2100C Logie Fish Counter

Operating and Technical manual

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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 its 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 PC or chart recorder (requires optional components) 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 counter’s 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 15-500 Ω.
- 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.
- The counter design is such as to mitigate against lightning strikes
- The counter requires a 24V, 2.3A DC source, which may be provided either from a mains DC power supply unit or heavy duty automotive battery.
- Indication of the counts recorded is available using a standard Personal Computer (PC) or "Palmtop PC" connected to the serial port on the front panel. The counts are resettable via the PC/Palmtop control software.
- The standard counter will store the date, time, channel, direction and size of fish signals detected, up to a maximum of 65536 total events. These data may optionally be printed on a local serial printer as they occur. They may also be downloaded via the PC mentioned above.
- The counter distinguishes between upstream and downstream movements of fish and stores each count separately.
- The counter can monitor up to four electrode sections simultaneously but independently and update 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 apart from the connection to a PC 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 can optionally provide 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.
- The counter is year 2000 compatible, although the year is only given as two digits, i.e. 1-February-2000 is stored as 01/02/00

1.2 Counter Description

1.2.1 Main Components

The fish counter comprises an instrument case containing:

- power supplies
- integral PCB rack with standard and optional printed circuit boards

front panel carrying

- electrode drive power supply LED indicators
- serial connector for control PC/Palmtop

rear panel carrying

- 24V DC power supply connector, ON/OFF switch and fuse.
- combined electrode, event relay and environmental transducer connectors
- serial data port to printer

In addition to the instrument, a separate mains power supply is normally provided.

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. The instrument is set up ready for use prior to delivery. Further adjustment should not be necessary, but in any case should only be undertaken by Aquantic Ltd or their approved agents.

Internal component details 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 pair of indicators which verify the condition of the electrode drive power supplies; a 9-pin serial connector for the controlling PC.

Primary control of the instrument is via the serial port (control port) which allows for control and interrogation either by local or remote computer.

1.2.3 Rear Panel Components

Situated on the rear panel are the following components

- 24V DC connector
- ON/OFF switch and fuse.
- multi-way terminal block for the purpose of connecting the counter to: the electrode array(s); the internal relays to subsidiary equipment; optional environmental monitoring transducers, e.g. conductivity.
- 25-way (RS232) socket for the purpose of connecting an optional serial printer

Connection details for the 2 RS232 sockets are as follows.

25-way (printer)

Pin 2	Transmitted data (from counter)
Pin 3	Received data (to counter - not used)
Pin 4	RTS (output)
Pin 5	CTS (input)
Pin 7	Ground

9-way (control)

Pin 2	Received data (to counter)
Pin 3	Transmitted data (from counter)
Pin 4	DTR (output)
Pin 5	Ground
Pin 7	RTS (output)
Pin 8	CTS (input)

The control port defaults to 2400 baud, and the printer port to 1200 baud but both may be changed independently via the 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. Unfortunately, this is now out of print, but it may be possible to obtain a copy from a technical library.

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 steelworks.

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 10Ω. 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 7mΩ/m. Applications of the Logie counter to installations near the 10Ω limit suggest a maximum cable run of 70m 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 External Connections

All external connections are via the screw terminal (Phoenix) connector blocks at the rear of the instrument. These are grouped as shown in Figure 1.1.

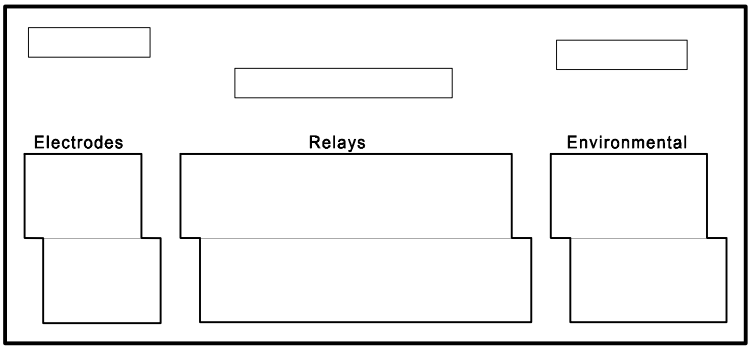

Figure 1.1 - Rear Panel connections

1.3.3 Electrode Connections

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 10Ω 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 12-way block at the rear of the instrument. (See figure 1.2)

2	4	6	8	10	12
E1 C	E2 U	E2 D	E3 C	E4 U	E4 D
E1 U	E1 D	E2 C	E3 U	E3 D	E4 C
1	3	5	7	9	11

Figure 1.2 - 12-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.

1.3.4 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 connector block at the rear of the instrument. Figure 1.3 gives details of the numbering of these terminals.

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 1.3 - 34-way Phoenix connector

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

1.3.5 Conductivity Probe Connections

The conductivity probe is connected to terminals 1, 2 and 3 of the 16-way connector block at the rear of the instrument, where the screen is connected to pin 2, the blue wire to pin 1, and the brown wire to pin 3. 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 emits a "beep" every second for 45 seconds. The time delay allows the internal circuitry to reach equilibrium. It then proceeds to calibrate up to four electrode sets and any optional conductivity probe. After this has finished, the software on the controlling PC may be executed and will attempt to establish communication with the counter.

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.

1.4.2 Command set

The controlling PC is used to set and/or display various parameters of the counter, a summary of which follows.

Continuous display of status	The PC may show a continuously updated display of counter status, including up/down counts, conductivity, buffer size etc.
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 or set from the controlling PC's built-in clock.
Time	The time of day may be entered as HH, MM, SS or set from the controlling PC's built-in clock.
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.
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.
Force Calibration	The counter may be forced to perform a calibration of all enabled channels.
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

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 (optional) 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

This counter is controlled via the CONTROL serial link (RS232) on the front panel. The commands are entered using the (supplied) controlling software. Two versions of this are provided: one for use with a remote PC via a modem; the other for use on a "Palmtop" PC or standard PC connected directly to the counter.

1.4.4 Command detail

If a command applies to the software for the **directly** connected PC **only** then it is marked ***(L)***; if it applies to the **remotely** connected PC **only** then it is marked ***(R)***. In the absence of either letter, the command is applicable to both versions of the software.

Set baud rates for communication with counter (L)
The user is prompted with *Control(C) or Printer(P)?* and should respond with the letter of the port whose speed it is desired to change. The counter will then ask for a new value, chosen from 300, 1200, 2400, 4800, 9600 or 19200. If the *Control* port is being changed, then the software will attempt to change the baud rate of the counter and re-establish communications at the new rate.

Set baud rates for communication with counter (R)
The user is prompted for the new baud rate, chosen from 300, 1200, 2400, 4800, 9600 or 19200. This is then used for subsequent communications - usually via a modem.

Interrogate counter and display its status (R)
The counter is interrogated and the current status displayed, including number of events, up/down counts, date and time, version number etc.

Continuously updated display of counter status (L)
This displays exactly the same information as the previous command except that the counter sends updated status information to the PC at regular intervals and on the occurrence of any change in status. It is primarily intended as a "front panel" for the counter when the PC/Palmtop is left permanently connected to the control port.

Show/download the information logged in the counter
This allows the events stored in the datalog to be displayed on the screen or stored in a file or both. The user is prompted for the number of events required and the destination. Optionally, a status dump of the counter may precede the data.

Insert a dummy fish
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 55 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 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 reduced.

Re-calibrate counter
If this command is chosen, then the counter will perform its calibration procedure, which normally occurs automatically every thirty minutes.

Log on, set or clear password
A simple password facility allows a four-digit code to be used to "lock" the counter. A password of 0000 effectively means no password is set. This command allows the user to *Log-in*, *Log-out* or *Change* the password.

Read the current conductivity
This gives a either a one-off or continuous display of conductivity in microsiemens per centimetre.

Send the counter a user defined command
This facility is intended for the advanced user and may be used to send the counter one or more (encoded) commands which may optionally be stored in a file. Details of the exact command formats are available from *Aquantic* on request.

Alter the date/time in the counter
The user may enter a new date and/or time manually, or the counter may be set to the date and/or time set on the controlling PC. (*System* date/time)

Set relay numbers and times
This allows the user to allocate relays to various conditions for individual channels. The user is first prompted to enter the channel number, then the condition (Up, Down or Event). The current relay allocation for that channel and condition is then displayed. The user is prompted to enter the numbers of up to two relays that are to be operated if this condition occurs and the time of operation. If a second relay is not required, then enter the letter D for the second relay number.

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.

Set new threshold values
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 a request to enter new values. If the user simply wishes to check the values for that channel then pressing *Enter* at this point ends the command.

Enable/disable the printer port on the counter
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, parity (even) and number of stop bits (one). In addition, the user can select whether the *pseudo-graph* output is enabled:

Pseudo-graph output
A pseudo graphical output has been made available via the printer port in addition to the standard chart recorder (analogue) output in order to be able to show the fish waveforms on a PC display. 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 at its normal sampling rate. A small example of the typical output might be as follows:

```
S 19/03/97 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 9600 in order that the counters internal buffer does not overflow and data is lost.

(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 IBM™ PC or compatible, fitted with CGA, EGA, VGA or Hercules™ graphics adapters.

(iii) To generate this type of output, the printer must be enabled, an event relay must be set for the required channel for a time greater than or equal to 4 seconds, and pseudo-graph output must be enabled.

Enable/disable event logging
It is possible for a signal to be detected which exceeds the pre-set 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.

Make the datalog buffer linear/circular/flushed
The buffer holding the logged counts and/or events may be set to either linear or circular mode, or cleared. The user is informed of the current setting and may then choose from *Linear, Circular* or *Flush*.

Change algorithm (fast/slow)
The fish discrimination algorithm built-in to the counter can take two forms: the *fast* version, which can count fish passing at a rate of up to one fish every 0.5s but which is more susceptible to false counts due to wind and waves; the *slow* version, which can only count fish passing at a rate of no more than one fish every two seconds, but which has better rejection of false counts.

Change maximum size (100/127)
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.

Clear the 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.

Continuous O/P On/Off
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.

Status dump On/Off
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.

Enable/disable a channel.
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 channel may then be enabled or disabled as required.

Change conductivity profile
A table of conductivity values are displayed on one row, and the corresponding gain compensations (in %) are displayed on the next with a top row giving the entry number. The user may then choose from *N(ew), D(efault), F(lat) or Q(uit):*
A predefined set of values may be used by pressing D or all values may be reset to 100% (the default when shipped) by pressing F. If any of the values need to be individually changed, then N should be pressed. The appropriate number from the top row should be entered and the value corresponding to that entry will be highlighted and the user allowed to enter a new value. This value can be greater than 100% to increase the gain, or less than 100% to decrease it. To change more values, press N again, or press *Enter* to exit and update the attenuations.

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.

Default conductivity setting or probe calibration
The operation of this command depends on whether the optional conductivity board has been installed. If it is

absent, then a "default conductivity" value may be entered, otherwise the following instructions apply.

The conductivity measurement may be calibrated to take into account the capacitance of the cable connecting the counter to the conductivity probe. The software 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.

Length/Depth of weir
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 asked for the channel number and then for the length and depth in cm. If no change is required then the *Enter* key should be pressed in response to the request(s) for new values.

Length compensation.
The electrode length compensation factor is entered in this section. The user is prompted for a length compensation factor (in % per metre). This is used, along with the electrode length, 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.

Dumb terminal for modem access (R)
This is used in the remote version to gain access to the modem in order to issue dialling commands and monitor call progress.

Hang-up the modem (R)
This instructs the **counter** to toggle the DTR signal on the control port so that the remote modem drops the line and terminates the call.

Toggle talk through mode (R)
In some circumstances it may be necessary to have more than one four-channel counter at a site, e.g. wide rivers with more than four sections to the weir. It is possible to "daisy chain" two counters by connecting the printer port of the first counter to the control port of the second one. This command permits commands to be transmitted through the first counter to the second and obviates the need for a second telephone line and modem for remote access.

Technical Description

2.1 Overview

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

rear panel carrying:

- 24V DC power supply connector, supply filter, ON/OFF switch and fuse.
- 24V DC-DC converter supplying ±12V isolated, +5V, to the instrument.
- rear panel board carrying surge limiting components and combined electrode, event relay and environmental transducer connector blocks
- serial data port to printer

integral PCB rack with standard and optional printed circuit boards:

- electrode drive board
- electrode interface board
- CPU board
- rear panel interface board
- optional environment board

front panel carrying:

- electrode drive power supply LED indicators
- serial connector for control PC/Palmtop

A detailed description of each of the major components is now given.

2.2 24V DC-DC Converter

This converter accepts a 24V DC input from a mains power supply or battery. It provides the regulated 5 volts required for the logic circuitry and the ±12V which is the source of the supply to that part of the analogue circuitry which interfaces with the fish-sensing electrodes and which is isolated from the rest of the analogue circuitry of the instrument. The 24V input is provided with a fuse to interrupt the supply in the event of the occurrence of high (fault) currents, and also a filter as a precaution against the export of instrument-generated switching signal components via the mains connection.

Because the converter is a sealed unit it is not possible to service it and no servicing information is included in this manual. A failure may be indicated by non-illumination of either or both of the power supply indicators on the front panel; in the event of failure the instrument should be returned to Aquantic Ltd.

2.3 Rear Panel Board

Refer to circuit diagram 2100-6120.

Interconnections between the instrument, the electrode array(s) and optional subsidiary equipment are made via ribbon cables from “D” terminals on the rear panel. The ribbon cables are terminated on (Phoenix) screw terminal blocks, clipped on a DIN rail on a subsidiary panel, which should be affixed to a vertical surface above and to the rear of the counter. This arrangement is designed to make access to the screwed signal connections easier for installation and servicing purposes.

Because the instrument is likely to be installed in a rural, outdoor environment, it is under substantial risk of damage by lightning. Strikes near the counter, as well as direct strikes, can cause damage, as the powerful magnetic field associated with the huge currents flowing to ground in the strike, induce damaging voltages in any associated wiring. Because of this risk, it is strongly recommended that transient suppression devices are used to intercept damaging transients on any signal or mains wiring connected to the counter. Provision is made on the subsidiary panel for the installation of lightning protection modules on the mains input connection and all electrode and conductivity connections. Aquantic Ltd can supply to order, a pre-wired subsidiary panel equipped with all necessary suppression. To be effective, the earth block on this panel must be securely earthed; the earth connection should be as short, direct and substantial as possible. A minimum earth conductor size of $6mm^2$ is recommended.

Figures 1.1 through 1.3 illustrate the detailed signal connections of the Phoenix connector.

Fig 2.1 illustrates a typical connection scheme for an instrument fitted with transient suppression

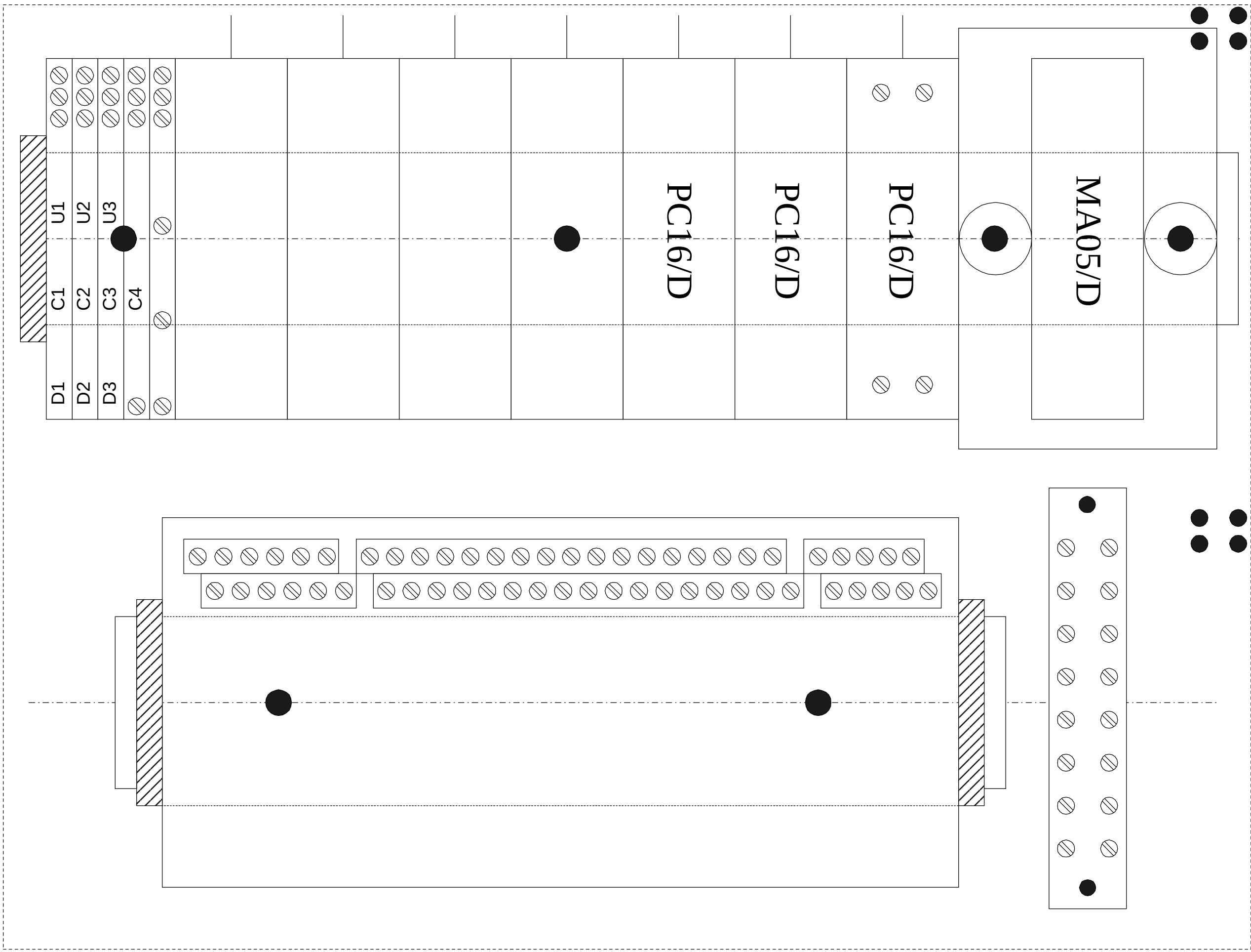

Figure 2.1

2.4 Integral PCB Rack

2.4.1 Overview

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

- Electrode drive board
- Electrode interface board
- CPU board
- rear panel interface board
- optional environment board

Boards are contained in a rack in which they engage the edge connectors of a backplane. This interconnects them with each other and with the power supplies. In addition, each interface board is connected via a ribbon cable to the appropriate input/output device e.g. the rear panel interface to the 34-way relay terminal block and the electrode interface to the 12-way electrode terminal block.

The functional description of each of these boards is now given.

2.4.2 Electrode Drive Board

Refer to circuit diagram 2100-6115

The main functional blocks contained on the PCB are

- DC-DC converter for the provision of the non-isolated ±12V supply
- Positive and negative series voltage regulators for the isolated electrode drive supplies
- The electrode drive oscillator
- The electrode drive amplifiers

The non-isolated analogue electronic circuitry of the instrument is powered from the ±12V supply provided from the on-board DC-DC converter; the converter is fed from the main 24V instrument supply via the low voltage sensing stages IC8 and IC9.

The drive signal to the detection electrodes is electrically isolated for the purposes of transient suppression and protection; thus all electronic circuitry immediately associated with the fish-sensing electrodes is operated from an isolated power supply. The isolated supply is obtained from the ±12V output from the rear panel DC-DC converter, regulated to ±8.25V by the series regulators IC6 and IC7 and associated components. Electrode drive supply indication is supplied to the front panel LED indicators via resistors R41, R42, zener diodes D22, D23 and connector J4. Additional transient suppression is provided by D19, D20, C8, C9; D1-D16.

The 3 kHz electrode drive oscillator is of the quadrature “sine-loop” type in which two integrators, IC5A and IC5B, are connected regeneratively. The output of the oscillator is supplied as an excitation source via the buffer IC5C to each of the electrode drive amplifiers; 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.

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

IC1 comprises two power op amps (sharing a common heat sink) connected in non-inverting and inverting modes. Thus the upstream (U/S) electrode is driven in phase with the drive oscillator and the downstream (D/S) electrode is driven in antiphase. (Note that both of these connections go via the rear panel board where they are transient-protected.)

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 R1, R2 and R3, R4 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 a 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 150Ω shunt resistors between U/S and centre and centre and D/S electrode connections, these resistors being sited on the electrode interface card (R49, R53).

The oscillator and amplifier signal levels are adjusted as part of a pre-delivery set-up procedure.

2.4.3 Electrode Interface Board

Refer to circuit diagram 2100-6110

Description of operation

The function of this board is

- to acquire signals from the electrode arrays
- to provide amplification and pre-processing 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 pre-processed and compensated signals so that they may be accepted by the CPU board for further digital processing.

Signal inputs to the board are from the centre electrodes. In the steady-state these signals are 3 kHz sinewaves of constant amplitude. Resistance changes at the electrodes cause amplitude modulation of these 3 kHz “carriers”; detection of the amplitude modulated carriers provide the basic signals 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 signals depends on the level of voltage drive obtained from the electrode drive amplifiers. (section 2.4.2). The amplitudes are set by adjustment of VR5-8 as part of a pre-delivery set-up procedure.

The signal acquisition and processing operation provided by the board may be explained by taking channel 1 as an example. The input signal is supplied via R1 to isolation amplifier IC1 which provides the boundary between the isolated and non-isolated sections of the instrument. R1 in association with diodes D! and D2 provide transient suppression for the centre electrode connection.

IC5 full wave rectifies and thereby detects the signal before it is passed to the filter stages IC9A, IC9B, and IC10B. IC9A is a first-order pre-filter. IC10A is a second-order low-pass filter with a cut-off frequency of 0.03 Hz. IC9B is a second-order low-pass filter with a cut-off frequency of 10 Hz.

Signals following the IC9A, IC10A path have all AC components removed except for those very low frequencies generated by type III signals. The output of IC10A 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 IC9A, IC9B, path have all AC components removed except for those generated by type I, II and III signals. The output of IC9B is thus essentially a positive DC voltage which in the absence of type I and II events is identical to the output of IC10A and which changes in sympathy with IC10A 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 IC10A and IC9B are supplied as inputs to the instrumentation amplifier IC17. 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 IC17 is thus very close to 0V in the steady-state with positive and negative excursions from 0V during type I and II events.

After the instrumentation amplifier stage the signal passes to a digitally-controlled attenuator IC21. 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 IC21 is converted to a voltage by IC15A which also imparts a voltage offset to the signal before it is supplied to the analogue to digital converter IC29. (The converter converts input signals in the range 0 to +2.5V. Offsetting the input by half scale (1.25V) allows the converter to convert input bipolar signals to offset binary code. Thus the offset inserted by IC15A should be 1.25V). The value of offset is fixed by the combination of R37 and VRi. VR3 allows fine adjustment to be made as part of the pre-delivery set-up procedure.

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. GAL1 and GAL2 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 kΩ is appropriate for the dummy resistance (R41-R48 on the diagram). Only in circumstances where it is intended to count very small fish might this be an inappropriate value.

R41 is switched across centre and upper then R45 across centre and lower electrodes by relays RL1 and RL2 respectively. Current for these relays as for the other channels is provided by IC25 which is driven by CPU OFF/ON commands supplied via latch IC26.

2.4.4 CPU Board

Refer to circuit diagram 2100-6112

This board 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
- 544K RAM (battery backed)
- Real time clock (battery backed)
- DART

The functions provided by the board are :

- interaction with the user via local or remote computer.
- automatic environmental compensation
- input signal ADC management
- optional 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 control and printer ports

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

2.4.5 Rear Panel Interface Board

Refer to circuit diagram 2100-6111

The function of this board 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 (option only).

The board communicates with the CPU board (Section 2.4.4) 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 optionally 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 kΩ.

2.4.6 Environmental Board (Optional)

Refer to circuit diagram 2100-6130

This board allows the water conductivity at the fish counting station to be measured.

Description of Operation

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 μS/cm produce a range of linearly-related resistances from 100 KΩ to 3.3 KΩ. 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 that 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 IC10A, IC10B, IC10C and associated components. The drive signal is supplied to the cell via DC-blocking capacitor C5 and connector J3. An alternative load, switchable by the CAL RELAY is provided by R1, the purpose of this is described later.

The current flowing in the cell is sensed by R2. The voltage, which appears across this resistor, is amplified by instrumentation amplifier IC1 before being supplied to the rms to DC converter IC2. Amplitude and gain setting component values in the IC10, IC1, IC2 chain are chosen so that the maximum signal at IC2 output, corresponding to a conductivity of 300 μS/cm, is 1V.

The conductivity-dependant voltage signal is supplied to the voltage to frequency converter IC3 which is set to operate in the range 40 Hz to 4 kHz by choosing a C1 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 IC2 by the setting of (R121+VR1) to 1 KΩ.

The signal in frequency form is relayed via the opto-isolator IC4 to timer IC5 where the signal information is converted to digital data for processing by the CPU.

The timer/counter device IC5 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 100μS. This latter value is measured during the half hourly alignment procedure.

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 μA). 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 IC10D, 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 R2 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 R1 previously referred to allows for self calibration of the conductivity channel. R1 has a high stability resistance of 10 KΩ, which is equivalent to a conductivity of 100 μS/cm and which should result in a frequency of 1334 Hz being produced by the V to F converter. Switching-in R1 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 R1 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 μS.

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 **Default conductivity setting or probe calibration** command - 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.

Transient Suppression

The provision of opto-isolation for the signal and the use of isolated power supplies allows the conductivity transducer and associated circuitry to be isolated from the rest of the instrument. This is for the purposes of transient suppression and protection. Additional transient suppression is provided by R3, R4, D1, D2, D3, D4; D11, D12; D7, D8, C9, C10.