

Input analog board

Board E457 is an input analog board for processing of DC current signals in system ZAT-E. E457 is A/D converter, -20 .. +20 mA DC, 14 bit. The board is used together with modules of VZ series or modules by RAMET company. Eight analog signals could be connected to the board.

Function description

The board E457 is intended for processing of eight analog current DC signals, which are connected by means of VZ or RAMET modules into the board. Input modules have to have galvanic separation of current output of input and module feeding. Beside, the module has to fulfill requirements for pulse noise immunity (complete EMC tests). The board E457 is a modification of board E455, therefore board analog inputs are not galvanic separated of the system and each other. It is forbidden to connect any board input directly to technology signal without separation module!

Signals from technology transmitters are led into relevant module, which performs galvanic separation of the signal and control system and transfers signal into current one with level -20 mA .. +20 mA. This signal is led through cable K35 into input connector of board E457.

Current input signal in input is converted to voltage signal. Conversion is performed in inductionless precise resistors with rated value 50Ω. After filtering, input signal is led to 14-bit converter, which data is processed by 16-bit microcontroller. Then processed signal is transferred to control board via BE bus. Microcontroller performs (beside signal transfer into BE bus) also functions needed for signal calibration and communication with PC via serial line. Entire measuring chain (including modules) is calibrated for E457 board calibration. This enables to eliminate errors of converters at signal processing. The board could be calibrated both via BE bus from control system or via serial line from PC. When calibrating via BE bus, algorithm used for board E453 has to be kept exactly for reason of 100% communication compatibility with control board of system ZAT-E. Calibration

by means of PC enables to perform calibration at full conserving of station functionality including all measurements excluding the channel, which is actually calibrated. Simulation of measured quantities could be used at calibrated channel, which enables easy calibration without any intervention into technological complexes operation. Calibrated values are stored in serial memory EEPROM that does not need feeding, which enables to keep calibrated values within minimally 10 years.

Description of individual circuits

Center of the board wiring is formed by microcontroller SAB80C166 (with clock frequency 40 MHz), which controls all converter functions. Program is stored in EPROM memories and fulfills following functions:

- multiplexer switching
- A/D conversion starting
- reading of measured values from A/D converter
- digital filtering of measured signal
- calibration of individual measuring channels
- communication with BE bus
- diagnostics of converter function
- safeguarding of calibration constants in memory EEPROM by cyclic code
- ability of interactive SW tuning by means of SODOB 166 system

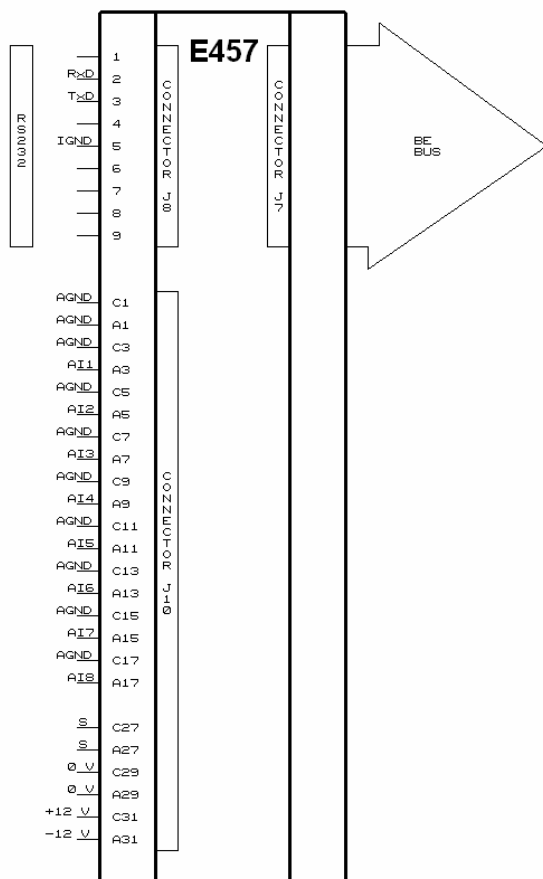
After feeding voltage connection or signal RESET activating in BE bus, supervisor circuit MAX696 performs reset of microcontroller SAB80C166. After reset microcontroller performs test of entire HW, SW is transferred from EPROM memories to RAM memories, check of all feeding voltages of the board is done and check of input signal amplitude against limit value is performed. If these conditions are fulfilled, red LED (D1) on the board front panel lights off. Green LED (D2) lights steadily at proper board operation.

