

# RL 400 Modular I/O system

Plug-in I/O modules

Suitable for  
CANopen/PROFIBUS-DP/MODBUS TCP

Modules for numerous sensors and signals

2, 4 or 8 channels, depending on module version

Flexible plant design

Simple commissioning

rail line

## PROFILE

The input/output modules with fieldbus communication ports provide a high degree of flexibility when designing new plants. The compact, plug-in modules can be combined into cost-effective, de-centralized I/O islands. Due to the modular concept, type and number of the I/Os can be matched optimally to the requirements. Subsequent system extensions present no problems.

## FEATURES

- ✓ **Broad range of available sensor and signal modules**
- ✓ **Standard fieldbus interfaces supported**
- ✓ **Cost-effective module size**
- ✓ **Well defined galvanic isolation concept**
- ✓ **Modules with configurable multi-functions**
- ✓ **Easy module exchange (Hotswap)**
- ✓ **Configuration via BlueControl®**
- ✓ **High signal resolution**
- ✓ **High accuracy**
- ✓ **Small housing size**
- ✓ **Flexible and easy to extend**
- ✓ **Optimized connection to KS108**

## APPLICATION

- Data acquisition
- Remote I/O
- I/O extension

## DESCRIPTION

### CONSTRUCTION

RL 400 consists of a bus coupler for „top hat“ rail mounting and the possibility to connect up to 62 I/O-modules. The I/O modules are interconnected by means of quick-connect plugs. One power supply module must be installed per 16 I/O modules.

### Power supply

The system supply of 24 VDC is connected to the bus coupler module. Apart from bus communication, the quick-connect facility also feeds the supply voltage to the I/O modules.

### Internal communication

An internal bus connects the I/O modules with the bus coupler module, where the statuses/values of the connected I/Os are continuously updated and stored. The stored data also contains information about the type and diagnostic results of the relevant I/O module. The scanning cycle depends on the type and number of inserted modules and the bus load.

### Galvanic isolation

In the bus coupler module, the bus system (CAN / PROFIBUS / RS485), the internal communication circuits are galvanically isolated from each other and from the 24 VDC system supply.

Furthermore, the I/O modules provide galvanic isolation for the internal system bus and for the I/O circuits.

Depending on the module, analog inputs/outputs are either galvanically connected or isolated up to 300 V working voltage. Galvanic isolation between modules is always provided.

The eight digital outputs of the DO-modules are combined into groups with four outputs each. The groups are galvanically isolated from each other and from the remaining electronics.

The eight digital inputs of the DI-modules are grouped together to four inputs each which are galvanically isolated from each other.

**Sensor energization**

**Transmitter supply**

The analog input module RL422-0 provides 10V/24V DC for energizing external two-wire transmitters.

**Digital inputs**

The RL 442 -1 / 442-0 provides 24V DC for operating proximity switches as well as NPN or PNP transistors.

**Input circuit monitoring**

Analog input signals are monitored for short circuit, open circuit, or polarity. A triggered monitoring circuit is signalled as a status change. Hereby, the status value for the fault signal can be defined in the configuration.

**Electrical connections**

The signal leads are connected to staggered terminal levels at top and bottom of the module. The screw terminals or spring-clamp connectors are plug-in units, and a connecting diagram is printed on the module front.

**Configuration**

Available as an accessory, the BlueControl® Engineering Tool not only contains a complete description, but also the EDS or GSD file (max. version with standard mapping of the variables) required for linking into CAN or PROFIBUS systems.

**Connection to KS108**

If the RL 400 is used as an I/O extension for the multi-function unit KS 108 via CANbus, parameter adjustment and configuration are done by means of additional functions in the Engineering Tool BlueDesign®. In this case, a CAN configurator is not needed!

