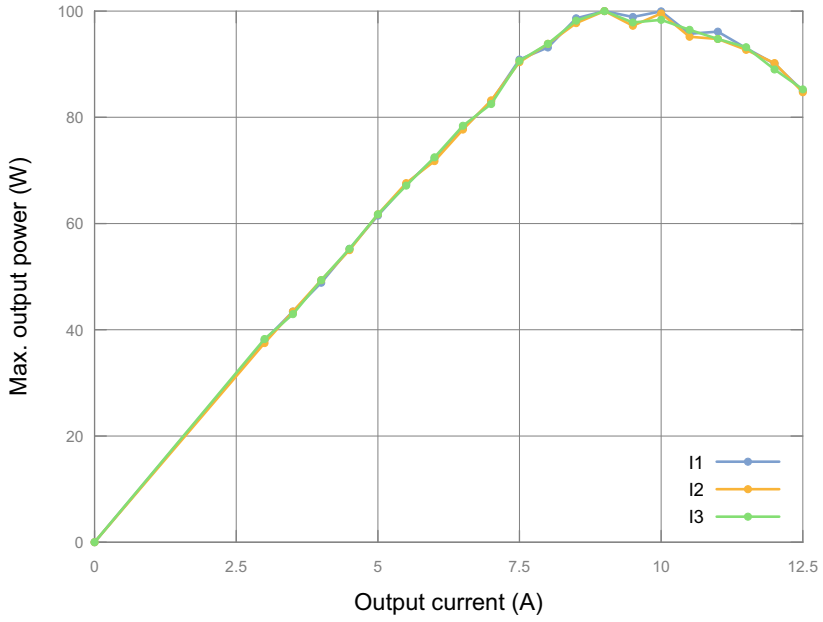
- The outputs are set to 50/60 Hz and symmetric conditions (0°, 120°, 240°).
- The outputs are connected to resistive loads.
- No overload is indicated.

	Typical	Guaranteed
Compliance voltage [1, 2]	> 12 V (RMS) > 18 V (DC)	
Max. compliance voltage	18 V (DC)	
Output power AC [3, 4]	3 x 95 W at 8 A … 12.5 A	3 x 85 W at 8 A … 12.5 A

1. Compliance voltage is the maximum voltage a current source will reach in its attempt to generate the programmed current. You can individually set the values for the compliance voltage.
2. For currents > 8 A, the compliance voltage is reduced to 66 % of max. compliance voltage (- 1.3 V/A)
3. Data valid for symmetric conditions (0°, 120°, 240°).
4. Output power guaranteed at test interface connector at the *ARCO 400* front panel.

Maximum output power

The diagram below shows the typical output power capability of *ARCO 400* with a constant gradient up to 8 A. Above this value, the compliance voltage decreases and therefore, limits the maximum possible output power.

