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IEEE-488 Interface for the AVS-47

RF interference is the problem

Perhaps the worst problem when measuring low temperatures with resistive sensors is that they are so easily heated by RF interference of any frequency. The measurement current is usually kept very low in order to avoid the self-heating error and sometimes a measuring power as low as $10E^{-15}$ watts is desired. This is equivalent to 3 uV across a 10 kohm sensor, but the RF interference should be even lower than the measuring power. At high frequencies and impedance levels, detecting and measuring such voltages is not easy.

Low RF emission level was a major design goal with the AVS-47 Resistance Bridge, and this is why we continued our tradition of using analogue techniques where possible. But the evolution of all instrumentation in general has made a standard computer interface mandatory. Most modern instruments can now provide some intelligent functions that an analog instrument, like the AVS-47, cannot offer.

IEEE-488 is still the most popular of the computer interface standards in scientific instruments. This interface was designed to be quite fast, which made it necessary to use high currents and short signal rise times in data transfer. These, in turn, can cause RF emissions and high-frequency ground loops. Using the IEEE-488 interface is therefore in contradiction with the hope for minimum difficulties with RF.

Dividing the computer interface in two separate parts

Our solution to this was to divide the computer interface of the AVS-47 in two parts: The resistance bridge incorporates a very silent, low-speed primary interface that contains no digital intelligence. This primary "Picobus" interface is the first of the two parts. The conversion to the IEEE-488 protocol is made by an external interface unit, the AVS47-IB. This "secondary unit" has its own enclosure, 21x15x6 cm, and it also has its own mains power supply. The two parts are connected by a shielded cable, and the signals in this cable can be filtered when they enter the shielded room. The standard length for the Picobus cable is 5 meters, but longer cables are also possible. Data between the two parts is transferred using a proprietary synchronous, serial protocol. Because of the synchronous operation, the bit rate can be arbitrarily slow, which makes filtering easy and allows for long cables. The word "Picobus" ends with "-bus" because one controller can control a few instruments, which all have their unique bus addresses.

This concept of a "two-stage interface" includes also that

- The AVS-47 can be interfaced with a PC computer using only the primary interface without any additional costs
- The noisy IEEE-488 bus can be separated from the cryostat by a sufficient physical distance
- The primary interface can be made without using a microprocessor inside the bridge.

AVS47-IB Key Features

- Commands for input multiplexer, range, excitation, input mode, deviation reference, display mode
- Averaging and statistics (average of N measurements, min/max/std)
- Digital filtering (reading based on a long running average is obtained immediately)
- Digital self-calibration (best accuracy also on low excitation levels)
- Automatic scanning of several sensors at predetermined intervals (saves a lot of labour, can be left to collect readings without computer supervision)
- Buffering of data (the computer is free for other purposes)
- Reading or printing the results either in real time or from the buffer
- Commands for the TS-530A include the set point and all the PID parameters plus measuring the heater voltage and current
- Self test (*TST?) covers both the AVS-47 and the TS-530A
- Emulates the DC900 commands for the old AVS-46 (only a limited set of features can be used)
- Serves as a printer port for the AVS-47 even without a computer
- IEEE-488.2 status reporting and common commands

Powerful macro commands

Many of the above "macro" commands are very powerful, and using them can make the control program in the computer much simpler.

For example, taking an average of 100 readings would need 40 seconds. But you can program the AVS47-IB to generate a service request on "OPeration Complete" (*OPC), give the "AVE100" command and let the secondary interface take care of the measurement.

Scanning is even more powerful, especially when using the autoranging feature of the AVS47-IB. Then you need not worry about possible overrange situations. Scanning is also safe in the meaning that the sensors are not overheated by mistake. The multiplexer, range and excitation are changed only when the bridge input is grounded. The scanning procedure includes delays for letting the bridge to balance before it starts to take readings. Individual excitation voltages and averaging lengths can be programmed for each sensor, and the results can be buffered and/or printed. If there is only one sensor to be scanned, the prodecure shrinks to measuring this sensor at pre-set intervals.