Fig. 1 : RL400 with different applications

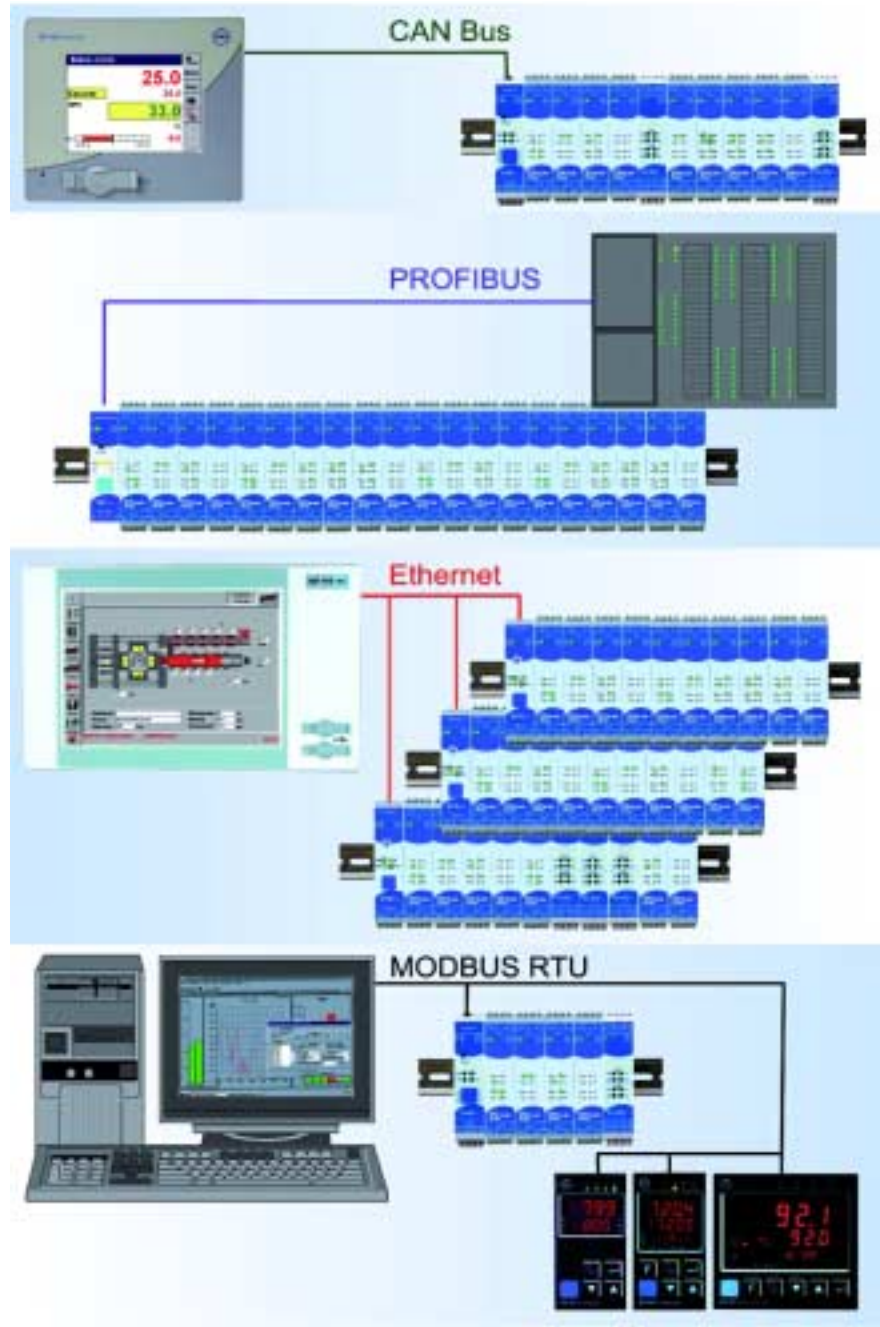
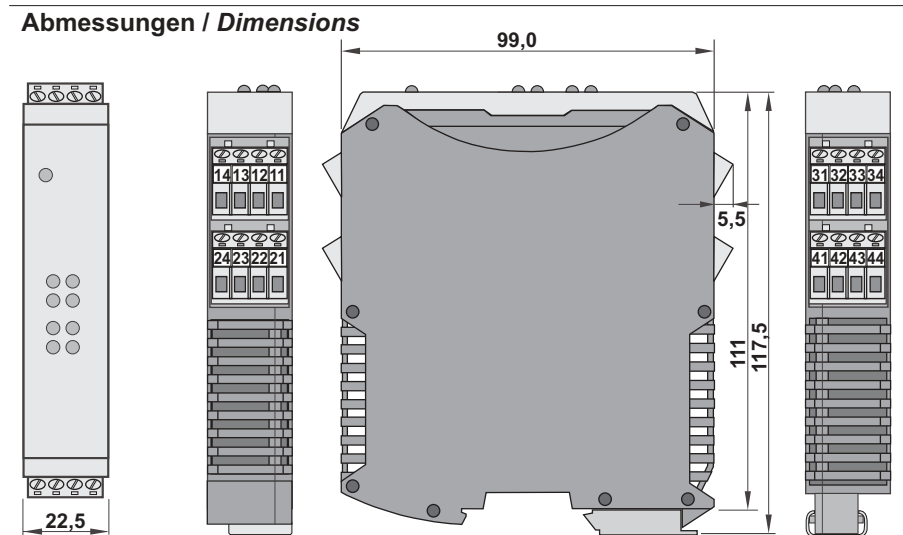


Fig. 2: Dimensions RL400 (Example RL 461)



## TECHNICAL DATA

### SYSTEM

#### Basic module

##### Internal scanning cycle of the I/O modules:

$t_s = 10\text{ms}$  (depending on the type and number of connected inserted I/O modules and the bus load).