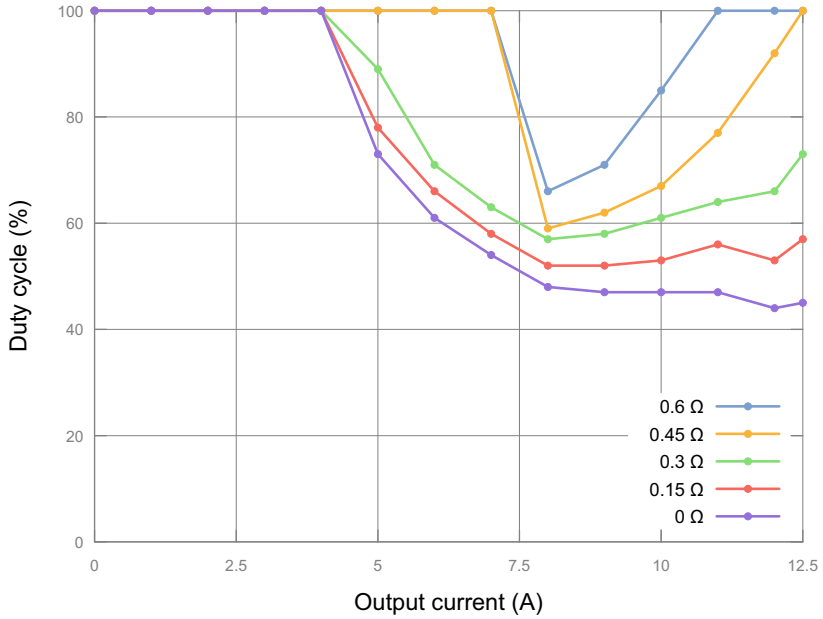


Duty cycle of output power

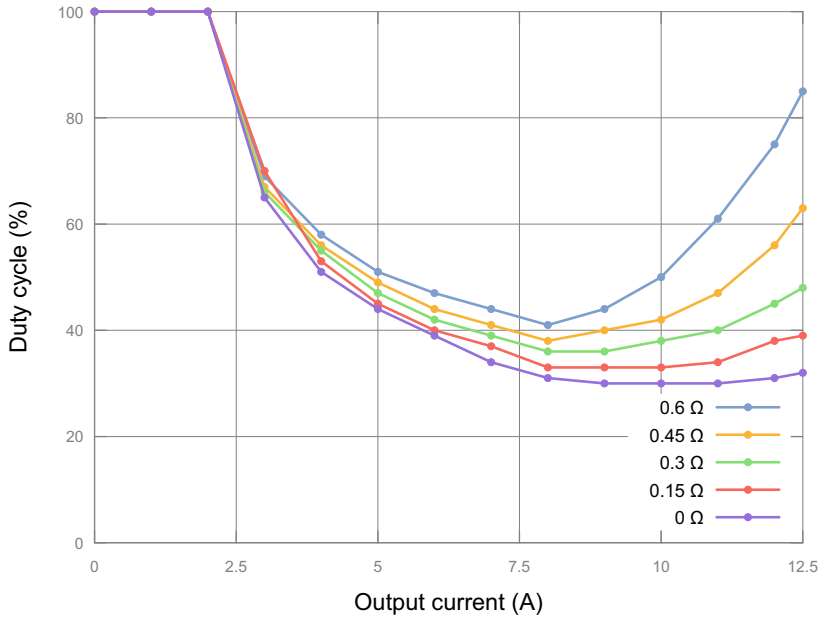
Continuous operation or **100 % duty cycle** is defined as an *ARCO 400* test set being able to typically provide a specified current and load for at least 30 minutes.

A **duty cycle of 75 %**, for example, means that the *ARCO 400* test set provides the specified current and load for 75 % of the time and needs the remaining 25 % of the time to cool off (for example: 180 s on and 60 s off).

Duty cycle at + 25 °C (+ 77 °F) ambient temperature



Duty cycle at + 50 °C (+ 122 °F) ambient temperature



1.3 Voltage output specifications

General voltage output specifications	
Number of outputs	6 (2 individual triples with common neutral)
Ranges	
Range I	0 ... 8 V (for more details refer to section “Low level output specifications” on page 13)
Range II	0 ... 150 V (Range II with 150 V is optional[1])
Frequency range	0 ... 599 Hz
Configurations (AC)	
L-N	6 x 8 V
L-N	6 x 150 V
Connection	Test interface
Potential group	Test interface; see section "Isolation coordination diagram" on page 17.

1. Ordering information for 6 x 150 V option: If you order this option, a 150 V range is added to the 6 x 8 V amplifier. The 150 V range is used for testing recloser controls that require higher voltage amplitudes.
Order number: VEHO0007

The amplifier is fully protected against short and open circuit. The outputs are open when they are not in operation.

