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AN INSTRUMENT UPDATE FOR COMPUTER INTERFACING

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This paper attempts to address some of the problems of taking 2 instruments with very different backgrounds and technologies and marrying them to produce a new unit. In addition, as a side issue, it is an interesting and cautionary tale of the difficulties of co-operation between companies in different countries.

BACKGROUND

In 1981 the french company Audioanalyse produced a real time analyser based on an L.E.D. array display. Since there was no equivalent product manufactured in Europe the project was partly financed by government funds. The resulting unit, the ATR1 was inexpensive and very compact and, while perhaps not having the style of the american Ivie of a similar era, was a good workmanlike unit with a number of unique features and, above all, achieved what it was intended for.

Cirrus Research on the other hand specialised in high performance, analogue units to precision standards and had, in 1981, no real experience of digital electronics in this form. The instrument that was current at the time was the CRL 2.35, a modular unit which could accept an accurate liquid crystal display plug-in to give digital readings. Cirrus, being also a microphone producer, had control of the acoustic performance while Audioanalyse purchased microphones externally. Thus the elements were there for a new unit made up of the real time display from the ATR1 together with the analogue input circuitry and display from the CRL 2.35. The two companies became aware of the potential of such a joint unit shortly after ICA 1983 and discussions started towards the end of that year. The initial conclusions were that it would be a simple project to graft one unit to another and assemble them into a larger case. The reality was somewhat different. The main problems occured as soon as the attempt to unite the various circuits was made:

1. They used very different power supply rails
2. Digital noise totally overwhelmed the signals
3. Much more voltage stability was required
4. The tolerances of IEC651,while relatively easy to meet, were inadequate for a dual display instrument
5. A decision was needed over the division of tasks bearing in mind that component availability and manufacturing techniques were not the same for each company.

THE PROBLEMS

Voltage incompatibility

Cirrus had traditionally used four 9V batteries to enable 27V to be available directly without the inefficiency and noise problems of invertors.

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This approach gives the absolute maximum battery life for a given volume and also simplifies significantly the analogue design problems.

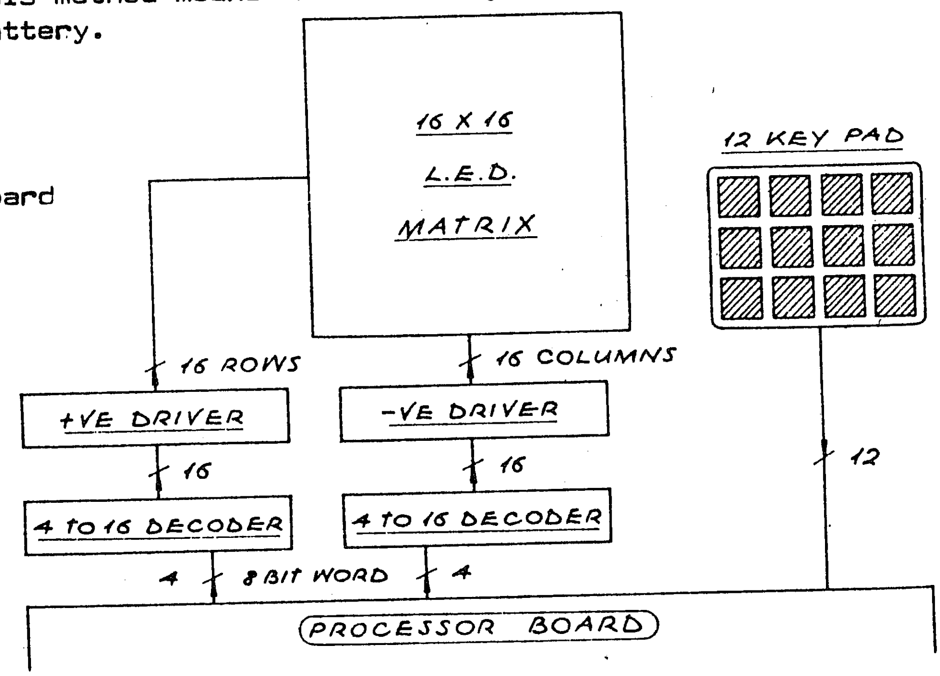
Audioanalyse, on the other hand, operated from low voltage, rechargeable batteries inverting their 6V up to the levels required for operation. Naturally none of the resultant levels corresponded. The CRL 2.35 being a plug-in unit system required particularly stable voltages and these were easily generated by the raw 27V battery supply. The inverting supplies of the ATR1 had no need to be quite so stable and were not adequate for the new use.