##### Restrictions:

Max. 62 modules can be used per coupler module.

One power supply module must be installed per 16 I/O modules.

### BUS COUPLER MODULES

#### Bus coupler module RL 40 CANopen

Full CAN controller according to CAN specification V2.0A; physical coupling according to ISO 11898.

##### Cycle time on the CANbus:

Depends on the selected transmission speed, and on the number and type of inserted I/O modules (PDOs).

##### Transmission speed:

10 / 20 / 50 / 100 / 125 / 500 kBd; adjustable with DIP switches or via automatic selection.

##### Bus cable length

depending on baudrate (10kBd...500kBd):  
 $\leq 1000/1000/1000/500/250/100/50/25\text{ m}$

##### Address configuration:

addresses 1...99, adjustable with DIP switches;  $\leq 42$  using the default mapping  
With engineering-tool 1...126

##### Terminating resistor:

external

##### CAN protocol:

CANopen Slave, supports DS301 V4.02 (communication profile)

##### Process data objects (PDOs):

1 Multiplex PDO send,  
1 Multiplex PDO receive  
Receive:  $\leq 5$

Transmit:  $\leq 10$ , of which max. 5 can be requested per RTR (Remote Transmit Request)

##### EDS file:

Maximum version; component part of the Engineering Set ES/RL 400; not necessary in conjunction with KS98+.

##### Galvanic isolation:

Supply voltage, CANbus and logic circuits are galvanically isolated from each other.

##### Indicator LEDs:

Function: State;  
1 x State  
1 x State of the fieldbus  
1 x internal bus  
2 x yellow (Transmit, Receive)

##### Bus coupler RL400DP

PROFIBUS-DP to EN 50 170

##### Cycle time on the PROFIBUS:

Depends on the selected transmission speed and number of I/O modules.

Fig.3: RL 400 system with I/O-modules



##### Transmission speed

9600 bit/s up to 12 Mbit/s via automatic selection

##### Bus cable length:

$\leq 1000 \dots 100\text{m}$ , depending on baudrate

##### Address configuration:

address 1...99, adjustable with DIP switches. With engineering-tool 1...126

##### Terminating resistor: external

##### GSD file:

component part of the Engineering Set ES/RL 400

##### Galvanic isolation:

Supply voltage, PROFIBUS and logic circuits are galvanically isolated from each other.

##### Indicator LEDs:

Function: State;  
1 x green (state);  
1 x yellow (data exchange)  
1 x yellow (internal bus)  
1 x yellow (diagnosis)

##### Bus cable length:

RS 232:  $\leq 3\text{ m}$   
RS 485:  $\leq 1200\text{ m}$

#### Bus coupler module RL40-ETH

Ethernet interface with TCP/IP - protocol.

##### Network connection:

Ethernet RJ45 10BaseT according to IEEE 802.3  
TCP/IP protocol

MODBUS/TCP server via TCP port 502

##### Network connector:

RJ45 10BaseT (socket)

##### Bus cable length:

Ethernet segment length: 100m with Cat5 - wire

##### Address configuration:

Adjusted via bootp or engineering-tool

##### Galvanic isolation:

Supply voltage, network and logic circuits are galvanically isolated from each other.

##### Indicator LEDs:

Function: State;  
1 x green (state);  
1 x yellow (internal bus);  
2 x yellow (Transmit/Receive )

### ANALOG INPUT MODULES

#### General

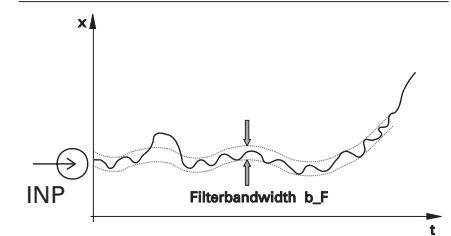
##### Measurement cycle:

$\leq 160\text{ ms}$  for all channels of a module

##### Digital filter:

Every input is fitted with a 1st-order filter that is adjustable for time constant or bandwidth.

Fig.4: Filterfunction



##### A/D converter:

Successive approximation, 16 bits. Sigma-delta modulation.

##### Input span monitoring:

Error message in case the upper limit is exceeded by more than  $> 160$  digits (resolution 16 bit)

##### Temperature drift: 0,08%/10K

**Analog inputs/outputs**  
**RL 422-0 to RL 461-0**

**Indicator LEDs:**

Status per channel

**Galvanic isolation**

RL 422-0: Inputs only separated from logic circuit; **not** from internal supply. Inputs are connected galvanically.  
 RL 461-0: Inputs are separated from logic circuit and from internal supply. Inputs are galvanically connected.