1.3.1 Signal quality of voltage output

	Typical	Guaranteed (1 year)
AC accuracy [1]		
50/60 Hz	Error < 0.04 % of rd. + 0.01 % of rg.	Error < 0.08 % of rd. + 0.02 % of rg.
≤ 100 Hz	Error < 0.08 % of rd. + 0.02 % of rg.	Error < 0.15 % of rd. + 0.05 % of rg.
≤ 250 Hz	Error < 0.48 % of rd. + 0.02 % of rg.	Error < 0.95 % of rd. + 0.05 % of rg.
≤ 599 Hz	Error < 1.48 % of rd. + 0.02 % of rg.	Error < 2.45 % of rd. + 0.05 % of rg.
Phase error to V_{a10} [1, 2]		
50/60 Hz	< 0.05°	< 0.10°
≤ 599 Hz	< 0.25°	
Phasor error to UTC[1]		
50/60 Hz	< 0.05°	< 0.20°
THD+N at 50/60 Hz (bandwidth = 20 kHz)	< 0.10 %	< 0.25 %
DC offset	< 10 mV	< 20 mV
DC resolution	< 10 mV	
Temperature drift		
+ 20 °C... + 50 °C (+ 68 °F ... + 122 °F)	< 25 ppm/K	< 50 ppm/K
- 10 °C ... + 20 °C (+ 14 °F ... + 68 °F)	< 50 ppm/K	< 100 ppm/K

1. The maximum output current for high accuracy is I_{Load} < 50 mA in a 150 V range.
2. The phase error refers to the first voltage output.

1.3.2 Performance data of voltage output

To improve the output duration, the compliance voltage of the voltage output can be configured to limit the power dissipation in the linear amplifiers. The optimum compliance voltage for each controller adapter is automatically set (because of the smart automatic controller adapter detection).

The performance test values below apply to the following test conditions:

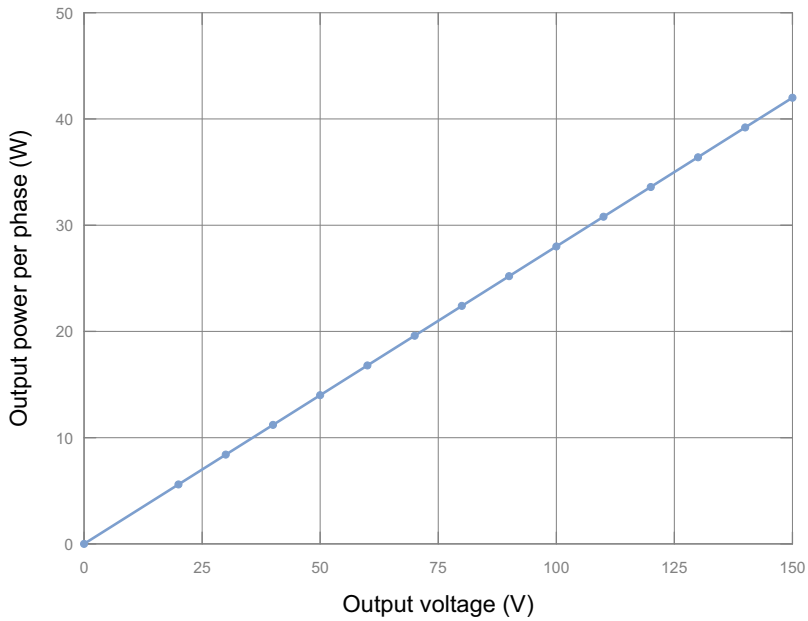
- The outputs are set to 50/60 Hz and symmetric conditions (0°, 120°, 240°).
- The outputs are connected to resistive loads.
- No overload is indicated.

	Typical	Guaranteed
Output current (AC)		
per channel	280 mA	250 mA
total	max. 1400 mA	
Compliance voltage range (DC)	75 V … 225 V	75 V ... 225 V
Output power (AC)[1, 2]	3 x 42 W at 150 V	3 x 37.5 W at 150 V
	6 x 42 W at 150 V	6 x 37.5 W at 150 V

1. Data valid for symmetric conditions in both triples (0°, 120°, 240°).
2. Output power guaranteed at test interface connector at *ARCO 400* front panel.

