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BRAUN INSTRUMENT
SPEED AND FREQUENCY

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Speed Monitor Series D421.5
with setpoint alarms and optional analog output

Instructions and Operation Manual
valid for serial nos exceeding 138320

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Available versions and corresponding Model Numbers

Functions	Programming	Model No
2 setpoint alarms	by keys with display on top of unit	D421.51
2 setpoint alarms + analog output	by keys with display on top of unit	D421.52

Power Supply
The power supply voltage is specified by an appendix to the model No.:
U1 = range 18....40 volts AC/DC (nominal 24 volts)
U2 = range 85...265 volts AC/DC (nominal 115 volts and 230 volts)

Application and Functions

Monitoring and (optionally) conversion into an analog signal, of any variable transmitted as a signal frequency, specifically speed by a contactfree sensor, or an incremental encoder, or ac-tacho, and flowrate by the frequency output of a flowmeter.
Note: for analog conversion only see series D421.31/33

Specific Features
Display indicates the variable, if not in programming phase.
Signal input with high sensitivity and high level input path.
Floating input period interval measurement, with programmable minimum measuring time 5 millisec to 99.9 sec.
Input frequency pre-divider to balance oscillating pulse sequence.
2 setpoints with individually programmable response characteristics, and starter function.
Optional analog output with programmable span.

Specifications

Design	snap-on track enclosure for DIN 50022 rail 35 mm, Dimensions: length 70 mm, width 75 mm, height 111 mm.
Installation Conditions	Ambient temperature in operation ....0°C...+50°C storage......................... -40°C....+85°C Electrical insulation grade .... I Voltage grade .... I Protection class.. housing.IP50 terminals IP20
Power Supply	Supply voltage for type .....U1: 18...40 volts AC/DC for type ....U2 85...265 volts AC/DC Consumption 5 W or 5 VA
Signal input	
high level path	matching speed sensors series A5S05...A5S09... and series A4S.... to other sources: response level on/off >6.8 volts/<6.6 volts input impedance 100 kohms sensor supply approx. 12 volts/max. 60 ma to NAMUR type sensors: >2.0 ma/<1.2 ma into 1k load with 8 volts supply,
high sensitivity path	response 500 mv RMS within frequency range 0.1...1 Hz response 50 mv RMS within frequency range 1 Hz...10 kHz, response 500 mv RMS within frequency range 10...100 kHz, maximum rating 100 v with 35 v DC superposed.
Measuring period time	floating, with minimum programmable 5 millisec ....99.999 sec
Accuracy	$\pm$ 0.05 % of measurement $\pm$ 1 in LSD
Alarm relay outputs	2 SPDT, each free programmable in setpoint and response characteristics. switch capacity voltage min 10 mv, max 250 v AC/DC current min. 10 ua, max 2 amp AC, 1 amp DC power rating max 100 W, 250 VA into ohmic load only. Inductive load must be equipped with spark extinguisher
Analog output (D421.52 only)	isolated and programmable 0/4...20ma resolution 12 bit max. load 750 ohms linearity error 0.1 %

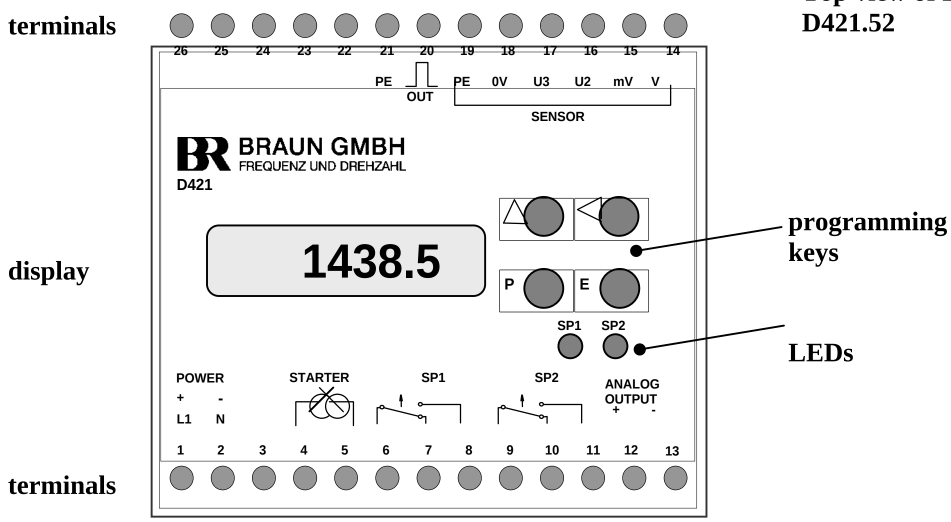
Instructions for the Operation

Programming

The below top view on unit shows operation push-button keys and display as provided with model Nos. D421.51 and D421.52. The keys are accessible through the circular holes. Use a pencil or a screw driver to actuate them.
For the operation of models D421.53 and D421.54 use the button keys of the programmer P300 respectively.

Easy programming by four button keys with unit or by plug-in programmer

Top view of D421.51 and D421.52



Program Structure
For an easy and fast access, the entire program is structured into groups, each assigned to a specific functional range, and program steps for the specific parameter within the group. See scope of program steps.