**Measuring range: selectable per channel**

RL 422-0: Single-ended inputs  
 4 x -20...20 mA / -10...10V / -5... 5V / -1...1V

RL 461-0: Difference inputs  
 2 x -20...20 mA and/or  
 2 x -10...10 V  
 -5... 5V / -1...1V

**Resolution: 16 bits**

**Characteristic: linear**

deviation:  $\leq 0,15\%$

**Input resistance:**

Current: approx.  $47\Omega$ ; Voltage:  $>730\text{ k}\Omega$   
 (with ground reference)

**Sensor monitoring:**

Exceeded limit: "out of range"  $>22\text{mA}$

**Interface:**

- integer 16 (fixpoint)
- float

**Two-wire transmitter supply(TPS)**  
**only RL 422-0**

One supply voltage "+24V OUT" for energizing a two-wire transmitter. Voltage:  $U_s = 10/24\text{ VDC} \pm 10\%$  (short-circuit proof)

Max. load: 20 mA at 10 V,  
 25 mA at 24 V

**Potentiometer measurement:**

(voltage-divider circuit)  
 Channels intended for voltage input can be configured in pairs for potentiometer measurement.

Uconst:  $U_s = 10\text{ VDC}$  (output instead of +24V OUT); short-circuit proof  
 Current limiting: 20mA

Fig. 5: Blockdiagram RL 422

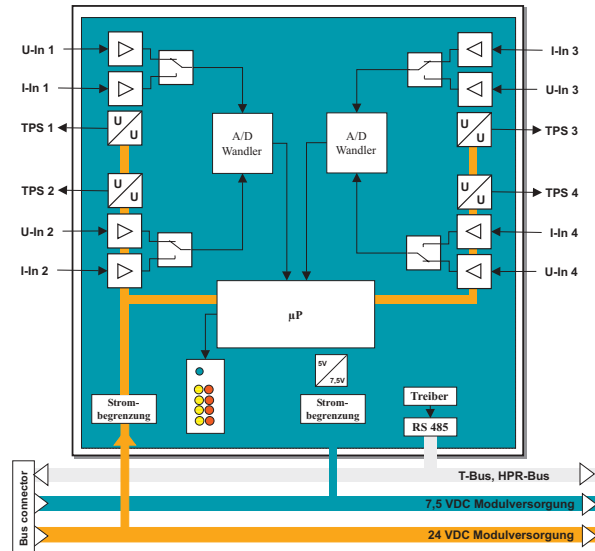


Table 1:

RL 422			
Type of input	single-ended		
Cycle time	160 ms		
Measuring range	Input resistance	Error	Resolution
-10..+10 V	$> 1\text{M}$	$= 0,1\%$	0,4 mV
-5..+5 V	$> 1\text{M}$	$= 0,1\%$	0,2 mV
-1..+1 V	$> 1\text{M}$	$= 0,1\%$	0,05 mV
-20..+20 mA	45	$= 0,1\%$	0,8 $\mu\text{A}$

Fig. 6: Blockdiagram 461

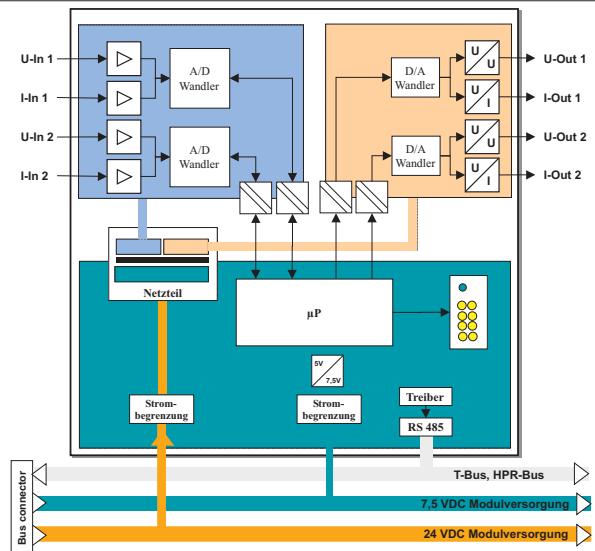


Table 2:

RL 461			
Type of input	difference		
Cycle time	80 ms		
Measuring range	Input resistance	Error	Resolution
-10..+10 V	$> 1,2\text{ M}$	$= 0,1\%$	0,4 mV
-5..+5 V	$> 1,2\text{ M}$	$= 0,1\%$	0,2 mV
-1..+1 V	$> 1,2\text{ M}$	$= 0,1\%$	0,05 mV
-20..+20 mA	50	$= 0,1\%$	0,8 $\mu\text{A}$