Maximum output power

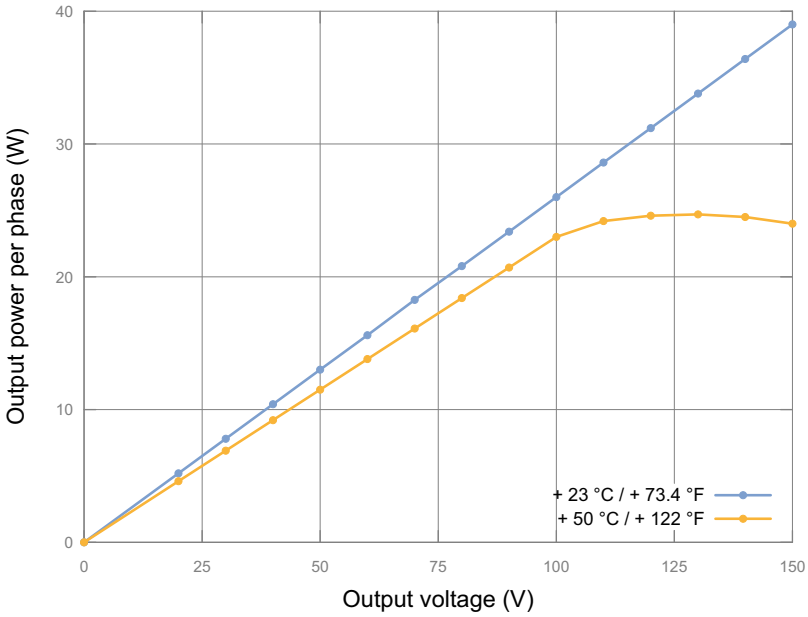
The diagram below shows the typical output power capability of *ARCO 400*.



Continuous output power for symmetric conditions in both triples

Continuous operation is defined as an *ARCO 400* test set being able to typically provide a specified voltage and load for at least 30 minutes.

The diagram below shows the continuous output power with optimized compliance voltage.



1.4 Low level output specifications

The voltage and current generators have three high accuracy low level voltage triples, i.e., nine configurable analog low level outputs. These nine low level outputs are used to simulate unconventional CTs/VTs either in linear or in Rogowski mode. When simulating Rogowski sensors, the output voltage is proportional to the derivative of the current with respect to time (di(t)/dt).

An additional high accuracy low level voltage output (i.e., a tenth low level output) is used to simulate automatically calculated ground current or voltage (I_E/V_E) by summing up one assigned generator triple.

General output specifications	
Number of outputs	10
Range	0 ... 8 V
Frequency range	0 ... 599 Hz
Maximum output current	1 mA[1]
Maximum output capacity	Stable for all capacitive loads
Connection	Test interface
Potential group	Test interface; see section "Isolation coordination diagram" on page 17.

1. Overload indication.

Signal quality of low level outputs

	Typical	**Guaranteed**
AC accuracy [1]		
50/60 Hz	Error < 0.04 % of rd. + 0.01 % of rg.	Error < 0.08 % of rd. + 0.02 % of rg.
≤ 599 Hz	Error < 0.08 % of rd. + 0.02 % of rg.	Error < 0.25 % of rd. + 0.05 % of rg.
Phase error to V_{a1} [2, 4]		
50/60 Hz	< 0.05°	< 0.10°
≤ 599 Hz	< 0.25°	
Phasor error to UTC [4]	< 0.05°	< 0.20°
THD+N at 50/60 Hz (bandwidth = 20 kHz)	< 0.10 %	< 0.25 %
DC offset	< 500 µV	< 1 mV
DC resolution	< 500 µV	
Temperature drift		
+ 20 °C ... + 50 °C (+ 68 °F ... + 122 °F)	< 25 ppm/K	< 50 ppm/K
- 10 °C ... + 20 °C (+ 14 °F ... + 68 °F)	< 50 ppm/K	< 100 ppm/K

1. The maximum output current for high accuracy is I_{Load} < 1 mA in an 8 V range.
2. The phase error refers to the first voltage output.