The first model used extra invertors to generate the 17V for the microphone supply. The CRL 2.35 can measure down to 20dB which represents 2 microvolts from a standard half inch capsule. Any ripple or digital noise of this order on the power supply was read as input via the polarising supply to the capsule. In the event, as we will show, the power supplies were to be the biggest problem area followed by the digital noise.

ATR1 FUNCTIONS

The display of the ATR1 is an LED matrix which appears to move at fast response. In fact it goes extremely fast and, somewhat like a TV picture, relies on persistance of vision to get the required effect. Each diode is only switched on for 1.25mSec out of a total period of 20mSec for each image. Thus each diode is only lit for about 6% of the total time and to get any brightness at all it must be pulsed very hard, about 20mA to 100mA depending on ambient light conditions. This method means unfortunately that huge pulses of current are drawn from the battery.

Fig.1 ATR1 Display Board



The matrix of 256 LEDs is addressed by an 8 bit word composed of 4 BCD address lines and 4 BCD column lines each word deciding which LED is to be lit. The non-multiplexed keyboard is mounted on the same board as the display giving 12 individual output lines.

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The pre-amplifier board holds the microphone attenuators and amplifiers whose weighting and gain (in 10dB steps) can be modified by control lines from the processor board. This board also contains the switching power supply running from the internal rechargeable batteries.