**Temperature input Pt100 /PT1000 /Ni100/ Ni 1000 / KTY**

RL 423-0 / -1 / -2

**Sensors: selectable per channel for RL 423-0/RL 423-2**

- Pt100/Ni 100 in two or three-wire connection  
Measuring range:  
Pt 100: -200...850°C  
Ni100: -60...300°C

**RL 423-1/RL 423-2**

Pt 1000 / Ni 1000 / KTY 11-6

**Characteristic: temperature-linear**

Conformity error: negligible

**Sensor monitoring: :**

Break and short circuit  
Permissible voltage difference between inputs: = 4 VAC rms

**Error**

see table for RL 423

**Interface:**

Data format:  
-integer 16 (fixpoint)  
-float

**Galvanic isolation:**

Inputs are separated from logic circuit and from internal supply, but are galvanically connected.

Fig. 7: Blockdiagram 423

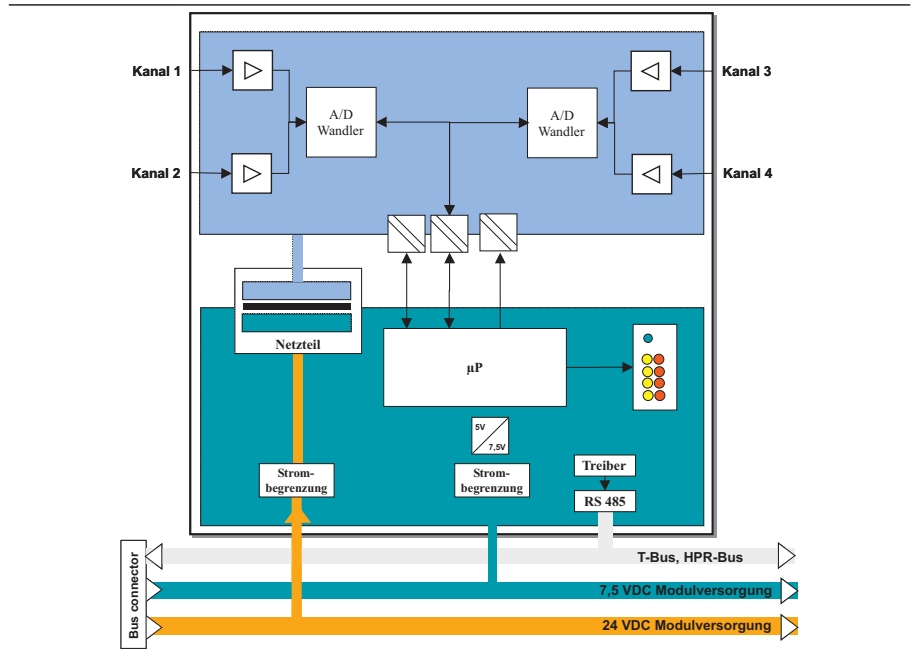


Table 3:

<b>RL 423</b>			
Type of input	3-wire		
Cycle time	160 ms		
Type	Measuring range	Error	Resolution
Pt100/1000	-200...850°C	= 1K	0,04 K
Ni100/1000	-60...300°C	= 1K	0,04 K
Kty	-50...125°C	= 1K	0,04 K

**Thermocouple input TC (RL 424-0/-1/-2)**

**Sensors: selectable per channel**

- Thermocouples: to DIN IEC 584  
Types see table RL 424

**Characteristic: temperature-linear**

Conformity error: negligible

**Resolution: 16 bits**

TC type E, J, K, L, T, N:  $\leq 0,01$  K/digit

TC type S, R, B:  $\leq 0,01$  K/digit

TC type W:  $\leq 0,01$  K/digit

**Error**

see table for RL 424

**Sensor monitoring:**

For break and shortcut

Permissible voltage difference between inputs:  $\leq 380$  VAC / 50Hz, 500 VDC

**Interface:**

Data format:

-integer 16 (fixpoint)

-float

**Galvanische Trennung:**

Eingänge gegen Logik und interne Versorgung RL 424-0 Kanal gegen Kanal (300 Volt Arbeitsspannung).

RL 424-1 und RL 424-2 Kanäle in Gruppen à 2 getrennt.

**Millivolt-/O<sub>2</sub> (RL 424-1)/thermocouple input**

**Number of channels: 4; galvanic isolated**

2 Kanäle mV/O<sub>2</sub>

2 Kanäle TC

**Channel 1: Millivolt input**

Measuring range:  $1 \times \pm 2000$  mV,  $\pm 1000$  mV,  $\pm 500$  mV,  $\pm 250$  mV.

Input resistance: approx: 200M $\Omega$  diff.

Connection with screened sensor leads.