1.5 Binary inputs

Binary inputs: BINARY INPUT 1 ... 6	
Number of binary inputs	6
Number of potential groups	6
Type	Wet
Sampling frequency	10 kHz
Time resolution	100 µs
Debounce time	0 … 100 ms[1] (refer to section 1.5.2 "Debouncing input signals" on page 15)
Deglitch time	100 µs … 100 ms[1] (refer to section 1.5.1 "Deglitching input signals" on page 15)
Rated input voltage	250 V CAT III (max. permitted input voltage)
Threshold voltage range	5 V ... 250 V[1]
Nominal threshold voltage	Configurable (is automatically set via cable detection)[1]
Resolution	1 V
Trigger criteria	DC voltage compared to threshold voltage[1]
Ternary trigger BIN IN 1 ... 3 BIN IN 4 ... 6	 Simultaneous trigger on positive and negative threshold. Trigger on positive threshold only.
Threshold accuracy	5 % of reading +/- 1 V offset (for upper and lower threshold)
Nominal hysteresis	10 % of threshold
Input impedance	Configurable (automatically set via cable detection) 148 kΩ (for ADC[2] measuring input)
Connection	Test interface
Potential group	Test interface; see section "Isolation coordination diagram" on page 17.

1. *ARCO 400* supports the settings that are either set automatically via cable detection or configured manually in the *ARCO Control* software.
2. ADC = Analog-to-Digital Converter

1.5.1 Deglitching input signals

In order to suppress short spurious pulses, you can configure a deglitching algorithm. 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.

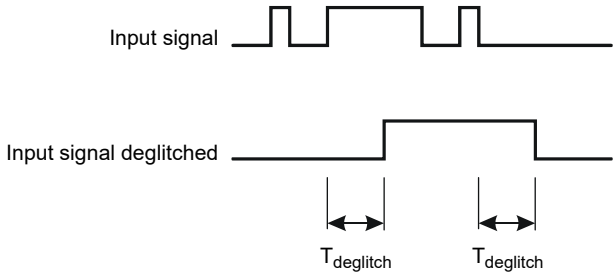


Figure 2-2: Signal curve, deglitching input signals

1.5.2 Debouncing input signals

For input signals with a bouncing characteristic, you can configure a debounce function. 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 *ARCO 400* 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 $T_{debounce}$.

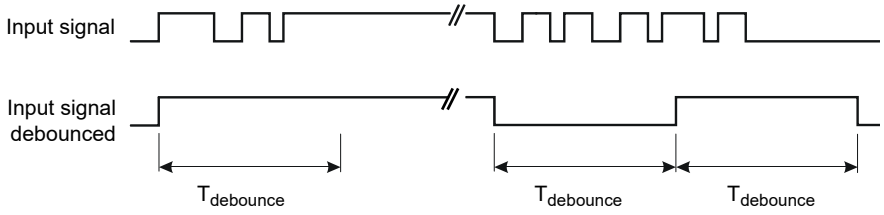


Figure 2-3: Signal curve, debounce input signals

1.6 Binary outputs

Binary outputs: BINARY OUTPUT 1 ... 9	
Number of binary outputs	9
Number potential groups	3 (1-3 / 4-6 / 7-9)
Type	Potential-free contacts, NO[1]
Rated input voltage	250 V CATIII
AC loading	V_{max} = 250 V; I_{max} = 0.5 A
DC loading	V_{max} = 250 V
Carry capacity	0.5 A continuous at 60 °C (140 °F)
Electrical lifetime	100 k switching cycles at 230 V / 0.5 A and resistive load (AC)
Total make time	< 6 ms
Total break time	< 3 ms
Functional isolation SEC	Creepage/clearance > 1 mm (0.04 ")
Pick-up time	Approx. 6 ms
Fall back time	Approx. 3 ms
Bounce time	Approx. 0.5 ms
Connection	Test interface
Potential group	Test interface; see section "Isolation coordination diagram" on page 17.

1. NO = normally open

1.7 Power supply

Main power supply	
Voltage, single phase	
Nominal voltage	100 V ... 240 V
Operational range	85 V ... 264 V
Nominal current	
at < 170 V	10 A max.
at > 170 V	8 A max.
Frequency	
Nominal frequency	50/60 Hz
Operational range	45 Hz ... 65 Hz
Overvoltage category	II
Connection	C14 connector according to IEC 60320-1
Potential group	Mains; see section "Isolation coordination diagram" on page 17.