Example:
How to modify the parameter of program step P01.01 from 01000 to 01010.
Note: *flashing digits are shown underlined*

Programming procedure — ***Display readings:***

Push [P] to enter the programming phase .... *P<u>00</u>.00*
Select program group by [△] .... *P<u>01</u>.00*
When in desired group, push [◁], to switch to step No.selection .... *P01.<u>00</u>*
Select program step No by [△] .... *P01.<u>01</u>*
When in desired step No, enter parameter by key [E] .... *0100<u>0</u>*
Select digit by key [◁] .... *010<u>0</u>0*
Adjust digit value by key [△] .... *010<u>1</u>0*
When parameter properly set in all digits, acknowledge by key [E] .... *P01.<u>01</u>*
Return to operation by key [P] .... *variable*

Summary of parameters on next page, and detailed information in section “Parameters”

Initial parameters

The unit comes programmed to initial parameters, as listed on page 4. In course of the installation however, the specific adjustment to the application conditions is indispensable.

Summary of programming steps and their initial parameters as set on delivery

program-Step No.	comments on page	parameter function		data set on delivery *) (initial data)
P00 .00	5	access code request		0000
.01	5	new code figure		0000
.02	5	access status (1= unlocked, 0=locked)		1 = unlocked
P01 .00	5	scaling (high end values)	decimals of input signal frequency	0 = none
.01	5		value of nominal input frequency (Hz)	00100
.02	5		decimals of corresponding variable	0 = none
.03	5		corresponding variable (unit as desired)	00100
.04	5	low end of measuring range		00001
.05	6	minimum measuring period (00005...99999 millisec)		00030
.06	6	pre-divider adjustment (01...99)		01
P02 .00	6	starter phase time elapse for both setpoints (XXX sec)		000 (sec)
P03 .00	7	setpointSP1	setpoint (SP1) in terms as programmed by scaling	10000
.01	7		hysteresis bandwidth (XX % of SP1)	05 (%)
.02	7		hysteresis location (0=above, 1=below, 2=symm)	1 = below SP
.03	7		alarm status assigned to "no-power" (0=<, 1=>)	1 = > SP
.04	7		starter function effective for SP1 (0=not, 1=yes)	1 = effective
.05	7		alarm status during starter phase (0=<, 1=>)	1 = > SP
P04 .00	7	setpoint SP2	setpoint in terms as programmed by scaling	01000
.01	7		hysteresis bandwidth (XX % of SP2)	05 (%)
.02	7		hysteresis location (0=above, 1=below, 2=symm)	1 = below SP
.03	7		alarm status assigned to "no-power" (0=<, 1=>)	1 = > SP
.04	7		starter function effective for SP2 (0=not, 1=yes)	1 = effective
.05	7		alarm status during starter phase (0=<, 1=>)	1 = > SP
P05 .00	8	analog output	low end of conversion range (terms as scaled)	00000
.01	8		output zero level (0 = dead zero, 1 = live zero)	1 = live zero

Note: Program Group P05...is irrelevant without the analog output option.

*) unless stated otherwise in extra sheet.

Programmable Parameters

Group P00.xx

Data Access and Minimum Measuring Period

Key figure to access

Step P00.00
Code figure to access

Programming access to all parameters can be locked by a password number. If not properly served, the parameters may be called to display but not varied. If not properly served, the display reads -E1-,and any programming in a later program step will be rejected.

Step P00.01
new code figure

Note:
If the knowledge of the password number went lost it may be recalled to display by a procedure, as described in a separate sheet K0-095 (not included into these instructions). In a subsequent program step, a new code may be established, substituting the one previously valid.

The key function may be disengaged by a next program step. With authorized access, set parameter to 1 in step No .02, to generally unlock the key. This may prove practical during the installation phase to facilitate the adjustments. Once installed, the key function should be re- activated, by programming parameter 0 in this step.

Step P00.02
unlock access key

Group P01.xx

Scaling and Definition of the Measurement Performance

Input Scaling

Scaling defines the relation between the input signal frequency (in terms of Hz), and the corresponding process variable (in the unit term and decimal position as required by the application), as it exists at the high end of the intended operating range. Both values are free programmable by their decimals and numerical amount. Of course, they must refer to the same operation level.

Step P01.00
decimals for input frequency

Step P01.01
signal frequency at reference

Step P01.02
decimals for display

Step P01.03
value of the variable at reference

Example:
A signal frequency of 1325.5 Hz corresponds to a speed of 5000 RPM.

Program as follows:	*in step P01.00*	*parameter 1*
	in step P01.01	*parameter 1325.5*
	in step P01.02	*parameter 0*
	in step P01.03	*parameter 5000*

Notes:
The level thus selected simultaneously defines the high end of the analog output (if provided);

Resolution:
Do not use too many decimals! If there are more decimals than justified by the operational fluctuation of the variable, and the transmitter resolution, the measurements will fluctuate accordingly.

The parameters as set on delivery, apply to a speed measurement application with 60 pulses per revolution.

Low end level

The parameter of this step defines the low end of active measurement, by the same terms as selected for the high end in the previous steps P01.02 and .03. When the speed is below this level, the measurement will be set to zero, in display, analog output, and alarm condition.,

Step P01.04
Low end definition

Minimum Measuring Period

Step P01.05
Minimum measuring period

The measurement is based on a time interval measurement over a (variable) number of input signal pulses. A programmable minimum measuring period thus will be maintained, automatically including more input pulses into every measurement with increasing input frequency. This establishes an averaging over the programmed period of time, which helps to stabilize the measurements, specifically with fluctuating variables. As a standard, a minimum time of 300 millisec is recommended. A shorter period should be selected to trace a fast variation (by the analog signal or alarm). A longer period however may be selected to stabilize the measurement against a fluctuating process variable.
The parameter of P01.05 defines the minimum measuring period of time, in terms of milliseconds, within a range of 00005....99999 millisec. A setting less than 00005 will be ignored.

Input Pre Divider

Step P01.06
Input Pre-Divider

The measuring principle, as explained in the corresponding chapter, calls for an optimum in repeatability in its pulse sequence, or in other words, equal pulse distance at a constant variable. This may be violated by an irregular profile at a speed measurement, or by the typical periodical pulse distance variation during the cycle of an oval gear flowmeter. The input pre-divider helps to balance this out, when set to the number of pulses included into one period of the fluctuation. It thus reduces the input pulse sequence to 1 pulse per period (= 1 pulse per 1cycle of the movement).
Set the parameter of P01.06 to this figure (range 01..99).

With a regular input sequence however, use 001 for this parameter.

Note:
The value of the input frequency, as used in program step P01.01, refers to the actual input frequency, *divided* by the pre-divider setting.

Group P02.xx
Starter Function

The starter function throws both alarm outputs to a defined condition, overriding the actual measurement. Which condition, and their activation at all, can be programmed in later steps (see Program Groups P03.xx and P04.xx), individually for both setpoints, whereas Program Step P02.00 defines the starter time elapse.

Starter phase time elapse

Step P02.00
Starter time elapse

The starter time elapse is set as the parameter of program step P02.00 within the range 000...999 (sec). The programmed time is valid for both setpoints SP1 and SP2

.

Program Groups P03.xx and P04.xx
Defining the Performance of alarm setpoints SP1 and SP2

The performance of each setpoint is defined by:

Step P03.00
Position of Setpoint SP1

Step P04.00
Position of Setpoint SP2

The position within the measuring range.
The setpoint position is programmed by the same terms as selected for the variable under P01.02, P01.03.

Step P03.01
Alarm hysteresis bandwidth of SP1

Step P03.02
Hysteresis location of SP1

Step P04.01
Alarm hysteresis bandwidth of SP2

Step P04.02
Hysteresis location of SP2

Its hysteresis by bandwidth and location.
The hysteresis is the margin between condition "excess" (>) and "no excess" (<), defined by its bandwidth and its position in reference to the setpoint.

The hysteresis bandwidth is set as the parameter of the corresponding program step, as a percentage of the setpoint, within the range of 01..99 (%).

The hysteresis band may be placed above setpoint, below setpoint, or symmetrically around the setpoint.
"Above" means, the alarm goes to excess state (>) when the speed exceeds the setpoint plus tolerance bandwidth, and it returns to no-excess (<), when the variable drops below setpoint.
Set parameter 0 for this performance.
"Below" means, the alarm goes to excess (>) when the variable exceeds the setpoint, and it cancels to no-excess (<), when the variable drops below setpoint minus tolerance.
Set parameter to 1 for this performance.
In "symmetrical" mode, the alarm goes to > when the variable exceeds the setpoint by half the tolerance band, and it cancels to < at half the tolerance below setpoint.
Set parameter to 2 for this performance.

Step P03.03
No-Power condition of SP1

Step P04.03
No-Power condition of SP2

Alarms condition assigned to “no power”.
Without power supply to the unit, the alarm relay is de-energized (as shown in the Function Diagram). To consider safety aspects of the application, this No-Power condition can be assigned to either alarm > or < condition, by a corresponding parameter selection in this step:
0 = < setpoint
1 = > setpoint

Step P03.04
SP1 included or not into the Starter Function

Step P03.05
Starter condition of SP1

Step P04.04
SP2 included or not into the Starter Function

Step P04.05
Starter condition of SP2

Alarms condition during the starter phase.
The starter function is explained under Program Group P02. The corresponding parameters of Program Groups P03 and P04 define the individual performance of each alarm during this phase.
One program step defines, individually for each alarm, whether or not it is included into the starter function. Thereby it is possible, for instance, to disable a low speed alarm during the starter phase, whereas a high speed alarm remains active all the time.
In the corresponding program step, set
Parameter = 0, to exclude the alarm from the starter function,
parameter = 1, to include the alarm into the starter function

A further program step defines, individually for each alarm, which condition it will take (if included into) during the starter function. Set
Parameter = 0 to throw the alarm to < setpoint,
parameter = 1 to throw the alarm to > setpoint.

Program Group P05.xx
Analog output (option)

Without this option, skip over this Program Group

High and low end of analog output span

Step P05.00
Low end of the analog output

The high end of the analog output equals the high end of the operating range as defined by program step P01.03. The low end of the analog output is assigned to a selectable value of the variable by program step P05.00:
It is set by the same terms as already defined for the variable by program steps P01.02 and P01.03.
Note:
This allows the low end to be set as high as 90 % of the high end, resulting in a 10 times spreading (enhancement) of the converted band. Further enhancement is not recommended.

Analog output zero level

Step P05.01
Analog output level at its low end

The parameter of step P03.02 defines:
0: without live zero (band 0...20 ma = low...high end),
1: with live zero (band 4...20 ma = low...high end).

Notes to the Principle and Specific Functions

Function Principle

Floating time interval measurement as the principle

The measurement evaluates the time interval between pulses of the frequency signal, which transmits the variable. The programmable minimum measurement period determines, how many of the input pulses are included into one evaluation. Obviously, this ensures the fastest response to the process signal. The result is computed from the precise time elapse, and the amount of pulses included into the evaluation period. It reads in programmable terms of the variable.

Step down sequence

If the input signal sequence cancels abruptly, the measurement steps down to zero, with its descent automatically adjusted by the most recent frequency level. At a programmable low end, it shuts off, eventually signalizing zero..

Minimum Measuring Period

The measurement is based on a time interval measurement over a (variable) number of input signal pulses. A programmable minimum measuring period thus will be maintained, automatically including more input pulses into every measurement with increasing input frequency. This establishes an averaging over the programmed period of time, which helps to stabilize the measurements, specifically with fluctuating variables. As a standard, a minimum time of 300 millisec is recommended. A shorter period should be selected to trace a fast variation (by the analog signal or alarm). A longer period however may be helpful to stabilize the measurement against a fluctuating process variable.

Input Pre Divider

input frequency divider

The measuring principle, as explained in the corresponding chapter, calls for an optimum in repeatability in its pulse sequence, or in other words, equal pulse distance at a constant variable. This may be violated by an irregular profile at a speed measurement, or by the typical periodical pulse distance variation during the cycle of an oval gear flowmeter. The input pre-divider helps to balance this out, when set to the number of pulses included into one period of the fluctuation. It thus reduces the input pulse sequence to 1 pulse per period (= 1 pulse per 1cycle of the movement).

Measuring Signal Input

Sensor signal input

Requirements to the repeatability of the sensor signal

The input is designed to meet a wide range of sensors, as non-contact speed probes, incremental encoders, pulse wheel transmitters, flowmeter outputs, as specified for the high level and the high sensitivity input path. A major requirement to the input signal, however, is its repeatability in reference to the process variable: a steady variable should result in a likewise steady pulse sequence. Otherwise, the fast and precise measurement would interpret this as a fluctuation of the variable, and respond accordingly. Repeatability is more important to a stable function than a high signal frequency. Several poles (slots, screw heads, etc.) must be placed in equal distance from each other. Piston type, or oval gear flowmeters, may introduce a periodical oscillation to the signal sequence. The input frequency divider (see program step P01.06) will help to balance this out, when adjusted to this period.

Input paths and signal sources

High level and high sensitivity input paths

The input offers two signal paths: the high level path (marked V) at terminal 14, and the high sensitivity path (marked mV) at terminal 15, both with reference to 0V at terminal 18. For their response values see “Specifications”.

With an adequate signal level, the high level path is preferable, as more immune against interfering signals on the transmission line. Our speed sensors series A4S..., A5S05...A5S09..., G1000...G3000, A1S40 meet this input path, also the output from our isolating barriers D461.., and preamplifiers A184... For other sources, see specs.

The high sensitivity path is intended for sensors with a low output, such as the A2S..., and the photoprobe A1S30...(these further requiring an adaptor cable and special precautions by marking with reflective tape on a clean surface). This path may also be required by sources, though of high amplitude but superposed to a DC level, or not travelling through the specified on/off levels.

Note: consequent shielding of the signal leads is required for both input paths.

Starter Function

Starter function and its use

A typical application of the starter function is the monitoring of a machine against low speed (as a shutdown criterion). Any starting of the machine would fail, if the starter function did not throw this alarm to > low speed, for a period of time which allows the machine to gain this speed level.
The starter function will be initialized by the starter signal (contact closure between terminals 4-5). See Function Diagram. The time elapse during which the function is true, extends from the begin of this external starter signal plus the time elapse programmed by step P02.00.

Performance of the Alarms

Alarms performance

The unit has 2 alarms, both individually programmable for their performance. This includes:

The setpoint position within the measuring range.

The setpoint position is programmed by the same terms as selected for the variable under P01.02, P01.03.

The hysteresis by bandwidth and location.

The hysteresis is the margin between condition "excess" (>) and "no excess" (<), defined by its bandwidth and its position in reference to the setpoint.

The hysteresis bandwidth is set as the parameter of the corresponding program step, as a percentage of the setpoint, within the range of 01..99 (%).

The hysteresis band may be placed above setpoint, below setpoint, or symmetrically around the setpoint.
"Above" means, the alarm goes to excess state (>) when the speed exceeds the setpoint plus tolerance bandwidth, and it returns to no-excess (<), when the variable drops below setpoint.
"Below" means, the alarm goes to excess (>) when the variable exceeds the setpoint, and it cancels to no-excess (<), when the variable drops below setpoint minus tolerance.
In "symmetrical" mode, the alarm goes to > when the variable exceeds the setpoint by half the tolerance band, and it cancels to < at half the tolerance below setpoint.

Alarms condition assigned to “no power”.
Without power supply to the unit, the alarm relay is de-energized (as shown in the Function Diagram). To consider safety aspects of the application, this No-Power condition can be assigned by program to either alarm > or < condition.

Alarms condition during the starter phase.
The starter function is explained above
One program step defines, individually for each alarm, whether or not it is included into the starter function. Thereby it is possible, for instance, to disable a low speed alarm during the starter phase, whereas a high speed alarm remains active all the time.
A further program step defines, individually for each alarm, which condition it will take (if included into) during the starter function.

Analog Output (option)

Analog output performance

This function converts the measured variable into a proportional analog output signal. The output is isolated against other circuits.
The high end of the conversion range (= 20 ma output signal) is assigned to the high end of the operating range, as defined by the scaling program group.
The low end of the conversion range can be assigned to a programmable value of the variable. This allows the low end to be set as high as 90 % of the high end, resulting in a 10 times spreading (enhancement) of the converted band. Further enhancement is not recommended.
The output signal level at this low end can be programmed to be 0 ma (dead zero), or 4 ma (live zero).

Installation

Mounting

The unit snaps on a standard DIN rail of 35 mm width.

Instructions for mounting

If a screw mounting is required, follow this procedure: Insert a small screwdriver blade under the clover-leaf sized flap of the black bottom strip, and lift the flap over the small gray projection in the enclosure. Remove the black strip, now loose, to mount it, flat side down, at the desired place. Then slip the enclosure over the fixed strip.

The unit can be operated in any position, but the General Instructions must be observed. Avoid the neighborhood of interfering sources.

For allowable ambient operating conditions see “Specifications”.

General Information to Mounting and Wiring

General Instructions for wiring

This instrument has been designed and inspected according to standards DIN 57 411 / VDE 0411Sect 1, and IEC 348. Observe these instructions and wiring diagrams carefully, to ensure this protection. The installation must only be done by adequately qualified personnel.
Specifically, connect the ground terminal (PE) of the instrument to a safe ground potential.
Do not open the instrument. Connections and adjustments are done from outside. When removing it from its enclosure however, for whatever reason, make sure that power is switched off.
All connections are made to terminals placed underneath the top, with access from the side. Wire or stranded wire can be used, up to 1.5 mm^2.
Signal leads must be carefully shielded, and should not be run in bundles with power or relay control wires.
The (PE) ground terminal (21) is internally separated from common zero, but tied by a 100 k resistor to it. It is internally connected to the screen terminal for the sensor leads (10).

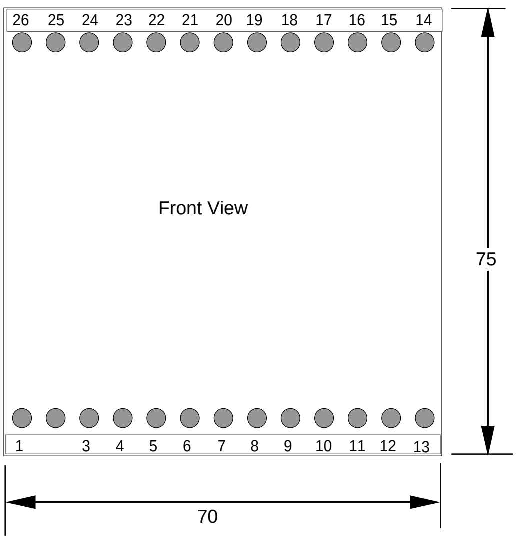
EMI/CE

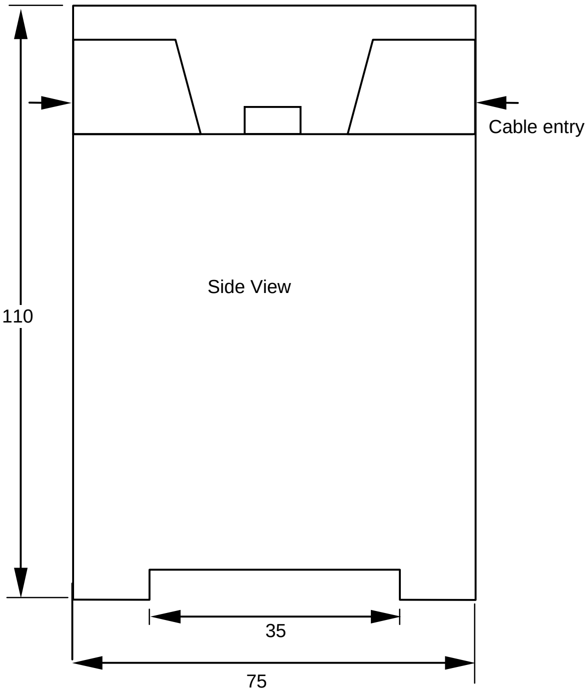
Notes concerning Electromagnetic Compatibility

The unit complies with all relevant regulations, as determined by the Policy of the European Committee for Electrotechnical Standardization (CENELEC), for the Electromagnetic Compatibility (89/336/EWG). Testing and inspection has been performed according to Standards DIN-EN 50081-2 and DIN-EN 50082-2 with status November 1994. Thereby, the product meets all requirements to be marked by the CE sign.

Strict observance of these instructions during installation and use is an indispensable precondition hereto. Specifically to be observed:
Terminals must be kept off all undue access. Power supply and all input and output leads must be protected against voltage interference, higher than specified operation data, and they must be protected against electrostatic discharge.

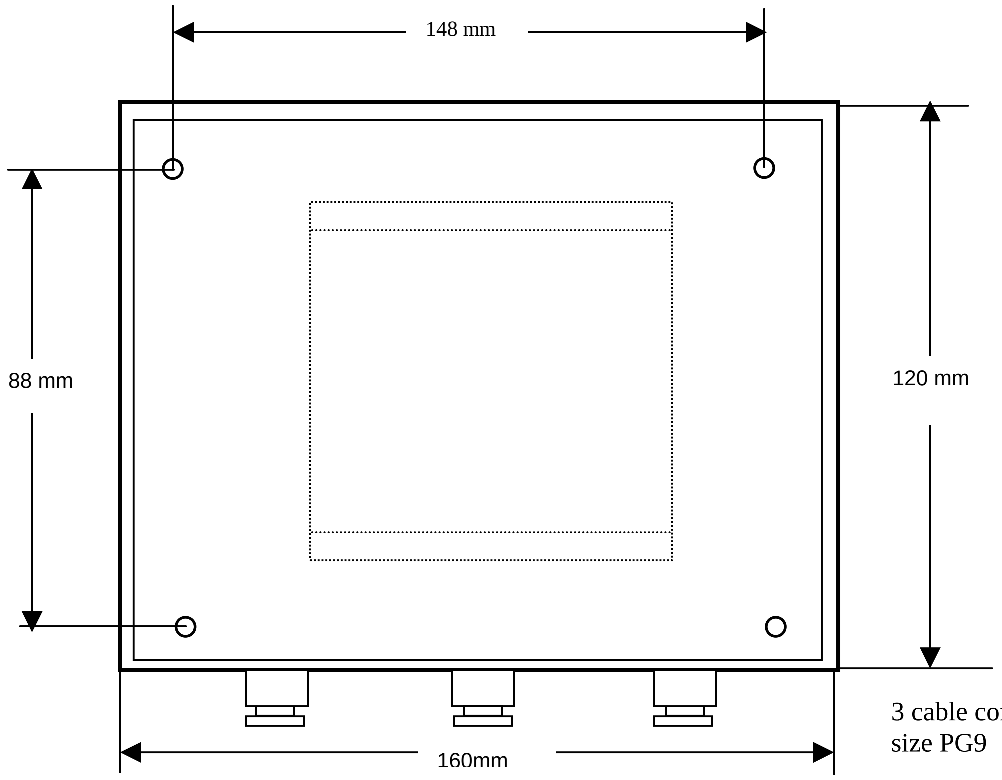
Dimensions of the Standard Snap on Track Version (by mm)





Mounting by snap on 35 mm rail
DIN 50022

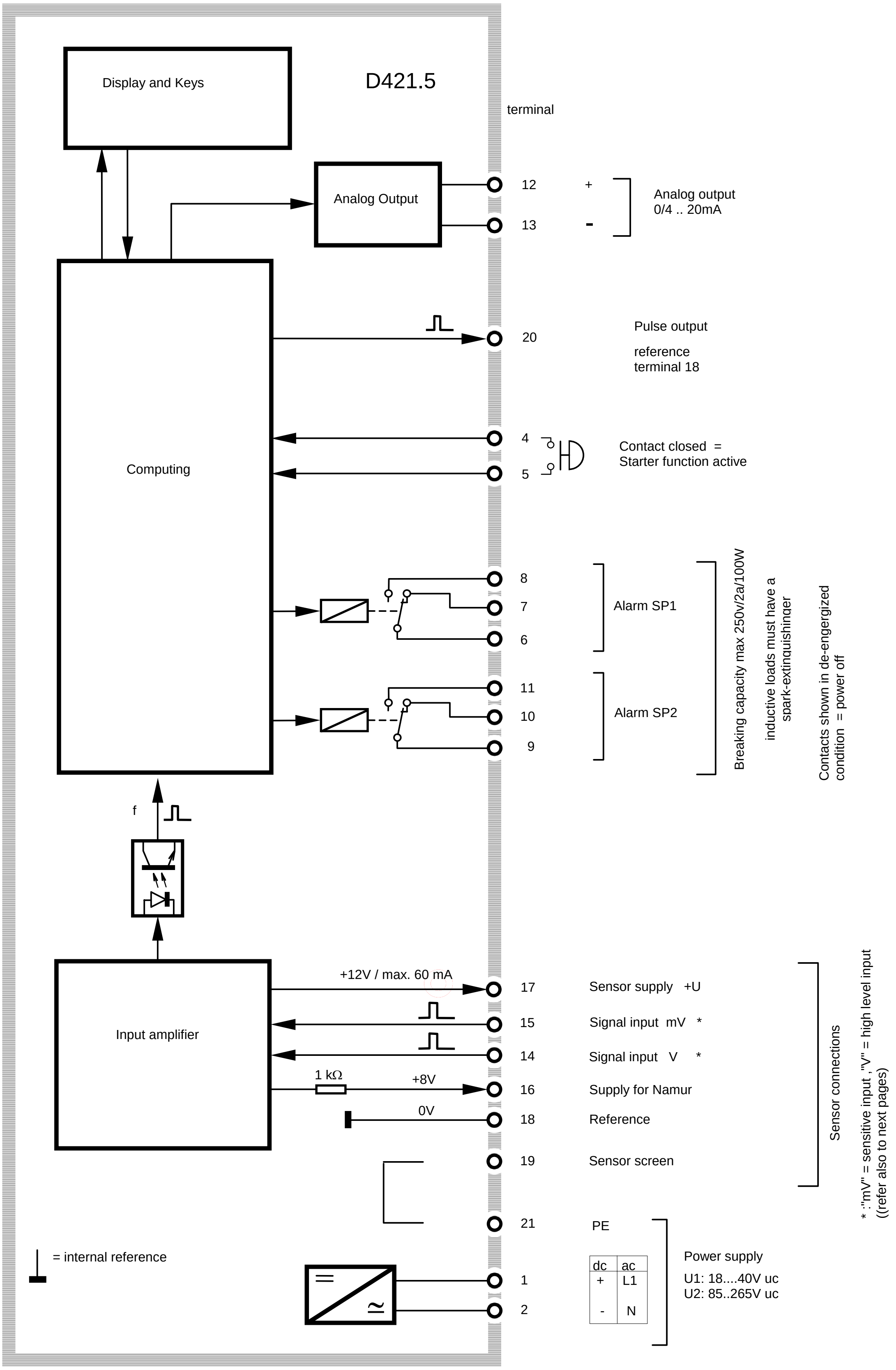
Dimensions of the (optional) Field Enclosure



4 mounting holes
4,2 mm diameter each
mounting pattern 148x88mm

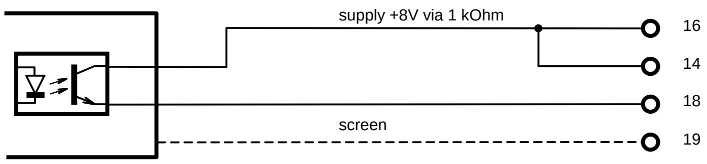
3 cable conduits
size PG9

Functiondiagram and Terminal Pin Nos

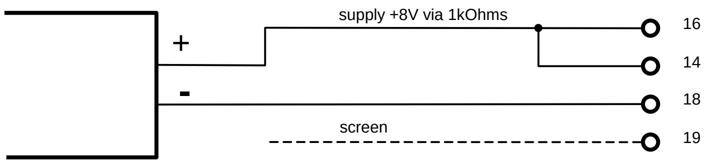


Connections to signal sources
(for connections to BRAUN-Sensors refer to next pages)

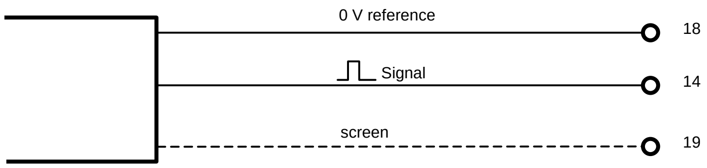
1
npn-transistor



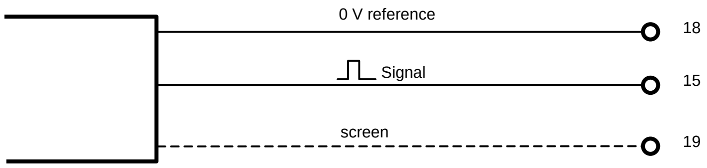
2
2leads prox.sensor
NAMUR or
DIN 19234



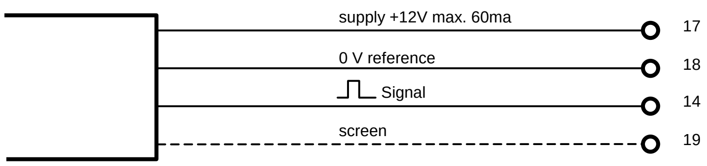
3
active signal sources
with:
high-level > 7 V,
low-level < 6 V



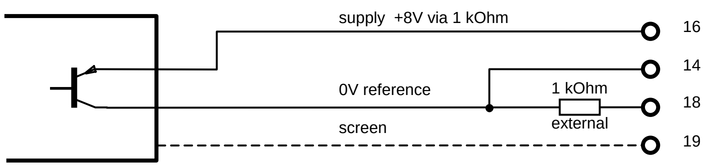
4
other active sources
> 50 mV eff.



5
3-leads sensors
(power supply
by device)



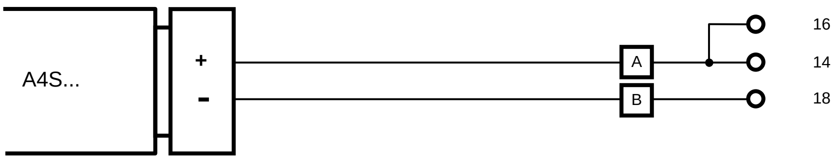
6
pnp-sensors



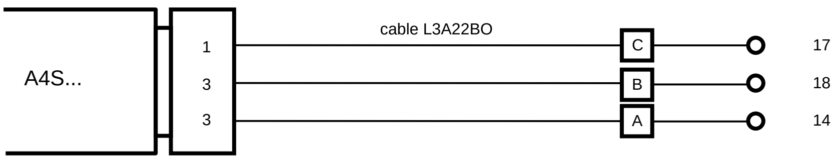
Input connections to BRAUN sensors
The indicated cable model Nos. define a ready prepared cable with connecting plug at the sensor end, other end labelled.

Terminal Pin Nos

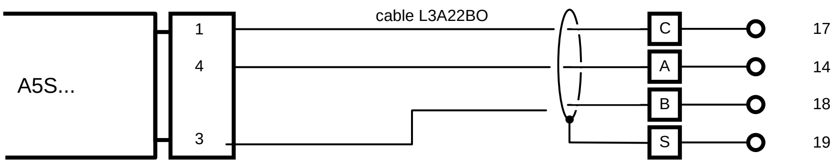
2-wire proximity sensors



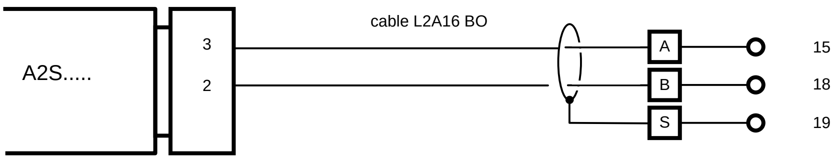
3-wire proximity sensors



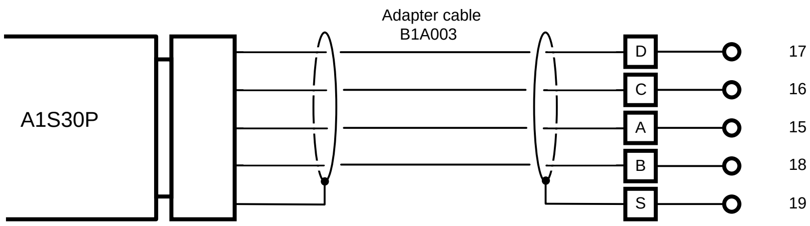
Hall-Sensors



Magnetic-Inductive Sensors

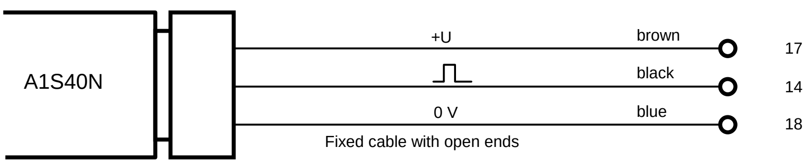


Photoelectric Sensor



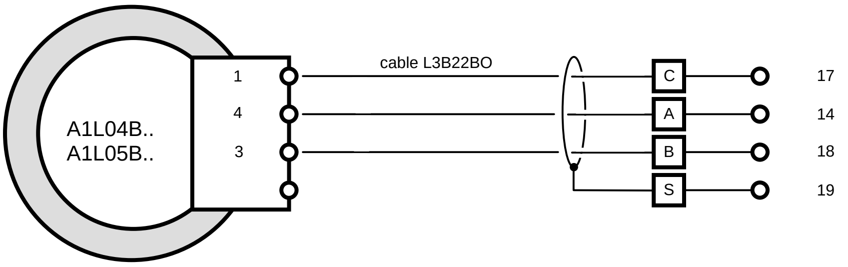
Remark: - The photoprobe requires marking by a high-reflex tape (U1A-006)on a clean surface.
- The built-in power-supply cannot drive 2 photoprobes simultaneously!

Photoelectric Sensor

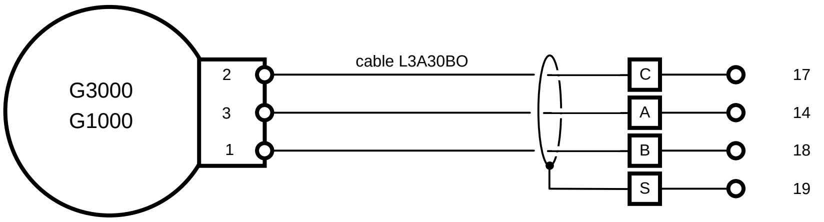


Terminal Pin Nos

Pulse wheels



Encoders



Form "Initial Parameters"

Device Type : D421.5
Serial No. : __________

Program-Step No.	Standard-Factory Sett. (Reset-values)	deviating settings. acc. to customer	deviating settings on installation	comment
P00 .00	0000	______	______	______________________________
.01	0000	______	______	______________________________
.02	1	______	______	______________________________
P01 .00	0	______	______	______________________________
.01	10000	______	______	______________________________
.02	0	______	______	______________________________
.03	10000	______	______	______________________________
.04	00001	______	______	______________________________
.05	00030	______	______	______________________________
.06	01	______	______	______________________________
P02 .00	000	______	______	______________________________
P03 .00	10000	______	______	______________________________
.01	05.0	______	______	______________________________
.02	1	______	______	______________________________
.03	1	______	______	______________________________
.04	1	______	______	______________________________
.05	1	______	______	______________________________
P04 .00	01000	______	______	______________________________
.01	05.0	______	______	______________________________
.02	1	______	______	______________________________
.03	1	______	______	______________________________
.04	1	______	______	______________________________
.05	1	______	______	______________________________
P05 .00	00000	______	______	______________________________
.01	1	______	______	______________________________