Current DC signal -20 mA .. +20 mA is led into analog inputs of the board. Conversion of measured quantities to current DC signal is done in VP, VH series modules and modules VZ002, VZ002B, VZ012 and VZ012B. Also modules by RAMET company or other ones meeting mentioned requirements could be used.

Each measuring channel is equipped with active analog second order low-pass filter, which

prevents from input of frequencies higher than 10 kHz into converter. Then signal is led into analog multiplexer, where it is selected (through relevant address) for measurement in A/D converter.

Interface of board E457



Itself A/D signal conversion is done in 14-bit A/D converter with sampling rate 128 kBd (AD779). Circuit AD586 is used as source of reference voltage because of very low thermal drift and initial error. Circuit solution of A/D converter enables to reach very high measurement exactness, maximal stability of measured values with preserving of sufficient measurement rate.

Measured values are transferred via 16-bit to managing controller. First the values are filtered by digital filter. A special solution has been used for draft of algorithm of the filter, which enables to suppress markedly pulse interference in input signal. Also signal approximation is performed, so as its coherence would be assured. It is important especially for use of this board in regulation chains, where stability of regulation chain is very important criteria. After filtering signals are recalculated according to calibration constants, which are stored in memory EEPROM.

Then measured values are transferred to control board via BE bus. Detailed description of program control through BE bus is stated in section *Program control and calibration via BE bus*. Circuits for contact with bus serve for communication with bus. Control signals of BE bus pass RC filter before entering the board, which improves markedly noise immunity of signals. The board enables to transfer data to BE bus in 12-bit or 14-bit format.

Circuits of serial interface RS232 serve for board calibration from PC. Interface signals are galvanic separated by means of optocouplers and feeding is galvanic separated by DC/DC converter. Integrated circuit MAX232 is used for transfer of serial interface signals from level TTL to RS232. Separating resistors are used in signals RS232 for reason of improving of noise immunity. Interface RS232 signals are led to connector J8 (CANNON 9-pin) on the board front panel.

Technical parameters

Feeding voltage and consumption

Feeding voltage:	+5 VDC
	+12VDC
	-12 VDC
Feeding voltage + 5V tolerance:	± 5%
Feeding voltage + 12V tolerance:	± 5%
Feeding voltage - 12V tolerance:	± 5%
Max. feeding current from + 5V:	300 mA
Typical feeding current from + 5V:	265 mA
Max. feeding current from + 12V:	80 mA
Typical feeding current from + 12V:	60 mA
Max. feeding current from - 12V:	80 mA
Typical feeding current from - 12V:	60 mA
Max. board consumption:	3.5 W

Bus

Bus type:	BE
- data signals:	8 (D0-D8)
- control signals:	3(RD,WD,R,NMI)
- address signals:	1 (AD, A/B, C/D)

Input signal and accuracy

Accuracy class *:	0.1
Transfer linearity:	<0.01%
Additional errors	
- data error caused by ambient temperature change *:	<0.05%/10°C
- data error caused by feeding voltage change *:	<0.01%/V
Input voltage range:	-21 .. +21mA
Input impedance:	50 kΩ
Input overload capacity:	-100 .. +100mA

Resistance against interference
into cable K35 in capacity tongs

(burst signal acc. to
CSN EN 61000-4-4,
group pulse 5/50 ns): 2 kV, 10 kHz, 15 ms
4 kV, 2.5 kHz, 15 ms

** errors are related to channel range and
ambient temperature 20°C.*

Note: Board E457 is intended for cooperation
with VP, VH, VZ or RAMET modules. Errors
of these modules participate to total
measurement accuracy.

Communication interface for calibration from PC

Commun. protocol: serial asynchr. acc. to
V24 and V28 CCITT

Number of data bits: 8

Number of stop bits: 1

Parity: none

Baud rate: 4800 Bd

Dielectric strength of galvanic
separation of communication
interface: 750 VDC, within 10 s
500 VDC, steadily

Insulation resistance of
galvanic separation of
communication interface: min. 20 MΩ

Resistance against interference
into cable K9 in capacity tongs
(burst signal acc. to
CSN EN 61000-4-4,
group pulse 5/50 ns): 2 kV, 10 kHz, 15 ms
4 kV, 2.5 kHz, 15 ms