1.8 Isolation coordination

Isolation coordination	
Overvoltage category (mains)	II
Pollution degree	2
Measurement category (BINARY INPUTS/OUTPUTS)	CAT III / 250 V (RMS) CAT IV / 150 V (RMS)

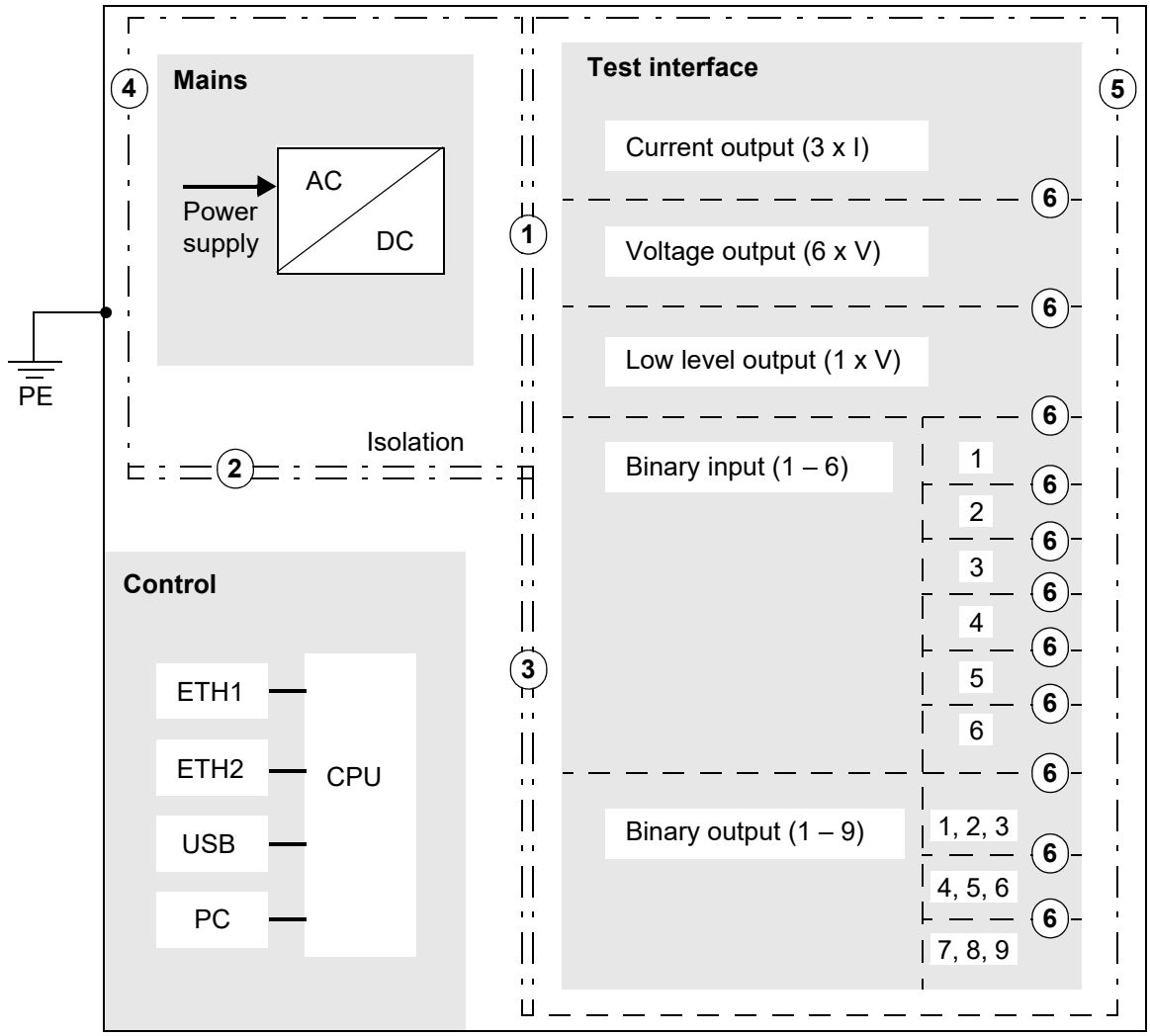
Isolation coordination diagram

The product safety requirements and the corresponding isolation coordination comply with standards IEC 61010-1 (Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use) and IEC 61010-2-030 (Particular requirements for testing and measuring circuits). For more detailed information, refer to the standards.

