PC STRAIN GAGE INPUT BOARDS

TENZOMETRICKÉ VSTUPNÍ DESKY PC

Dostál J.

Článek přináší informaci o speciálních analogových vstupních deskách počítače IBM PC/XT/AT určených pro zpracování signálů ze silových a tlakových snímačů s kovovými tenzometry v úplném můstkovém zapojení. Použitím programové autokalibrace a moderních konstrukčních principů se dosahuje význačných provozních charakteristik vyhrazených dosud spíše pro podstatně dražší přístrojové tenzometrické aparatury.

Key words: strain gage, load cell, pressure transducer, PC board

The paper presents technical information on a series of special-purpose IBM PC/XT/AT-compatible analog input boards committed to signal conditioning of load cells and pressure transducers based on the use of metal-foil strain-gage sensors in the full-bridge configuration. By using software autocalibration and modern design principles, outstanding operating characteristics typical of more expensive strain-gage measuring instruments are achieved at the board level and price.

Board architecture

Measurement and processing of low-level analog data from strain-gage sensors in the 0.01% accuracy class under industrial operating conditions represents one of the most demanding metrological tasks. Temperature and long-term instability of zero and full scale as well as inherent noise of the analog circuitry, interference noise from the digital PC environment, interference noise from the industrial environment along the signal leads and around the transducer, thermoelectric voltages inside the whole input part, ground loops, ground currents, ground voltage drops, and mechanical vibrations of the weighing platform: these are the main contributors to the equivalent system noise which invades

the measurement configuration and which should be suppressed well below 1 µV at the board input, for proper operation.

The system, design and construction measures utilized to this purpose involve:

o isolating the board from computer power by means of magnetic and optical barriers,
o using a standard 6-wire technique (4-wire excitation, 2-wire signal) to connect the sensor,
o specifying a low-noise instrumentation amplifier and low-noise, high-resolution A/D converter for the analog portion,
o using analog prefilter and digital post-filter techniques,
o implementing sophisticated software autocalibration,
o including transducer into the autocalibration game.

The system approach to the board design is marked by the following steps:

o the board is functionally complete (it contains bridge-excitation circuitry, as well),
o the board is fully software programmable (besides the address switch, it contains no mechanical switches and jumpers),
o the board is fully software calibrated (it contains no potentiometers and no selected resistors),
o the metrological accuracy of the board is traced to a stable on-board calibration standard,
o the system calibration of the board is achieved by automatically writing calibration constants onto the disk by running a special super-calibration subroutine.

Board description

Software autocalibration of transfer characteristic is the key feature in designing PC input boards with internal resolution of 16 bits and above. Besides dramatically improving functional characteristics, the software autocalibration provides ultimate simplification of the analog circuitry, as well. The accuracy of the software-calibrated board is concentrated into a single part,

the calibration standard. The board lacks for distributed preci-
sion: apart from the calibration standard, it does not use any
precise and stable resistors and references, it does not use
trimming pots and selected resistors and it manages with a
10% design accuracy to achieve a 0.001% system accuracy.

All circuitry of the board is powered from the PC, the floating
input and excitation sections being isolated by a DC-to-DC con-
verter. Digital data and control signals are transmitted via
optocouplers. All functional characteristics of the board are
software programmable.

Programmable bridge excitation of 5 V or 10 V at max 120 mA
allows for connection of a single 120 Ω or 350 Ω load cell or
pressure transducer, or connection of up to four parallel 350 Ω
load cells in a larger weighing system (platform, container).
The three programmable bridge sensitivities of 1 mV/V, 2 mV/V
and 4 mV/V combined with two excitation voltages of 5 V and 10 V
result in four programmable-amplifier gains of 50, 100, 200, and
400. The 16-bit sigma-delta A/D converter with inherent differen-
tial linearity and noise immunity provides sufficient internal
resolution for mathematical autocalibration routines. A 6-pole
low-pass digital filter with no overshoot of the step response
allows for suppression of inherent and interference noise and for
rejection of ac signal components caused by mechanical vibrations
of the weighing system. The filter corner frequency is programmed
in 8 binary steps from 10 Hz to 0.08 Hz.

The PC board comes complete with a software package which cont-
rols acquisition of the actual weight data and provides addional
operating functions.

The acquired data is corrected in software by the stored zero and
full scale calibration constants, before being displayed or stored.
The calibration constants are periodically refreshed, effectively
rejecting long-term and temperature drift effects. Tare value in
the range from -FS to +FS is inserted by pressing a key or by wri-
ting into software. Motion indicator indicates that the weighing
scale is in motion. Zeroing of the display is automatically per-

formed upon power-up, provided gross weight load is within ±1% of FS. Zero tracking is automatically performed at a rate of 0.1 div per 10 measurement cycles within ±1% of FS.

Design modifications

Model PCB581 is the basic non-isolated single-channel strain gage board suitable for conditioning of up to four load cells connected in parallel.

Model PCB582 is a true two-channel strain gage board. Its two channels are fully isolated both from the PC and from each other.

Model PCB584 is a multiplexed four-channel strain gage board. Basically, this is a multiplexed and isolated version of the PCB581. The PCB584 allows for connection of up to four unmatched load cells, with four sets of individual calibration constants per channel stored on the disk.

Specifications

The basic electrical specifications are common with all three design modifications PCB581, PCB582, PCB584, as follows.

Nominal sensitivity	1 mV/V, 2 mV/V or 4 mV/V
Excitation voltage	5 V or 10 V
Excitation current	min 120 mA
Amplifier gain	50, 100, 200 or 400
Internal resolution	16 bits (20 bits, opt. H)
External resolution	up to ±10,000 div
Filter corner frequency	10 Hz to 0.08 Hz
Sampling rate	up to 1000 samples/s
Measurement error (+25•C)	max 0.02% FS
Temperature coefficient (ZS & FS)	max 5 ppm/•C
Supply voltage	+5 V at max 1.5 A p. ch.
Operating temperature range	0•C to +50•C

Ing. Jiří Dostál, CSc.
VUMS a.s., Koněvova 3, 13000 Prague 3, Phone (02)276641,(02)366251