Other parameters

Dielectric strength against
board panel: 750 VAC, 50 Hz, 1 min

Insulation resistance against
board panel: min. 20 MΩ

Operational temperature range: 0°C..60°C

Dimension: 6HE 4TE

Weight: 0.25 kg

Program control and calibration of board E457

E457 (eight input A/D converter) could be
controlled both through internal BE bus or
through serial interface RS232, which
connector is on board front panel. Calibration
via BE bus is performed by program P022
(control board E350) or P041 (control board
D352) with selection E453. SW service of
board E457 from control board is performed by
means of function blocks intended for board
E453 or by special SW. Calibration through
serial interface from PC is done by program

E455_1.EXE (the same program like for board
E455 calibration) and enables a set of other
functions when comparing with calibration via
BE bus.

Program control and calibration via BE bus

Communication of converter E457 with control
board runs through BE bus. Control board
sends to converter control word and read
response. The board enables communication
with control board in 12-bit or 14-bit mode. 12-
bit mode is fully compatible with board E453,
14-bit mode is not supported in SW way. Board
E457 contains output buffer in circuits for
contact with bus, i.e. valid data is always
provided in bus and board service does not
require any timeouts.

Selection of 14-bit or 12-bit mode is determined
by value of upper nibble of control word. If the
nibble is equal to 0, the board will operate in
12-bit mode, nibble's non-zero value sets 14-bit
mode.

Communication with converter in 12-bit mode
uses following control words:

Selection of measuring channels

00H selection of channel 1

01H selection of channel 2

02H selection of channel 3

03H selection of channel 4

04H selection of channel 5

05H selection of channel 6

06H selection of channel 7

07H selection of channel 8

Control of function (related to channel, which
has been selected)

08H initial setting of additive and
multiplicative constants in all channels
(additive set to 0.000, multiplicative to
1.000)

09H increment of additive constant

0AH increment of multiplicative constant

0BH decrement of additive constant

0CH decrement of multiplicative constant

0DH not used

0EH not used

0FH initial setting of constants in certain
channel (additive = 0.000, multiplicative
= 1.000)

Data about size of measured quantity in selected channel is granted by converter in two consecutive bytes. Converter gives following diagnostics messages in lowest 4 data bits:

Message at running measurement

- 00H correct measurement
- 01H exceeding of limit (set only in channel, where exceeding occurs)
- 02H overexcitation of input (set only in channel, where overexcitation occurs)
- 03H voltage ± 12 V out of range, board HW error (set in all channels)

Limit setting is possible only at calibration via PC. It is convenient in situation, when analog signal value is compared in certain required value in user SW (analog board acts as comparator). Special SW is necessary for limit processing.

Setting of initial constant values in all channels (control word 08H) has to be done at first calibration. Board E457 could be calibrated via BE bus by means of program P022 (for E350) or P041 (for D352). See Description of these programs in document *ZAT-E information about system*.

Use of board E457 in user SW

Function block B151

If board E457 operates correctly, output 2 reports log. 0. Change to log. 1 comes in following cases:

- failure of converter or feeding voltage
- input overexcitation
- drop of input current under 2 mA (only in case of analog signal selection to type 4-20 mA)

If board E457 cooperates for example with module VZ002 and entire chain is correctly calibrated, increasing of input current over 21 mA causes input overexcitation.

Function block B153

If board E457 operates correctly, output 2 reports log. 0. Change to log. 1 comes in following cases:

- failure of converter or feeding voltage
- drop of input current under 2 mA (only in case of analog signal selection to type 4-20 mA)

This means that B153 does not report input overexcitation.

Program control and calibration via PC

Calibration of board E457 or inputs simulation needs to interconnect connector J8 (marked RS232) on board E457 front panel with serial channel COM1 or COM2 in PC through cable K9. Program for calibration of board E457 is identical with program for calibration E455.

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+-----+
|                                     - E455 -                                     |
+-----+-----+-----+-----+-----+-----+-----+-----+
|                                     Hodnoty na vystupu                                     |
|                                     Kalibrovane hodnoty                                     |
+-----+-----+-----+-----+-----+-----+-----+-----+
|n|   14 bit   |   12 bit   | Fals. |S| Nasob. amp. | Posuv amp. | Limita |
+-----+-----+-----+-----+-----+-----+-----+-----+
|1| -0.0040   |   -8      |   0   |3|  1.5000   |   0.0000   |  9.9999 |
+-----+-----+-----+-----+-----+-----+-----+-----+
|2| -0.0039   |   -8      |   0   |3|  1.5000   |   0.0000   |  9.9999 |
+-----+-----+-----+-----+-----+-----+-----+-----+
|3| -0.0036   |   -7      |   0   |3|  1.5000   |   0.0000   |  9.9999 |
+-----+-----+-----+-----+-----+-----+-----+-----+
|4| -0.0032   |   -7      |   0   |3|  1.5000   |   0.0000   |  9.9999 |
+-----+-----+-----+-----+-----+-----+-----+-----+
|5| -0.0040   |   -8      |   0   |3|  1.5000   |   0.0000   |  9.9999 |
+-----+-----+-----+-----+-----+-----+-----+-----+
|6| -0.0038   |   -8      |   0   |3|  1.5000   |   0.0000   |  9.9999 |
+-----+-----+-----+-----+-----+-----+-----+-----+
|7| -0.0040   |   -8      |   0   |3|  1.5000   |   0.0000   |  9.9999 |
+-----+-----+-----+-----+-----+-----+-----+-----+
|8| -0.0039   |   -8      |   0   |3|  1.5000   |   0.0000   |  9.9999 |
+-----+-----+-----+-----+-----+-----+-----+-----+
| [S]im. (ZAP/VYP); [D]efault; [R]ozliseni 12bit; [Enter] - edit <ESC> |
+-----+

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Description of functions of board E457 calibration program

1. Program start and description of basic features.

Start program from command line by command:

E455_1.EXE %

where % is number of PC serial channel (1 for COM1, 2 for COM2). In case of proper board function and correct interconnection with PC basic program menu is called:

Basic menu could be divided into side of values in output (left) and side of calibrated values (right). Transfer between sides is done by key TAB, movement through menu is done through cursor keys. Meaning of individual columns is as follows:

A. Column n - number of measured channel

B. Column 14 bit - value measured by board in 14-bit resolution, basic range for values -1.000 .. 1.000.

C. Column 12 bit - value measured by board in 12-bit resolution, basic range for values -2048 .. 2047. This mode fully emulates older board E453.

D. Column False - value sent by board to BE bus in case of simulation of measured value. Simulation mode is switched on by pressing of key S. Key R selects resolution 12 and 14 bits. Edit of simulated value - relevant value is selected by means of cursor keys, after pressing of key ENTER required value could be assigned. Another pressing of key ENTER quits mode of simulated values editing. After program start all channels have simulation off and resolution 12 bit.

E. Column S - status word. Board status is displayed here. Meaning of displayed data:

- 0 - Feeding voltage $\pm 12V$ in BE bus is out of range. Also other HW failures of board E457 are signaled by this status.
- 1 - Inputs overexcitation. This data expresses that input voltage in relevant analog channel is more than +2.5V or less than -2.5V.
- 2 - Out of permitted range. This data expresses that measured value in input of relevant analog channel exceeds data set in column Limit both in direction of positive or negative measured value.
- 3 - Measured value OK. Voltage in relevant board channel is within thresholds given by board technical data, it is less than value

stated by limit and HW of board E457 and its feeding voltage is without defects.

X - Channel simulation. This data signals that simulated value stated in column *False* is transferred to BE bus instead of value measured in relevant channel.

F. Column Nasob.amp. - multiplicative constant of amplitude. This data states number, by which measured value in relevant channel is multiplied before transfer to system bus BE. This constant is used for setting of upper limit of calibrated value. Change of multiplicative constant is done by following keys:

V	- change by +0.1
PgUp	- change by +0.01
+	- change by +0.001
Space	- change by +0.0001
M	- change by -0.1
PgDn	- change by -0.01
-	- change by -0.001

Attention! Pressing key **D** causes setting of multiplicative constants in all channels to default value (1.000).

G. Column Posun amp. - amplitude shift. Number in this column states, by which measured value in relevant channel is shifted at transfer to system bus BE. This constant is used for setting of bottom limit of calibrated value (or zero calibration). The same keys like at multiplicative constant are used for change of shift value.

Attention! Pressing key **D** causes setting of amplitude shift in all channels to default value (0.000).

H. Column Limita - setting of limit. Data set here is compared with level of input signal and if input signal exceeds limit (concerning positive and negative polarity), status word is set to mode out of range. This data is transferred to BE bus and could be evaluated by special SW. Data *Limita* is set in the same way like data in column *False*. Use of this board function could simplify user SW at comparison of measured data with certain value in SW.

Attention! Pressing key **D** causes setting of limit in all channels to default value (9.999).

2. Reading and display of measured values in analog channels.

Reading and display of measured values in analog channels is done permanently during program run. Measured values are displayed in 12-bit and 14-bit resolution.

3. Simulation of measured values.

Simulation of measured values is done through following sequence: Assign required simulated value in column *False* and pres key **S**. Data **X**, identifying channel simulation, occurs in column *S* (status word) at relevant channel. At this moment simulated value is transferring to BE bus instead of measured analog value in relevant channel. Canceling of simulation is done through another pressing of key **S** or by terminating of program E455_1.EXE. Display of calibration values is kept during simulation; also multiplicative constants, amplitude shifts and limits could be changed.

4. Calibration of analog channels.

Calibration of analog channels by means of PC without intervention into control function of control board could be supposed as most convenient functions of board E455. Lead voltage responding to bottom limit of calibrated value (or zero) into input of relevant channel. Set bottom limit to required value by means of number change in column *Posun amp.* for relevant channel. Value is displayed in column *12 bit* in range -2048 .. 2047, in column *14 bit* in range -1.000 .. 1.000. When setting bottom limit to zero, use 14-bit resolution (maximal utilization of converter accuracy). Then lead voltage responding to upper limit of calibrated value into input of relevant channel. Set upper

limit to required value by means of number change in column *Nasob.amp.* for relevant channel. Calibration is always done for entire measuring chain including VZ modules or other analog converters. Calibrator, which could emulate relevant source of analog signal (e.g. source 4 .. 20 mA, thermocouples, etc.), has to be used for calibration.

Simulation of measured value and calibration of analog channels could be performed simultaneously. This means that before calibration such value, which suits to given technology mode is simulated in relevant channel. Perform needed changes in measuring chain (e.g. sensor or converter exchange, insertion of another instrument into measuring loop, etc.) and calibrate channel. After verifying of function and measuring values correctness release simulation of channel. Finally write new calibration constants to EEPROM memory.

5. Writing of constants into EEPROM memory.

Through pressing of key **Esc** in main menu enter this mode. User could write calibration constants and limits into EEPROM by key **W**. Key **N** returns to main menu, pressing of key **A** terminates program E455_1.EXE.

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+-----+
|                                     - E455 -                                     |
+-----+
|                                     |                                     |
|          Hodnoty na vystupu          |          Kalibrovane hodnoty          |
|-----+-----+-----+-----+-----+-----+-----+-----+-----+
|n|  14 bit  |  12 bit  |  Fals.  |S| Nasob. amp. | Posuv amp. |  Limita  |
|-----+-----+-----+-----+-----+-----+-----+-----+
|1| -0.0042  |    -8    |    0    |3|  1.5000  |  0.0000  |  9.9999  |
|-----+-----+-----+-----+-----+-----+-----+
|2| -0.0040  |    -8    |    0    |3|  1.5000  |  0.0000  |  9.9999  |
|-----+-----+-----+-----+-----+-----+-----+
|3| -0.0036  |    -7    |    0    |3|  1.5000  |  0.0000  |  9.9999  |
|-----+-----+-----+-----+-----+-----+-----+
|4| -0.0033  |    -7    |    0    |3|  1.5000  |  0.0000  |  9.9999  |
|-----+-----+-----+-----+-----+-----+-----+
|5| -0.0040  |    -8    |    0    |3|  1.5000  |  0.0000  |  9.9999  |
|-----+-----+-----+-----+-----+-----+-----+
|6| -0.0039  |    -8    |    0    |3|  1.5000  |  0.0000  |  9.9999  |
|-----+-----+-----+-----+-----+-----+-----+
|7| -0.0054  |   -11    |    0    |3|  1.5000  |  0.0000  |  9.9999  |
|-----+-----+-----+-----+-----+-----+-----+
|8| -0.0050  |   -10    |    0    |3|  1.5000  |  0.0000  |  9.9999  |
|-----+-----+-----+-----+-----+-----+-----+
|                                     |                                     |
|   Chcete skoncit? - [A/N],       |   Nebo snad zapsat konstanty do EEPROM? - [W]   |
|                                     |                                     |
+-----+

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