Control:
Potential group to control the *ARCO 400* test set is considered to be accessible (i.e. touchable).

Test interface:
Isolated potential group to connect the device under test.

Mains:
Line input to supply the *ARCO 400* test set with power.



Potential groups		Isolation	
①	Mains ↔ Test interface	RI[1]	240 V / OVC III[2], IEC 61010-1
②	Mains ↔ Control	RI[1]	240 V / OVC III[2], IEC 61010-1
③	Control ↔ Test interface	RI[1]	250 V / CAT III, IEC 61010-1 and IEC 61010-2-030
④	Mains ↔ PE[3]	BI[4]	240 V / OVC III[2], IEC 61010-1
⑤	Test interface ↔ PE[3]	BI[2]	250 V / CAT III, IEC 61010-1 and IEC 61010-2-030
⑥	Test interface ↔ Test interface	WI[5]	Functional isolation (with > 1.5 mm / 0.06 " creepage) between secondary isolation groups (current amplifier, voltage amplifier, binary inputs 1-6, binary outputs 1-9)

1. Reinforced isolation
2. OVC = Overvoltage category
3. PE = protective earth
4. Basic isolation
5. Working isolation (not safety-relevant)

1.9 Environmental conditions

1.9.1 Climate

Climatic specifications	
Operating temperature	- 10 °C ... + 50 °C / + 14 °F ... + 122 °F
Storage and transportation	- 25 °C ... + 70 °C / - 13 °F ... + 158 °F
Maximum altitude	
Operating	4,000 m / 13,000 ft
Non-operating	15,000 m / 49,000 ft
Humidity	5 % … 95 % relative humidity; no condensation

1.9.2 Mechanics

Size, weight, and protection	
Dimensions W x H x D	200 mm x 350 mm x 455 mm / 7.87 " x 13.78 " x 17.91 "
Weight	10 kg / 22 lbs
Ingress protection rating according to EN 60529	IP31 IP32 with front cover

1.10 Relevant standards

1.10.1 Climate

Damp heat specifications		
Damp heat	12 h + 25 °C/+ 77 °F and 12 h + 55 °C/+ 131 °F; 95 % r.H.	IEC 60068-2-30 (6 cycles)
Dry heat	+ 50 °C/+ 122 °F 16 h operated + 70 °C/+ 158 °F 96 h not operated	IEC 60068-2-2
Cold temperatures	- 10 °C/+ 14 °F 16 h operated - 25 °C/- 13 °F 96 h not operated	IEC 60068-2-1

1.10.2 Mechanics

Standards for testing mechanical conditions	
IEC 60721-3-7 - 7M3	Classification of mechanical conditions: Use at location and direct transfer between locations with significant vibrations or with high level shocks. The handling and transfer of products is rough. (for not operated mode)
IEC TR 60721-4-7	Classification of environmental conditions

Data for testing mechanical conditions

Basic standard	Description	Test values		Device conditions
IEC 60068-2-64	Random vibration	4.96 g RMS	10 – 2000 Hz, 30 min	not operated
IEC 60068-2-27	Shock response	30 g	11 ms (half sine) (3 shocks +/-)	not operated
IEC 60068-2-31	Free fall	0.5 m /1.64 ft	two drops, transport position	not operated

1.10.3 Electromagnetic compatibility

EMC standards	
Emission	
Europe	EN 61326-1; EN 61000-3-2; EN 61000-3-3, EN 55022 Class A
International	IEC 61326-1; IEC 61000-3-2; IEC 61000-3-3, CISPR 22 Class A
USA	FCC Subpart B of Part 15 Class A
Immunity	
Europe	EN 61326-1
International	IEC 61326-1

Standards and data for emission testing

Basic standard	Description	Port	Limit	Frequency range
EN55011/22	Radiated	Enclosure	A	30 MHz – 13 GHz
FCC, 47 CFR Part 15				
EN55011/22	Conducted	LAN[1]	A	0.15 – 30 MHz
FCC, 47 CFR Part 15		AC power		
EN61000-3-2	Harmonic current emission	AC power	A	
EN61000-3-3	Voltage fluctuation and flicker	AC power		

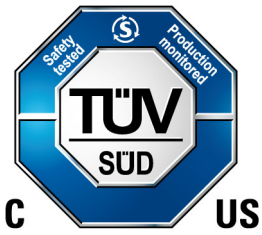
1. Shielded LAN cable required.

Standards and data for immunity testing

Basic standard	Description	Tested port	Test values		Performance criterion
IEC 61000-4-2	ESD	Enclosure	4 kV contact		A
			8 kV air		
IEC 61000-4-3	EM field	Enclosure	10 V/m	80 – 1000 MHz	A
			3 V/m	1.4 – 2 GHz	
			1 V/m	2 – 2.7 GHz	
IEC 61000-4-8	Rated power frequency magnetic field	Enclosure	30 A/m		A
IEC 61000-4-4	Burst	AC power	2 kV / 5 kHz	L → Ground N → Ground PE → Ground	A
		LAN, controller interface	2 kV / 5 kHz	→ Ground	
		USB	500 V / 5 kHz	→ Ground	
IEC 61000-4-5	Surge	AC power	1 kV	L – N	B
			2 kV[1]	L, N → PE	
		LAN	1 kV	→ PE	
IEC 61000-4-6	Conducted RF	AC	3 V	0.15 – 80 MHz	A
		LAN, controller interface			
IEC 61000-4-11	Voltage dips	AC power	to 0 % 1 period		A
			to 40 % 10 periods		A
			to 70 % for 25 periods		A
			to 0 % during 250 periods		C

1. Taking measurements during high disturbances at the mains port is not intended. Therefore, the device switches off when testing “2 kV L/N to PE”.

1.10.4 Safety

Safety standards	
Europe	EN 61010-1; EN 61010-2-030 Isolation of SELV[1] interface complies with EN 60950-1
International	IEC 61010-1; IEC 61010-2-030
USA	UL 61010-1; UL 61010-2-030
Canada	CAN/CSA-C22.2 No 61010-1-04; CAN/CSA-C22.2 No 61010-2-030-12
Certificate	 
Isolation	
Protection class	I (electrical earth)
Pollution degree	2
Isolation of functional groups	Standards IEC 61010-1 and IEC 61010-2-030

1. SELV = Safety extra low voltage according to IEC 60950

1.11 Calibration interval

OMICRON suggests that you calibrate your test sets at least once a year.

The drift of test equipment, that is, the change of accuracy over time, depends strongly on environmental conditions and the application field. Excessive use or applied mechanical and/or thermal stress may result in a necessity of shorter calibration intervals.

Moderate working environments, on the other hand, allow you to increase the calibration interval to once every two or even three years.

Particularly in cases of extended calibration intervals, verify the accuracy of the test set by cross-referencing the measurement results with traceable reference equipment either on a regular basis or prior to use. You can accomplish that by, for example, using a typical, often-used device under test as a reference, or by using measurement equipment with a certified high accuracy.

Should the test equipment fail, get it either calibrated or repaired immediately.

Limited warranty:

OMICRON guarantees that the test set is working properly within the quantified specifications at the time of calibration.

OMICRON offers a free-of-charge repair and readjustment for equipment that fails or drifts out of specification within the first 24 months after first shipment (new products), or 6 months after repairs.

The limited warranty excludes repair cases due to mechanical damage, high voltage or current injection, or any kind of use deviant from the equipment’s designated use.