**Resolution: 16 bits**

Characteristic: linear

Error:

With 100 k $\Omega$  sensor output resistance:

linearity:  $\leq 0.05\%$

temperature:  $\leq 0.05\%$

with 1 M $\Omega$  sensor output resistance:

linearity:  $\leq 0.5\%$

temperature:  $\leq 0.4\%$

**Internal calculation**

– O<sub>2</sub> content at measured temperature

– O<sub>2</sub> content with heated sensor and a constant

2-point measurement adaptation

**Interface:**

Data format:

-integer 16 (fixpoint)

-float

Fig. 8: Blockdiagram 424-0

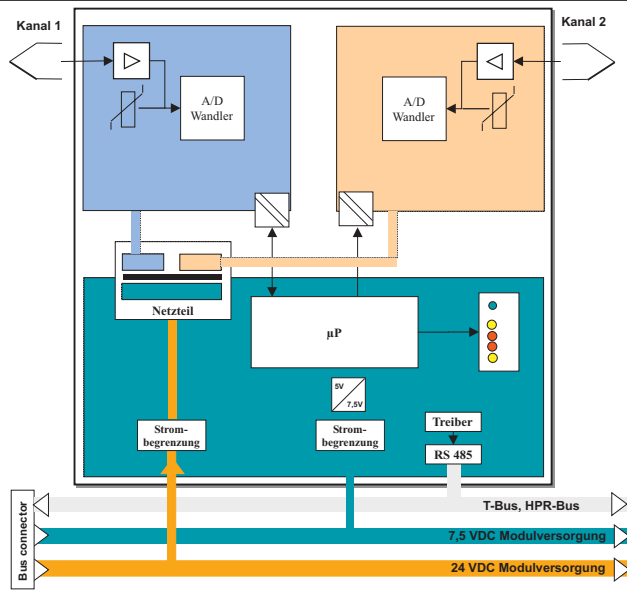


Fig. 9: Blockdiagram 424-1

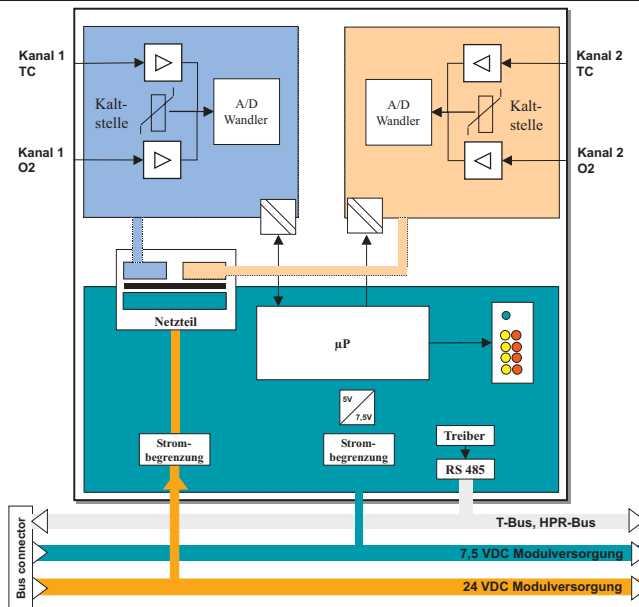


Table 4:

RL 424				
Type of input	difference			
Cycle time	160(240)** ms			
Measuring range	Input resistance	Measuring range	Error	Resolution
L	> 1M	-200...900°C	= 2K	0,05 K
J	> 1M	-210...1200°C	= 2K	0,05 K
K	> 1M	-270...1370°C	= 2K	0,08 K
N	> 1M	-196...1299°C	= 2K	0,08 K
S	> 1M	-50...1760°C	= 2K	0,07 K
R	> 1M	-50...1760°C	= 2K	0,07 K
T	> 1M	-270...400°C	= 2K	0,02 K
E	> 1M	-270...1000°C	= 2K	0,04 K
B	> 1M	25...1820°C	= 3K	0,1 K
W	> 1M	0...2299°C	= 3K	0,1 K
80mV	> 1M	-80...80mV	= 0,1%	3 µV

\* \*) 4-channel and TC/O<sub>2</sub> version

## **ANALOG OUTPUT MODULES**

### **Standard signals I,U (RL 461-0)**

#### **Number of channels: 4 (2AI, 2AO)**

For technical data of analog inputs, see "Analog Input Modules".

Signal ranges: selectable per channel  
All outputs are short-circuit proof.

#### **Resolution: 12 bits**

±20mA  
-10...10V / -5...5V / -1...1V

#### **Node guarding**

Behaviour at communication failure: configurable

- Fail safe: output is set to 0V/0mA
- Hold: retain last value
- vault value

#### **Characteristic: linear**

overall error: ≤0,25% (0...10V);  
≤0,6% (-10...10V); ≤0,63% (0...20mA) of  
measurement range.