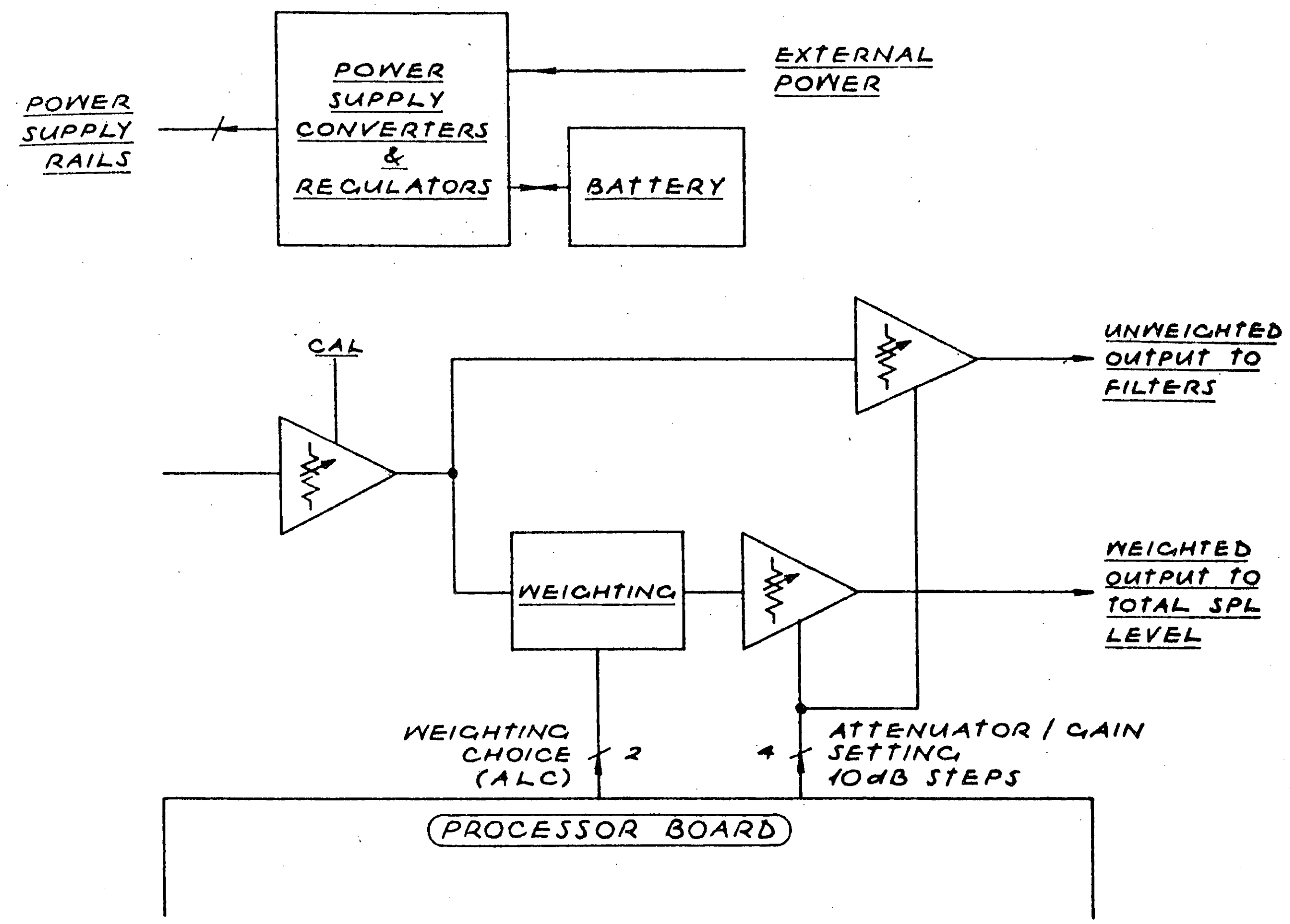

Fig 2. ATR1 Preamplifier board

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The filter board consists of 1Ø bandpass octave filters and an eleventh 2ØHz to 2Økhz filter, each with associated rectifiers, programmable fast or slow integrators, and output to a processor controlled multiplexer.

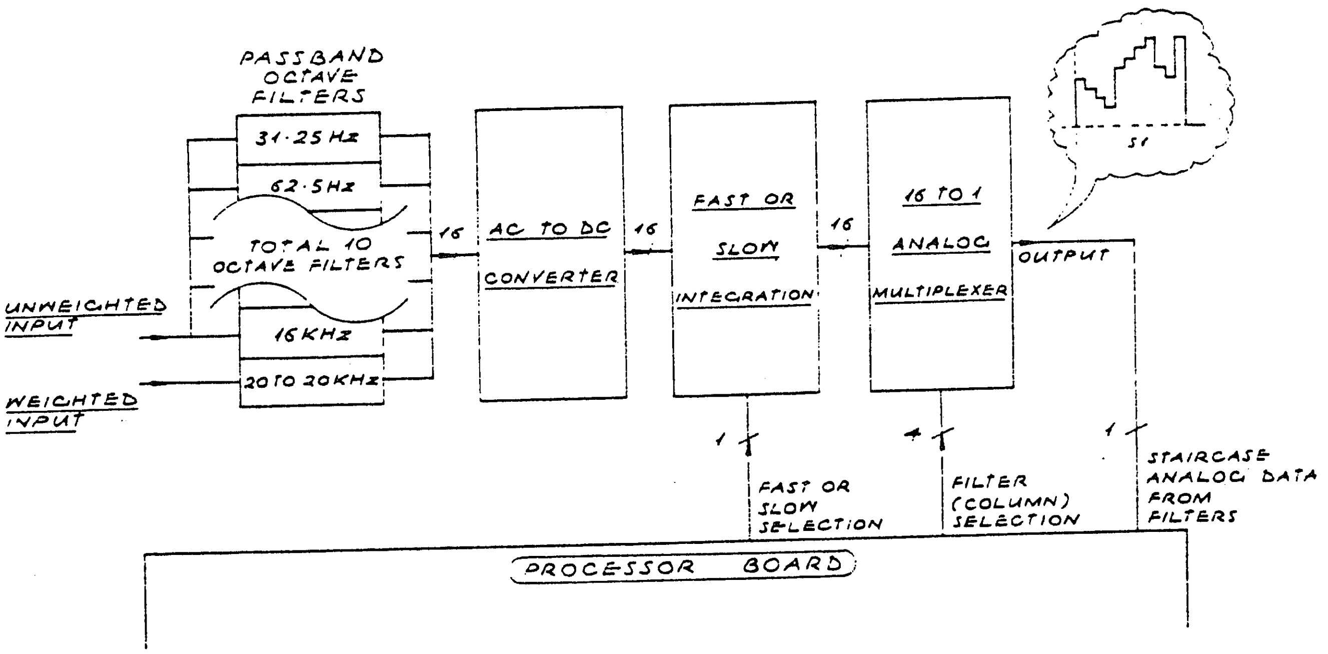

Fig 3. ATR1 Filter board

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The processor board reads the keyboard data along with the electrical signals emanating from the octave filters, and outputs the requested data to the display board.

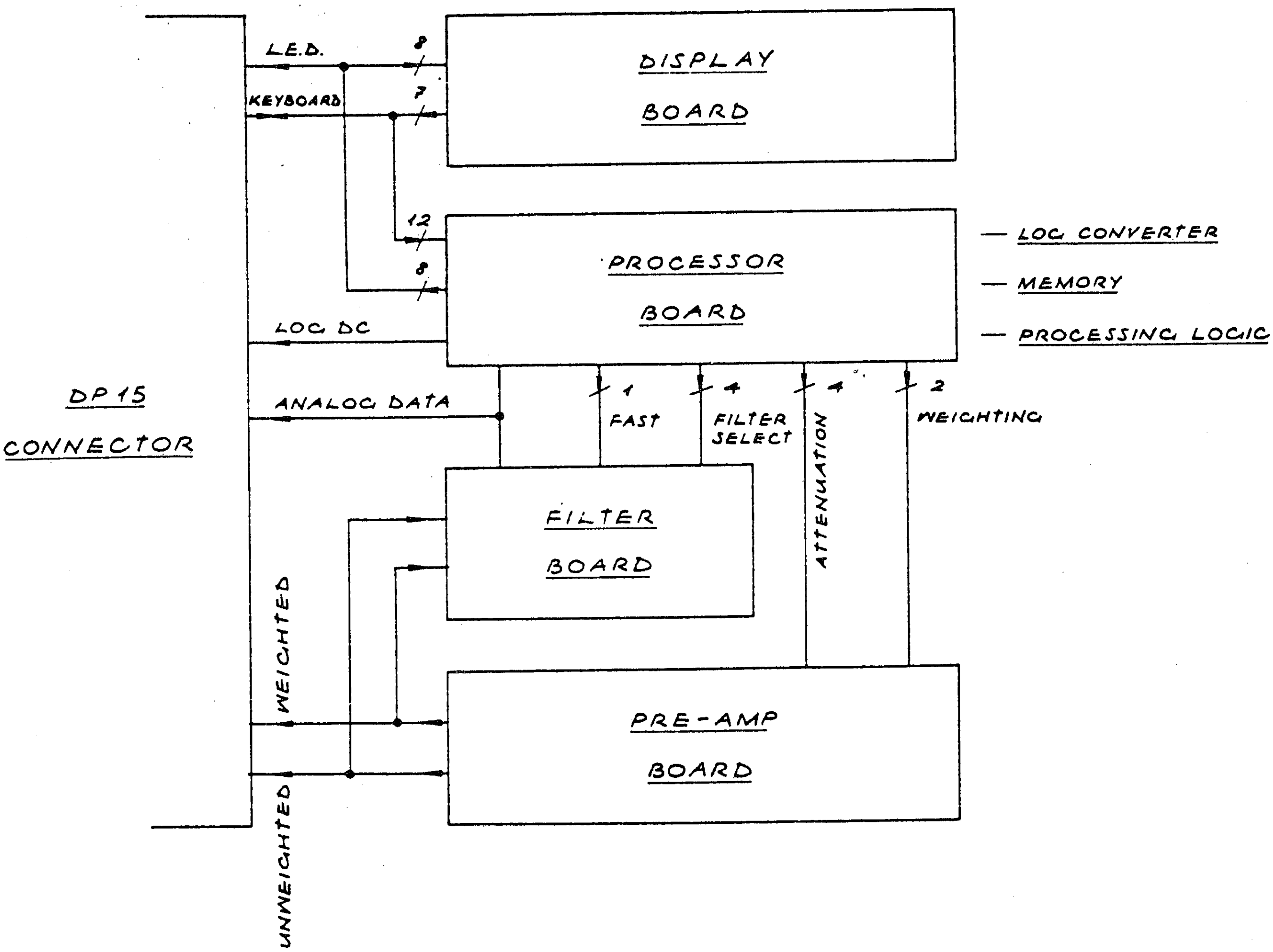

Fig 4. ATR1 Processor board and DP25 Socket Connections

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CRL 2.35 SOUND MEASUREMENT SYSTEM

The organisation of this unit has been described elsewhere [1]. Because of the unique nature of the analogue interface fitted to the unit, particular care had to be taken with the power supplies. For example, when a different plug-in is fitted the reference for calibration must not move by more than Ø.Ø5dB to enable the unit to remain in the Ø.1dB tolerance specified. This is done by highly stable power supplies acting as the reference for the logarithmic converters in the main unit and plug-ins with sophisticated null re-entrant current circuitry in each module. Simply reducing all the voltages down to ATR1 levels would mean the ratio between errors and aiming volts would become too low for comfort, thus either the unit had to be redesigned or extra power supplies had to be added.

NEW UNIT REQUIREMENTS

Not only was the new unit required to have the display of the ATR1, the numerical display of the CRD 1.26, and the L3M interface of the CRL 2.35, but also additional features requested by the market.

Firstly an interface to a computer was asked for to enable the downloading, filing, and printing of the unit's 16 memories. This interface would allow the computer to read in real time thus expanding the memory size to that of the computer.Finally, if the new device could talk to a computer it could be made to listen as well thus allowing computer-testing of the unit.

INTERFACE

The DP15 was established many years ago and the DP37 digital bus was announced in 1984. Clearly as the new unit was in the same form of housing these two interfaces should be implemented. In the event this was not done. Instead, parts of each interface were combined in a new dedicated system called the DP25.

It could be considered a backwards step to invent a special interface but as the method of generating the display was unusual, the conventional DP37 was not the optimum solution. The DP25 simply takes the row and column information as 4bit sets and calculates the dot position. Also a multiplexed output is available which can feed an oscilloscope or external display. Finally, the log dc signal as used on the DP15 is sent out to allow the standard Cirrus Short Leq software to run with the DP25 output. In the event the DP25 made a significant reduction in the software burden and the machine code acquisition routine for display is only about 25 lines in total.

MECHANICAL RESTRAINTS

By some chance the width of the original ATR1 and the CRL 2.35 were almost identical.

Indeed it was the closeness of their respective dimensions that made the original idea so attractive. However, certain problems remained to be solved. Firstly, the batteries had to be removable. No-one, who has done night consultancy far from a power point, can have any doubt that batteries must be replaceable. Also, the type of battery must be available everywhere, particularly the local corner shop.

The keyboard of the ATR1 was also to be improved and a mechanical slide switch was to replace the electronic switch of the ATR1. Not only was it possible to accidently power up the unit but the Cirrus team had visions of an ATR1 developing an internal short-circuit risking a potential fire hazard from the ni-cad batteries.

One of the errors made here was for Cirrus to insist that the batteries should be fitted in the same type of compartment as other standard Cirrus products. This was a mistake and many units of the first series failed because of poor battery mounting. Finally a new system was adopted.

The original ATR1 had a very poor acoustic shape and it was intended that the new unit should be in the standard cone shaped box. A cultural difference came up here- we called it a milk bottle shape, the french called it wine bottle.

ERRORS

The Ø.1dB resolution of the display is required by several specifications, despite the fact that the inaccuracies of even a type 1 system are typically of the order of Ø.7dB. Thus we are faced with a digital resolution significantly higher than the typical accuracy. In the academic world this a bonus as the accuracy is not limited by the resolution. However, in the real world, the unsophisticated user expects the accuracy to be the same as the resolution and indeed fondly believes that it is. The bar-graph display on the other hand makes a virtue out of necessity and limits the resolution to 1dB, but with a 'blinking' algorithm to give Ø.5dB effective resolution; near the typical Ø.7dB of type 1.

To test a unit with only 1dB base resolution can be difficult as all the weighting and response tolerances must be assumed to be 1dB tighter at either end. For example the A weighting tolerance at 4ØHz is +1.5dB for type 1. Thus if we allow 1dB at either side we have a +Ø.5dB tolerance. To resolve this problem, a careful check is done of "scaleshape" or, in a discontinuous display, the linearity of resolution. Then the analogue and rectifier circuits are checked using the multiplexer outputs (see fig 3). The external computer can sample at time S1 and thus read the output to the resolution of the A/D converter used. This output was also used to check the acoustic performance. Cirrus have used the same basic body shell for some years and can be "almost" sure that any new unit has no reflections to cause response bumps. However, for standards authorities "almost" is not enough, and therefore random units are checked in an anechoic chamber on a rotating table.

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Compliance with standards did not prove to be a great problem, except that the first units showed a drift with temperature. While this was predictable and permitted under IEC 651, we take the view that requiring people to measure the temperature before correcting their spectrum is, in Yorkshire terms, "plain daft". Thus we modified the unit to ensure the Ø.3dB of the Cirrus specification was met from -15 to +5Ø degrees C, tighter and wider than IEC 651. With two notable exceptions, many companies seem to take the view that if a single unit can be type tested inside the specification parameters this is good enough. We take the view that units WILL worsen in production and with age and thus the test specification MUST be tighter than the sales specification, which is usually IEC651 or IEC8Ø4. Furthermore, we have tested many units of other manufacturers, and again with three exceptions have found that the electrical tolerances took up all of IEC651 leaving nothing for microphone error. We have yet to see the zero tolerance microphone to go with these devices.

SUMMARY

A marriage of two units from two companies in two countries was finally achieved and despite both team leaders speaking both languages differences of culture, communication and company "flavour" made what should have been a simple exercise into a long hard struggle. Baptised by Cirrus the CRL 2.39A this instrument marks a milestone in acoustic-computer interfacing and if the lessons learnt by the two companies were the only benefit, it was a valuable exercise.

REFERENCES

[1] The Plug-in Concept of a New Acoustic Measuring System
Noise & Vibration Control May/June 1981