2100A Logie Fish Counter

Operating and Technical manual

Issue 7, October 1992

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Operation

1.1 Introduction

1.1.1 Principle of Operation

The Logie fish counter is used in conjunction with an electrode set to detect the upstream and downstream passage of fish in the body of water in which the electrode set is installed.

The electrode set comprises 3 similar corrosion-resistant metal conductors placed in a parallel alignment to form an open array configuration for weir use or a closed tube configuration for tunnel use.

The electrodes, in association with the water in which they are immersed, constitute a resistive transducer. For a given constant water depth, water temperature and water conductivity, the resistance measured between an electrode pair will be constant. A fish swimming through the array displaces its own volume of water; its body mass is considerably less resistive than the volume of water which it displaces. Thus the passage of the fish causes a transient reduction in the resistance detected between an electrode pair. If the fish is moving upstream first the centre-lower then the centre-upper resistance will show a reduction; if the fish is moving downstream the centre-upper resistance drops first followed by the centre-lower.

The instrument continuously monitors these resistances and from them derives a signal which defines the instantaneous relative magnitude of one to the other. The perturbation of this signal by a fish swimming through the array allows the counter firstly to detect it's passage and secondly to gauge it's swimming direction and approximate size.

Wide variations can be expected in those factors that determine inter-electrode resistance, namely depth, temperature and conductivity. It is not unusual for inter-electrode resistances to vary by hundreds of percent. An extremely important subsidiary function of the Logie fish counter is to regularly measure those factors affecting bulk resistance and to automatically adjust the sensitivity of its signal processing path in order to compensate for any change. On sites where moderate to high water conductivities prevail, the standard counter is able to make this adjustment. On sites where low water conductivities occur the adjustment is made with the aid of precise conductivity data supplied from the optional environmental card. The result of these compensatory adjustments is a good correlation between the size of fish and processed signal magnitude if a constant swimming depth is assumed. It is therefore possible for the user to set threshold levels which define a size below which a fish will not be counted. It is also possible for the counter to sort fish into approximate size groupings.

In addition to the passage of fish other events can cause transient changes in the resistance between the electrodes; these events include the downstream passage of debris and ice masses and the perturbation of the water depth over the electrodes by the action of the wind. If no precautions are taken in the counter design then there is every possibility of events such as these being interpreted as fish movements and consequently causing false counts. A successful counter must therefore be endowed with the ability to discriminate between genuine and false signals. In the Logie counter this ability is provided by a powerful algorithm which is executed by the system microprocessor.

The discrimination capability is based on the knowledge that the passage of a fish produces a typical “fish” signal whereas other events produce signals which are atypical of fish. Sometimes the differences between genuine and false signals are very subtle and so the discrimination task is not a trivial one.

As soon as an event is detected which is above the user-defined threshold the processor commences execution of the discrimination algorithm. In essence the action of the algorithm is to compare a set of parameters derived from the received signal with a set of stored parameters which define a genuine signal. If the comparison is negative the signal is rejected; if positive the signal is accepted and counted.

If a chart recorder is connected to the counter then the user may opt to record only genuine signals or to record all signals which exceed the threshold. The latter option helps the user to build confidence in the counter in that all events may be inspected visually so that a manual check may be made on the counters performance. However, the option can prove expensive in terms of chart paper, especially when the counter is operating in windy conditions.

1.1.2 Specification

- The counter is able to use most existing river installations and their fish detection electrodes.
- The counter is able to count adult salmon and grilse moving both up and downstream.
- The counter operates on installations with an equivalent bulk resistance of 10-500W.
- Fish of a resistance up to 500 times the inter-electrode resistance will be detected.
- The counter is designed to discriminate between fish and non fish signals including those generated by wind and ice.
- The counter compensates for changes in environmental parameters e.g. water conductivity, depth and temperature.
- Visual indication of the counts recorded are provided on a panel mounted Liquid Crystal Display and are resettable via the operator keyboard or CONTROL port.
- All data displayed and keyboard operations on the front panel are accessible via a serial data link (CONTROL port) and can be accessed by computer.
- The standard counter will store the date, time, channel, direction and size of fish signals detected, up to a maximum of 2048 total events. An optional RAM card can increase this to a maximum of 65536. These data may optionally be printed on a local serial printer as they occur. They may also be downloaded via the serial data link mentioned above.
- The counter distinguishes between upstream and downstream movements of fish and outputs each count separately.
- The counter can monitor up to four electrode sections simultaneously but independently and display separate upstream and downstream counts for each simultaneously.
- The counter is designed to detect and count fish crossing the electrodes at a steady speed of up to 6m/s and at a frequency not exceeding one fish every 0.5 seconds, depending on the velocity of the fish.
- The counter is of modular construction and is capable of continuous operation. All cabling is at the rear of the instrument.
- No special training in, or knowledge of, electronics or computing is necessary to operate the counter.
- The counter provides analogue signal outputs for each channel suitable for driving a chart recorder. Relay contacts are provided for triggering the operation of data loggers etc.
- The counter has facilities for setting and/or reading threshold values, channel counts, date and time, relay selection etc.
- The counter operates in an ambient temperature of 0-50 degrees Centigrade.

1.2 Counter Description

1.2.1 Main Components

The fish counter comprises an instrument case containing:

- ELCB and power supplies
- electrode drive module
- 19" rack and PC card set

front panel carrying

- user keypad
- display
- rear panel carrying
- mains connector and ON/OFF switch with integral fuse.
- electrode connector block
- event relay connector block
- environmental transducer connector block[1]
- serial data port to printer
- serial data port to remote controller
- earth leakage circuit breaker

Users only have access to those components carried on the front and rear panels. Internal components are not accessible to users, and removal of instrument panels to allow such access should only be carried out by qualified personnel for the purposes of servicing and/or adjustment.

Internal component details and set-up procedures are described in Section 2.

A description of front and rear panel components now follows.

1.2.2 Front Panel Components

An important consideration in the design of the Logie Counter has been its ease of use. Thus only two components are contained on the front panel, namely a 4 X 4 user keypad, and a 40 X 2 character liquid crystal display.

[1] The environmental board, connector and conductivity probe are optional extras, part 2100-6030, and are only necessary in circumstances of extremely low conductivity when additional gain compensation may be required. References within this manual to conductivity probes, conductivity compensation etc., only apply if the aforementioned parts have been installed.

Primary control of the instrument is via the keypad although a serial port (on the rear panel) allows for remote control and interrogation by computer.

The Display allows the user to view the functional settings of the counter and monitor up/down counts for all channels in use.

1.2.3 Rear Panel Components

Situated on the rear panel are the following components

- mains connector (IEC)
- mains ON/OFF switch with integral fuse.
- 20-way terminal block for the purpose of connecting the counter to the electrode array(s)
- 34-way terminal block for the purpose of connecting internal relays to subsidiary equipment
- 34-way terminal block for the purpose of connecting external sensors to the environmental board e.g. the conductivity probe
- 25-way (RS232) socket for the purpose of connecting an optional serial printer
- 25-way (RS232) socket for the purpose of connecting an optional remote computer (via modem if necessary)
- Note that connection details for the 2 RS232 sockets are as follows.

Pin 2	Transmitted data (from counter)
Pin 3	Received data (to counter)
Pin 4	RTS
Pin 5	CTS
Pin 7	Ground
Pin 20	DTR (CONTROL port only)

The control port defaults to 2400 baud, and the printer port to 1200 baud but both may be changed independently via the keypad or CONTROL port to one of 300, 600, 1200, 2400, 4800, 9600, or 19200 baud. Both ports are set permanently to seven data bits, even parity and one stop bit.

1.3 Installation

1.3.1 The fish counting station

The resistivity method of fish counting is well established, having a development history dating from 1949.

As explained in section 1.1 the method depends on the body mass of a fish being considerably less resistive than the volume of water which it displaces; thus when a fish traverses a pair of adjacent electrodes a momentary reduction in the resistance between them can be detected. The fish counter must therefore be used in association with a set of electrodes installed in the water channel through which the fish are passing.

The attention of novice users of fish counting equipment is drawn to the publication *"Fish counting stations - Notes for guidance in their Design and Use"* by R B Bussell (Department of the Environment, November 1978) which as the title suggests contains comprehensive advice on the design of and equipment for a fish counting installation.

A brief summary of important points from the publication are included here for preliminary guidance only.

The counter is intended for use in fish counting stations where electrode strips have been installed in a tube, channel or downstream face of a "Crump" weir. "Crump" describes a triangular section weir on which the upstream face is inclined at 1 in 2 and the downstream face at 1 in 5.

The hydraulic design of the installation should be such as to promote as near-optimum water flow as is possible. In particular, structural surfaces should be as smooth as possible to avoid entrapment of air, an adequate water depth should be maintained to encourage the passage of fish and an adequate water velocity should be maintained to discourage loitering. On weirs the upper electrode should be placed some way below the water crest while the lower electrode should be sited above the standing wave.

The structural design of the installation should preclude the use of any significant metal components near the electrodes. In particular any concrete work should avoid the use of reinforcing bars or related steelwork.

Electrodes should be of stainless steel, typical cross-sections being in the range 50mm x 3mm to 50mm x 6mm depending on the strength of fixing employed. Separation of the electrodes depends on the size of fish to be counted but is normally in the range 300 - 600mm. Electrode strips may have a continuous length of up to 20m although the maximum depends on local conditions. (The Logie counter has a specified minimum inter-electrode resistance of 10W. The inter-electrode resistance reduces as strip length increases and so a maximum length of 20m can only be accommodated where the local conductivity range permits)

To avoid electrochemical problems the making of dissimilar metal connections under water should be avoided. Thus connection to the stainless steel electrodes should be by welded-on stainless steel rods which can then be taken to a point above highest water level where insulated joints to copper cable can be made.

Interconnecting cables between the electrodes and the instrument should be maintained in a waterproof condition. They should either be of an armoured type which can be buried or be contained within a robust weatherproof duct. The interconnection should as far as possible be proof against vandalism.

The gauge of the interconnecting wire should be such that the resistance is negligible compared to the lowest value of inter-electrode resistance which is likely to be encountered. This indicates the use of heavy gauge wire with the length of cable run kept to a minimum.

(For example a 2.5mm copper conductor has a resistance of approximately 0.04W/m. Applications of the Logie counter to installations near the 10W limit suggest a maximum cable run of 25m using this gauge of conductor) The fish counter itself should be housed in an instrument cabin or building which can be ventilated in summer and heated in winter in order that the specified operating temperature range is maintained.

Counter performance can be seriously affected by the accumulation of debris or weed in the vicinity of the electrodes. Regular visits to the station should be made so that any such accumulations can be removed.

1.3.2 Connecting the instrument to the electrodes

Before connecting the instrument to the electrodes the electrode circuits should be tested for continuity and absence of short circuits. It should also be verified that none of the inter-electrode resistances are below the 10W specified minimum for the Logie counter.

The Up, Centre and Down electrodes of each section should be connected to a set of U, C and D terminals which are of a convenient screw type grouped together in a 20-way block at the rear of the instrument [1](See figure 1.1)

2	4	6	8	10	12	14	16	18	20
		E1 C		E2 C		E3 C		E4 C	
		E1 D	E1 U	E2 D	E2 U	E3 D	E3 U	E4 D	E4 U
1	3	5	7	9	11	13	15	17	19

Figure 1.1 - 20-way Phoenix Connector

Choice of a particular set of terminals determines the channel number allocated by the counter to the electrode section connected to those terminals. On power-up the counter will adjust the sensitivity of each channel to the correct level for the environmental conditions which exist at that time. Users should ensure that channels in use are not inadvertently disabled during their initial set-up procedure. (See section 1.4 - Instructions for use)

After the power-up and self-calibration sequences users can verify correct operation by making use of the self-test facility in which the counter is caused to insert a “dummy fish” resistance (nominally equivalent to a 550mm fish) across the electrodes so that the passage of a fish is simulated. A useful exercise is to experiment with the setting of the threshold levels until those settings are found where the dummy fish is just counted.

It is recommended that after installation users should embark on their own calibration trials to find threshold levels appropriate to the minimum fish size which they wish to count. The environmental compensation feature of the counter ensures that once these levels have been established no further adjustment should be necessary.

1.3.3 Relay Connections

The instrument is provided with a total of 12 programmable relays. These may be allocated by the user to such ancillary equipment as is being used with the counter and which, on detection of an event requires activation by the opening or closing of a switch. Typical examples of the application of such relays include the activation of chart recorders and data loggers.

Relay connections are grouped together in a 34-way terminal block at the rear of the instrument. Figure 1.2 gives details of the numbering of these terminals.

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1 Please note that it is sometimes necessary for us to supply an alternative style of connector block, which has the numbering of the top and bottom rows interchanged, i.e. instead of 2,4,6 etc being on the top row, they have 1,3,5... These alternative connectors are coloured orange, as opposed to the standard ones which are green. However, the connections as shown in the figure are still correct e.g. on the 34-way relay connector, pin 3 is still the chart output for channel four.

2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
0V	K8 A	K8 B	K7 A	K7 B	K6 A	K6 B	K5 A	K5 B	K4 A	K4 B	K3 A	K3 B	K2 A	K2 B	K1 A	K1 B
0V	ch 4	ch 3	ch 2	ch 1	K12 A	K12 C	K12 B	K11 A	K11 C	K11 B	K10 A	K10 C	K10 B	K9 A	K9 C	K9 B
1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33

Figure 1.2 - 34-way Phoenix connector

Relay allocation and control is described in detail in section 1.4 “Instructions for use”.

1.3.4 Conductivity probe Connections

The conductivity probe is connected to terminals 4, 6 and 8 of the second 34-way terminal block at the rear of the instrument, where the screen is connected to pin 8, the blue wire to pin 6, and the brown wire to pin 4. It should be noted that the instrument is aligned for use with a specific cell together with its interconnecting cable, and errors will result if a different cell and cable is used unless the instrument is subsequently realigned.

The cell should be carefully deployed in the water channel which carries the fish detection electrodes but not in close proximity to them. The method of deployment should be such as to avoid mechanical damage to the cell and should ensure that it remains submerged at all times. The installation should be inspected regularly and the cell cleaned as necessary.

1.4 Instructions for use

1.4.1 Power-up sequence

On power-up, the counter displays the logo *"The Aquantic Logie fish counter"*, the version number and date, the quantity of RAM installed (normally 16K on a standard counter, although this may be expanded to 512K using an optional "Paged RAM" card) and a countdown from 44 to 0 seconds. It then proceeds to calibrate up to four electrode interface cards. The display will indicate "Calibrating channel" followed by the channel numbers of the cards and the attenuation values being sent to each electrode interface card. After this has finished, the display will show the current values of up and down counts for all channels, and the word `Off' for those that have not been "enabled" (see later).

If this is not the first time the counter has been switched on, then all previous values of counts, thresholds etc. will have been retained in the battery-backed memory. It is possible, however, to force the counter to reset all its internal values to predefined defaults, if the "F" (Forget) key is held depressed while power is applied, and kept depressed until the "Aquantic" logo appears.

1.4.2 Commands available from the keypad

The keyboard and display are used to set and/or display various parameters of the counter, a summary of which follows.

Thresholds	The values, expressed as a percentage of full-scale, that a signal must exceed, before being considered as a possible fish.
Reset counts	After confirmation, the totals of all up and down counts are reset to zero.
Self test	Allows the insertion of a "standard" fish signal into any of the four channels, as either an upstream or downstream "fish".
Date	The current date may be entered as YY, MM, DD.
Time	The time of day may be entered as HH, MM, SS.
Enable/disable	Individual channels may be enabled or disabled as required.
Event relay Up relay Down relay	The instrument is fitted with a total of eight single-pole normally open relays and four single pole changeover relays. These may be assigned using the above commands to particular channels.
Printer	The counter may, at the users discretion, print information on each count, as it occurs. This command will enable or disable the printed output.
Events	Signals which exceed the user-defined sensitivity thresholds, but which are rejected by the counter as non-genuine, will not be counted but can still be selected to trigger the event relay and so generate a chart record. This command enables/disables this facility.
Password	A user defined four-digit password may be entered to provide some protection against inadvertent changes to the counter status.
Test mode	The counter may be placed in a `test mode', when all logged and/or printed data is marked with an asterisk. This may be useful during set-up procedures. The asterisk will automatically be inserted during `self-test' commands.
Baud rates	The serial ports may be individually configured to operate at one of the following baud rates: 300, 600, 1200, 2400, 4800, 9600, 19200.
Logged events	The total capacity of the counter, the number of events currently stored, and the number of free entries remaining may be displayed.
Force Calibration	The counter may be forced to perform a calibration of all enabled channels.
Setup/Working Attenuation	The attenuation at `setup' time, and the attenuation after compensation for conductivity and electrode length may be displayed.

Conductivity calibration	The conductivity probe may be calibrated, and cable capacitance compensated for.
Show conductivity	The current value of conductivity, as read by the probe, can be continuously displayed.
Channel length / depth	The electrode length and normal water depth of each channel may be entered.
Length and conductivity compensation	The length and conductivity compensation factors may be entered.
Pseudo-graph output	Generation of fish waveform data may be enabled or disabled on a per-channel basis.
Maximum size	The range of values allocated to fish sizes may be set to 0-99 or 0-127
View logged data	A quick way of looking at logged data, one at a time, on the LCD display
Display enable/disable	The display of counts may be hidden or not
Datalog buffer format	The buffer holding the logged data may be made linear, circular or flushed - see section 1.4.6
Continuous analogue output	The chart recorder outputs may be set to give a real-time signal from the electrodes
Status dump	A dump of the counter's status may be sent to the printer after a self-calibration

1.4.3 Command implementation

Most of the previously described commands may be implemented by either

(a) pressing one or more keys, or
(b) via remote computer control.

(a) Using one or more keys

This is the most direct method of entering commands, since they can all be actioned by pressing at most two keys on the keypad. These keys and the respective commands are as follows

0	Threshold setting for any channel
1	Resetting of counts for all channels
2	Introduction of a dummy fish, for self-test purposes, into any channel
3	Setting of the system date
4	Setting of the system time
5	Enabling or disabling the operation of any channel
6	Allocation of relays for Up, Down or Event occurrences to a particular channel.
7	Enabling or disabling the printer
8	Enabling or disabling the event relay plus chart output, whether it operates instantaneously or not and whether events are logged or not
9	Password - setting/changing the password and logging on/off
A	Toggles test mode on or off
B	Baud rate selection for CONTROL and PRINTER ports
E0	Details of available RAM, amounts used and remaining
E1	Calibrating the enabled channels
E2	Displaying the setup attenuation, and the working attenuation

E3 Conductivity probe calibration

E4 Display of conductivity

E5 Setting up the water depth and electrode length for any channel

E6 Setting conductivity and electrode length compensation

E7 Enable/disable the pseudo-graph output

E8 Changing the maximum size value from 100 to 127

E9 Viewing logged data

EA Enabling the display of counts or not

EB Changing the format of, or clearing, the datalog buffer

EC Enabling continuous output of analogue data

ED Dumping the status of counter to the printer after a self-calibration

NB The commands that are listed as applying to any channel will prompt the user for the channel number after that command has been entered. This should be a number in the range 1 to 4.

(b) Remote computer control

This allows control of the counter via the CONTROL serial link (RS232) on the rear panel. The commands are entered by sending the same sequence of characters from the controlling computer as would be entered on the keypad to perform the same task, except that they are preceded by STX (ASCII code 2) and followed by ETX (ASCII code 3). In addition, there are commands a,b,c,d and e (described below) which are not implemented using the keypad and are only accessible using the CONTROL port.

1.4.4 Command detail

0 **Threshold setting.**
The user is prompted to enter the channel number (1-4), upon which the current values for the Up and Down thresholds are displayed followed by the request A(lter), C(ancel)?. If the user simply wishes to check the values for that channel then keying C at this point returns the counter to the default display of counts.

1 **Zero counts.**
The user is asked to confirm by pressing the C key that he wishes to reset the currently stored values of all channel counts to zero. Pressing any key other than C will return to the default display without changing the values.

2 **Self-test.**
The object of this command is to allow the user to check the settings of the thresholds for a particular channel by simulating the passage of a fish through that channel. In the standard counter this fish is nominally equivalent to a 50 cm salmon. The user is first prompted to enter the channel number (1-4), and then to select Up(1) or Down(2)? upon which the dummy fish is inserted across the electrodes for the channel and direction selected. The display then returns to the default, and the count for the appropriate channel and direction should be seen to be incremented by one. If this does not occur, then the thresholds for that channel are too high and should be altered using command 0.

3 **System date.**
The current date is displayed, and the user prompted with A(lter),C(ancel)?. If A is entered, then the counter will prompt in turn for the year, month and day. All of these must be entered as two-digit values, i.e. 7th April 1992 would be entered as 92 followed by 04 followed by 07. Incorrect values, e.g. 31 April, will result in the display Out of range followed by Invalid date.

4 **System time.**
The current time is displayed, and the user prompted with A(lter),C(ancel)?. If A is entered, then the counter will prompt in turn for the hour, minute and second. All of these must be entered as two-digit values using the 24 hour clock, i.e. 5 minutes and 20 seconds past 3pm would be entered as 15 followed by 05 followed by 20. Incorrect values will result in the display Out of range followed by Invalid time.

5 **Enable/disable.**
The user is prompted to enter the channel number (1-4), upon which the current status of that channel is displayed, i.e. enabled or disabled. The user is then prompted with A(lter),C(ancel)?. If A is entered, then the state of that channel is altered.

6 **Relay allocation.**
This allows the user to allocate relays to various conditions for individual channels. The user is first prompted to enter the type of condition i.e. Up(1),Down(2) or Event(3)? for which a relay has to be allocated, then for the channel number. The current allocation for that channel/condition is then displayed e.g. Up relays are 04 10 time 02. This example indicates that relays 4 and 10 will operate for two seconds if an Up count occurs on this channel. The display then changes to A(lter), C(ancel)?. If A is entered, then the user is prompted to enter the numbers of up to two relays that are to be operated if this condition occurs. If a second relay is not required, then pressing D (Default) will move on to the request for Time?. This should be entered as a two digit value being the time in seconds for which the relay contacts are to operate.

It is permissible to allocate the same relay to more than one condition, so that for example, relays 9 and 10 could be made to operate on an event occurring on any channel.

NB (i) There are eight, single-pole normally-open relays and four single-pole changeover relays in the system, which may be allocated as desired. The former are numbered 1 through 8 and the latter 9 through 12.

(ii) An event is regarded as any signal that exceeds one or more of the threshold settings on a particular channel, whether or not it is a fish.

(iii) The chart recorder output is only generated if an event relay has been allocated for a particular channel. Note that the event duration is measured from a point two seconds before the mid-point of the fish waveform.

7 **Printer status.**
The counter may, at the users discretion, print information on each count, as it occurs. This will consist of the date and time, the conductivity at the time of the most recent calibration, channel, whether upstream or downstream and the size (0-99% or 0-127). This command either enables or disables the printed output. If enabled, a printer with an RS232 serial connection should be attached to the PRINTER port on the rear panel and set to the correct baud rate.

8 **Event relay and chart recorder status.**
It is possible for a signal to be detected which exceeds the preset thresholds, but does not pass the internal checks that determine whether or not it is a fish. The signal may, if the user desires, trigger the event relay, and generate a trace on the chart recorder output. This command enables or disables this occurrence. In addition, the user may choose to have the event relay operate as soon as an event is detected, rather than after the signal is processed. This could be useful for the triggering of still cameras etc. The user may also choose to log these signals or not, as required.

9 **Password.**

A simple password facility (consisting of a user-defined four-digit number) is available. If no password has been set (or it has been set to 0000) then the counter will operate as it normally does, and respond to keypad and control port commands. If key 9 is pressed under these circumstances, the prompt Enter new password will be shown, and a 4 digit number should be entered. The user is now logged on and may give any operating commands necessary. If key 9 is pressed whilst logged on, the user is prompted Change password(1), Log off(2)? and has the choice of either entering a new password or logging off. Once logged off, the counter will not respond to any command other than 9, whereupon the counter will prompt Password? and the user should enter the four digit password. The message Password OK or Wrong password will be given as appropriate.

Note that:

(a) The user will be automatically logged off if no commands have been entered for a period of ten minutes.

(b) If the counter is powered up with the F key depressed - as described in the manual - the password is removed.

(c) See section 1.4.5 for details of operation of this command via the CONTROL port.

(d) If the password has been forgotten, then contact Aquantic for help on gaining access to the data.

A **Test mode.**

This places the counter in a mode where it still operates normally, but any events logged will have an asterisk appended to them, in order that they may be distinguished from genuine fish events. If no commands are entered for five minutes, this mode will be reset automatically. An indication that this mode is enabled is given by a T in the lower right hand corner of the LCD display. Test mode is also entered for three seconds during entry of self-test signals (dummy fish).

B **Baud rates.**

The user is prompted with Control(1),Printer(2)? and should respond with the number of the port whose speed it is desired to change. The counter will then show the current setting for that port, and ask for a new value. Up to a five digit number may be entered at this point, chosen from 300, 1200, 2400, 4800, 9600 or 19200. If less than five digits are entered then the E (Enter) key should be used to terminate the number.

E0 **Logged data.**

If E is pressed, followed within one second by 0, the counter will display the total number of events it is possible to hold, the amount currently logged, and the amount remaining. A standard counter with 16K of logging RAM can hold 2048 events. With the optional paged RAM board, which may hold up to 512K of memory, it is possible to store a maximum of 65536 events.

E1 **Calibrate Channels.**

In a similar way to E0 above, if 1 is pressed instead of 0, then the counter will perform its calibration procedure.

E2 **Display attenuations.**

This shows the values of attenuations that were calculated for each channel, both for the setup procedure and the working value calculated as a result of the various compensation algorithms.

E3 **Cable capacitance compensation.**

This allows the user to calibrate the conductivity measurement to take into account the capacitance of the cable connecting the counter to the conductivity probe. The counter will prompt the user to confirm that the probe is out of the water and if so, calculate the capacitance of the cable, so that this may be discounted from future readings. However, if the probe is not out of the water, any key other than C should be pressed, and this calibration will be omitted. Failure to calibrate the probe in this way will result in small errors in conductivity measurements.

E4 This gives a continuous display of conductivity in microsiemens per centimetre.

E5 This allows the user to set up the values of water depth and electrode length (in cm) for use by the conductivity compensation algorithm. The user will be prompted for the channel number, and then for the length and depth in cm. If no change is required then the D key should be pressed in response to the request(s) for new values.

E6 **Length and Conductivity compensation.**
The electrode length compensation factor is entered in this section. This command also displays the current conductivity compensation table, and allows the user to modify it.

The user is prompted for a length compensation factor (in % per metre). This is used, along with the electrode length set using E5, to calculate a gain compensation factor for different sizes of weir sections, e.g. with a factor of 110% and a weir length of 240cm, the gain would be increased by (110-100) * 2.4%. It is also possible to enter values less than 100%, in which case the gain will be reduced.

A table of conductivity values are then displayed on the top row, and the corresponding gain compensations (in %) are displayed on the bottom row. If any of these need to be changed, then the A key should be pressed (but see below), whereupon the top row of the display will change to show the numbers 1 to 8. The appropriate number should be entered and the value corresponding to that entry will be removed from the bottom row, and the user allowed to enter a new 3-digit value. This value can be greater than 100% to increase the gain, or less than 100% to decrease it. To change more values, press the A key again, or the C key to exit and update the attenuations.

A predefined set of values may be used by pressing the D key, instead of the A, after which these preset gains will appear on the bottom of the display in place of the existing values. In addition, all values may be reset to 100% (the default when shipped) by pressing the F key.

The values entered are used to calculate the gain compensation required for a particular conductivity reading, by using interpolation between the points entered by the user. This compensation takes place every half hour, at the end of the usual self-calibration procedure.

E7 **Pseudo-graph output**
A pseudo graphical output has been made available via the printer port in addition to the standard chart recorder (analogue) output. The user may select pseudo-graphical output on a per-channel basis, although if **any** channel has this form of output enabled, **all other channels** have their normal printer output suppressed. The output takes the form of pairs of characters, representing the encoded value of the channel number and the signal value measured by the counter every 0.01 seconds. A small example of the typical output might be as follows:

```
S 19/03/92 23:11:54 150 1 D 050
D @@PP``pp@@PP``pp@@PP``pp@@PP``pp@@PP``pp@@PP``pp@@
D pp@@PP``pp@@PP``pp@@PP``pp@@PP``pp@@PP``pp@@PP``pp
F 1
```

The start of a fish is indicated by the S record, which is in the same format as the normal logged or printed data, except for the preceding S. The ensuing D records are the blocks of data as previously mentioned. The end of the output is indicated by the F record.

NB (i) Because of the large volume of data being transmitted, it is essential that the baud rate of the printer port be set to 4800 or greater in order that the counters internal buffer does not overflow.

(ii) As can be seen from the example above, it is not feasible to manually interpret the data in its encoded form, and the printer should be replaced with a personal computer (PC) and appropriate logging software. This software is supplied with the counter, and is capable of logging the data and displaying it graphically on an IBMÔ PC or compatible, fitted with CGA, EGA, VGA or HerculesÔ graphics adaptors.

(iii) To enable the pseudo-graphical output, three commands must be used: (a) printer enable (b) Event relay enable, for a time greater than or equal to 4 seconds (c) Pseudo-graph enable (this command).

E8 **Maximum size**
When the counter prints data on logged fish or events, it includes a figure for size. This is usually a percentage of full scale (0-99) but may be changed to utilise the full resolution of the analogue to digital converter which gives values up to 127.

E9 **View logged data**
Normally the data on logged fish or events is accessed using the CONTROL port (See 1.4.5) but this command may be used as a quick check on the last few values. The LCD display will show the latest data on the bottom line, and the available commands on the top line; these are A to move to previous data, B to move to the next data and C to quit from this command. If no keys are pressed within 10 seconds, the display will revert to normal.

EA **Display or not display counts**
The user may choose to hide the Up/Down counts from casual observers using this command. The Aquantic name and telephone number are displayed instead of the counts. It is recommended that this command is used in conjunction with a password.

EB **Log buffer control**
The buffer holding the logged counts and/or events may be set to either linear or circular mode, or cleared. The LCD will show the current format and ask the user to choose from Linear(1), Circular(2) or Flush(3). The user is asked to confirm a request to clear the buffer by pressing C.

EC **Continuous analogue output**
The normal chart recorder outputs only produce signals when a fish or event occurs and for a time determined by the event relay time. This command forces continuous, real-time output to take place and therefore the event times are ignored other than for relay operating times.

ED **Dump status to printer**
Every 30 minutes, the counter performs its self-calibration routines, including reading the conductivity. The user may choose to have a status dump of the counter sent to the printer after this calibration has been performed.

1.4.5 Commands available from the control port

The following description is intended for users interested in developing their own control programs, however, suitable software is provided with the counter and runs on an IBM PCÔ or compatible.

Certain commands are only available (and are only sensible) via the CONTROL port, at the rear of the instrument. This port is configured for RS232 operation, and is intended for connection to a MODEM in order to access and interrogate the instrument over the public telephone network. It is possible, however, to connect a local computer if the appropriate cable is used. All the above commands are also available via this port.

In order to avoid commands being spuriously generated by noise or interference on the telephone line, all commands must be preceded by STX and followed by ETX (ASCII 2 and 3 respectively), but otherwise follow the format of the standard keypad commands. For example, to set the UP relays for channel one, to 1 and 3, operating for two seconds, the following keys on the keypad would be pressed

6 1 1 A 0 1 0 3 0 2

where the meaning of the individual characters are

6 Set relays command
1 Select UP relays
1 Channel 1
A Alter the current values
01 Relay number one
03 Relay number two
02 Operate for two seconds

To perform the same actions using the CONTROL port, those characters must be preceded and followed by STX and ETX respectively, i.e.

<STX>6 1 1 A 0 1 0 3 0 2<ETX>

Similarly, to set the date to 19th August 1992, the sequence would be

3 Date command

A Alter the current value
92 the year
08 the month
19 the day

and via the control port

<STX>3 A 9 1 0 8 1 9<ETX>

Password command

In order that the controlling system can ascertain the current state of the counter (Logged on or off) and whether password entry is successful or not, additional information is returned from the counter when the password system is accessed via the CONTROL port.

An interrogatory 9 should be sent to the counter in order to obtain a status response:

(a) If NO password has been set, then the string NEW is returned and a new four-digit password may be sent to the counter.

(b) If a password is set and the user is NOT logged on, then OLD is returned, and the correct four-digit password should be sent. The counter will then return either OK or WRONG as an indication of the success or otherwise of password entry.

(c) If a password is set and the user IS logged on, then 1OR2 is sent - i.e. Change password(1) or Log off(2). A 1 or a 2 should then be sent as required. If 2 is sent, then the counter will attempt to disconnect the modem by sending the string +++ATH0 (Hayes command to hang-up) then dropping the DTR line for one second.

1.4.6 Extra commands

a
This commands the counter to transmit its status, which consists of five lines of text, containing the following information

Line one:

DD/MM/YY HH:MM:SS P E I L B NNNNN VX.XX

where DD/MM/YY is the date, and HH:MM:SS the time.

P gives the status of the printer (1 = enabled / 0 = disabled)
E gives the status of the event (1 = enabled / 0 = disabled)
I gives the status of the event relay (1 = instant / 0 = delayed)
L gives the status of event logging (1 = enabled / 0 = disabled)
B gives the status of the buffer (1 = circular / 0 = normal)
NNNNN is the number of items stored in the buffer, and VX.XX is the version number.

Lines two through five give information on each channel:

C E UT DT UUUU DDDD U1 U2 D1 D2 T1 E1 E2 T2 P SA WA

where C is the channel number, E indicates whether it is enabled or disabled (1 or 0), UT and DT are the Up and Down thresholds, and UUUU and DDDD are the Up and Down counts.

The remainder of the line gives: the relay numbers and times of operation, i.e. U1, U2 are the Up relays, D1 and D2 the Down relays, T1 the time for the Up/Down relays, E1 and E2 the event relays, and T2 the time for the event relays; the pseudo-graph status (1=on/0=off); the setup (SA) and working (WA) attenuations.

A typical example might be

19/08/92 12:37:42 1 0 0 1 0 00137 V8.20
1 1 45 38 0013 0029 01 03 02 04 02 12 05 07 0 45 34
2 0 50 50 0000 0000 00 00 00 00 00 00 00 00 1 34 26
etc.

NB Where relay numbers are given as 00, this indicates that no relays have been assigned. Valid relay numbers are in the range 1 to 12.

After the counter transmits each line, it waits for an acknowledgment that the data has been received. The controlling system should send the character ACK (ASCII 6) in order to receive the next line. (It should be preceded and followed by STX and ETX as usual). The controlling system may request up to three retransmissions of the last line of data by responding with a NAK (ASCII 21) instead of ACK. If the counter receives no response within 10s, or more than three NAKs are received then the command will be aborted.

bn bc
Sets the buffer to normal or circular mode. A standard counter - with no Paged RAM - has a buffer capable of holding the data on up to 2048 counts (total of all enabled channels). If it fills completely, then two options are possible:

(a) it stops logging count information (i.e. date, time etc.) at the time the buffer is filled, and will only restart once the buffer is cleared, (normal mode) or,

(b) the new data starts to overwrite the existing data, oldest first, and continues to do so after every count (circular mode).

c
Clears the buffer. All data in the buffer is lost. This command is normally issued after the buffer data has been downloaded into the controlling system.

dnnnnn
Downloads the last nnnnn logged values. If nnnnn is 00000 then the whole buffer is downloaded. Each line transmitted takes the same form as that produced on the printer, i.e.

DD/MM/YY HH:MM:SS CND C D MM

where DD/MM/YY and HH:MM:SS are the date and time, CND is the conductivity, C is the channel, D the direction (U D or E) and MM is the signal magnitude (00-99% or 0-127). As with the status command, the controlling system should transmit an ACK to acknowledge each line received. Note that each real fish event is terminated by a space, and dummy fish events by an asterisk.

e
The counter will send the “Hayes”Ô hangup string to the modem (+++ATH0), followed by dropping the DTR line for one second. This will break any telephone connection.

f
The counter will send the conductivity profile to the CONTROL port. This takes the form of a list of eight numbers, separated by spaces, being the “gains” set by the user for each standard conductivity value.

g
The current conductivity reading is sent to the CONTROL port.

Technical Description

2.1 Overview

The counter hardware can be considered as subdivided into the following subsidiary parts;

- Mains power supply supplying ±15V, +5V to the 19" rack
- Electrode drive module containing isolated power supply, electrode drive oscillator, electrode drive amplifiers.

19" rack containing

- electrode interface card(s) (one per channel up to a maximum of 4)
- CPU / front panel interface card (one)
- rear panel interface card (one)
- optional paged RAM card (one)
- optional environment card (one)
- Front panel carrying liquid crystal display and user keyboard
- Rear panel carrying electrode and event relay connector block, printer and remote controller ports.

A detailed description of each of these components is now given.

2.2 Mains power supply

The mains power supply is a switching converter providing the regulated 5 volts required for the logic circuitry and the regulated plus and minus 15 volt supplies required for the analogue sections of the counter at a high (approx 80%) efficiency.

Because the module is connected directly to the mains it is not advisable to attempt to service it and no servicing information is included in this manual. In the event of module failure a replacement can be obtained either from Aquantic Ltd. or directly from Intelligence Power Technology Ltd. (Tel 0723-420196)

2.3 Electrode drive module

2.3.1 Overview

Refer to drawing 2100-6015

The electrode drive module is on a separate PCB at the left hand side of the main rack, and supplied with DC from a transformer and bridge rectifier attached to the rear panel of the instrument.

The main functional blocks contained on the PCB are

- The isolated power supply smoothing capacitors, regulators and heatsinks
- The electrode drive oscillator
- The electrode drive amplifiers

2.3.2 The Isolated power supply

The drive signal to the detection electrodes is electrically isolated both for the purposes of electrical safety and so that mains referenced interference is minimised; thus all electronic circuitry associated with the electrode drive is operated from an isolated power supply (note however that all main metal chassis components are tied to the mains earth bus within the instrument.)

The isolated power supply comprises a toroidal mains transformer T1, bridge rectifier, and an associated printed circuit board carrying the following components:

Smoothing capacitors C1, C2
Positive and negative series voltage regulators U2, U3
Regulated voltage setting resistors R1 - R4
Output Stabilisation Capacitors C3, C4

The supply delivers the current requirements of up to four electrode interface cards at a nominal output voltage of ±8.25V

The printed circuit board also carries the oscillator and electrode drive amplifiers.

2.3.3 The Electrode drive Oscillator

The 3 KHz electrode drive oscillator is of the quadrature “sine-loop” type in which two integrators are connected regeneratively. It provides the signal source for each of the four drive amplifier pairs. As a result of this strategy each electrode section is driven in phase with its neighbour; the bootstrapping effect thereby obtained reduces crosstalk between detector sections to a minimum.

Op amp U1D buffers the oscillator against the relatively low input impedances presented by the four drive amplifier pairs.

2.3.4 Electrode drive amplifiers

The operation of these amplifiers may be explained by taking channel 1 as an example.

U4 and U5 are power op amps connected in non-inverting and inverting mode respectively. Thus the U/S electrode is driven in phase with the drive oscillator and the D/S electrode is driven in antiphase.
Given that the resistances from upstream to centre and centre to downstream electrodes are approximately equal the centre electrode represents the median point between the U/S and D/S drive signals.

The level of asymmetry provided by the unequal closed loop gains set by the feedback resistor pairs R16, R17 and R18, R19 is such that the centre electrode always displays an in-phase bias.

The passage of an upstream-moving fish through an electrode section firstly reduces the D/S to centre resistance and then the centre to U/S resistance. The centre electrode signal will thus display a momentary reduction in signal level followed by a momentary increase; the passage of a downstream-moving fish has the opposite effect, that of a momentary increase followed by momentary reduction.

A wide variation in the range of inter-electrode resistances may be expected, depending on the nature of the site and the environmental conditions which prevail. Particularly high resistance values which are associated with low flow conditions, results in excessively high signal levels being passed to the electrode interface channel. The range of signals is restricted by connecting 150W shunt resistors between U/S and centre and centre and D/S electrode connections, these resistors being sited on the electrode interface card (R34, R35).

The oscillator and amplifier signal levels have to be adjusted as part of a set-up procedure, see section 2.4.2.

2.4 PC Rack

2.4.1 Overview

The main electronic circuit functions of the fish counter are contained on the following cards :

- Electrode interface card (one for each channel of the installation)
- Rear panel interface card (one)
- CPU card / front panel interface card (one)
- Paged RAM card (optional) (one)
- Environmental card (optional) (one)

These cards are contained in a 19" rack in which they engage the edge connectors of a backplane. This interconnects the cards with each other and with the power supplies. In addition, each interface card is connected via a ribbon cable to the appropriate input/output device e.g. the front panel interface is connected to the keyboard and the display, the rear panel interface to the 34-way relay terminal block and the electrode interface to the 20-way electrode terminal block.

The functional description of each of these cards is now given;

2.4.2 Electrode interface card

Refer to circuit diagram 2100-6010

Description of operation

The function of this card is

- to acquire signals from the electrode array
- to provide amplification and preprocessing for these signals
- to discard spurious signals which are caused by environmental changes to provide compensation (as determined by the CPU) for the effect of environmental changes on the amplitude of genuine signals
- to perform A/D conversion on the amplified preprocessed and compensated signals so that they may be accepted by the CPU card for further digital processing.

Signal input to the card is from the centre electrode. In the steady-state the signal is a 3 KHz sinewave of constant amplitude. Resistance changes at the electrodes cause amplitude modulation of this 3 KHz “carrier”. Detection of the amplitude modulated carrier provides the basic signal from which fish movements are deduced.

Typical signals acquired from the electrodes may be classified as follows:

Type I signals result from genuine fish movements; they are characterised by a pronounced rise and then fall of the modulation for a downstream-moving fish or fall and then rise of the modulation for an upstream-moving fish. The period of the event is of the order of one second.

Type II signals result from events which transiently change the electrode resistances but which are not caused by fish. The change in modulation of the carrier which is produced, and the period of the change is superficially similar to that caused by a fish; however there are significant differences which allow these false signals to be rejected.

Events which cause signals in this category include the passage of debris and ice over the electrodes and the depth modulation of the water over the electrodes by wind-induced ripples.

Type III signals result from changes in the electrode bulk resistances due to environmental variation. Changes in water depth, temperature and conductivity all affect the bulk electrode resistances which in turn affect the steady-state amplitude of the modulated signal at the centre electrode.

Environmental changes are typified by their very low frequency, their period being of the order of tens of minutes or hours. Thus type III signals are easily rejected by filtering techniques.

The precise voltage amplitude of the input signal depends on the level of voltage drive obtained from the electrode drive amplifiers. (section 2.3.4). The amplitude is set by adjustment of VR1.

The input signal is buffered by op amp U1A before being passed to the isolation interface comprising U1B, U2, and U3A.

The buffer U1A and input side of the opto-isolator U2 are on the isolated side of the interface and are supplied from the isolated supply ±Vi.

The output side of the opto-isolator and all subsequent components on the board from this point are mains earth referenced and are supplied from the ±15V, +5V rails.

Unity gain transfer of signal across the isolation boundary is set up by adjustment of VR2. For adjustment procedure see Section 3.

Op amps U3B and U3C full wave rectify the signal before it is passed to the filter stages U3D, U4A, U4B.

U3D is a first-order prefilter.

U4A is a second-order low-pass filter with a cut-off frequency of 0.03 Hz.

U4B is a second-order low-pass filter with a cut-off frequency of 10 Hz.

Signals following the U3D, U4A path have all ac components removed except for those very low frequencies generated by type III signals. The output of U4A is thus essentially a positive dc voltage which only exhibits very slow changes in sympathy with changes in water depth, temperature and conductivity.

Signals following the U3D, U4B, path have all ac components removed except for those generated by type I, II and III signals. The output of U4B is thus essentially a positive dc voltage which in the absence of type I and II events is identical to the output of U4A and which changes in sympathy with U4A to type III signals. The bandwidth of this channel however is sufficient to accommodate type I and II signals which cause relatively rapid perturbations of the steady-state voltage level.

Signals from U4A and U4B are supplied as inputs to the instrumentation amplifiers U5, U6, U7. The amplifier has high differential gain and extremely low common mode gain; thus type III signals which essentially constitute a common mode input are rejected while type I and II signals undergo substantial voltage amplification. The output from U7 is thus near OV in the steady-state with positive and negative excursions from OV during type I and II events.

After the instrumentation amplifier stage the signal passes to a digitally-controlled attenuator U8. This attenuates the analogue input signal by an amount between 0 and 48db in steps of 0.375dB as determined by the CPU. Thus the signal is environmentally compensated. Details of the compensation mechanism are given later in this section.

The current output from U8 is converted to a voltage by U9 which also imparts a voltage offset to the signal before it is supplied to the analogue to digital convertor U10. (The convertor converts input signals in the range 0 to +2.5V. Offsetting the input by half scale (1.25V) allows the convertor to convert input bipolar signals to offset binary code. Thus the offset inserted by U9 should be 1.25V). The value of offset is fixed by the combination of R27 and VR3. VR3 allows fine adjustment to be made; the set up procedure is given later in this section.

The digital signal is output via the data bus to the CPU board. The data control words for the attenuator are relayed in the opposite direction along the data bus from the CPU board. U11, U12 and U13 provide address decoding to permit these data transfers.

The electrode interface board also provides compensation for event-related signals. For consistent performance the signal recorded for a given event should be constant under a wide range of environmental conditions. That is, a fish of a certain size should always produce a signal of a certain magnitude no matter what conditions of depth or temperature pertain.

The amplitude of the raw signal from the electrodes is greatly affected by environmental parameters. In fact for a given fish size the amplitude of signal at the centre electrode is determined by the bulk electrode resistances. High bulk resistances produce large amplitude signals and vice-versa. Thus signals must undergo a level of amplification dependent on the current value of bulk resistance.

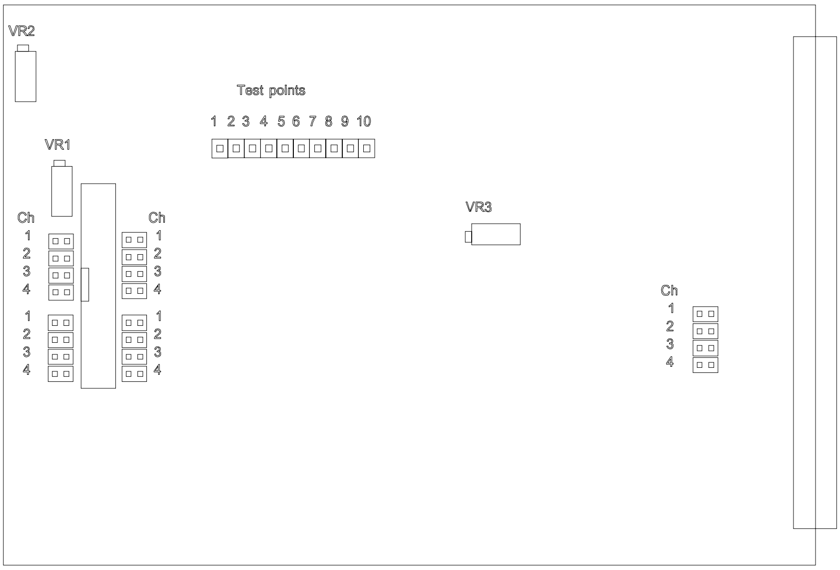
Gauging of the electrode bulk resistance is achieved by switching a known “dummy” resistance across the electrode pairs. This causes a signal, the amplitude of which depends on the bulk resistance values at this time. The gain of the signal path is then adjusted (with the digital attenuator) using a successive approximation technique until the signal reaching the CPU is of the appropriate amplitude for the dummy resistance used.

The CPU performs this function as a “background task” at half hour intervals. Implementation of this procedure endows the Logie counter with the following desirable features:

- All environmental changes affecting the counter sensitivity are accommodated in one operation.
- The integrity of the connections to the electrodes are checked regularly.
- The instrument is calibrated automatically 48 times a day; no user adjustments are necessary.

Normally a value of 2.7 KW is appropriate for the dummy resistance (Rs on the diagram). Only in circumstances where it is intended to count very small fish might this be an inappropriate value.

Rs is switched across centre and upper then centre and lower electrodes by relays RL1 and RL2. Current for these relays is provided by TR1 and TR2 which are driven by CPU OFF/ON commands supplied via decoder/driver U14.



Alignment procedure (Refer to figure 2.1)

1 Disconnect the electrode drive wires for all channels to be aligned and replace these with 12W resistors.

2 Using TP1 as a zero volt reference, monitor the signal on TP2 which should be a 3 KHz sinewave of amplitude 0.64V pk-pk. Amplitude adjustment is made using VR1.

3 Using TP10 as a zero volt reference, monitor the signal on TP4 which should be a 3 KHz sinewave of amplitude 1.28V pk-pk. Amplitude adjustment is made using VR2.

4 Monitor the DC level at TP9 which should be +1.25 Volts. Adjustment is made using VR3.

Note that if a board is to be replaced then the channel selection links of the new board should match that of the old.

2.4.3 CPU / front panel interface card

Refer to circuit diagram 2100-6012

This card provides all of the fundamental functional control for the instrument by means of a CPU executing EPROM-resident software.

The major components of the board are:

- Z80 CPU(6 MHz)
- 32K EPROM
- 32K RAM (battery backed)
- Real time clock (battery backed)
- DART
- Z80 PIO
- Keypad encoder

The functions provided by the card are :

- interaction with the user via the keypad and liquid crystal display
- automatic environmental compensation
- input signal ADC management
- output (chart) signal DAC management
- event interpretation
- updating of up and down counts
- maintenance of counts datalog (date and time, conductivity, channel number, direction, magnitude)
- control of relays
- management of remote control and printer ports
- scanning of the 4 X 4 keypad
- control of the intelligent “Supertwist” liquid crystal display

A single PIO is used to control both the display and keypad encoder.

The display has on-board control circuitry which simplifies its use; data has only to be presented to it via port A of the PIO and toggled by a control line on port B. The contrast of the display may be adjusted to obtain an optimum viewing level.

The keypad matrix is scanned by the keypad encoder which presents the binary equivalent of a keypress to port B of the PIO, along with an indication that data is available. The CPU polls the PIO regularly and reads the key data when required.

This board is not user adjustable or serviceable except for the LCD contrast potentiometer. In the event of the instrument developing a fault which is attributable to this board repair is effected by replacement only.

2.4.4 Rear panel interface card

Refer to drawing 2100-6011

The function of this card is:

- to operate the eight single pole normally-open relays and the four single pole changeover relays

- to convert event-generated signals into analogue form suitable for presentation to a chart recorder or data logger.

The card communicates with the CPU Card (Section 2.4.3) via the system backplane and has its address set by means of a jumper connected to address decoders U6 and U7.

A PIO, U5, is used to control the twelve relays via two Darlington drivers U3 and U4. The eight single pole normally-open relays are connected via port B, and the four single pole changeover relays are connected via port A.

Four chart recorder outputs are provided by quad DAC U2 and quad buffer amplifier U1.

The 10V reference for the DAC is supplied by a 10V zener diode connected to the +15V supply. The -5V supply required by the DAC is derived from the ±15V supply by voltage regulator U8.

The buffer amplifiers supply a low impedance output of maximum amplitude ±5V pk-pk. Users may choose to modify the output signal amplitude by inserting a suitable attenuation network of impedance not less than 1 KW.

2.4.5 Paged RAM (Optional)

Refer to circuit diagram 2100-6016

This optional card is used to expand the logging capability of the counter. Without this option, the standard memory resident on the CPU card is 16 KBytes, making the maximum number of logged events 2048. The RAM card however, can hold up to 16 memory chips, each of 32 KBytes, giving a total of 32 times the memory (and hence events) of the standard system. A fully expanded RAM board can therefore hold up to 65536 events. The jumper link on the board selects its address, and should not be changed.

If a counter without a RAM board is being upgraded, then jumper link J1 on the CPU board (diagram 2100-6012) should be changed to the opposite position, such that it connects the two pins nearest the edge of the board.

2.4.6 Environmental card

Refer to circuit diagram 2100-6030

Description of operation - general

This card provides for the acquisition of up to 16 channels of environmental data associated with the fish counting station.

Signals after acquisition and amplification are defined in the range 0 to +1V and are multiplexed by U7 before being supplied to the voltage to frequency converter U9. This converter is set to operate in the range 40 Hz to 4 KHz by choosing a C6 value of 47 nF. The full scale frequency corresponds to an input current of 1 mA which is derived from the 1V maximum voltage obtained from U7 by the setting of (R21+VR1) to 1 KW.

The signal in frequency form is relayed via the opto-isolator ISO2 to timer U8 where the signal information is converted to digital data for processing by the CPU.

The timer/counter device U8, uses the frequency signal to gate the system clock into a 16-bit counter. Since the value in the counter can be set and read under CPU control, the conductivity can therefore be determined from (a) the number of counts accumulated during a gate period, and (b) the number of counts that are known to correspond to 100mS. This latter value is measured during the half hourly alignment procedure.

The provision of opto-isolation for the signal, opto-isolation for the multiplexer address lines and the use of isolated power supplies (±VI,±VI5) provides the environmental channels with isolation from mains earth potential.

Description of Operation - Conductivity Channel

Estimation of water conductivity is made using a conductivity cell (Kent Industrial Measurements type 2023 or equivalent). For a cell constant K=1 water conductivities in the range 10 to 300 mS/cm produce a range of linearly-related resistances from 100 KW to 3.3 KW. Thus the conductivity of the water in which the cell is deployed can be estimated from measuring the resistance which appears across the cell electrodes. This can be done by applying a voltage across the electrodes and measuring the resultant current which flows between them. It is important that an AC rather than DC measurement is made so that electrochemical effects are avoided.

AC excitation for the cell (1.3 V rms, 3 KHz) is obtained from a quadrature oscillator comprising U1A, U1B, U1C and associated components. The drive signal is supplied to the cell via dc-blocking capacitor C4
and connector J1. An alternative load, switchable by the CAL RELAY is provided by R29, the purpose of this is described later.

The current flowing in the cell is sensed by R8. The voltage which appears across this resistor is amplified by instrumentation amplifier U4 before being supplied to the rms to dc converter U5. Amplitude and gain setting component values in the U1, U4, U5 chain are chosen so that the maximum signal at U5 output, corresponding to a conductivity of 300 mS/cm, is 1V.

The cell connection cable may be up to 100 m long and the signal current flowing in it may be of a very low value (13 mA). Thus the acquisition circuit is susceptible to interference pick-up. To protect against this risk the cable and signal points connected to it are screened with the screen maintained at a guard potential derived from the common mode potential presented to the instrumentation amplifier. The guard potential is imparted to the screen by the guard drive amplifier U1D, the output of which provides a low impedance
path for interference currents. Mains-earth referenced interference sources do not effect the conductivity channel because of its isolated nature.

As has been described, the water conductivity is estimated by measuring the flow of current through the water between the cell electrodes. However the capacitance of the interconnecting cable provides an alternative path for AC drive current. Thus the voltage appearing across R8 will be the resultant of the desired resistive current and an unwanted reactive current.

This potential error source is removed as part of the alignment procedure when a measurement of reactive current is made with the cell in air; its effect is then nullified by subsequent digital processing.

The alternative load resistor R29 previously referred to allows for self calibration of the conductivity channel. R29 has a high stability resistance of 10 KW, which is equivalent to a conductivity of 100 mS/cm and which should result in a frequency of 1334 Hz being produced by the V to F converter. Switching-in R29 allows the adjustment of VR1 to obtain this frequency, and this is performed as part of the pre-delivery alignment procedure. However this facility also allows a continuous check of conductivity channel drift to be made.

Every 30 minutes the CPU switches over to R29 and measures the V to F output frequency which results. This frequency measurement allows the gain drift of the channel to be compensated for automatically by using it as a standard for 100 mS.

Alignment Procedure

The major alignment of the oscillator is made before the board is shipped and consists of the adjustment of VR1 to obtain an oscillator frequency of approximately 1334 Hz. Additional compensation can be made to eliminate the effects of the reactive component (as mentioned above), using the extended command E3 - see section 1.4.4. This compensation removes the error due to the capacitance of the cable that is currently being used, and MUST be repeated if the cable is changed for any reason.

2.5 Front Panel

2.5.1 Display

The display is a 40 character by 2 row “Supertwist” display with on-board controllers and interfacing such that it may be connected directly to the bus of a four or eight bit microprocessor. The only adjustment possible is to the contrast, made using VR1 on the CPU board. Repair is by replacement only.

2.5.2 Keyboard

The keypad has 16 keys arranged in 4 by 4 matrix with the legends 0 to 9 and A to F. No part of this item is adjustable or serviceable, and repair is by replacement only.