#### **Permissible load:**

Current output: ≤ 500 Ω  
Voltage output: ≥ 1000 Ω  
Load effect: 0,1%/100Ω  
Temperature drift: ≤0,01%/10K

#### **Interface:**

Data format:  
-integer 16 (fixpoint)  
-float

#### **Galvanic isolation:**

Outputs are separated from logic circuit  
and from internal supply, but are galvanically  
connected.

#### **Indicator LEDs:**

Function: Display of the selected signal  
range (U or I) 4 x 2 x yellow

## **DIGITAL INPUT MODULES**

### **RL 442-X, RL 443-0**

#### **24 VDC logic**

##### **Number of channels: 8**

Input: Logic signals, contacts or 3-wire  
sensors (NPN or PNP transistors); accor-  
ding to module

##### **Signal level: according to IEC 61131**

„Low“: -3...5 VDC  
„High“: 15...30 VDC

Messzyklus: ≤10 ms für alle Kanäle  
(Zykluszeit auf dem Systembus  
10ms/Modul)

##### **Operating sense: configurable**

##### **Input resistance: 6,8k**

Filter: analog, fg = 1 kHz  
Surge voltage protection: fitted

##### **Galvanic isolation:**

Between inputs and logic circuits.  
Groups of 4 separated from each other,  
from logic circuits, and internal supply.

##### **Indicator LEDs:**

Function: signal status  
8 x yellow

### **115V/230V AC-logic (RL 443-0)**

#### **Number of channels: 4**

##### **Signal level:**

„Low“: 0...50 VAC  
„High“: 90...250 VAC

##### **Measurement cycle:**

≤10 ms for all channels  
(cycle time on the system bus: 10  
ms/module)

##### **Operating sense: configurable**

Input resistance: 240 kΩ  
Filter: input delay ≤10 ms/ channel  
Surge voltage protection: fitted

##### **Galvanic isolation**

Inputs from logic, between inputs

##### **Indicator LEDs:**

Function: signal status  
4 x yellow

## **DIGITAL OUTPUT MODULES**

### **RL 451-X, RL 452-0**

#### **Node guarding**

Behaviour at communication failure con-  
figurable:

- Fail safe: outputs 0/1 (selectable)
- Hold: retain last value
- vault value

#### **24 VDC logic (RL 451-0)**

Number of channels: 8 (2 groups of 4  
channels); suitable for switching loads  
with 12 and 24 VDC.

##### **Control voltage:**

Uc = 2 x 24 VDC; separated according to  
groups.

Permissible range: 8...34 VDC  
Forward resistance: ≤140 mΩ  
(≤200 mΩ typical); voltage drop ≤1,2V

##### **Leakage current:**

approx. 30 μA (non-conducting)

##### **Load current:**

Depends on ambient temperature:

At 25°C: ≤2A / output

At 50°C: ≤1,5A / output

##### **Lead break and short circuit**

detected and made available as a status  
signal on the bus.

- function can be switched off.

##### **Protective circuits:**

Fitted as standard against short circuit,  
and surge voltage; thermal current limi-  
ting.No reversed-polarity protection.

##### **Free-wheel diode for inductive loads:**

at RL 451-1 included

##### **Cycle time: 10 ms for all channels**

(cycle time on the system bus: 10  
ms/module)

##### **Operating sense: configurable**

##### **Galvanic isolation**

Logic from output group, groups among  
each other

##### **Indicator LEDs:**

8 x yellow (signal status)

### **Relays (RL 452-0)**

#### **Number of channels: 4 relays**

Contacts: potential-free change-over

Contact rating:

AC: ≤ 1250 W, 250 V, 5A

DC: ≤ 120 W, 120 V, 5A

RC suppressor circuit:

must be provided externally

##### **Cycle time: 10 ms for all channels**

(cycle time on the system bus: 10  
ms/module)

##### **Operating sense: configurable**

##### **Galvanic isolation:**

Relays from logic circuits and internal  
supply

##### **Indicator LEDs:**

4 x yellow (signal status)

## **POWER SUPPLY**

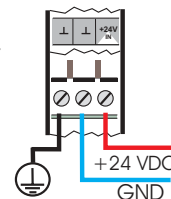
The basic module is energized via its bus  
coupler module.

Supply voltage: 24 V DC (20...30VDC)

Current consumption: ≤1,5A

Influence power supp-  
ly: negligible

- The GND of the 24V  
power supply has to  
be connected to  
protective earth  
(PE).



## **ENVIRONMENTAL CONDITIONS**

##### **Permissible temperature:**

Operation: -10...55 °C (32...122 °F)

Storage and transport: -20...70 °C

(-4...158 °F)

##### **Climatic category:**

KUF according to DIN 40 040

Relative humidity: ≤75% yearly average,  
no condensation  
*Electromagnetic compatibility:*  
DIN EN 61000-6-3  
DIN EN 61000-6-2

*Shock and vibration:*  
To DIN 40046 IEC 60068-2-6

## GENERAL

### Electrical connection:

Screw terminals and spring-clamp connectors for leads with max. 2,5 mm<sup>2</sup> cross-section.

### Mode of protection:

IP20

### Housing:

Material: polyamide PA 6.6  
Flammability class: V0 to UL 94

### Mounting:

on 35 mm „top hat“ rails to DIN EN 50022

### Mounting position: vertical

Overall dimensions (W x H x D):  
RL 400 22,5 x 99,0 x 117,5 mm

### Weight:

All modules: approx. 100 g (3,53 oz.)

## ACCESSORIES

BlueControl®

Type **RL 400**

R L 4 0 - 1 1 x - 0 0 0 0 0 x 0 0

### Fieldbus coupler

CAN	RL40-CANopen	1
DP	RL40-DP PROFIBUS DP V1	2
MOD	RL40-MOD* MODBUS RTU	3
ETH	RL40-ETH Ethernet MODBUS/TCP	4

### Power module

PWR	RL40-PWR Power module PWR	9
-----	---------------------------	---

Analog inputs AI R L 4 0 - 1 x 0 - x x x x 0 - x 0 0

AI	RL 422-0 Analog inputs, 4 x I / U / TPS / Pot Universal module	4 2 2 0
AI	RL 423-0 RTD 4 x Pt100 galvanic isolated	4 2 3 0
AI	RL 423-1 RTD 4 x Pt1000 galvanic isolated	4 2 3 1
AI	RL 423-2 RTD 4 x Pt100/Pt1000 galvanic isolated	4 2 3 2
AI	RL 424-0 2 x TC galvanic isolated	4 2 4 0
AI	RL 424-1 2 x TC / O2 (mV)	4 2 4 1
AI	RL 424-2 4 x TC galvanic isolation 2/2	4 2 4 2
AIO	RL 461-0 Combi module, 2 x AI (±U / ±I, 16 Bit) differential inputs; 2 x AO (±U / ±I, 12 Bit)	4 6 1 0

Analog outputs AO R L 4 0 - 1 x 0 - x x x x 0 - x 0 0

AO	RL 431-0* 4 x I / U (±10V / ±20mA, 12 Bit)	4 3 1 0
AIO	RL 461-0 Combi module, 2 x AI (±U / ±I, 16 Bit) differential inputs; 2 x AO (±U / ±I, 12 Bit)	4 6 1 0

Digital inputs DI R L 4 0 - 1 x 0 - x x x x 0 - x 0 0

DI	RL 442-0 Digital inputs 2 x 4 24 VDC (pnp)	4 4 2 0
DI	RL 442-1 Digital inputs 2 x 4 24 VDC (npn)	4 4 2 1
DI	RL 442-2 Digital inputs 2 x 4 contact (potential-free) 115V / 230V	4 4 2 2
DI	RL 443-0 4 x relay (115/230V AC)	4 4 3 0

Digital outputs DO R L 4 0 - 1 x 0 - x x x x 0 - x 0 0

DO	RL 451-0 Digital outputs 2 x 4 24 VDC/2A	4 5 1 0
DO	RL 451-1 Digital outputs 2 x 4 24 VDC/2A (free wheeling diode)	4 5 1 1
REL	RL 452-0 Relay outputs 4 x 230 VDC/5A	4 5 2 0

### Terminations

Without terminal blocks	0
Screw terminal	1
Spring-clamp terminal	2

### Approvals

CE	0
UL/cUL*	U

### RL Accessories

4 x Screw terminal blocks	9 4 0 7 - 9 9 8 - 0 7 1 0 1
4 x Spring-clamp terminal blocks	9 4 0 7 - 9 9 8 - 0 7 1 1 1
1 x Top-hat rail bus-connector	9 4 0 7 - 9 9 8 - 0 7 1 2 1
1 x Plug for busconnection left (for bus coupler)	9 4 0 7 - 9 9 8 - 0 7 1 3 1
1 x Plug for busconnection right (bus extension)	9 4 0 7 - 9 9 8 - 0 7 1 4 1

\* in preparation



## Germany

PMA Prozeß- und Maschinen- Automation GmbH  
Miramstraße 87, D-34123 Kassel

Tel.: +49 -561- 505 - 1307  
Fax: +49 -561- 505 - 1661  
E-mail: [export@pma-online.de](mailto:export@pma-online.de)  
Internet: <http://www.pma-online.de>

## Your local representative: