

**ECHO CANCELLER TESTER**  
**ECT-1**  
**Technical Reference Manual**

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# 1. INTRODUCTION

## *CONTENTS*

## INTRODUCTION

### THE IMPORTANCE OF THE G.168 STANDARD

Standards have a major role to play in any field or industry where products or components from one manufacturer have to inter-work or be compatible with those of another. The importance of standards in telecommunications has long been recognized, and has become increasingly vital in recent years due to the massive growth in international communications, and the rapid pace of technological change.

The G.168 Recommendation defines requirements for the objective performance of echo cancellers, and compliance with this standard is an important step towards ensuring that echo performance on long-distance connections meets the expectations of modern-day customers. Compliance with G.168 should ensure satisfactory performance of the echo canceller with respect to the following:

- rapid convergence;
- low returned echo level during single-talk;
- low divergence during double-talk;
- assured double-talk detection;
- proper operation and behaviour during facsimile and voice-band data transmissions.

Echo cancellers are one of the key elements aimed specifically at improving the quality of network connections. With the explosive growth in the world telecommunication market and resulting intensity in competition between telecom companies, the emphasis on network quality has never been greater. Complying with the G.168 standard has therefore assumed considerable importance, for network operators and equipment manufacturers alike.

### THE ECHO CANCELLER TESTER

With so many different types of echo canceller on the market, there is inevitably a varying degree of conformance to the ITU specifications. With the new benchmark of G.168 established there is now an obvious need to test existing and future echo cancellers against it. Accordingly, DSPG Ltd. has developed an Echo Canceller Tester, the *ECT-1*. Based on DSP technology, the tester achieves accurate and repeatable results by implementing all G.168 test procedures digitally. Signal injection and monitor points are provided, allowing analogue measurements to be made if desired.

It will be possible to upgrade the tester to perform G.168(2000) tests when this forthcoming ITU Recommendation is published.

As the tester has its origins in DSPG's network emulation technology, it can also be used for subjective assessment of an echo canceller's performance in combination with selected hybrid models and values of network delay. Additionally, there are equipment options that allow low bit rate coding standards such as the GSM codec to be included in the emulations.

### ORGANIZATION OF THIS MANUAL

For a new user, the early sections of this manual are best read in their order of presentation. However, as far as practical, each section of the manual can be read without having to make reference to other sections. Therefore, if a user wishes to operate the tester only in its objective testing mode, there is no essential need to read or refer to the section on the subjective evaluation mode (and vice versa).

A very brief outline of the contents of each section is given below.

#### 1. Introduction

(This section.)

#### 2. General Overview

Overview of hardware and software implementation, and of the basic method of operating the *ECT-1*.

### 3. **Getting Started**

Straightforward instructions on how to perform a quick check on the *ECT-1* without connecting an echo canceller.

### 4. **Connecting an Echo Canceller**

Full details of how to make the connections between the *ECT-1* and an echo canceller.

### 5. **Subjective Evaluation Mode**

How to use the facilities of the *ECT-1* in its subjective evaluation mode.

### 6. **Objective Testing Mode – G.168**

How to run G.168 objective tests on the *ECT-1*.

### 7. **Objective Testing Mode – G.168(2000)**

How to run G.168(2000) objective tests on the *ECT-1*.

### 8. **Verification Procedures**

Suggested methods to verify the accuracy of the signal levels and delays generated by the *ECT-1*, and the accuracy of the level measurement procedures.

### 9. **Troubleshooting**

Help in identifying the meaning of status indicators and error messages. Possible reasons for unexpected test results.

### 10. **Optional Modules**

Description of software and hardware modules that are not supplied as standard items with the *ECT-1*.

### 11. **Specification**

Technical Specification Summary for the *ECT-1*.

### 12. **Appendix A Measurement Software**

Outline of the methods used in the *ECT-1* for RMS measurements, and for estimating the convergence time of the echo canceller under test.

### 13. **Appendix B The G.168 Echo Path Model**

Description of the *ECT-1* implementation of the echo path defined in G.168.

### 14. **Appendix C Special Modes of Operation**

Description of how a single E1 or T1 echo canceller unit is used in the emulation of a complete connection.

How the chosen hardware configuration simplifies testing of bi-directional echo cancellers, and allows easy performance comparison of two or more echo cancellers.

### 15. **Appendix D Cabling**

Pin-outs and cables for the *ECT-1* control interface to the echo canceller. Cables for the PCM interface.

### 16. **Appendix E DS PCM1 Card**

Description and technical specification of E1 and T1 PCM interface card.

### 17. **Appendix F DS 32C Card**

Description and technical specification of DSP32C digital signal processing card.

### 18. **Appendix G DS 2181 Card**

Description and technical specification of ADSP2181 digital signal processing card.

### 19. **Appendix H DS AD2 Card**

Description and technical specification of high quality A/D D/A card.

### 20. **Appendix I Single-Board Computer**

Technical specification of SSC-5x86HVGA single-board computer.

## **2. GENERAL OVERVIEW**

### ***CONTENTS***

# GENERAL OVERVIEW

## OVERVIEW OF HARDWARE IMPLEMENTATION

The principal functions of the *ECT-1* hardware are to emulate aspects of the telephone network required for the tests, to provide send/receive and control interfaces to the echo canceller under test, and to provide PC control and storage facilities for configuring the system and running the test software. Analogue interfaces are also included for monitoring purposes, or for subjective evaluation of canceller performance.

The hardware is housed in either a portable 3U case or a 19" rack, and consists of several DSP boards, two E1 or T1 interface boards, a TTL multiple I/O board and a Single Board Computer (SBC) with a hard disk drive (HDD). The system is based on the industry standard ISA bus. A block schematic is shown in Figure 2-1.

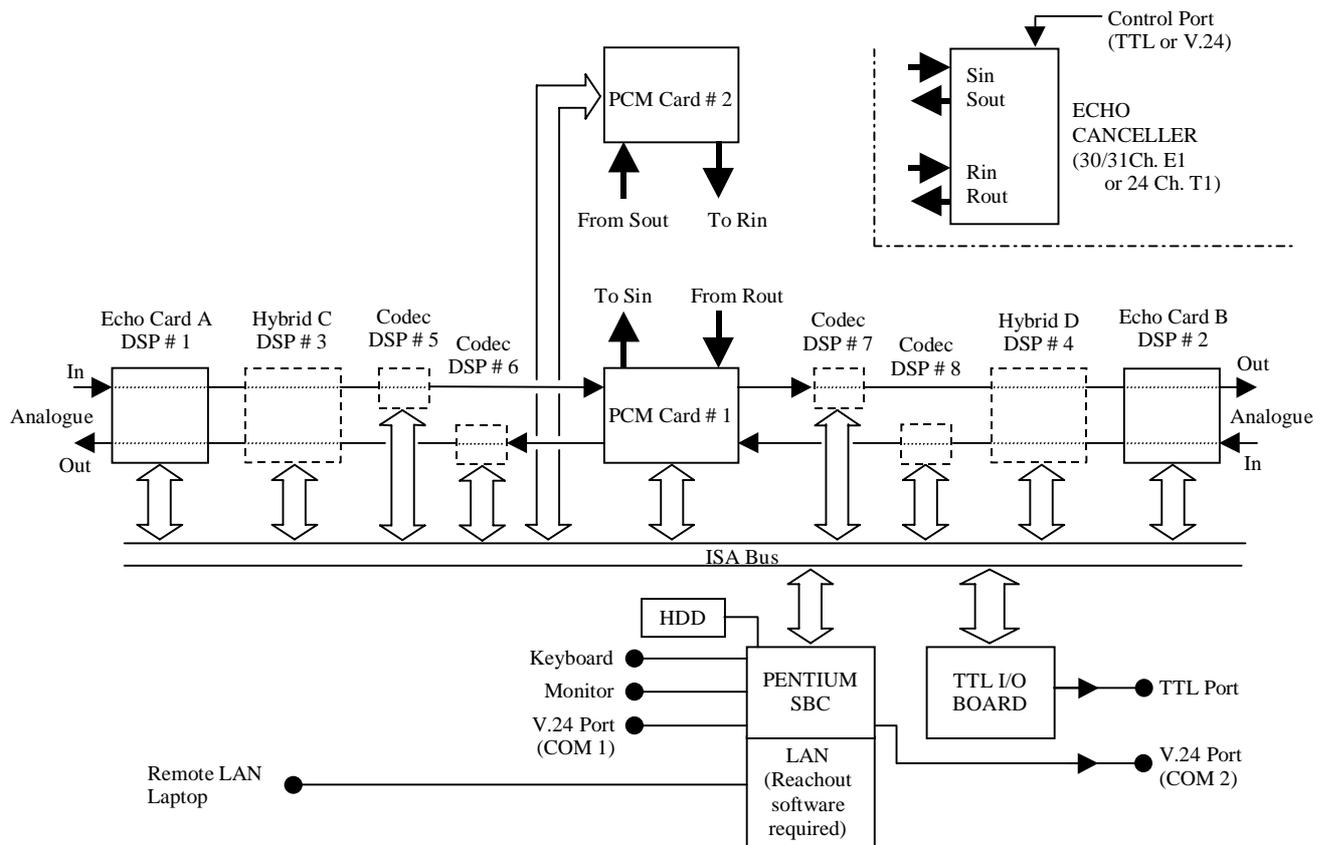


Figure 2-1. Schematic of ECT-1 Hardware

All cards are proprietary, with the exception of the SBC. Regarding the latter, it will be possible to keep pace with technology by upgrading to a card with higher specification in the future (consult with DSPG).

Specific features of the tester are implemented by the on-board Field Programmable Gate Arrays (FPGAs). Under PC control, the application programs are downloaded into the DSP memories and the system configuration files are downloaded into the FPGAs. If any changes are required in the future to either the firmware or software of the *ECT-1*, these changes would only require software upgrades on the PC.

Figure 2-2 shows the front panel of the *ECT-1*. The I/O ports of the echo canceller under test are connected to the unit via two input and two output PCM sockets in the 'PCM I/O' section of the instrument front panel. Either E1 or T1 interfaces are available, and use separate connectors. Note that connector labelling for this section of the front panel uses the names commonly assigned to the echo canceller I/O ports. Thus "FROM R out" is an *input* to the *ECT-1*, and "TO R in" is an *output* from the *ECT-1*, etc.

The control port of the echo canceller under test is connected to the V24 or the TTL D-type socket (as appropriate) on the front panel of the tester ('Echo Cancellor Control' section).

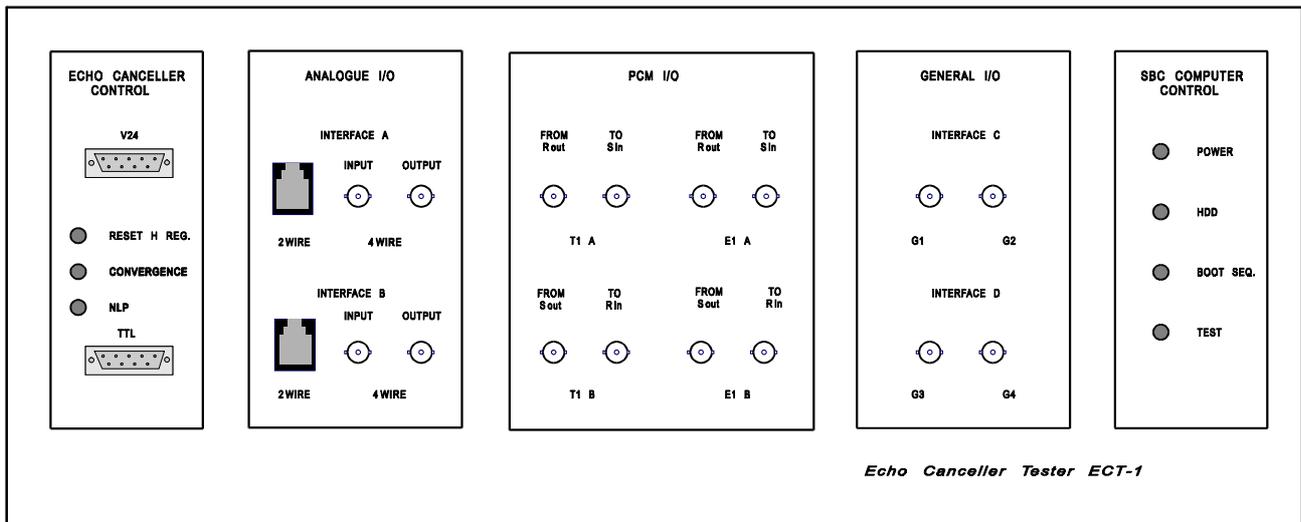


Figure 2-2. The ECT-1 Front Panel Layout

Two analogue inputs and two analogue outputs are also available on the front panel of the ECT-1 ('Analogue I/O' section) and can either be used for monitoring or for direct connection to the four-wire TEL-4 telephones. Connectors labeled "INPUT" are inputs to the ECT-1 (i.e. *not* inputs to the TEL-4 telephones). Similarly, connectors labelled "OUTPUT" are outputs from the ECT-1.

Also in the 'Analogue I/O' section of the front panel there are two RJ11 sockets, currently unused.

For any future upgrades there are two uncommitted interfaces 'C' and 'D' in the 'General I/O' section of the front panel. A high quality A/D D/A card is available as a hardware option, and the I/O to this card is via the C and D interfaces.

To operate the unit, either an external keyboard, mouse and monitor should be connected, or the ECT-1 can be operated from an external host computer via the built-in Ethernet interface using software packages such as 'Reach Out' and 'PC Anywhere'. (The communication software is not supplied by DSPG.)

## OVERVIEW OF SOFTWARE IMPLEMENTATION

In addition to the programs and files necessary to configure the system, the ECT-1 software includes a Windows-based package designed to perform the ITU G.168 test suite when used in conjunction with the ECT-1 hardware. The software allows the user to configure and set up each parameter of the testing procedures. Any test or sequence of tests may be selected, and may be run completely automatically without any user interaction.

The ECT-1 controls the echo canceller parameters (Convergence, H register, and NLP), generates all of the test signals, measures the output and processes the results. At the end of the test session, the user is able to check the results using either the graphic viewer or by printing out a detailed report. Graphical results can easily be transported to a report or document being prepared by the user (after modifying the display format if desired). The format of the results is compatible with Microsoft Excel.

The ECT-1 software is designed to run in a Windows 95 environment, and a backup of the entire Windows 95 operating system is contained in directory C:\WIN95 on the ECT-1 hard disk drive.

Available as an option, there is a version of the software available (the 'Viewer' software) that has useful functionality without being connected to the ECT-1 hardware. Using this software, the data from a previous test session can be processed on a separate computer, and the results examined. By archiving testing sessions, the results for different echo cancellers may be compared using any PC as a notebook.

## OVERVIEW OF BASIC OPERATION

The ECT-1 echo canceller tester has two separate modes of operation - objective and subjective. In objective mode the unit performs the G.168 test suite (fully automatically if desired), processes and stores the results, and allows the

results to be viewed or printed in either numerical or graphical format. In subjective mode the unit allows conversational evaluation of an echo cancellers performance, and permits parameters of the emulated network connection such as echo loss and delay to be varied even while the test is in progress. There is also an option to install codecs (such as the GSM codec) and complex hybrids in the emulated connection.

In most respects, the connections to be made to the *ECT-1* are the same for both objective and subjective modes of operation. However, the V24 or TTL control link to the echo canceller is only essential for the objective test mode. Similarly, the two *TEL-4* telephones (or equivalent) need only be connected when the *ECT-1* is used in the subjective mode, (although the telephones are often useful for monitoring purposes even in the objective test mode).

When the unit is powered-up and Windows 95 has loaded, the *ECT-1* initialization software is loaded automatically, and the 'Scenario Control Utility' window is displayed on the monitor screen. In addition, a selection of icons will appear on the *desktop* area of the display. The Scenario Control Utility enables certain configuration operations to be performed before using the *ECT-1* in either its objective or subjective mode. To reset the hardware at any time, the Scenario Control Utility window should be closed by the user, and then re-loaded using one of the desktop icons (the 'HW\_setup' icon).

A brief summary of the purpose of all the desktop icons is given below, but the reader must refer to subsequent sections of this manual for full details of how to operate the *ECT-1*.

- **HW\_setup:** Hardware set-up. Double-click on this icon to initialize the cards in the *ECT-1*, and to display the 'Scenario Control Utility' window.
- **Autodet:** Double-clicking on this icon presents a window displaying the base addresses in hexadecimal (jumper settings) of all DSP and PCM I/O cards in the unit.
- **Tester:** Double-click on this icon to use the *ECT-1* to perform G.168 objective tests. (These tests use an echo path model with three simple branches.)
- **Tester\_2000:** Double-click on this icon to use the *ECT-1* to perform G.168(2000) objective tests. (These tests use a complex hybrid model (Hybrid C)).
- **EchoA:** Double-clicking on this icon displays a dialogue box that allows control of the echo path (G.168 echo model) at one end of the connection. This facility is used during subjective tests, and certain of the verification tests described in this manual. Other facilities such as sidetone level and playback of stored signals are also accessed via this dialogue box.
- **EchoB:** As for *EchoA*, but at the other end of the connection.
- **HybridC:** If the necessary DSP card is fitted, double-clicking on this icon displays a dialogue box that allows control of the parameters of a complex hybrid model at one end of the connection (the same end as *EchoA*). This facility is used during subjective tests. (Hybrid C is also used when performing G.168(2000) objective tests.)
- **HybridD:** If the necessary DSP card is fitted, double-clicking on this icon displays a dialogue box that allows control of the parameters of a complex hybrid model at one end of the connection (the same end as *EchoB*). This facility is used during subjective tests.
- **CalibrateA:** Calibration utility for high quality A/D D/A at end A.
- **CalibrateB:** Calibration utility for high quality A/D D/A at end B.

As an alternative to using the desktop icons, each program can also be accessed via the Windows 95 'Start' menu. Click the 'Start' button, point to 'Programs', point to 'DSPG ECT-1', and click on the desired program in the displayed list. The individual programs have the same names as the desktop icons. (Note that throughout the rest of this manual, it is assumed that the programs are accessed by means of the desktop icons rather than the 'Start' menu, but the user can use either method.)

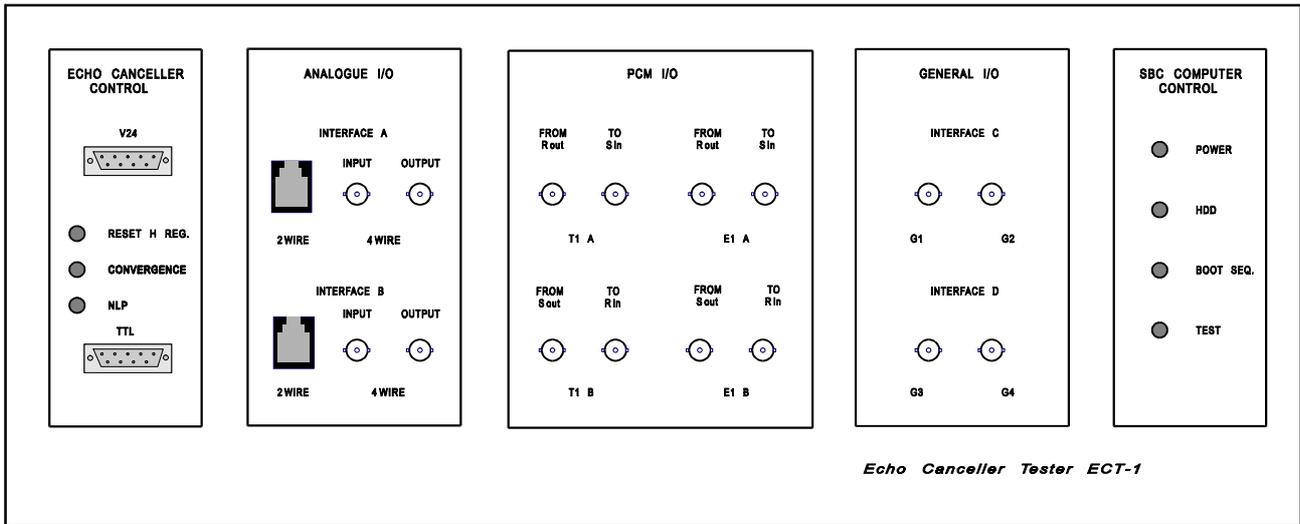
## UPGRADEABILITY

The *ECT-1* software will be upgraded to follow progress in the G.168(2000) specification. Users who enter into a maintenance agreement with DSPG will receive upgrades via the Internet.

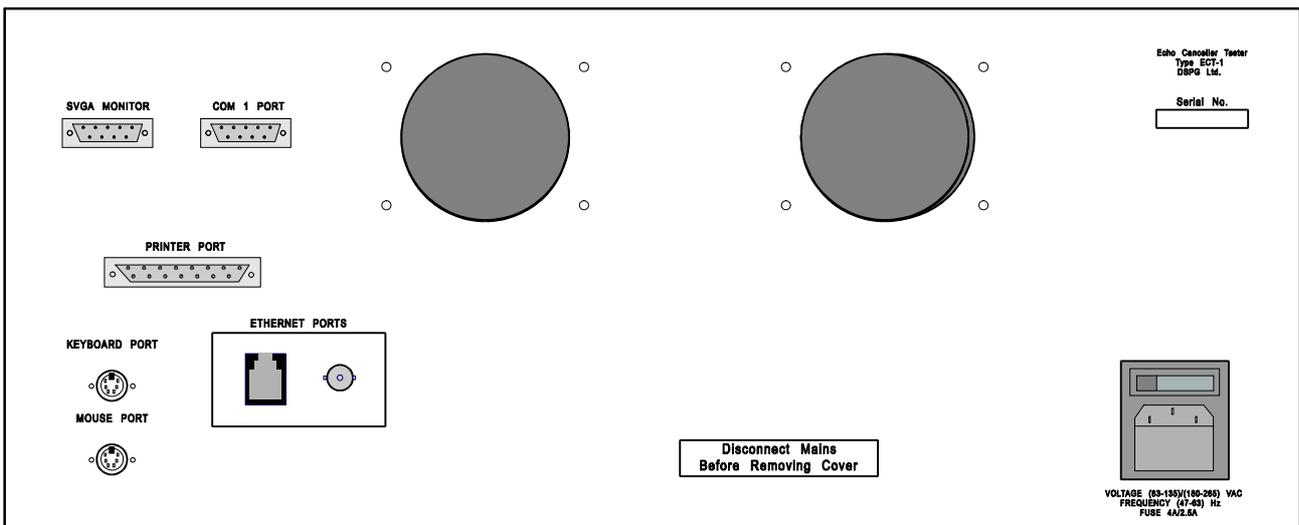
## **3. GETTING STARTED**

### ***CONTENTS***

## GETTING STARTED



*Figure 3-1. The ECT-1 Front Panel Layout*



*Figure 3-2. The ECT-1 Back Panel Layout*

## QUICK START AND TEST

The purpose of this section is to enable the user to perform a quick check on the basic hardware and interfaces of the *ECT-1*. The described test is useful, for example, to confirm that no damage has occurred in transit following delivery or other transport of the equipment. If the test suggests a problem, the cause is more easily identified due to the simplicity of the external connections. As no echo canceller is involved in the test, this eliminates one potential source of the problem.

After making the physical connections and following the instructions for initializing the cards in the *ECT-1*, it should be possible to converse using the two *TEL-4* telephones.

- Connect a *TEL-4* telephone to the four-wire analogue input/output of Interface A on the front panel of the *ECT-1* ('Analogue I/O' section). (Take care to ensure that the 'INPUT' of the *ECT-1* is connected to the 'OUT' socket of the *TEL-4* and that the 'OUTPUT' of the *ECT-1* is connected to the 'IN' socket of the *TEL-4*.)

- Similarly connect a second *TEL-4* telephone to interface B. (The *TEL-4* telephones are used during subjective tests, and can be used for monitoring purposes during objective tests.)
- Connect an external monitor, keyboard and mouse to the appropriate ports located on the back panel of the *ECT-1*. (Note that the *ECT-1* can also be controlled from an external host computer using an Ethernet link and software packages such as 'Reach Out' and 'PC Anywhere'. This software is not supplied by DSPG.)
- The *ECT-1* unit may be fitted with either E1 (Europe) or T1 (North America) PCM interface cards, or it may optionally be equipped with both E1 and T1 interfaces. Do not connect an echo canceller for this test, but make the following direct connections on the *ECT-1*:

Using the E1 Interface

Connect the BNC sockets located in the 'PCM I/O' section of the *ECT-1* front panel in the following manner:

- Link "From S out" (E1 B) and "To S in" (E1 A) using a BNC-to-BNC cable.
- Then link "From R out" (E1 A) and "To R in" (E1 B) using another BNC-to-BNC cable.

Using the T1 Interface

Connect the BR2 sockets located in the 'PCM I/O' section of the *ECT-1* front panel in the following manner:

- Link "From S out" (T1 B) and "To S in" (T1 A) using a BR2-to-BR2 cable.
- Then link "From R out" (T1 A) and "To R in" (T1 B) using another BR2-to-BR2 cable.

Note: In response to feedback from current users, there are plans to use RJ45 connectors in preference to BR2 connectors in future production of the *ECT-1*.

**Initializing Cards in the ECT-1 Unit**

- Plug the unit into the mains and switch it on using the switch on the rear panel. In the 'SBC Computer Control' section on the front panel, the 'Power' LED will light up and the 'HDD' LED will blink, indicating that Windows 95 is loading.
- If a Network Card is installed in the *ECT-1*, a window titled 'Enter Network Password' will appear. Click on 'Cancel' to proceed.
- Next, the front panel 'Boot Seq.' LED will illuminate indicating that the initialization software is loading. A selection of icons will appear on the monitor screen, and the 'Scenario Control Utility' window will be displayed (Figure 3-3).

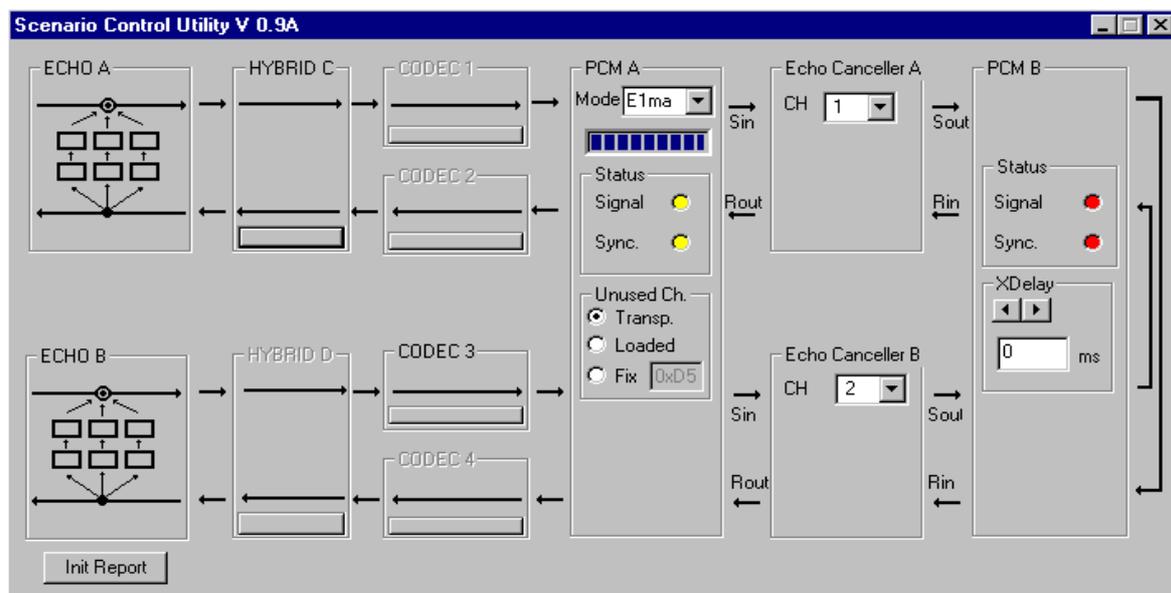


Figure 3-3. The Scenario Control Utility

- Examine the 'PCM A' box, which is near the centre of the Scenario Control Utility window. Wait until the Progress Bar has completely lit. (The Progress Bar is near the top of the 'PCM A' box, and is shown fully lit in Figure 3-3.)
- It is now necessary to select the appropriate E1 or T1 interface according to the interface cards fitted in the *ECT-1*, and the links made on the front panel. In the 'PCM A' box of the Scenario Control Utility window, use the interface selection facility to select 'E1ma' or 'T1ma' (as appropriate) from the drop-down list.  
[Note: There are two types of timing mode: selecting the master mode, 'E1ma' or 'T1ma', the PCM reference timing is provided by the *ECT-1* unit; the slave mode, 'T1sl' or 'E1sl', is used when the reference timing is to be provided by the echo canceller.]
- At this stage, the two 'Signal' and two 'Sync' lights in the Scenario Control Utility window should all be yellow, indicating that the hardware set-up is configured properly. If any are red, this indicates there is a faulty connection to the front panel 'PCM I/O' section of the *ECT-1*.
- If the 'Signal' and 'Sync' lights are all yellow, it should be possible to converse using the two *TEL-4* telephones.
- The Scenario Control Utility will detect which cards the user may activate in the *ECT-1* unit. The presence of Hybrids C and D or Codecs 1-4 will be indicated by bold lettering in the Scenario Control Utility window and, if present, they may be switched in or out using the buttons below each of them.
- To view the status of the DSP and PCM cards, click on the 'Init Report' button in the bottom left-hand corner of the Scenario Control Utility window. All lines of the report should be commented "OK". Three lines will be displayed per card, and they will be similar to the following:
  - OK: blanking DSP32C card 80MHz (C) at 210...
  - OK: loading LCA DSP32C card 80MHz (C) at 210...
  - OK: storing DSP32C card 80MHz (C) at 210...
- Note: Whenever the Scenario Control Utility window is loaded, the *ECT-1* hardware configuration is reset to its default status. For this reason it is best not to close the Scenario Control Utility window during a test session, since the hardware configuration will be reset to the default status if it is subsequently necessary to re-load the Utility. Rather than closing the window, simply minimize it.

## **4. CONNECTING AN ECHO CANCELLER**

### ***CONTENTS***

## CONNECTING AN ECHO CANCELLER

This section describes how to make the physical connections between the echo canceller and the *ECT-1*.

It is also necessary to ensure that the echo canceller set-up is compatible with the *ECT-1*. The *ECT-1* allows the selection of either an E1 or T1 interface by means of the Scenario Control Utility. This Utility also allows the user to select whether the *ECT-1* or the echo canceller supplies the reference timing. However, regarding other aspects of the E1 or T1 interface, the user should check that the echo canceller set-up corresponds to that of the *ECT-1*.

The Default set-up of the *ECT-1* E1 Interface is as follows:

- CCS signalling (i.e. 30 channel mode), no CRC4 multi-framing, HDB3 line coding.

Note 1: It is possible to put the *ECT-1* into CAS (31 channel) signalling mode by using the 'Advanced' page of the configuration options for objective testing (see "*Configuring the Test Session*" in section 6).

Note 2: In a future release of the tester, it is planned that all aspects of the E1 interface will be configurable at the *ECT-1*.

- The *ECT-1* provides the reference timing from both PCM cards, using an internal source, i.e. it is not using the recovered clock as a reference. (The echo canceller may be selected to provide the reference timing via the Scenario Control Utility window.)

The Default set-up of the *ECT-1* T1 Interface is as follows:

- 12-frame superframe format - 193S (D4), B8ZS line coding and the Network Interface mode as per FCC part 68, option A.
- The *ECT-1* provides the reference timing from both PCM cards, using an internal source, i.e. it is not using the recovered clock as a reference. (The echo canceller may be selected to provide the reference timing via the Scenario Control Utility window.) At present the *ECT-1* does not control or support the signalling bits of the superframe.

Note: If the interface is configured incorrectly in any respect, in operation this will normally be detected by the Scenario Control Utility and flagged to the user; (for further details, refer to section 9, "*Troubleshooting*").

Once the echo canceller set-up is completed, connect the canceller to the appropriate E1 or T1 inputs/outputs of the *ECT-1* in the following manner:

- When using the E1 interface, the cable to be used should be a standard coaxial cable (75 ohm nominal impedance).
- When using the T1 interface, the cable to be used can be a standard twisted-pair type (100 ohm nominal impedance).
- Connect the 'From Sout' socket on the front panel of the *ECT-1* to the 'Sout' connector of the echo canceller using a suitable cable link (see above). In the same way, connect the 'From Rout' socket to the 'Rout' connector, the 'To Sin' socket to the 'Sin' connector, and the 'To Rin' socket to the 'Rin' connector.
- If the user should wish to connect a third party E1 or T1 interface board to the *ECT-1*, it should be noted that
  - the socket 'From Rout' is the E1 or T1 input to the *ECT-1*
  - the socket 'To Sin' is the E1 or T1 output from the *ECT-1*.

To be able to perform G.168 objective tests, it is also necessary to connect the control port of the echo canceller under test to the appropriate control socket on the *ECT-1*. As this interface may be either V24/RS232 or TTL, the user should check the echo canceller specification to determine which is used. Appendix C, "*Cabling*", provides details of cables and connectors for these interfaces.

For echo cancellers using V24/RS232 control:

- Connect the 'V24' D-type connector located in the 'Echo Canceller Control' section on the front panel of the *ECT-1* to the appropriate port on the echo canceller.

Note: The 'V.24' connector on the front panel of the *ECT-1* is the COM2: port of the single-board computer. Alternatively, the COM1: connector (located on the back panel) may be used instead (see "*Configuring the*

*Communication Protocol*" in section 6). The flexibility to use either connector may be useful when conducting comparative tests on two different echo cancellers (see Appendix C).

For echo cancellers using TTL control:

- Connect the 'TTL' D-type connector located in the 'Echo Cancellor Control' section on the front panel of the *ECT-1* to the appropriate port on the echo canceller.

Note: Alternatively, the PC printer port (located on the back panel of the *ECT-1*) may be used instead (see "*Configuring the Communication Protocol*" in section 6). The flexibility to use either connector may be useful when conducting comparative tests on two different echo cancellers (see Appendix C).

## **5. SUBJECTIVE EVALUATION MODE**

### ***CONTENTS***

## SUBJECTIVE EVALUATION MODE

### INTRODUCTION

The *ECT-1* has a mode of operation that allows echo cancellers to be subjectively evaluated in an emulated connection. For this use, it is crucial to have flexible and accurate control of the emulated echo paths. Windows-based software has been written for this purpose, and is designed to be quick and easy to use while remaining powerful and accurate. The software allows real-time control of all the parameters of the echo paths, separately for the two ends of the emulated connection. The standard echo path model supplied with the *ECT-1* is based on the 3-branch model of the G.168 Recommendation.

Connecting the *ECT-1* with *TEL-4* telephones allows a full range of subjective tests to be performed.

### UPGRADE OPTIONS

#### *Complex hybrid:*

In addition to the standard echo path model supplied with the *ECT-1*, a second model is available as an option, and is based on the complex hybrid model of the forthcoming G.168(2000) Recommendation. Further information on this option is given in section 10, “*Optional Modules*”.

The complex hybrid model can be configured as the sole echo path, or it can be used together with the standard echo path model such that both models contribute to the total echo.

#### *Low bit rate codecs:*

A simple hardware upgrade of the *ECT-1* allows GSM encoding/decoding to be selected. The user may then perform subjective tests in a GSM environment. Software for other codecs is available from DSPG (see section 10, “*Optional Modules*”).

Details of how to enable/disable codecs is given below in the “*Scenario Control Utility*” sub-section.

#### *High quality A/D D/A:*

As an alternative to the standard 14-bit linear analogue-to-digital conversion used in the *ECT-1*, a high quality 16-bit A/D D/A may be added. Use of the high quality A/D D/A card ensures that subjective opinions or analogue measurements do not suffer the unwanted effects of lower quality A/D D/A conversion.

(Due to clock synchronization considerations, presently, **the optional high quality A/D D/A card can only be used when the PCM I/O interface is configured for the E1 mode of operation and the *ECT-1* is providing the reference timing.**)

When the *ECT-1* is configured to use the high quality A/D D/A, the analogue input and output connections to the *ECT-1* must be made to the ‘General I/O’ section of the instrument’s front panel. (For the standard 14-bit A/D D/A, the connections are made to the ‘Analogue I/O’ section of the front panel.)

The ‘General I/O’ section of the front panel contains four connectors. Two of the connectors represent the I/O interface at one end of the emulated connection (‘Interface C’), and the other two connectors represent the I/O interface at the other end of the connection (‘Interface D’). The function of each connector is given by the following:

#### Interface C:

Connector **G1:** Analogue input to A/D at end ‘A’

Connector **G2:** Analogue output from D/A at end ‘A’

#### Interface D:

Connector **G3:** Analogue input to A/D at end ‘B’

Connector **G4:** Analogue output from D/A at end ‘B’

The high quality A/D D/A is selected as an option when selecting the PCM interface mode.

Details of how to use and calibrate the high quality A/D D/A are given in section 10, “*Optional Modules*”.

## HARDWARE CONFIGURATION OPTIONS

### Standard Configuration:

Figure 5-1 shows the standard configuration of the *ECT-1* hardware. Table 5-1 itemizes the cards installed in the standard unit.

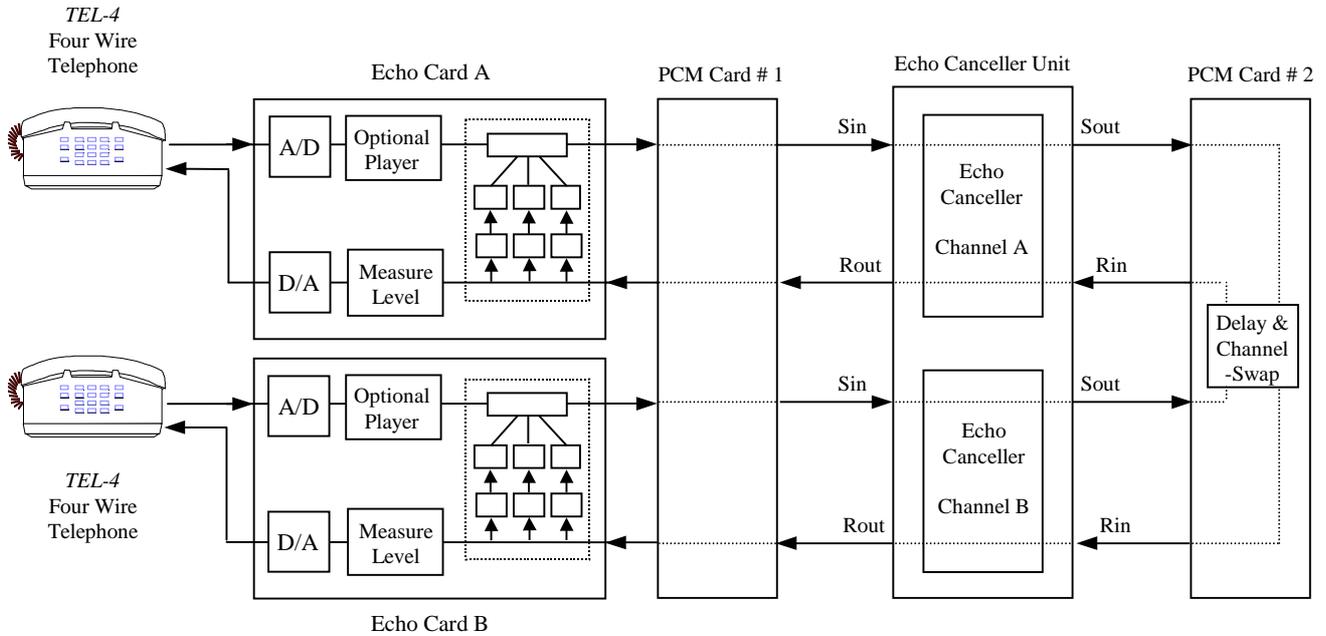


Figure 5-1. Basic Hardware Configuration of the *ECT-1*

Table 5-1. Hardware Components of the Standard *ECT-1*

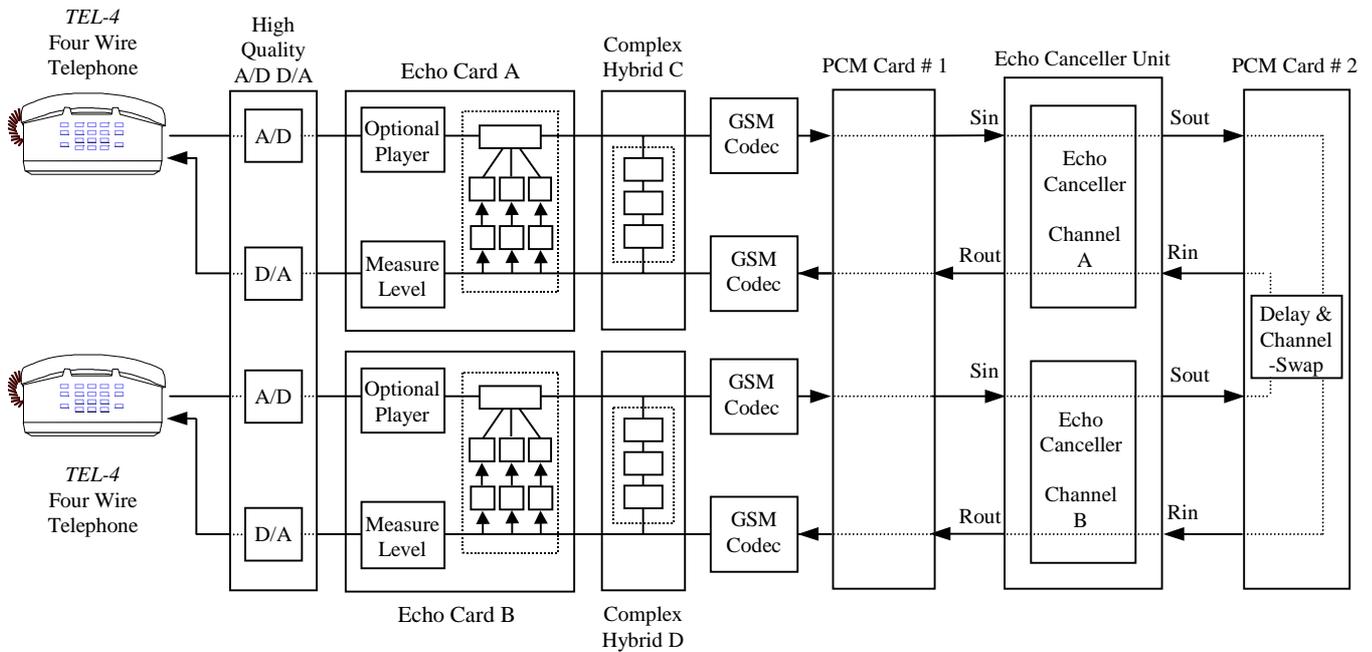
Quantity	Item	Function in <i>ECT-1</i>	Comments
1	DS 32C board	Echo Card A	Emulating the G.168 hybrid (3 simple branches)
1	DS 32C board	Echo Card B	Emulating the G.168 hybrid (3 simple branches)
1	DS PCM1 (E1 or T1)	PCM #1	Interfacing to the echo canceller under test
1	DS PCM1 (E1 or T1)	PCM #2	Interfacing to the echo canceller under test
2	TEL-4	Four wire telephone	Reference telephone for subjective tests

Note: Any other analogue input/output device could be used in place of the four-wire telephones.

**Enhanced Configurations:**

Various hardware upgrade options may be installed in the *ECT-1*, as outlined above. Figure 5-2 illustrates the hardware configuration of the *ECT-1* when all available upgrade options are installed for both ends of the emulated connection. Table 5-2 itemizes the cards in the *ECT-1* for such a configuration.

Note, of course, that it is not necessary to install all the upgrade options together. Any combination of options may be chosen. For example, it would be possible to upgrade to a GSM codec at one end only, or both ends of the emulated connection.



**Figure 5-2. Hardware Configuration of the ECT-1 with All Upgrade Options Installed**

**Table 5-2. Hardware Components of the Fully Upgraded ECT-1**

Quantity	Item	Function in ECT-1	Comments
1	DS AD2	A/D D/A	High quality A/D D/A
1	DS 32C board	Echo Card A	Emulating the G.168 hybrid (3 simple branches)
1	DS 32C board	Echo Card B	Emulating the G.168 hybrid (3 simple branches)
1	DS 32C board	Hybrid C	Emulating the complex hybrid model (512-tap FIR filter)
1	DS 32C board	Hybrid D	Emulating the complex hybrid model (512-tap FIR filter)
1	DS 2181 board	GSM Codec	Emulating the GSM encoder/decoder (other codecs available)
1	DS 2181 board	GSM Codec	Emulating the GSM encoder/decoder (other codecs available)
1	DS 2181 board	GSM Codec	Emulating the GSM encoder/decoder (other codecs available)
1	DS 2181 board	GSM Codec	Emulating the GSM encoder/decoder (other codecs available)
1	DS PCM1 (E1 or T1)	PCM #1	Interfacing to the echo canceller under test
1	DS PCM1 (E1 or T1)	PCM #2	Interfacing to the echo canceller under test
2	TEL-4	Four wire telephone	Reference telephone for subjective tests

## GETTING STARTED

- Connect an echo canceller to the *ECT-1*, as described in section 4.
- Connect an external monitor, keyboard and mouse to the appropriate connectors located on the back panel of the *ECT-1*. (Note that the *ECT-1* can also be controlled from an external host computer using an Ethernet link and software packages such as 'Reach Out' and 'PC Anywhere'. This software is not supplied by DSPG.)
- Plug the unit into the mains and switch it on using the switch on the rear panel. In the 'SBC Computer Control' section of the front panel, the 'Power' LED will light up and the 'HDD' LED will blink, indicating that Windows 95 is loading.
- After Windows 95 has loaded, the front panel 'Boot Seq.' LED will illuminate indicating that the initialization software is loading. A selection of icons will appear on the monitor screen, and the 'Scenario Control Utility' window will be displayed (see Figure 5-3 below).

[Note: To reset the hardware at any time, the Scenario Control Utility window should be closed by the user, and then re-loaded by double-clicking on the 'HW\_setup' icon. Then follow the steps outlined below.]

- Examine the 'PCM A' box, which is near the centre of the Scenario Control Utility window. Wait until the Progress Bar has completely lit.
- It is now necessary to select the appropriate E1 or T1 interface according to the interface cards fitted in the *ECT-1*, and the type of echo canceller under test. In the 'PCM A' box of the Scenario Control Utility window, use the interface selection facility to select E1 or T1, either in master mode ('*E1ma*' or '*T1ma*') or slave mode ('*E1sl*' or '*T1sl*'). (In master mode the PCM reference timing is provided by the *ECT-1*, and in slave mode the reference timing is provided by the echo canceller.)
- At this stage, the two 'Signal' and two 'Sync' lights in the Scenario Control Utility window should all be yellow, indicating that the hardware set-up is configured properly. If any are red, this indicates there is a faulty connection to the front panel 'PCM I/O' section of the *ECT-1*, or the PCM interface is configured incorrectly (see section 9, "*Troubleshooting*").
- The *ECT-1* is now operating in its subjective test mode with the 'Scenario Control Utility' window displayed on the monitor.
- Refer below to the sub-section "*The Scenario Control Utility*" for full details of this utility, which include how to enable/disable the codecs and complex hybrids (if fitted), and how to set the delay of the link between the echo cancellers at opposite ends of the emulated connection.
- Refer below to the sub-section "*Controlling the Echo Card*" for details of how to invoke and operate the two displays 'Echo Card A' and 'Echo Card B' for controlling the parameters of the G.168, 3-branch echo path model, and other features including signal generation and level measurement facilities.
- Users who have the G.168(2000) hybrid cards fitted should also refer to the section "*The Complex Hybrid Model*" for details of how to configure these hybrids using the 'Card C' and 'Card D' windows. This information is in the "*Optional Modules*" section of the manual.

## THE SCENARIO CONTROL UTILITY

This software has been designed to set the hardware configuration of the *ECT-1* with its upgrades (hybrids/codecs), and enables the user to choose various different configurations, even whilst subjective testing is in progress.

The information is presented as an easy-to-use Windows-style interface, and provides access to a status report after the boot sequence, to indicate whether the unit is functioning normally.

The Scenario Control Utility detects the hardware contained in the *ECT-1*, and uses bold lettering to indicate what is present. In Figure 5-3 below, it has detected one complex hybrid (Hybrid C) and one codec (Codec 3). These can be enabled/disabled by clicking the buttons beneath them.

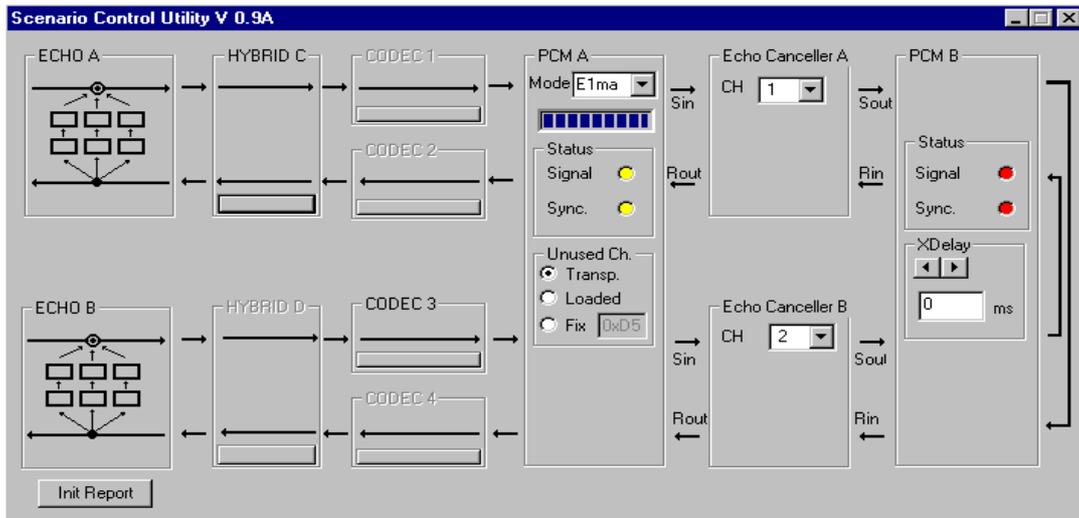


Figure 5-3. The Scenario Control Utility

**The progress bar:**

This is a simple progress display of the loading of the hardware configuration, which can take up to 10 seconds to complete. The progress bar will run automatically at the boot sequence. (The Progress Bar is near the top of the 'PCM A' box, and is shown fully lit in Figure 5-3, and again, in Figure 5-4.)



Figure 5-4. The Progress Bar

**The initialization report:**

To view the status of the DSP and PCM cards after the boot sequence, click on the 'Init Report' button in the bottom left-hand corner of the Scenario Control Utility window. All lines of the report should be commented "OK". Three lines will be displayed per card, and they will be similar to the following:

- OK: blanking DSP32C card 80MHz (C) at 210...
- OK: loading LCA DSP32C card 80MHz (C) at 210...
- OK: storing DSP32C card 80MHz (C) at 210...

**Interface selection:**

The Interface Selection Button in the 'PCM A' box enables the user to choose the appropriate interface, either E1 or T1. (Changing the PCM A interface automatically changes the PCM B interface.) There are two types of timing mode: selecting the master mode 'E1ma' or 'T1ma', the PCM reference timing is provided by the ECT-1 unit; selecting the slave mode 'T1sl' or 'E1sl', the reference timing is provided by the echo canceller.

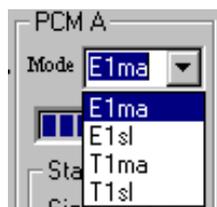


Figure 5-5. Interface Selection

Note: If the optional high quality A/D D/A is installed, there will be an additional PCM interface option, 'E1Hi ma'. Selecting this option, the high quality A/D D/A will be used, and the ECT-1 will provide the reference timing.

**Status indicator lights:**

The Status Indicator Lights, 'Signal' and 'Sync' show whether the unit is connected and running correctly. If both sets of lights (PCM A and PCM B) are yellow, the unit is connected properly and the PCM set-up is correct. If the *Signal* light is red, this means there is a loss of signal and if the *Sync* light is red there is either no connection or an incorrect PCM set-up. If a red light is present, check the connections to the PCM I/O section of the front panel of the ECT-1 unit.

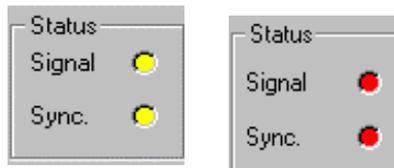


Figure 5-6. Status Indicator Lights

**Channel selection:**

To select a channel, the user should simply click on the button shown in Figure 5-7 or, alternatively, type in a value directly and press the 'Tab' key to confirm the selection. For the E1 interface there are 31 channels and for the T1 Interface there are 24 channels.

For E1 the default channels are 1 and 2.

For T1 the default channels are 2 and 3.

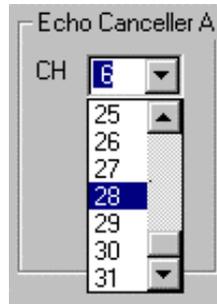


Figure 5-7. Channel Selection

Note: The difference between the E1 and T1 default channels arises because the ECT-1 uses Timeslots 1 and 2 of the PCM bitstream by default in both cases. For E1, Channel 1 means Timeslot 1; for T1, Channel 1 means Timeslot 0.

**Unused channels:**

At any one time, only two channels are selected for use in the emulated connection. For the remaining 'unused' channels, the user may select one of three options.

- **Transparent:** No action is taken to load the unused channels with any specific signal. The signals on the unused channels are passed transparently from input to output of the PCM card.
- **Loaded:** The unused channels are loaded with the same signal as the selected channels.
- **Fix:** A fixed 8-bit word is selected, and is transmitted repetitively on all unused channels. Normally, the 8-bit word is chosen to represent network idle code.

Selection is made in the 'PCM A' box by clicking on the chosen option. A dot appears in the button adjacent to the selected option.

**The 'Xdelay' feature:**

The 'extra delay' facility is used to introduce delay in both directions of transmission, and so emulates a longer trip delay, for example a satellite connection.

The range for the added delay is from 0 to 1.5 seconds in 1 millisecond steps. The user may type in the value directly or use the buttons to scroll the displayed value up or down (Figure 5-8).



**Figure 5-8. XDelay**

**The voice codec:**

By installing the necessary DSP cards for the Voice Codec upgrade in the *ECT-1*, it is possible to emulate different kinds of voice compression such as GSM, ADPCM, etc. The software for the desired codec is stored in a directory on the PC, and it is possible to maintain a library of different codec types. The software for various codecs may be ordered from DSPG (see section 10, "Optional Modules").

The Scenario Control Utility software automatically recognizes the presence of the codec DSP cards and allows the user to enable or disable each codec by clicking the on-screen codec buttons. The process of enabling or disabling a codec is carried out in real-time, allowing the user to perform a quick comparative test of performance with and without the codec.

Note that it is possible to enable the codec in the receive or send path separately.

**The complex hybrid:**

By installing the necessary DSP cards for the Complex Hybrid upgrade in the *ECT-1*, this hybrid model may be selected to provide a source of echo in the emulated connection.

The Scenario Control Utility software automatically detects the presence of the complex hybrid DSP cards and allows the user to enable or disable the hybrids by clicking the on-screen buttons. The process of enabling or disabling a hybrid is carried out in real-time, which is one way of quickly removing or reinstating the echo signal.

Users who have the complex hybrid cards fitted should also refer to the section "The Complex Hybrid Model" for details of how to configure these hybrids using the 'Card C' and 'Card D' windows. This information is in section 10, "Optional Modules".

**Points to note:**

- Whenever the Scenario Control Utility window is loaded, the *ECT-1* hardware configuration is reset to its default status. For this reason it is best not to close the Scenario Control Utility window during a test session, since the hardware configuration will be reset to the default status if it is subsequently necessary to re-load the Utility. Rather than closing the window, simply minimize it.
- The user may enable/disable codecs and hybrids and change channels and XDelay values while subjective testing is in progress. However, if the user changes the E1/T1 interface, the hardware will be reset.
- When proceeding from a *subjective* test session to an *objective* test session (i.e. G.168 or G.168(2000) tests), it is essential that the hardware is correctly reconfigured. Perhaps the easiest way to ensure this (without powering-down the *ECT-1*) is to close the Scenario Control Utility window, then re-open it, and then perform the subsequent operations specified in the appropriate 'objective testing' section of this manual.

## CONTROLLING THE ECHO CARD

Once an emulated connection has been established, the user will probably wish to vary the parameters of the echo path and the link to the telephone instrument. These facilities are provided by the Echo Cards and the associated software. The software is ready to run by launching the two programs 'Echo A' and 'Echo B' by double-clicking the icons on the monitor screen. The Echo Card dialogue boxes will be displayed. (Note that separate arrangements exist to customize the echo path for objective tests, so the Echo Card dialogue boxes are normally only used for subjective tests.)

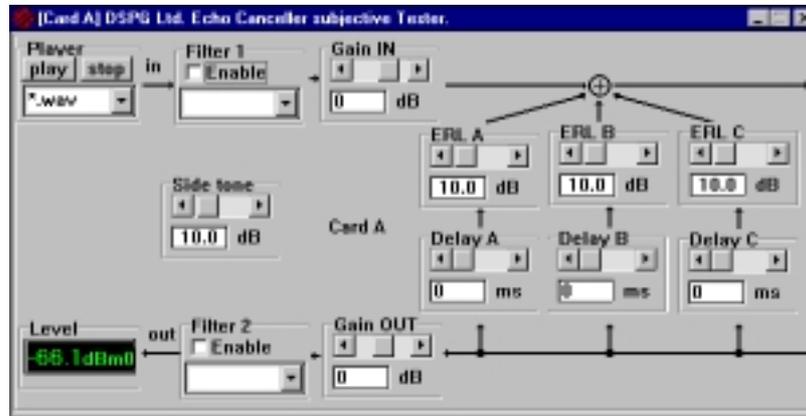


Figure 5-9. The Echo Card Dialogue Box

By placing the two dialogue boxes (Card A and Card B) on the Windows desktop, the user can access every parameter at once.

By moving the slide controls with a mouse, the related parameters of the DSP program will change immediately and the user will hear the difference on the telephone ear-piece.

### The controls:

The various controls displayed on the Echo Card dialogue box may be divided into four different types:

- Gain controls,
- Attenuation controls,
- Delay controls,
- Extended controls.

In the following table, the control-type is identified for each of the individual controls in the Echo Card window. The adjustment range and step-size is also shown for each individual control.

**Table 5-3. Functions of the Controls**

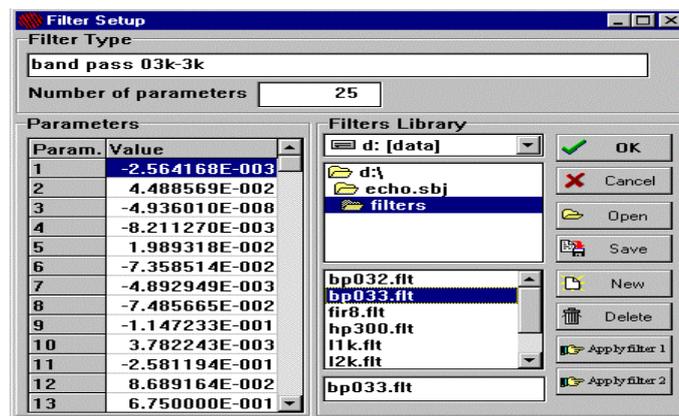
Box name	Control Type	Units	Min	Max	Step
Gain In	Gain	dB	-60	20	0.1
Gain Out	Gain	dB	-20	20	0.1
Side Tone	Attenuation	dB	0	100	0.1
ERL A	Attenuation	dB	1	100	0.1
ERL B	Attenuation	dB	1	100	0.1
ERL C	Attenuation	dB	1	100	0.1
Delay A	Delay	milliseconds	0	250	1
Delay B	Delay	milliseconds	0	250	1
Delay C	Delay	milliseconds	0	250	1
Filter 1	Extended		OFF	ON	
Filter 2	Extended		OFF	ON	
Player	Extended		OFF	ON	

The use of the *extended* controls (the ‘Filters’ and the ‘Player’), are described separately below. The use of the *non-extended* controls may be summarized as follows:

- the user may set the parameter value either by typing it directly into the edit box, or by using the scrollbar;
- by typing in the value directly, the related parameter will be adjusted straight after the *TAB* character has been typed;
- using the scrollbar, the related parameter will be adjusted immediately.

**The Filter Controls:**

The filter boxes in the Echo Card display window (Figure 5-9) allow full control of separate FIR filters in the send and receive connections to the 4-wire *TEL-4* telephone. It is possible to enable or disable a filter by using the *Enable* check-box. The combo box allows quick access to the *Filters Library*. Double-clicking on either the ‘Filter 1’ or ‘Filter 2’ box will bring up a dialogue box (Figure 5-10) that allows the user to change the default directory of the ‘Filters Library’. This dialogue box also allows the user to customize or create new filters.



**Figure 5-10. The Filter Editor**

All the controls for managing a filter library are present on the right-hand side of the dialogue box, so the user is able to load a pre-stored filter, create a new one, or save a filter description to a named file.

Note: The format of the file describing the filter is the same as that used by the DFDP filter design program (by Atlanta Signal Processors Inc.).

The number of taps for the FIR filter must be configured in the 'Number of Parameters' edit box, and can have a maximum value of 50.

Using the table on the left of the dialogue box, it is possible to enter the values of individual parameters manually.

There are separate 'Apply' buttons for Filter 1 and Filter 2. Clicking an 'Apply' button writes the values into DSP memory (but does *not* save the file or display an associated filename in the filter box of the Echo Card dialogue box). The filter may be enabled/disabled using the check-box facility on the Echo Card dialogue box.

To save a filter description to a specified filename, use the 'Save' button of the filter editor (Figure 5-10). The filename should be given the suffix '.flt'.

### **The Player:**

It is possible to play waveforms on the system which bypass the analogue input of the *ECT-1*. The format of the waveforms has to be 16 bits linear mono with a sampling rate of 8 kHz. The sample cannot exceed 30 seconds. By clicking the 'play' button (Figure 5-9), the system will play the sample in a continuous loop until the user clicks on the 'stop' button.

By using small samples containing sine waves it is possible to generate continuous tones. A small library of waves is included in the software package. This library includes the ITU testing samples (CSS, CSS double-talk, white noise, etc.).

By double-clicking on the 'player' combo box a new dialogue box will appear allowing the user to change the default directory of the samples library.

NOTE: when using custom samples, pay attention to the level, as the system will clip any signal exceeding the A-law or  $\mu$ -law limit.

### **The 'Presets' function:**

To use the *presets* function, the user simply clicks anywhere on either the Card A or Card B window using the right-hand mouse button. A pop-up menu will then appear with three options; choosing 'presets' will bring up the presets window which is a simple table.

The user will see that the status of Delays A, B and C and ERLs A, B and C are displayed in the 'Current' line of the table. By adjusting the parameters of the Delays and ERLs with the mouse using the slide controls, or by typing in new values directly, the readings in the 'Current' line of the presets table will change accordingly.

To store a set of values from the 'Current' line to any of the presets lines (*PRE 1*, *PRE 2* etc., up to a maximum of fifty) the user simply clicks on, drags and drops the whole of the 'Current' line into any empty preset line. To make changes, the user may click on any value to select it, then click on it again before editing the value.

To delete a complete line, click on, drag and drop an empty line into one containing values. Alternatively, click on each value and press *Delete* on the keyboard.

To make use of an existing preset to set the parameters of the current test, double-click on any line in the list (*PRE 1*, *PRE 2* etc.) to copy it to the 'Current' line at the top of the table. This allows all the delay and ERL parameters to be set in one operation.

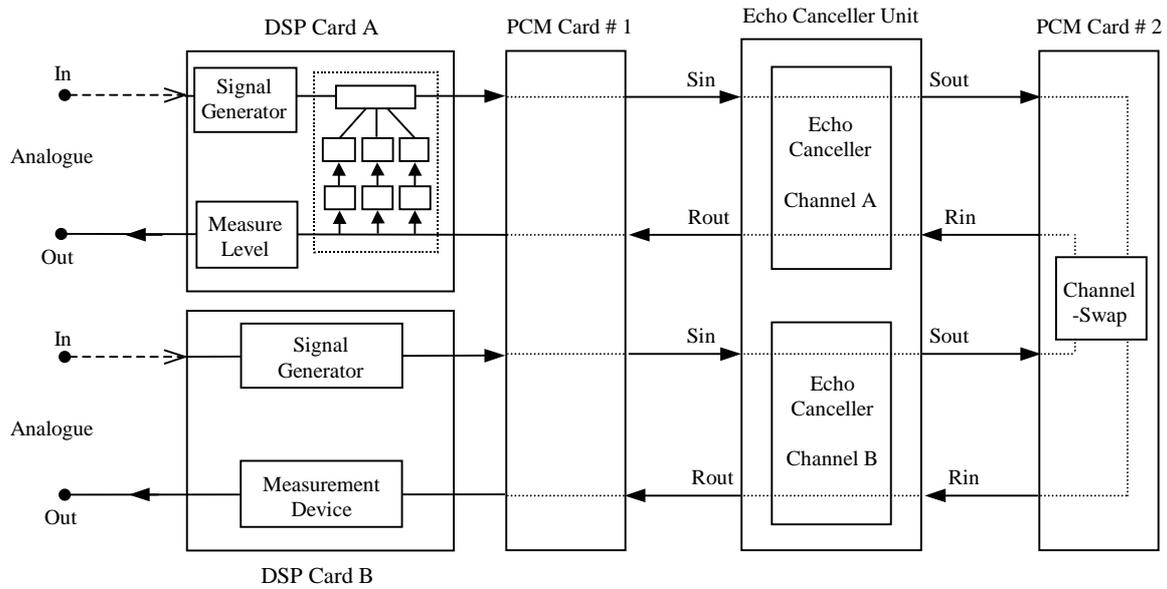
## **6. OBJECTIVE TESTING MODE - G.168**

### ***CONTENTS***

## OBJECTIVE TESTING MODE - G.168

### HARDWARE CONFIGURATION

Figure 6-1 shows the *ECT-1* hardware configured to perform G.168 objective tests. The cards required in the *ECT-1* are itemized in Table 6-1, and are the same as for the simplest configuration of the unit in its subjective evaluation mode.



**Figure 6-1. Hardware Configuration of the ECT-1 to Perform G.168 Tests**

**Table 6-1. Cards Required in the ECT-1 to Perform G.168 Test**

Quantity	Item	Function in ECT-1	Comments
1	DS 32C board	DSP Card A	Emulating the G.168 hybrid (3 simple branches)
1	DS 32C board	DSP Card B	Test signal generation, and level measurement
1	DS PCM1 (E1 or T1)	PCM #1	Interfacing to the echo canceller under test
1	DS PCM1 (E1 or T1)	PCM #2	Interfacing to the echo canceller under test

Note: The reasons for the particular hardware configuration of Figure 6-1 are outlined in Appendix C.

### GETTING STARTED

- Connect an echo canceller to the *ECT-1*, as described in section 4.
- Connect an external monitor, keyboard and mouse to the appropriate connectors located on the back panel of the *ECT-1*. (Note that the *ECT-1* can also be controlled from an external host computer using an Ethernet link and software packages such as 'Reach Out' and 'PC Anywhere'. This software is not supplied by DSPG.)
- Plug the unit into the mains and switch it on using the switch on the rear panel. In the 'SBC Computer Control' section on the front panel, the 'Power' LED will light up and the 'HDD' LED will blink, indicating that Windows 95 is loading.

- After Windows 95 has loaded, the ‘Boot Seq.’ LED will illuminate indicating that the initialization software is loading. A selection of icons will be placed on the *desktop*, and the ‘Scenario Control Utility’ window will be displayed (Figure 6-2).

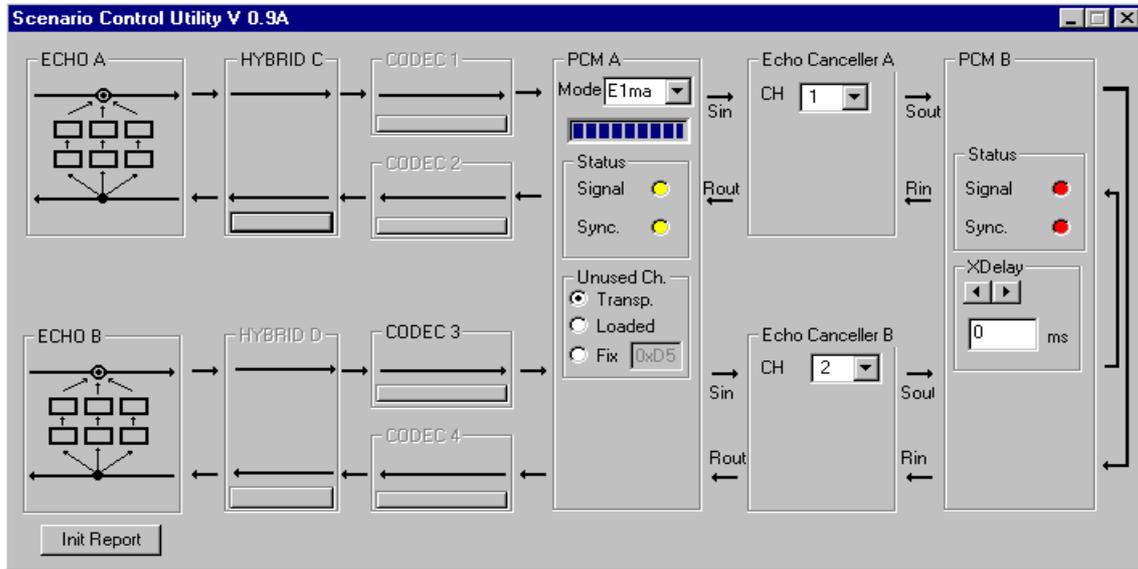


Figure 6-2. The Scenario Control Utility

- Examine the ‘PCM A’ box, which is near the centre of the Scenario Control Utility window. Wait until the Progress Bar has completely lit. (The Progress Bar is near the top of the ‘PCM A’ box, and is shown fully lit in Figure 6-2.)
- It is now necessary to select the appropriate E1 or T1 interface according to the interface cards fitted in the *ECT-1*, and the type of echo canceller under test. In the ‘PCM A’ box of the Scenario Control Utility window, use the interface selection facility to select E1 or T1, either in master mode (‘E1ma’ or ‘T1ma’) or slave mode (‘E1sl’ or ‘T1sl’). (In master mode the PCM reference timing is provided by the *ECT-1*, and in slave mode the reference timing is provided by the echo canceller.)
- At this stage, the two ‘Signal’ and two ‘Sync’ lights in the Scenario Control Utility window should all be yellow, indicating that the hardware set-up is configured properly. If any are red, this indicates there is a faulty connection to the front panel ‘PCM I/O’ section of the *ECT-1*, or the PCM interface is configured incorrectly (see section 9, “Troubleshooting”).
- The default PCM channels can be changed if desired. To select a channel, simply click on the button in the ‘Echo Canceller A’ or ‘Echo Canceller B’ box. Alternatively, type in a value directly and press the ‘Tab’ key to confirm the selection.
- Select one of three options for the ‘unused’ channels:
  - Transparent:** No action is taken to load the unused channels with any specific signal. The signals on the unused channels are passed transparently from input to output of the PCM card.
  - Loaded:** The unused channels are loaded with the same signal as the selected channels.
  - Fix:** A fixed 8-bit word is selected, and is transmitted repetitively on all unused channels. (Normally, the 8-bit word is chosen to represent network idle code.)

Selection is made in the ‘PCM A’ box by clicking on the chosen option. A dot appears in the button adjacent to the selected option.

- Do not modify any other settings in the Scenario Control Utility window.  
 Note: By following the above steps, the *ECT-1* hardware will be correctly configured for objective testing. The correct hardware configuration is essential for objective tests to be valid. **If the *ECT-1* had been already switched on and in use, the hardware configuration may have been modified (e.g. during a subjective test session). In this situation, it is safest to reset the hardware by closing and then re-opening the Scenario Control Utility window. The PCM interface should then be re-configured, as described above.**

- Before running the tests, it is important to set channel 'B' of the echo canceller unit (Figure 6-1) to bypass mode. If the *ECT-1* default channels are used (i.e. the channel selection was not modified using the Scenario Control Utility), this means that for an E1 interface, channel 2 must be set to bypass mode, and for a T1 interface channel 3 must be set to bypass mode. This operation cannot be performed by the *ECT-1*, and must be carried out using the control facilities of the echo canceller itself.
- Double-click on the 'Tester' icon.
- A list of tests will appear indicating that the software is ready to be configured (Figure 6-3).
- Open the configuration dialogue box by clicking the 'Configure' button in the bottom left-hand corner of the window.
- There are many settings and details that can be entered, and these are fully covered in the next sub-section "*Configuring the Test Session*". However, as many of these details are for filing and record purposes, it is not essential to complete them all to perform a quick test. A quick configuration requires only that the echo canceller control port is configured correctly. This is most easily achieved by going to the 'Connections' page of the configuration dialogue box, and choosing the appropriate configuration file by double-clicking on the name of the echo canceller under test in the 'Canceller Library' drop down list. Then click the 'OK' button.

[**Note 1:** If the echo canceller under test is not in the Canceller Library, it will be necessary to configure the separate parameters of the control port connection (see "*Configuring the Communication Protocol*" in the next sub-section). If this is not done correctly, the test results will not be valid.

**Note 2:** For an E1 PCM interface, the user may also wish to use the 'Advanced' page of the configuration dialogue box to select 31 channel (CAS) mode. (See "*Configuring the Advanced Set-Up Options*" in the next sub-section.)

**Note 3:** As the quick configuration has not selected a 'working directory' in which to store the results of the tests, the results will be stored under the default directory *echocanc.tsr*. A subsequent test session, configured in the same way, would overwrite the earlier results. Therefore, to prevent results being overwritten, it is necessary to specify a new 'working directory' for each test session. (See "*Configuring General Details of the Current Test Session*" in the next sub-section.)]

- The preceding step has configured the software to control the H register, NLP, and convergence parameters of the echo canceller under test.
- The test list is displayed on the monitor. Each test can be run by double-clicking on the appropriate line in the list, or by selecting it and clicking the 'Start' button.
- Full details of how to run tests, and the facilities available are given in the sub-section "*Running the Tests*". However, an example of running a quick test is given below.

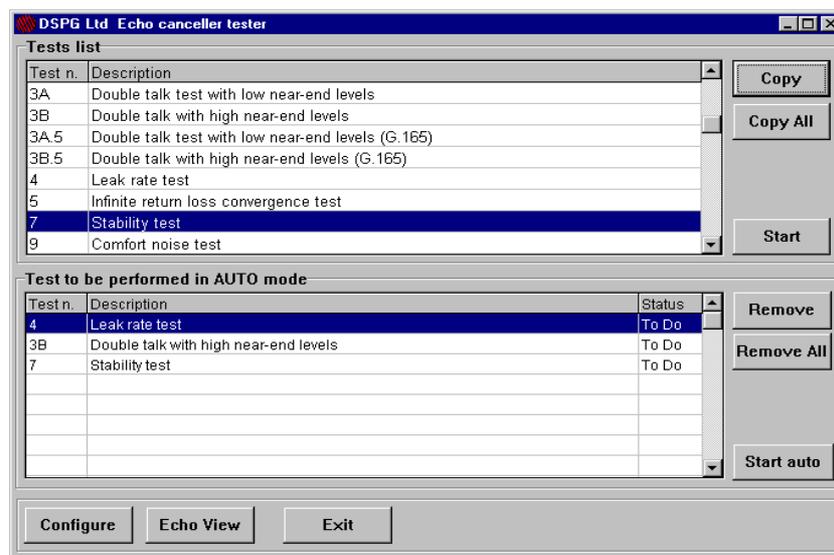
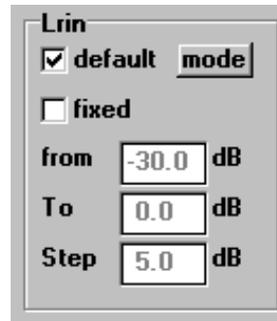


Figure 6-3. The Test Selector

An example of running a test:-

- ◆ Double-click on test 2A in the list.
- ◆ After a quick initialization procedure, the software permits the selected test to be customized, by allowing changes to the values of the three parameters: *Lrin*, *Aecho*, *Td*.
- ◆ To perform a quick test, click the 'mode' button to mode 1 for each parameter (see Figure 6-4). Then select the 'fixed' (single value) option for each parameter.



**Figure 6-4. A configuration box in mode 1**

- ◆ Click 'Start' to confirm the choice and pass to the next step. A new window will appear.
- ◆ The selected test is started by clicking on the 'Start' button in the new window.
- ◆ The 'Status' field will first show 'in progress' then will be replaced with the message 'pass', 'fail' or 'under study', as appropriate.  
(If a working directory has not been selected during the system configuration, 'results' and 'settings' will be stored in folders of that name under the default directory *echocanc.tsr*.)
- ◆ To view a graphic representation of a test simply double-click on a chosen line in the table.

## CONFIGURING THE TEST SESSION

Start-up the *ECT-1* in its objective test mode, as described in the previous sub-section. The 'Tests list' window (Figure 6-3) will be displayed on the monitor. Click on the 'Configure' button at the bottom of this window to view the configuration dialogue box. There are five categories of settings to be configured, and each category is represented by a separate page in the dialogue box:

- ◆ **Advanced:** advanced set-up options; (30 or 31 channel E1 PCM interface; G.168(2000) test option).
- ◆ **Cancellers:** details of the echo canceller under test.
- ◆ **Operators:** information relating to the user or operator of the test equipment.
- ◆ **Connections:** the communication protocol (for controlling the status of certain parameters of the echo canceller under test). A tool to manage a library of echo canceller communication protocols is available on this page.
- ◆ **General:** directory to store results, and summary details of the current test session.

Details of how to configure each category are presented below. When all categories have been configured, return to the 'Tests list' window by clicking the 'OK' button in the bottom left-hand corner of the configuration dialogue box.

### Configuring the Advanced Set-Up Options

The user clicks on the 'Advanced' page of the configuration dialogue box to configure the advanced set-up options. Currently, these options allow only the choice of 30 or 31 channel mode for the E1 PCM interface. In the near future, G.168(2000) tests will be able to be selected by users who have this option installed.

### Configuring the Echo Cancellor Details

For record purposes and easy selection of echo canceller details in future tests, the details of any echo canceller to be tested should be added to the 'Cancellers' database.

The user clicks on the 'Cancellers' page of the configuration dialogue box to specify the details of the echo canceller (Figure 6-5).

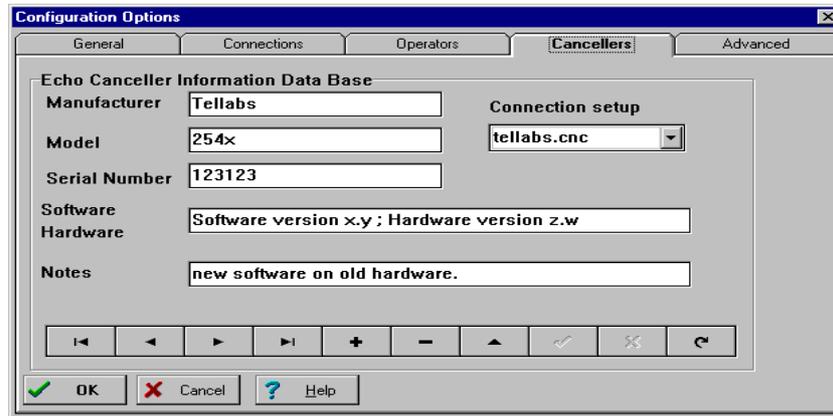


Figure 6-5. The Echo Cancellor Database Management Utility

The database stores the following details relating to the echo canceller:

- ◆ **Manufacturer:** the manufacturer's name.
- ◆ **Model:** the echo canceller model.
- ◆ **Serial number:** the echo canceller serial number.
- ◆ **Software/Hardware:** information about the version of the software and the hardware.
- ◆ **Notes:** any other notes.
- ◆ **Connection set-up:** the library file containing the description of the communication protocol.

NOTE: The key of the *Cancellor* table is the set of *Manufacturer*, *Model* and *Serial Number*. This combination should be unique in the database, so if it is necessary to add the same echo canceller twice, at least one of the three strings should be different (e.g. *Serial Number 12345x/A - 12345x/B*).

A simple tool bar (navigator) allows access to all of the controls which manage the database:

#### The Navigator Toolbar:

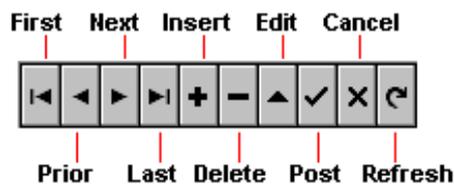


Figure 6-6. The Navigator Toolbar

**Table 6-1. Functions of the Navigator Buttons**

BUTTON	PURPOSE
First	Sets the current record to the first record in the dataset, disables the First and Prior buttons and enables the Next and Last buttons if they are disabled.
Prior	Sets the current record to the previous record and enables the Last and Next buttons if they are disabled.
Next	Sets the current record to the next record and enables the First and Prior buttons if they are disabled.
Last	Sets the current record to the last record in the dataset, disables the Last and Next buttons and enables the First and Prior buttons if they are disabled.
Insert	Inserts a new record before the current record and sets the dataset into Insert and Edit states.
Delete	Deletes the current record and makes the next record the current record.
Edit	Puts the dataset into Edit state so that the current record can be modified.
Post	Writes changes in the current record to the database.
Cancel	Cancels edits to the current record, restores the record display to its condition prior to editing and turns off Insert and Edit states if they are active.
Refresh	Redisplays the current record from the dataset, thereby updating the display of the record on the form.

### Configuring the Operator Details

For reporting purposes, it is necessary to configure some details about the system user.

Before starting a testing session, the user should be registered in the ‘Operators’ database using the ‘Operators’ page of the configuration dialogue box (Figure 6-7).



**Figure 6-7. The Operators Database Management Utility**

Note: The key of the *Operators* table is *Name* so this should be unique in the database.

Refer to “*Configuring The Echo Canceller Details*” for a complete description of the navigation toolbar.

### Configuring the Communication Protocol

To perform any of the G.168 tests, the software needs to control some parameters of the echo canceller:

i.e. NLP (enable or disable),

H Register (reset, freeze, unfreeze),

Convergence (enable or disable).

To control these parameters, the *ECT-1* software can use two different kinds of connection to the echo canceller: a direct TTL connection or a V24/RS232 connection. The choice is dictated by the control port type of the echo canceller under test.

For a TTL connection, the *ECT-1* has a dedicated port on its front panel; alternatively, the PC parallel (printer) port may be used, and is located on the back panel of the *ECT-1*. The flexibility to use either connector may be useful when conducting comparative tests on two different echo cancellers (see Appendix C).

For a V24/RS232 connection, the *ECT-1* has a serial port connector on its front panel (this is the PC COM2: port). Alternatively, the COM1: serial port may be selected, and this connector is located on the *ECT-1* back panel. The flexibility to use either connector may be useful when conducting comparative tests on two different echo cancellers (see Appendix C).

All aspects of the connection can be modified using the ‘Connections’ page of the configuration dialogue box (Figure 6-8).

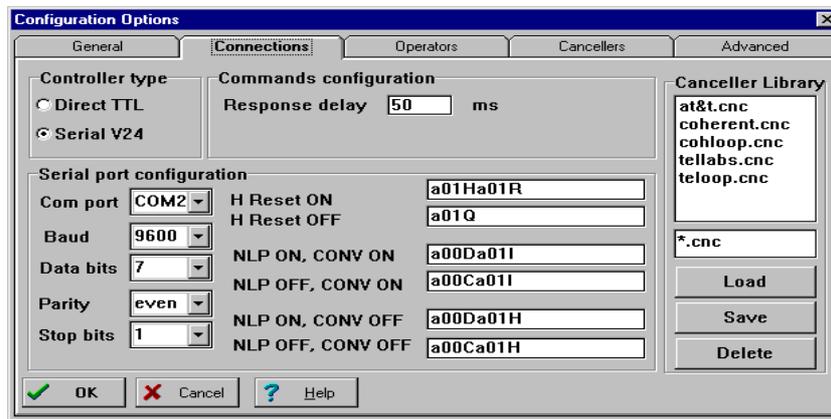


Figure 6-8. Configuring the Communication Protocol

In the ‘Controller type’ box:-

Choose ‘Direct TTL’ to use the *ECT-1* TTL port, or to use the PC parallel port. In these cases, three TTL lines control the three parameters of the echo canceller.

Choose ‘Serial V24’ to use the COM1: or COM2: port of the computer to control the echo canceller.

If a TTL connection has been selected, use the ‘Logic’ box to select erect or inverted logic levels according to the requirements of the echo canceller under test.

If a V24 connection has been selected, use the ‘Serial port configuration’ box to set the PC COM1: or COM2: port to the same configuration as the echo canceller serial port.

Also in the ‘Serial port configuration’ box, set the appropriate strings to be sent to the serial port to control the various combinations of echo canceller parameters. [Note: After the string, the software automatically sends a RETURN character.]

The ‘Response delay’ has to be set to achieve perfect synchronization between the signals and the commands. The value of this delay must be extracted from the echo canceller specifications or obtained from the echo canceller manufacturer.

It is possible to create and manage a library of Connections using the ‘Canceller Library’ options. If the appropriate library file exists, simply select and ‘load’ this file to set all the preceding steps automatically. If an appropriate library file does not exist, one may be created by first entering the details as above, then naming the file by typing this into the small edit box currently containing ‘\*.cnc’ in Figure 6-8, and then clicking on ‘Save’.

Note: The canceller library files are stored in the *echocanc.tsr\config* directory.

## Configuring General Details of the Current Test Session

To start a new test session or read the results of a previous one, the user must provide some basic details. This may be done using the 'General' page of the configuration dialogue box. (Figure 6-9).

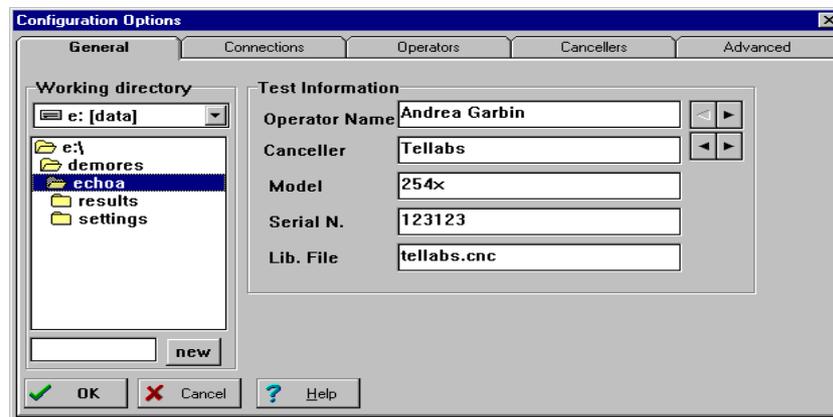


Figure 6-9. Configuring General Details of the Current Test Session

To start a new test session, it is necessary to select a new working directory in the 'Working directory' box. The working directory is the directory where the software will save all the results and the various settings of the test session.

To choose a directory, simply navigate the available drives and directories using the list boxes.

To create a new directory, simply type the name into the small edit box and click 'new'. A new directory will be created in the current directory (the directory selected from the list box).

Select the new directory when it appears in the list box, double-clicking on its name.

After choosing the working directory, use the 'Test Information' box to select the name of the operator and the echo canceller to be tested using the two small navigation tools. The software automatically reads all of the parameters from the relevant databases.

Note: It is not possible to modify individual parameters at this page; the user must go to the related database pages to change them.

To read the values of an old test session, simply choose the relevant existing directory by navigating within the 'Working directory' box. The software will automatically load all of the information about the session.

Note: When selecting an existing directory in order to examine the results of an earlier test session, the directory will contain two sub-directories named 'Results' and 'Settings'. Stop the navigation at this level (as shown in Figure 6-9); i.e. do *not* select either of the two sub-directories. For information, the sub-directories contain the following data:

**settings:** the directory where the software saves all the configurations about the tests, such as the settings of any parameter box (*form, to, step, etc.*).

**results:** the directory where the program will save the results of any test.

Inside the results folder, the software will create a directory for each completed sequence of tests bearing the name of the related G.168 test.

In each directory there is usually a file for each test. The name of the file gives the description (parameter values) of the completed test.

The file name structure is:

EEEELLLL.DDD

where:	EEEE	= 10 * Aecho	(Aecho = The value of the ERL parameter according to G.168)
	LLL	= 10 * LRin	(LRin = Receive level (dBm0) at echo canceller)
	DDD	= Td	(Delay (ms) of the canceller echo path)

The file is easy to read with other programs such as Microsoft Excel and allows checking of the test results with other commercial programs. The first line is the description of the test (date, time and parameters).

Subsequent lines are a list of records of three values each:

- ◆ the first value is the time period: multiply by 35 to obtain the value in milliseconds,
- ◆ the second is the output value: divide by 10 to obtain the value in decibels,
- ◆ the third is the mask value: divide by 10 to obtain the value in decibels.

Click on the 'OK' button to return to the 'Tests list' screen, from which the test session may be started (or previous results examined).

## RUNNING THE TESTS

Note that with the *ECT-1* in the objective test mode, but while no tests are being run, the analogue interfaces on the front panel of the *ECT-1* may be used for miscellaneous checks. However, **while objective tests are in progress, the software effectively disconnects the analogue input.** This is because the analogue input signal would affect the measurements and invalidate the results. As the software takes care of this crucial consideration, it is not necessary to disconnect the *TEL-4* telephones from the front panel to prevent a signal being injected via the telephone microphone. (The *ECT-1* analogue outputs may be used as monitor points at all times.)

Before running the tests, **it is important to set channel 'B' of the echo canceller unit (Figure 6-1) to bypass mode.** If the default channels are used (i.e. the channel selection has not been modified using the Scenario Control Utility), this means that for an E1 interface, channel 2 must be set to bypass mode, and for a T1 interface channel 3 must be set to bypass mode. This operation cannot be performed by the *ECT-1*, and must be carried out using the control facilities of the echo canceller itself.

From the 'Tests list' window, click on 'Configure' to configure the current test session or to load a previous session, as described in the previous sub-section, "*Configuring the Test Session*".

### Single Test Mode

This mode of operation allows a single chosen G.168 test to be performed. Although a single test is selected, a sequence of tests is normally generated because the test is repeated over a range of parameter values. The test sequence is performed fully automatically.

A simple dialogue box allows the user to choose the G.168 test (see Figure 6-10 below). To choose a test, double-click on the relevant line in the list or select that line and press 'Start'. The window that then appears allows certain test parameters to be changed (see "*Custom Testing*" below); to proceed with the default parameter settings, simply click the 'Start' button in the 'Controls' panel. The next window allows the test to be started (see "*Dynamic Report Viewer*" below).

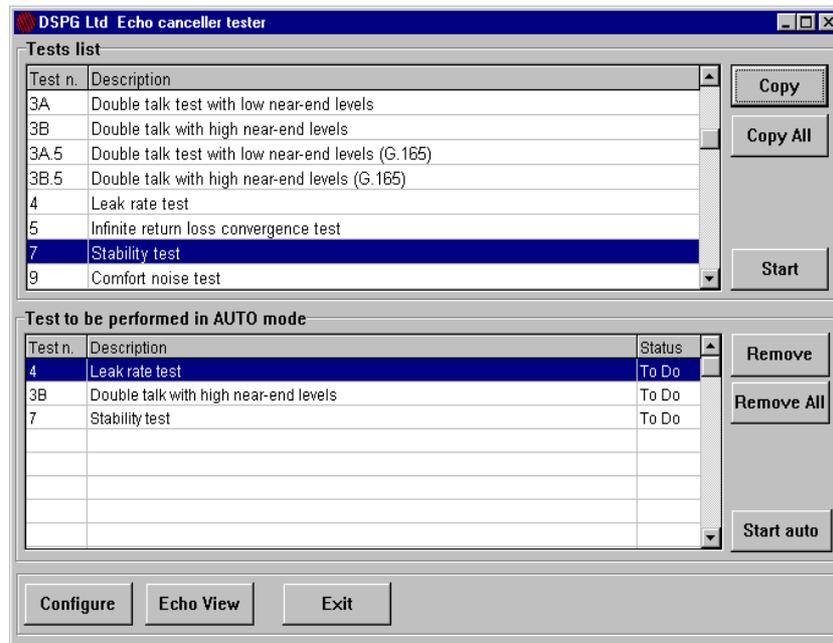


Figure 6-10. The Test Selector

### Multi-Test Mode

If the user wishes to perform more than one test in a row, there is a facility to enable a sequence of G.168 tests to be run automatically. (Additionally, each test is repeated over a range of parameter values.)

By highlighting the chosen test and then clicking 'Copy', it will appear in the 'AUTO mode' section of the test list window (the 'Remove' button will delete it). When the required tests have been copied, the user simply clicks the 'Start auto' button and the *ECT-1* will run each of the tests in turn, assign a 'pass', 'fail' or 'under study' status, and report the results. Using this method, from two to all of the tests in the G.168 specification can be run automatically in whichever sequence the user chooses.

### Custom Testing

The user is able to customize the test sequence to be performed by the system using the *Generator* dialogue box (Figure 6-11). This allows the parameter values *Lrin*, *Aecho*, and *Td* to be changed from their default values, as described below. Parameter values may be changed for both the single test mode and the multi-test mode. To use customized parameter values in the multi-test mode, the parameter values should be changed *before* the test is copied into the 'Auto mode' section of the test list window.

To call up the *Generator* dialogue box, double-click on the chosen test or select the test and click 'Start'. The dialogue box that appears is divided into two different parts: the parameter settings and the report memo box.

#### The report memo box:

The report memo box can be seen in the lower half of Figure 6-11, and contains the initialization procedure error reports in case of hardware or software failures. For further information on these error messages, refer to section 9, "Troubleshooting".

The report memo box also shows the addresses of cards used in the tests, the date and time, and other information concerning the test about to be performed, including details of the signals needed to perform the current test, and the time it will take to run.

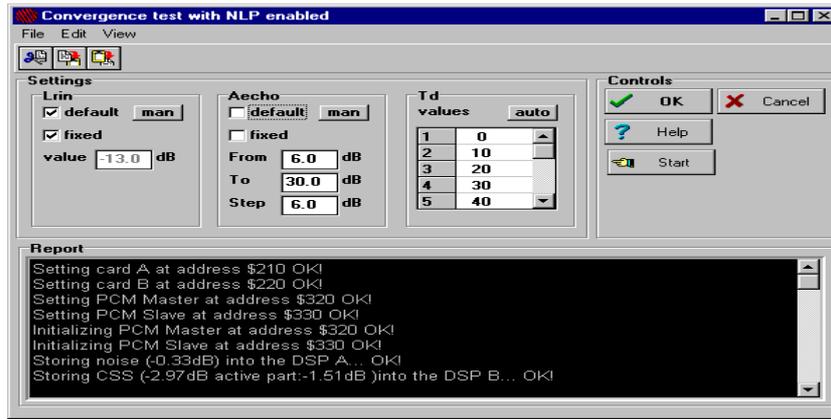


Figure 6-11. Customizing the Test Sequence

**Setting the parameters:**

This description applies to every test because the parameters to be configured are similar each time.

Usually, the user can choose the values of three parameters:

- ◆ **Lrin:** the level in dBm0 of the signal sent to the echo canceller ‘R in’ port.
- ◆ **Aecho:** the power sum in decibels of the three ERL values (ERL A, ERL B, ERL C).
- ◆ **Td:** the greatest of the three delays emulating the echo path delay.

The range of each one of these parameters can be customized using the associated configuration box.

There are two modes of operation:

**Mode 1:** Selects uniform step-size between upper and lower limits. (There is also an option to select a single value rather than a range of values.)

**Mode 2:** The user can define each value.

To change mode simply click on the ‘mode’ button, which has a toggle action.

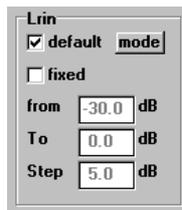


Figure 6-12. Configuration box in mode 1

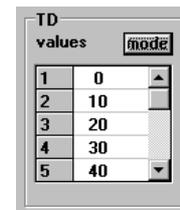


Figure 6-13. Configuration box in mode 2

- If the ‘default’ box is checked, the default test values are set automatically. [Note: The default values are provisional, but have been agreed with some PTTs and manufacturers.]
- The ‘fixed’ check box allows selection of a single fixed value or a range of values:
  - leave the box unchecked for a range of values (defined by upper and lower limit values and a step size);
  - check the box to use a single value.

The list of values is totally customizable:

- A single value may be modified - click on the value then edit it.
- By double-clicking on a value an empty cell is created, allowing another value to be inserted into the list.
- Double-clicking on an empty cell will remove it.
- Note: Non-numerical values will be interpreted as zero.

If the test is to be run in single test mode click the ‘Start’ button, but if the test is to be run in multi-test mode, click the ‘OK’ button instead. The effect of these two buttons is different:

the ‘Start’ button generates a sequence of tests and displays the next window;

the ‘OK’ button returns the display to the test list window, from where the test (with the modified parameters) can be copied to the ‘Auto mode’ section of the test list window.

The sequence of tests represents all combinations of values chosen for the three parameters.

### The Dynamic Report Viewer

The dialogue box allows the test to be performed or the results of a previous test session to be viewed (Figures 6-14 and 6-15).

Before proceeding with a new test session, to obtain valid results **it is important to ensure that channel ‘B’ of the echo canceller (Figure 6-1) is set to bypass mode.** (If the default channel selections are used, channel B corresponds to channel 2 for an E1 interface, and to channel 3 for a T1 interface.)

Note that, while the tests are running, the software will effectively disconnect any analogue input signal applied to the ECT-1.

T.n	TD ms	AEcho	LRin	Exp.	Status	LRout	C Time
18	50	6.0	-20.0	-46.7	pass	-57.7	210
19	0	6.0	-15.0	-42.5	pass	-55.2	105
20	10	6.0	-15.0	-42.5	pass	-55.5	140
21	20	6.0	-15.0	-42.5	pass	-54.3	175
22	30	6.0	-15.0	-42.5	in progress		
23	40	6.0	-15.0	-42.5	to do		
24	50	6.0	-15.0	-42.5	to do		
25	0	6.0	-10.0	-38.3	to do		
26	10	6.0	-10.0	-38.3	to do		
27	20	6.0	-10.0	-38.3	to do		
28	30	6.0	-10.0	-38.3	to do		
29	40	6.0	-10.0	-38.3	to do		
30	50	6.0	-10.0	-38.3	to do		

Figure 6-14. The Dynamic Report Viewer during a Test Session

T.n	Td ms	Aecho	Lrin	Mask	Status	Lres	Ctime	File name
1	20	6.0	-30.0	-55.0	pass	-66.1	280	00600300.20
2	20	6.0	-25.0	-50.8	pass	-65.5	280	00600250.20
3	20	6.0	-20.0	-46.7	pass	-62.5	1225	00600200.20
4	20	6.0	-15.0	-42.5	pass	-60.7	805	00600150.20
5	20	6.0	-10.0	-38.3	pass	-55.6	1225	00600100.20
6	20	6.0	-5.0	-34.2	pass	-49.6	1225	00600050.20
7	20	6.0	0.0	-30.0	pass	-46.9	490	00600000.20
8	20	12.0	-30.0	-55.0	pass	-66.1	175	01200300.20
9	20	12.0	-25.0	-50.8	pass	-66.0	210	01200250.20
10	20	12.0	-20.0	-46.7	pass	-63.4	525	01200200.20
11	20	12.0	-15.0	-42.5	pass	-62.4	455	01200150.20
12	20	12.0	-10.0	-38.3	pass	-57.7	525	01200100.20
13	20	12.0	-5.0	-34.2	pass	-51.7	595	01200050.20

Figure 6-15. The Dynamic Report Viewer Reading a Previous Test Session

The appearance of the dialogue box is different for each test but the design is similar.

The controls are very simple:

- ◆ **Start:** Restart the test sequence.
- ◆ **Stop:** Interrupt the test sequence.

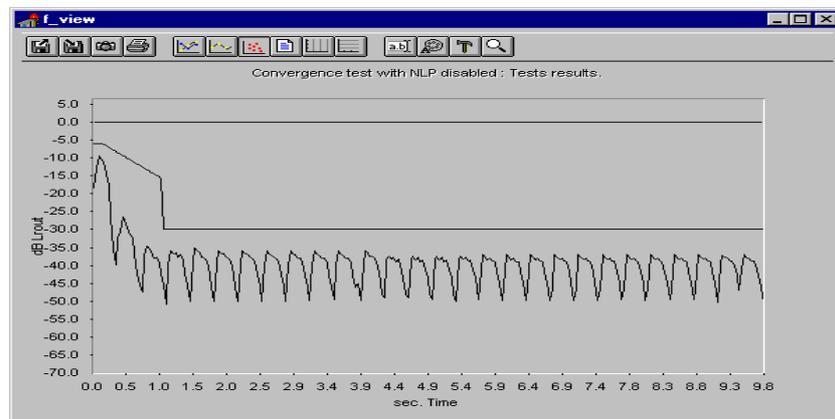
- ◆ **OK:** Go to previous dialogue box.
  - ◆ **Print:** Print the table as a report.
  - ◆ **Double-click on a line:** Display associated graphic. (N.B. Wait until the end of the test sequence before clicking.)
- Note: REFER TO G168 DOCUMENTATION FOR DETAILS OF THE SIGNIFICANCE OF THE VALUES.

### The Graphic Viewer

Double-click on a line in the Dynamic Report Viewer (Figure 6-15) to display the associated graphic. (N.B. Wait until the measurement sequence has finished before clicking.)

The graphic viewer allows the user to examine a test in more detail. Figure 6-16 shows a typical graphical display (for test No. 2B in this example).

Note that a graphical display is not available for Test No. 1 or Test No. 4.

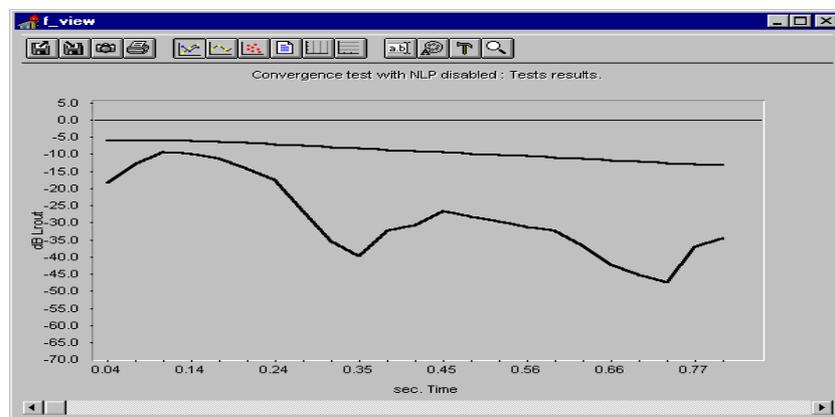


**Figure 6-16. The Graphic Viewer**

The graphic viewer displays a level/time graph of the selected test. The display is derived from a series of RMS measurements using a 35ms sliding window.

Two lines are plotted: the output level line and the limit (mask) line. If the level line is lower than the limit line for each time value, the test has been passed.

In addition to the normal view shown in Figure 6-16, it is possible to zoom on the time-scale for a magnified view. An example of a zoom view is shown in Figure 6-17.



**Figure 6-17. The Graphic Viewer in Zoom Mode**

By clicking on the tool button of the graphic viewer and choosing *Data Editor*, another useful display is presented (Figure 6-18).

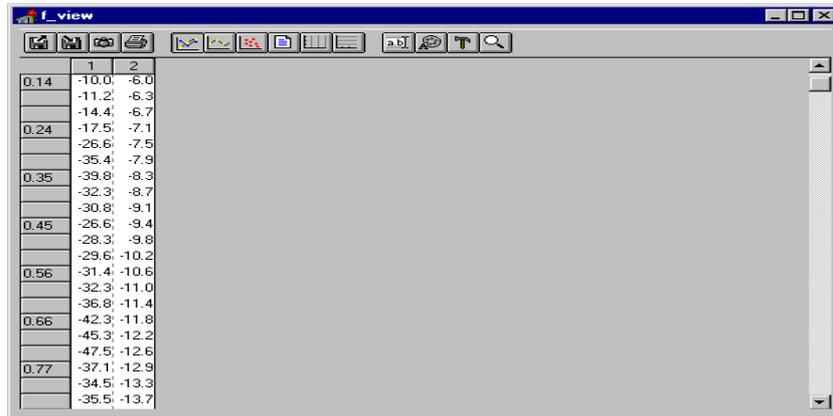


Figure 6-18. The Graphic Viewer in Data Editor Mode

The data editor shows a list of the following three values: timescale, output value, expected value.

The graphic viewer has other options that can help when checking test results, such as; save the graphic, print it, copy it on to the clipboard, and others.

### THE ECHO VIEWER

Although not part of G.168 tests, the ‘Echo Viewer’ is an additional objective *ECT-1* test facility accessed via the ‘Tests list’ window, and so is described in this section of the manual.

The Echo Viewer window consists of two graphical displays, one above the other (Figure 6-19). For a transmitted impulse, the upper plot provides a simple and convenient way to view the pure delay and pulse dispersion of the transmission network and echo path model emulated on the *ECT-1*. The lower plot shows the frequency spectrum of the received signal plotted on a linear frequency scale from 0 to 4000 Hz.

The upper graph plots the received energy in dB against time in milliseconds. The calibration is such that a transmitted impulse that suffers no attenuation or pulse spreading when transmitted round the echo path would appear as a single vertical line with its peak at 0 dB. The attenuation and dispersion width resulting from more realistic echo paths is, therefore, easily estimated from the graph. These facilities are likely to be even more useful with the G.168(2000) complex hybrid model than with the G.168 (3 simple branches) echo path model.

Section 8, “Verification Procedures”, describes how to use the Echo Viewer to measure the internal delay of the *ECT-1*.

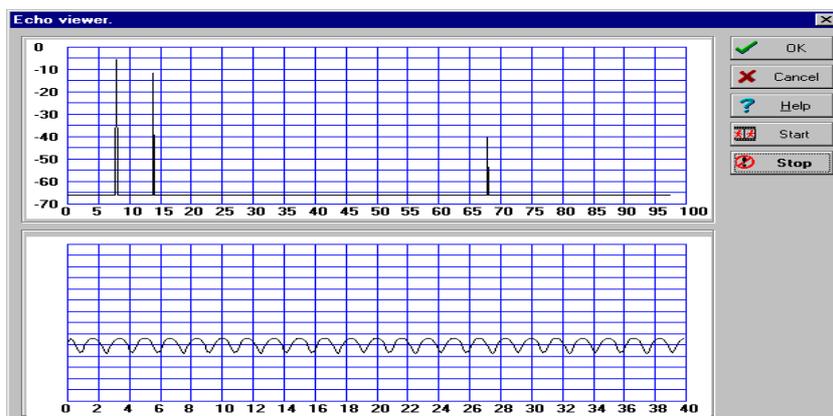


Figure 6-19. The Echo Viewer

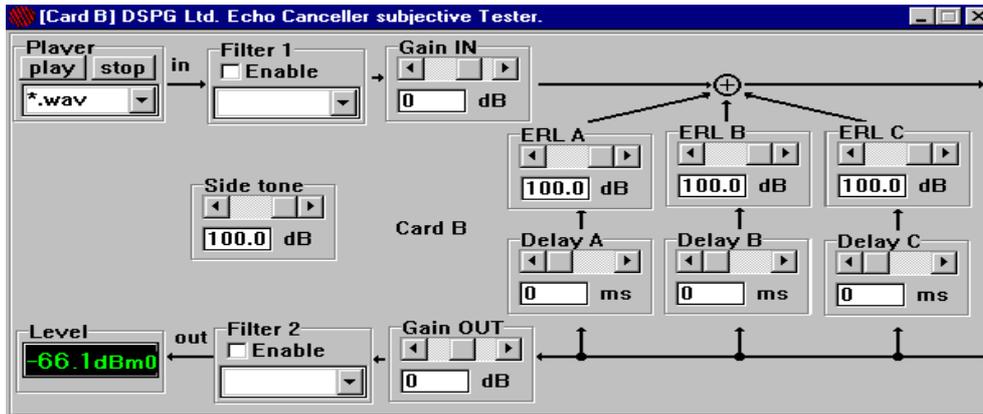
**Using the Echo Viewer:**

Set the echo canceller to bypass mode or, alternatively, replace it with direct links on the *ECT-1* (i.e. link ‘To Rin’ and ‘From Rout’, and link ‘To Sin’ and ‘From Sout’ on the *ECT-1* front panel).

Double-click on the ‘EchoA’ and ‘EchoB’ icons to view the Echo Card dialogue boxes.

Stop the level meters running on these displays by clicking on the black boxes (the level meter displays will be disabled).

Set the parameters of Echo Card B as shown in Figure 6-20.



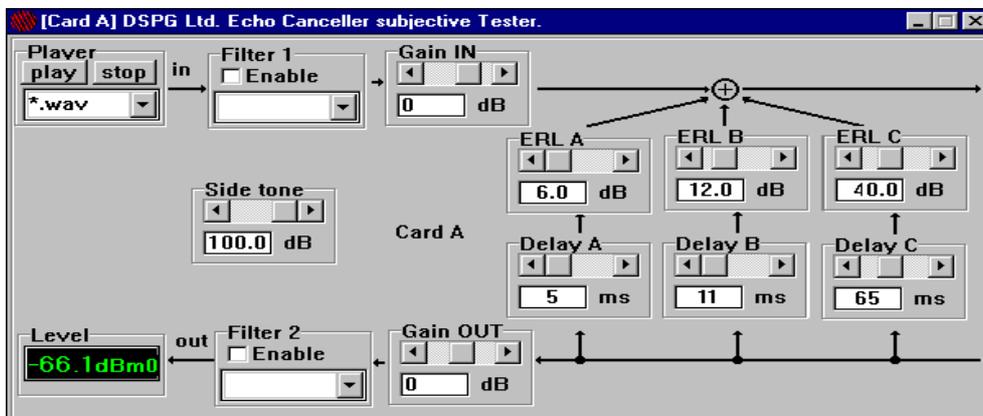
**Figure 6-20. Echo Card ‘B’ Configured for use with the Echo Viewer**

Set the parameters of the echo path on Echo Card A to the desired values.

Run the Echo Viewer software by clicking the ‘Echo View’ button in the ‘Tests list’ window, then clicking the ‘Start’ button in the Echo Viewer display.

The *ECT-1* will generate an impulse on Echo Card B, which will pass via the echo cancellers (if connected) and the emulated echo path on Echo Card A, to arrive back at Echo Card B for measurement.

The echo path parameters set on Echo Card A will have a direct influence on the Echo Viewer display. Figure 6-19 shows the Echo Viewer display when Echo Card A is set as shown in Figure 6-21; (in this instance, the Echo Card provides the only significant gain or attenuation in the loop, and the only other significant delay is due to the internal delay of the *ECT-1*).



**Figure 6-21. Example of an Echo Path Configuration on Echo Card A**

**TESTS IMPLEMENTED & STATUS - [G.168]**

Test ID	Test title	ITU status	Development status	From version
1.d	Steady state residual echo level test with NLP disabled	fully defined	released	0.6
1.e	Steady state returned echo level test with NLP enabled	fully defined	released	0.6
2A	Converge test with NLP enabled (SHORT)	NOT ITU	released	0.6
2A.L	Converge test with NLP enabled (LONG)	not fully defined	under development	0.9B
2B	Converge test with NLP disabled (SHORT)	NOT ITU	released	0.6
2B.L	Converge test with NLP disabled (LONG)	not fully defined	under development	0.9B
2C.d	Convergence test in the presence of background noise with NLP disabled	not fully defined	released	0.7
2C.e	Convergence test in the presence of background noise with NLP disabled	fully defined	released	0.7
3A	Double-talk test with low near-end levels	under study	released	0.7
3B	Double-talk test with high near-end levels	under study	released	0.7
3A.5	Double-talk test with low near-end levels (G.165)	fully defined	released	0.8d
3B.5	Double-talk test with high near-end levels (G.165)	fully defined	released	0.8d
3C	Double-talk test under simulated conversation	under study	not implemented	
4	Leak rate test	fully defined	released	0.8
5	Infinite return loss convergence test	under study	released	0.8
6	Non divergence on narrow band signals	under study	not implemented	
7	Stability test	Fully defined	beta release	0.9
8.0	Non-convergence on in-band signalling (2000 Hz)	NOT ITU	alpha release	0.9A
8.1	Non-convergence on in-band signalling (2010 Hz)	Optional – not fully defined	alpha release	0.9A
8.2	Non-convergence on in-band signalling (2400 Hz)	Optional – not fully defined	alpha release	0.9A
8.3	Non-convergence on in-band signalling (2600 Hz)	Optional – not fully defined	alpha release	0.9A
8.4	Non-convergence on in-band signalling (2400+2600 Hz)	Optional – not fully defined	alpha release	0.9A
9	Comfort noise test	under study	released	0.8
10A.e	Facsimile test during call establishment phase with NLP enabled	under study	released	0.6
10A.d	Facsimile test during call establishment phase with NLP disabled	fully defined	released	0.6
10B.e	Facsimile test with NLP enabled (canceller operation on the called station side)	under study	released	0.6
10B.d	Facsimile test with NLP disabled (canceller operation on the called station side)	fully defined	released	0.6
1S.d	Frequency response on tones transmission	NOT ITU	released	0.9
1S.e	Frequency response on tones transmission	NOT ITU	released	0.9

## **7. OBJECTIVE TESTING MODE - G.168(2000)**

### ***CONTENTS***

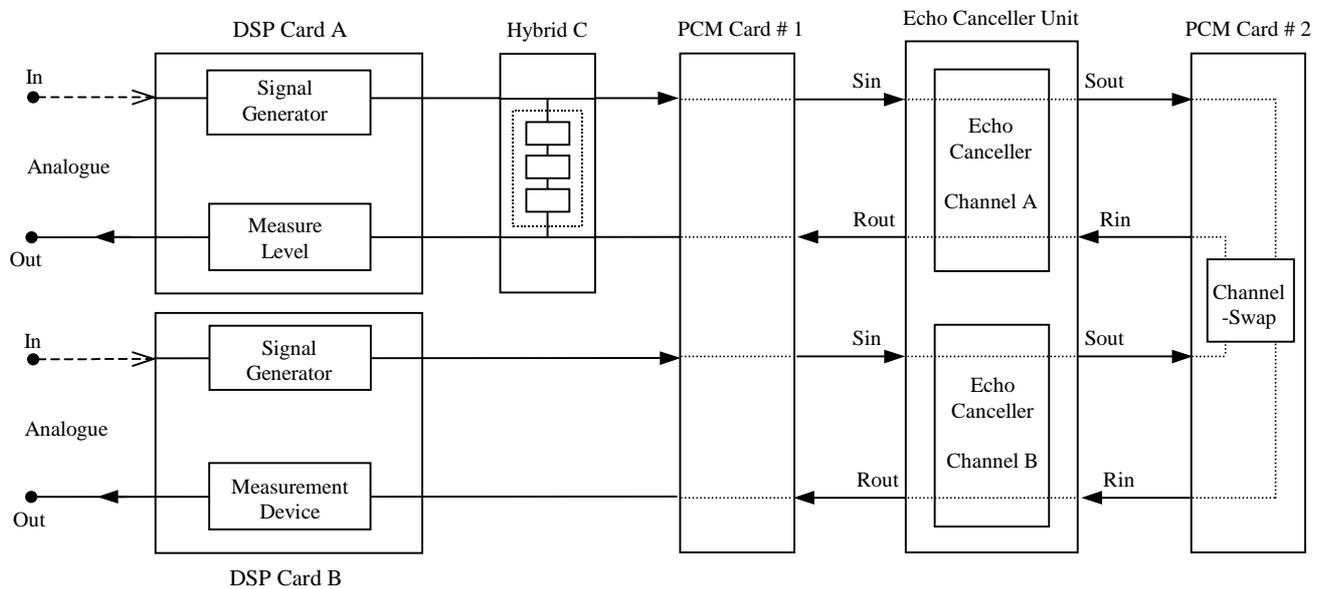
## OBJECTIVE TESTING MODE - G.168(2000)

DSPG are actively tracking progress of the G.168(2000) Recommendation so that, with the necessary hardware and software upgrade, the *ECT-1* will be capable of performing the G.168(2000) tests at the earliest possible time. Software has already been written for many of the tests in their present status, and this software will be updated as necessary.

The hardware upgrade needed to implement the alternative (single-branch) hybrid model of the G.168(2000) Recommendation is available now. The parameter values for the implementation are fully programmable, and so can be set to the G.168(2000) values once these are defined.

### HARDWARE CONFIGURATION

Figure 7-1 shows the *ECT-1* hardware configured to perform G.168(2000) objective tests with the single-branch hybrid model. The cards required in the *ECT-1* are itemized in Table 7-1.



**Figure 7-1. Hardware Configuration of the ECT-1 to Perform G.168(2000) Tests**

**Table 7-1. Cards Required in the ECT-1 to Perform G.168(2000) Tests**

Quantity	Item	Function in ECT-1	Comments
1	DS 32C board	DSP Card A	Test signal generation, and level measurement
1	DS 32C board	DSP Card B	Test signal generation, and level measurement
1	DS 32C board	Hybrid C	Emulating the G.168(2000) complex hybrid
1	DS PCM1 (E1 or T1)	PCM #1	Interfacing to the echo canceller under test
1	DS PCM1 (E1 or T1)	PCM #2	Interfacing to the echo canceller under test

Note: The reasons for the particular hardware configuration of Figure 7-1 are outlined in Appendix C.

## CONFIGURING & RUNNING A TEST SESSION

The method of performing G.168(2000) tests with the *ECT-1* is very similar to that for G.168 tests described in section 6. The differences are described below.

When preparing for the tests, the *ECT-1* should be powered-up, or the Scenario Control Utility re-loaded, in the same way as described for G.168 objective testing (section 6). To perform G.168(2000) tests, there is an additional operation to be performed in the Scenario Control Utility window if the alternative (single-branch) hybrid model is to be used. As well as selecting the E1 or T1 PCM interface, it is also necessary to enable 'Hybrid C'. Assuming the required DSP card is installed in the *ECT-1*, 'Hybrid C' will be indicated by bold lettering in the Scenario Control Utility window, and it should be enabled by clicking the button beneath it.

The Hybrid C filter parameters must be configured in accordance with the G.168(2000) specification. The method and facilities for configuring the hybrid are presented below, in the sub-section "Configuring the Hybrid Model".

To perform G.168(2000) tests, the *ECT-1* is put into objective test mode by double-clicking the 'Tester\_2000' icon. A 'Tests list' dialogue box will appear. Open the configuration dialogue box by clicking the 'Configure' button in the bottom left-hand corner of the Tests list window. Click on the 'Advanced' tab at the top of the dialogue box to view the 'Advanced' page of the configuration options. Click on 'G.168 2000' to select a G.168(2000) test session. Once this has been done, the procedure to configure and run a sequence of tests is the same as for a G.168 test session, with the same facilities available (see section 6).

### Configuring the hybrid model

To configure the G.168(2000) complex hybrid model, click the 'Hybrid C' icon on the computer *desktop*. A new window titled 'Card C' is displayed (Figure 7-2) that allows the parameters of the model to be configured.

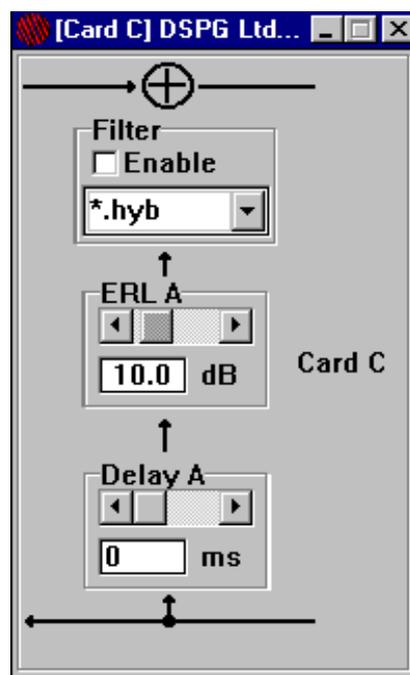


Figure 7-2. Setting the Parameters of the Hybrid Model

The hybrid model has three controls:

- ERL A in dB (unweighted attenuation),
- Delay A in milliseconds,
- Enable/Disable of the filter implementation.

However, for a G.168(2000) test session, it is only necessary for the user to specify the filename of the filter implementation, and to enable it using the check-box. The delay and ERL parameters are under the control of the ECT-1 software during the test session, and these parameters are set automatically to the values needed for the test.

The filter combo box in Figure 7.2 allows quick access to the *Filters Library*.

Double-clicking on the 'Filter' box will display a dialogue box (Figure 7-3) that allows the user to change the default directory of the 'Filters Library'. This dialogue box also allows the user to customize or create new FIR filters.

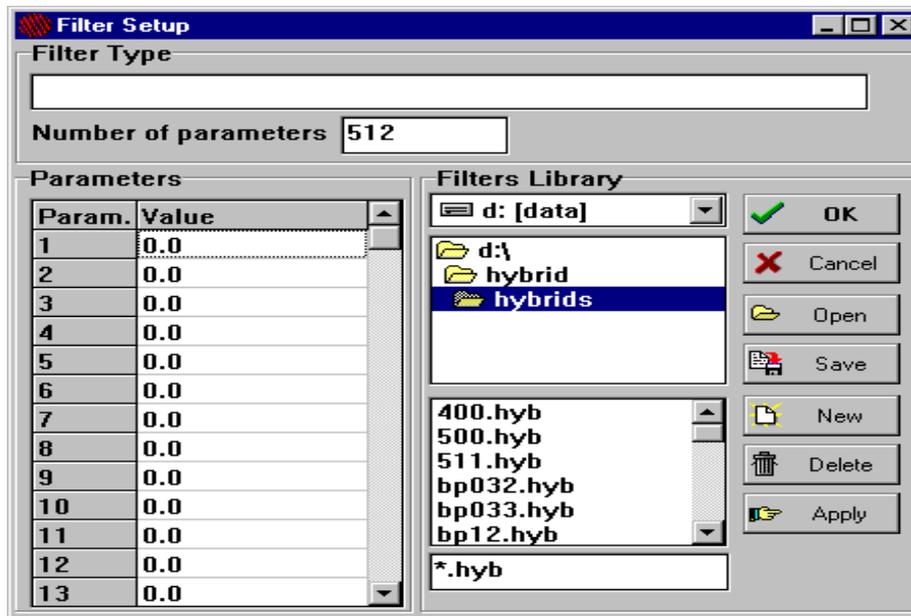


Figure 7.3. Defining the filter

All the controls for managing a filter library are present on the right-hand side of the dialogue box, so the user is able to load a pre-stored filter, create a new one, or save a filter description to a named file.

Note: The format of the file describing the filter is the same as that used by the DFDP filter design program (by Atlanta Signal Processors Inc.).

The number of taps for the FIR filter must be configured in the 'Number of Parameters' edit box, and can have a maximum value of 512.

Using the table on the left of the dialogue box, it is possible to enter the values of individual parameters manually.

Clicking the 'Apply' button writes the values into DSP memory (but does *not* save the file or display an associated filename in the Filter box of the 'Card C' dialogue box). The filter may be enabled/disabled using the check-box facility on the 'Card C' dialogue box.

To save a filter description to a specified filename, use the 'Save' button of the filter editor (Figure 7-3). The filename should be given the suffix *'.hyb'*.

**TESTS IMPLEMENTED & STATUS - [G.168(2000)]**

## **8. VERIFICATION PROCEDURES**

### ***CONTENTS***

## VERIFICATION PROCEDURES

The following sub-sections outline some suggested tests to verify the accuracy of the hardware interfaces and software processes of the *ECT-1*.

Certain verification tests require a G.168 objective test to be performed on the *ECT-1*. Before running a G.168 test, it is important that the *ECT-1* hardware is in its default configuration. In fact, the default configuration should be used for all of the verification tests described below. If the state of the hardware configuration is in doubt, it is advisable to reset the hardware by re-loading the 'Scenario Control Utility', and then select the appropriate E1 or T1 PCM interface, as described in section 6, "*Objective Testing Mode – G.168*".

### LEVEL SENT TO ECHO CANCELLER

To perform G.168 tests, the *ECT-1* generates the necessary test signals, and these must be sent to the echo canceller at specified, or known levels. Using a PRA1, it is possible to verify the accuracy of the signal levels sent to the echo canceller.

For example:

Connect an echo canceller to the *ECT-1* in the normal way or, alternatively, replace the echo canceller with direct connecting links (i.e. link 'To Rin' and 'From Rout', and link 'To Sin' and 'From Sout' on the *ECT-1* front panel).

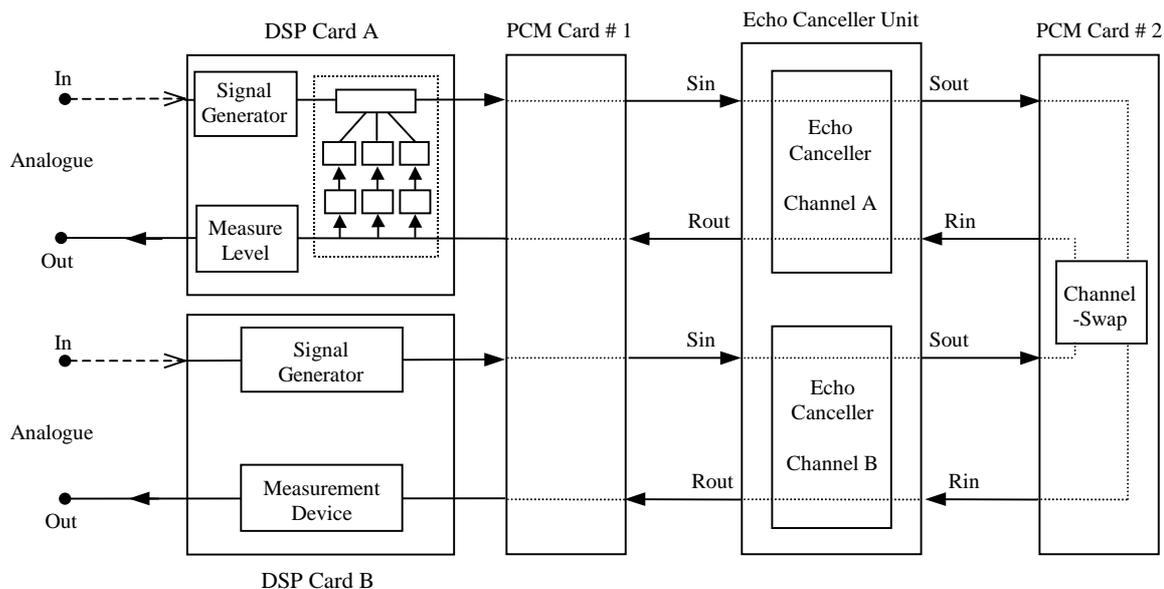
Note that if an echo canceller is connected, channel B (Figure 8-1) should be set to bypass mode. If the *ECT-1* default channels are used (i.e. the channel selection has not been modified using the Scenario Control Utility), this means that for an E1 interface, channel 2 must be set to bypass mode, and for a T1 interface channel 3 must be set to bypass mode. This operation cannot be performed by the *ECT-1*, and must be carried out using the control facilities of the echo canceller itself. (For convenience, *all* echo canceller channels may be set to bypass mode for the purposes of this test.)

Connect a PRA1 (set for high input impedance) in parallel at the Rin PCM connection.

Extract timeslot 1, and monitor the signal level on this timeslot with a reference level meter.

Run test No.1 (steady state residual echo level test with NLP disabled).

The measured level on timeslot 1 should correspond to the Lrin level (or sequence of levels) configured for the test.



**Figure 8-1. Hardware Configuration of the ECT-1 to Perform G.168 Tests**

## LEVEL RECEIVED FROM ECHO CANCELLER

Having checked the accuracy of the levels sent to Rin as described above, these confirmed levels may now be used to verify the procedures for measuring the power of a signal received from the echo canceller.

Before proceeding, both channel A and channel B (Figure 8-1) of the echo canceller should be set to bypass mode. For convenience, *all* echo canceller channels may be set to bypass mode for the purposes of this test. Alternatively, the echo canceller may be replaced with direct links on the *ECT-1* (i.e. link ‘To Rin’ and ‘From Rout’, and link ‘To Sin’ and ‘From Sout’ on the *ECT-1* front panel).

Note that when performing the RMS calculation, in general, the *ECT-1* uses a **700ms** (5600 samples) window for the purpose of **numerical display**, but uses a **35ms** (280 samples) window for the purpose of **graphical display**.

Due to the requirements of G.168, for tests 2A and 2B the calculation of *Lrin* uses a 700ms window, modified to exclude the pauses in the CSS.

### To verify the 700ms RMS measurement:

Run Test No.1.d (steady state residual echo level test with NLP disabled), and set the input level (*Lrin*) to a range of values from 0 to -30 dBm0.

Set the value of *Aecho* to 0 dB and the delay to 0ms.

Run the test. The measured levels will be displayed on the monitor.

The measured level of the residual echo signal (*Lres*) should, in this instance, be equal to the level applied at Rin (*Lrin*), as shown in Figure 8-2. This verifies the 700ms RMS level measurement procedure.

Note: For *Lrin* values greater than -4 dB the CSS is clipped, and this affects the measured level.

T.n	Td ms	Aecho	Lrin	Mask	Status	Lres	File name
1	0	0.0	-30.0	-55.0	fail	-30.0	00000300.0
2	0	0.0	-28.0	-53.3	fail	-28.0	00000280.0
3	0	0.0	-26.0	-51.7	fail	-26.0	00000260.0
4	0	0.0	-24.0	-50.0	fail	-24.0	00000240.0
5	0	0.0	-22.0	-48.3	fail	-22.0	00000220.0
6	0	0.0	-20.0	-46.7	fail	-20.0	00000200.0
7	0	0.0	-18.0	-45.0	fail	-18.0	00000180.0
8	0	0.0	-16.0	-43.3	fail	-16.0	00000160.0
9	0	0.0	-14.0	-41.7	fail	-14.0	00000140.0
10	0	0.0	-12.0	-40.0	fail	-12.0	00000120.0
11	0	0.0	-10.0	-38.3	fail	-10.0	00000100.0
12	0	0.0	-8.0	-36.7	fail	-8.0	00000080.0
13	0	0.0	-6.0	-35.0	fail	-6.0	00000060.0
14	0	0.0	-4.0	-33.3	fail	-4.1	00000040.0
15	0	0.0	-2.0	-31.7	fail	-2.5	00000020.0
16	0	0.0	0.0	-30.0	fail	-1.0	00000000.0

Figure 8-2. Level Verification Using Test 1

### To verify the 35ms RMS level measurement:

Run Test No. 2C.d (convergence test in the presence of background noise with NLP disabled) with the same parameter settings as specified above.

Wait until the test finishes.

The tabulated values for *Lres* (residual echo signal) are measured using a 700ms window, and should correspond to the levels applied at Rin (*Lrin*) for this verification test.

To verify the 35ms RMS measurement, it is necessary to view the results graphically. Choose a value of *Lrin* and double-click on the corresponding line in the table.

The active part of the displayed *Lres* signal (Figure 8-3) should be about 1.5dB greater than *Lrin*. This is because *Lrin* is calculated using a 700ms window, and therefore represents the power of the CSS including the pauses.

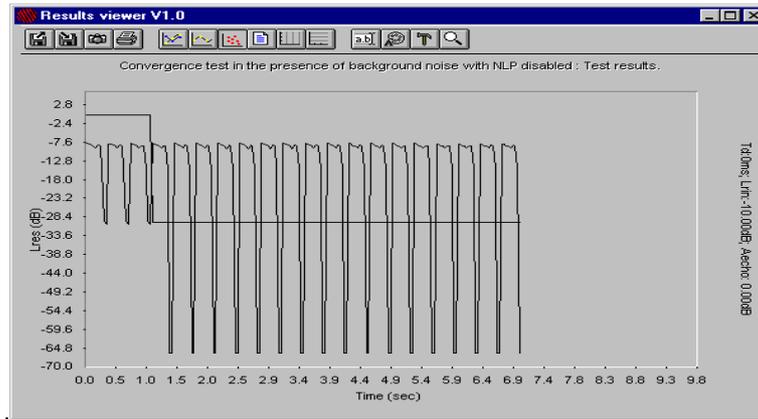


Figure 8-3. Level Verification Using Test 2C (Lrin=-10 dB)

**To verify the procedure used for tests 2A and 2B:**

Tests 2A and 2B represent a special case due to the requirements of G.168. The calculation of *Lrin* is modified to exclude the pauses in the CSS.

In the *ECT-1*, *Lret* is measured using a 35ms window for the purposes of graphical display, but for tabulated display, a 700ms window (including pauses in the CSS) is used. *Lrin* is measured using a 700ms window, modified to exclude the pauses, and this is the value shown in the tabulated display of test results.

Run Test No. 2A (convergence test with NLP enabled) with the same parameter settings as specified above.

The measured level of the returned echo signal (*Lret*) may be compared with the level applied at *Rin* (*Lrin*). Specimen results are illustrated in Figure 8-4.

Note that because the algorithm used to measure *Lret* differs to that used for calculating *Lrin*, the measured level '*Lret*' should be approximately 1.5dB less than the level '*Lrin*'.

T.n	Td ms	Aecho	Lrin	Mask	Status	Lret	Ctime
1	0	0.0	-30.0	-65.0	fail	-31.5	0
2	0	0.0	-28.0	-65.0	fail	-29.6	0
3	0	0.0	-26.0	-65.0	fail	-27.6	0
4	0	0.0	-24.0	-65.0	fail	-25.5	0
5	0	0.0	-22.0	-65.0	fail	-23.5	7000
6	0	0.0	-20.0	-65.0	fail	-21.5	0
7	0	0.0	-18.0	-65.0	fail	-19.5	6965
8	0	0.0	-16.0	-65.0	fail	-17.5	7035
9	0	0.0	-14.0	-65.0	fail	-15.5	7035
10	0	0.0	-12.0	-65.0	fail	-13.5	7035
11	0	0.0	-10.0	-65.0	fail	-11.5	7035
12	0	0.0	-8.0	-63.0	fail	-9.5	7035
13	0	0.0	-6.0	-61.0	fail	-7.5	7035
14	0	0.0	-4.0	-59.0	fail	-5.5	7035
15	0	0.0	-2.0	-57.0	fail	-3.7	7035
16	0	0.0	0.0	-55.0	in progress		

Figure 8-4. Level Verification Using Test 2A

**ANALOGUE OUTPUT**

Set the echo canceller to bypass mode or, alternatively, replace it with direct links on the *ECT-1* (i.e. link 'To Rin' and 'From Rout', and link 'To Sin' and 'From Sout' on the *ECT-1* front panel).

Use a level meter (600 Ohm load) connected directly to the analogue output of 'Interface A' of the *ECT-1*.

Run the fax test (test No. 10) which generates sine waves with a fixed power of -13 dBm0.

The absolute gain error of the D/A converter is ±1 dB.

The maximum output level is 4V peak-to-peak (clipping point).  
 The 0 dBm0 value is equivalent to 1V RMS.

## ANALOGUE INPUT

Set the echo canceller to bypass mode or, alternatively, replace it with direct links on the *ECT-1* (i.e. link 'To Rin' and 'From Rout', and link 'To Sin' and 'From Sout' on the *ECT-1* front panel).

Connect a reference signal (sine wave) generator to the analogue input of 'Interface B' of the *ECT-1*.

Use the software facilities for Echo Card A to check the levels (Figure 8-5).

Set all the ERL controls to 100 dB.

Set the Side-tone control to 100 dB.

Set the other Gain controls to 0 dB.

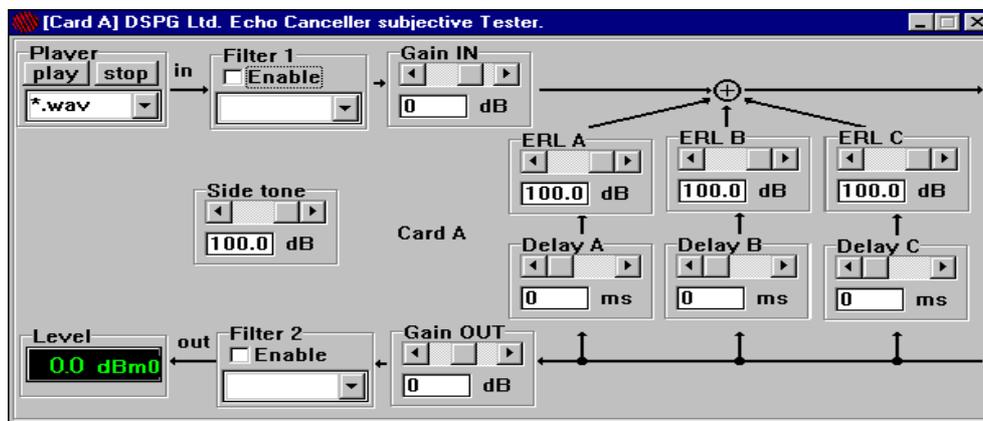


Figure 8-5. Input Level Verification using the Echo Card Software

The maximum input value is 4V peak-to-peak (clipping point).

The 0 dBm0 value is equivalent to 1V RMS.

The absolute gain error of the A/D converter is  $\pm 1$  dB.

## INTERNAL DELAY

To test the internal delay of the *ECT-1*, disconnect the echo canceller, and link the PCM I/O (E1 or T1) front panel connections of the *ECT-1* in the following manner; link 'To Rin' and 'From Rout', and link 'To Sin' and 'From Sout'.

To test the total delay, connect the echo canceller unit in the usual way and set it to bypass mode.

Set the parameters of the Echo Cards A and B as in Figures 8-6 and 8-7 respectively.

Stop the level meters running by clicking on the black boxes (the displays will be disabled).

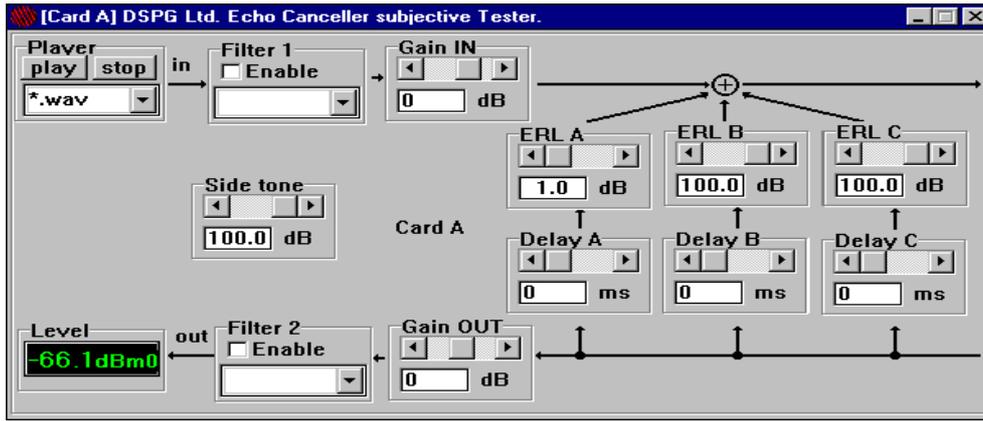


Figure 8-6. The Echo Card Configured to Check the Delay (CARD A)

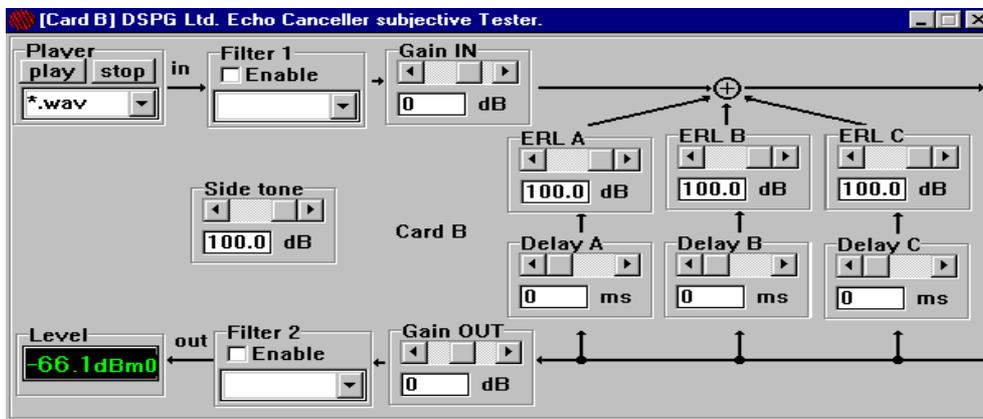


Figure 8-7. The Echo Card Configured to Check the Delay (CARD B)

Run the Echo Viewer software by double clicking on the ‘Tester’ icon, clicking the ‘Echo View’ button in the ‘Tests list’ window, then clicking the ‘Start’ button in the Echo Viewer display.

The ECT-1 will generate an impulse on Echo Card B, which will pass via the echo cancellers (if connected) and the emulated echo path on Echo Card A, to arrive back at Echo Card B for measurement.

The delayed impulse arriving back at Echo Card B will be displayed in the upper graph of the Echo Viewer display (Figure 8-8). The lower graph shows the frequency spectrum of this signal.

In Figure 8-8, the single vertical line on the top plot represents the delayed impulse. The delay value is indicated by the scale (milliseconds) on the x axis of the graph.

The impulse is delayed even though Echo Card A is set to emulate an echo path with zero delay. The delay value represents the internal delay of the ECT-1 plus the delay of the echo canceller (if connected).

[Note: Because of the basic hardware configuration shown in Figure 8-1, if an echo canceller unit is connected, the total delay will consist of the internal delay of the ECT-1 plus the delay of two echo cancellers connected as shown in the Figure. (The reasons for the choice of hardware configuration are discussed in Appendix C.) ]

The internal delay of the ECT-1 alone, is usually less than 3ms. Only half this delay (~1.5ms) is in the echo path of the echo canceller under test, therefore only this value need be taken into account when customizing the echo path delay parameter.

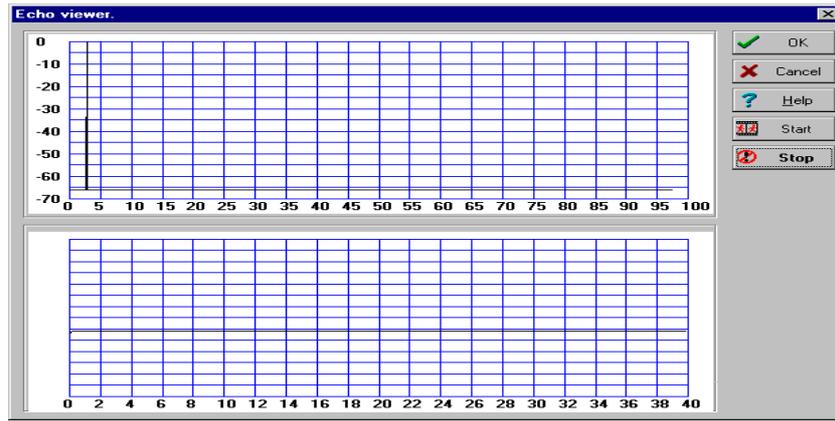


Figure 8-8. The Echo Viewer during the Internal Delay Test

### ERL & ECHO PATH DELAY

To check the accuracy of the echo path generator, configure the Echo Cards as described above for the *Internal Delay* test.

By adjusting the controls of Echo Card A, it is possible to verify the accuracy of any single control.

Figure 8-10 shows the three delayed impulses resulting from the echo path settings shown in Figure 8-9. Note that the internal delay of the *ECT-1* (~3ms) features in each delayed impulse.

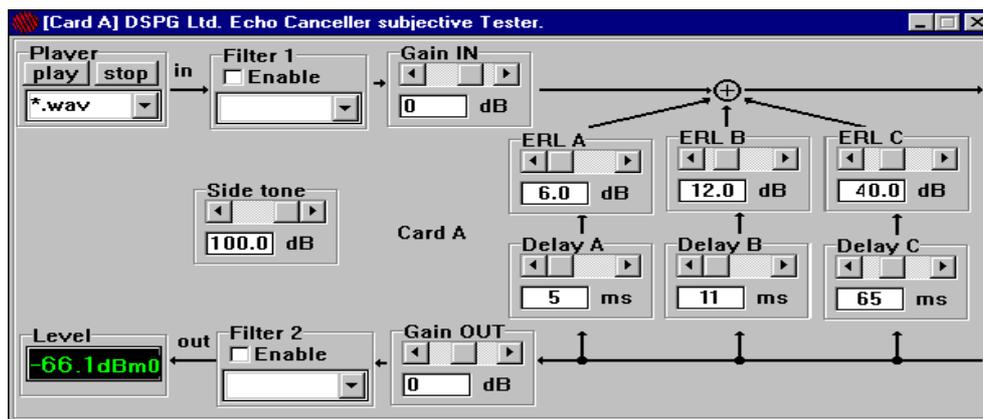


Figure 8-9. Example of a Configuration to Verify the Echo Generator

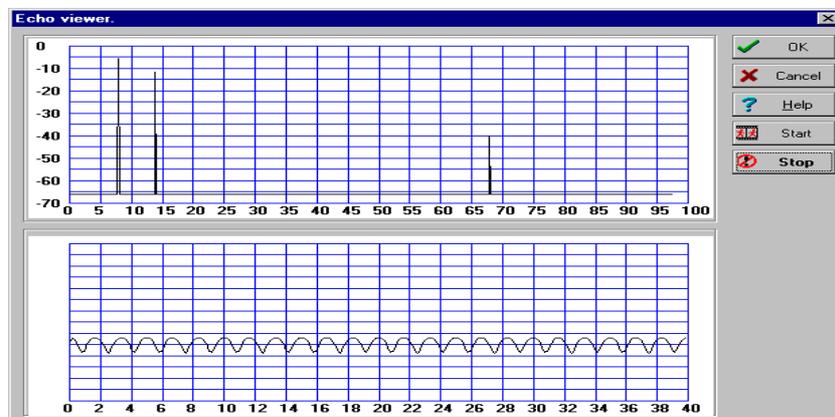


Figure 8-10. The Echo Viewer when Echo Card 'A' is Configured as in Figure 8-9

## XDELAY

The value of 'Xdelay' is set via the Scenario Control Utility window, and refers to the 'extra delay' (0 to 1500 ms) that can be inserted between the echo cancellers at opposite ends of the emulated link to represent trunk or satellite delay.

The accuracy of the 'Xdelay' generator may be checked using the Echo Viewer. However, this check is restricted by the range of the Echo Viewer time axis (0 to 100 ms).

Configure the Echo Cards as described above for the *Internal Delay* test.

By adjusting the 'Xdelay' value in the Scenario Control Utility window, it is possible to check that the received impulse is delayed by the expected amount in the Echo Viewer display. As 'Xdelay' is implemented in both directions of transmission, the received impulse should appear on the Echo Viewer time axis at a time equal to *twice* the 'Xdelay' setting, plus the internal delay of the *ECT-1*. This limits the 'Xdelay' setting to less than 48ms for the purposes of this test.

## EVENTS TIMING

Using a two-channel digital oscilloscope the user may check the correct timing of events during any test.

Connect one channel of the oscilloscope to the analogue output of 'Interface B', and the other channel to pin 3 of the 'TTL' D-type connector on the front panel of the *ECT-1*. (Pin 3 of the D-type controls echo canceller convergence.)

Use pin 5 of the 'TTL' D-type (the *Testing* line) to trigger the scope in single-shot mode.

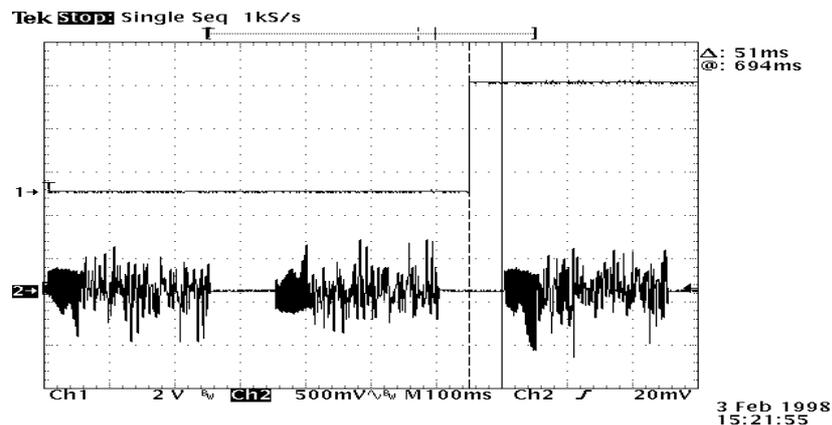


Figure 8-11. Snapshot of the Oscilloscope during Test 2

The oscilloscope will show when the command signal is sent to the echo canceller relative to the timing of the signal at the analogue output.

The actual moment the command is applied in the echo canceller depends on implementation dependent delay associated with the type of control link used (TTL or V24/RS232).

For a direct TTL connection this delay should be less than 5ms.

For a serial RS232 connection this delay may be greater than 50ms. In this case a correction factor is needed.

Use the 'Response Delay' facility in the 'Connections' page of the *ECT-1* 'Configuration Options' to apply a correction factor (Figure 8-12).

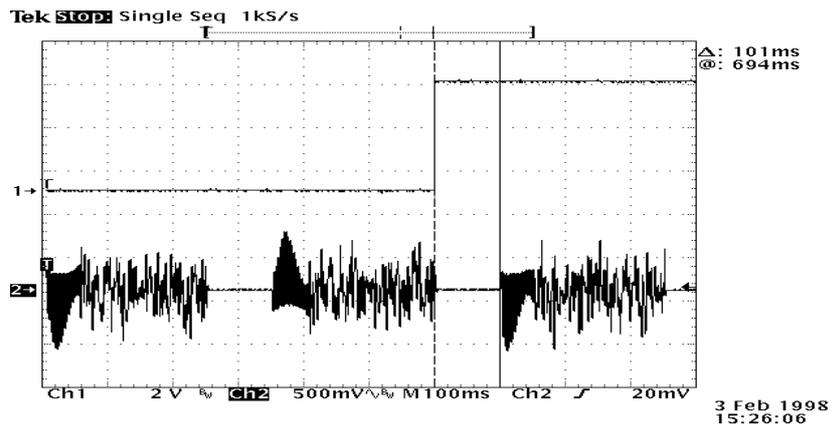


Figure 8-12. Snapshot of the Scope during Test 2 Using a Response Delay Correction Factor of 50ms

## **9. TROUBLESHOOTING**

### ***CONTENTS***

## TROUBLESHOOTING

The troubleshooting information below is intended to provide guidance in the event of basic set-up and operating problems. If a problem cannot be solved after reference to these notes, the user should contact DSPG for assistance. **The ECT-1 unit should not be opened, and on no account should modification or repair to the internal cards of the ECT-1 be attempted, without specific instruction from DSPG.**

Note that all the cards in the ECT-1 are configured and controlled by the in-built single-board computer. This has significant advantages, since firmware and software upgrades to the cards only require software upgrades on the PC. As all the hardware is controlled by software on the PC, there is no 'reset' button such as that found on certain types of DSP test equipment. In the event of a problem in the 'Windows 95' operating environment, re-start the PC in the usual way.

### THE PCM INTERFACE

The Status Indicator Lights, 'Signal' and 'Sync' in the Scenario Control Utility window, show whether the unit is connected and running correctly. If both sets of lights (PCM A and PCM B) are yellow, this indicates that the unit is connected properly and the PCM set-up is correct. If the *Signal* light is red, this means there is a loss of signal and if the *Sync* light is red there is either no connection or an incorrect PCM set-up.



*Figure 9-1. Status Indicator Lights*

Note that either the ECT-1 or the echo canceller must be configured to supply the reference timing. If both are configured to operate in 'slave' mode, the status lights may not warn of the problem, but the performance of the PCM interface and other aspects of the tester may be affected.

If a red light is present, check the PCM set-up and the connections to the PCM I/O section of the front panel of the ECT-1 unit. If the problem cannot be diagnosed, contact DSPG for assistance.

### THE INITIALIZATION REPORT

An early indication of a hardware problem in the ECT-1 can be obtained by clicking the 'Init Report' button in the bottom left-hand corner of the Scenario Control Utility window after the initialization software has loaded. The status of the DSP and PCM cards will be displayed, and all lines of the report should be commented "OK". Three lines will be displayed per card, and they will be similar to the following:

OK: blanking DSP32C card 80MHz (C) at 210...  
 OK: loading LCA DSP32C card 80MHz (C) at 210...  
 OK: storing DSP32C card 80MHz (C) at 210...

If any lines are commented "FAIL", this indicates there may be a problem with the DSP or PCM card concerned. Contact DSPG for assistance.

### THE REPORT MEMO BOX

When an objective test is selected to be run, the lower half of the window that is initially displayed contains the 'Report Memo Box' (Figure 9-2).

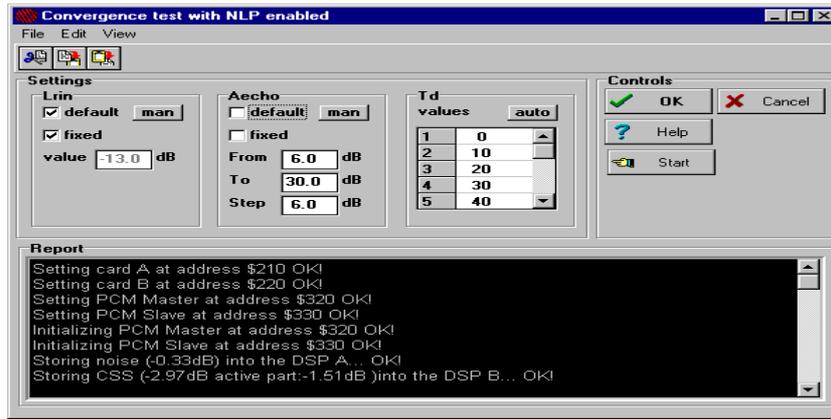


Figure 9-2. The Report Memo Box

The report memo box contains the initialization procedure error reports in case of hardware or software failures. This facility helps to identify the cause of problems. Refer to the table below for problem solving:

Table 9-1. Interpreting the Report Memo Box Messages

STRING ON THE BOARD	CAUSE	REMEDY
Setting card A at address \$000 FAIL! Setting card B at address \$000 FAIL! Setting PCM Master at address \$000 FAIL! Setting PCM Slave at address \$000 FAIL!	The cards are missing, or there is some other hardware problem.	Check presence of cards by double-clicking 'Autodet', then contact DSPG for assistance.
Setting card A at address \$210 OK! Setting card B at address \$220 OK! Setting PCM Master at address \$320 OK! Setting PCM Slave at address \$330 OK! Initializing PCM Master at address \$320 FAIL! Initializing PCM Slave at address \$330 FAIL!	The cards are OK but the hardware is not initialized.	Re-load the Scenario Control Utility by double-clicking on 'HW_setup'.
Setting card A at address \$210 OK! Setting card B at address \$220 OK! Setting PCM Master at address \$320 OK! Setting PCM Slave at address \$330 OK! Initializing PCM Master at address \$320 OK! Initializing PCM Slave at address \$330 OK! Storing noise (-0.33dB) into the DSP A... OK! Storing CSS into the DSP B... FAIL!	There is not enough memory in some DSP cards or the card is damaged.	Contact DSPG for assistance or hardware upgrade.
Setting card A at address \$210 OK! Setting card B at address \$220 OK! Setting PCM Master at address \$320 OK! Setting PCM Slave at address \$330 OK! Initializing PCM Master at address \$320 OK! Initializing PCM Slave at address \$330 OK! Storing noise (-0.33dB) into the DSP A... OK! Storing CSS (-2.97dB active part:-1.51dB) into the DSP B... OK!	Everything is OK.	

In the case of any other messages, it is possible to copy the text on to the clipboard, ready to be pasted into a word processor. The user can then send the message to DSPG for assistance.

(The report memo box also shows the addresses of cards used in the tests, the date and time, and other information concerning the test about to be performed, including details of the signals needed to perform the current test, and the time it will take to run.)

## UNEXPECTED RESULTS FOR OBJECTIVE TESTS

If objective test results suggest that there may be a problem with the test set-up, the following points should be checked.

- Are the PCM connections between the *ECT-1* and the echo canceller connected correctly?  
*Check that the send and receive paths of the echo canceller are not swapped. Refer to section 4, "Connecting an Echo Canceller".*
- Is the hardware configuration of the *ECT-1* correct?  
*If in doubt, re-load the 'Scenario Control Utility'. Refer to section 6, "Objective Testing Mode – G.168".*
- Is the echo canceller E1 or T1 PCM interface configured to match the *ECT-1* PCM interface?  
*Refer to section 4, "Connecting an Echo Canceller".*
- Does the PCM channel selection in the Scenario Control Utility correspond to the echo canceller channels selected for the tests?  
*Refer to the sub-section "The Scenario Control Utility" within section 5.*
- Has 'channel B' of the echo canceller been correctly set to bypass mode?  
*This has to be set at the echo canceller (not the ECT-1). Refer to section 6, "Objective Testing Mode – G.168".*
- Is the echo canceller control port connected to the correct connector on the *ECT-1*?  
*Check that the correct connector (V24 or TTL) is used on the ECT-1. Refer to section 4, "Connecting an Echo Canceller".*
- If V24/RS232 control of the echo canceller is used, has the communications protocol been configured correctly?  
*Refer to the sub-section "Configuring the Communication Protocol" in section 6.*
- If TTL control of the echo canceller is used, has the active logic state been selected correctly?  
*Refer to the sub-section "Configuring the Communication Protocol" in section 6.*
- If TTL control of the echo canceller is used, are the *ECT-1* control lines connected to the appropriate control points on the echo canceller?  
*Refer to Appendix D, "Cabling".*
- Does the echo canceller feature comfort noise injection (or equivalent feature)?  
*Comfort noise features must be disabled for certain G.168 tests.*
- Does the echo canceller contain additional enhancement features (e.g. noise reduction, automatic level control)?  
*These features should be disabled at the echo canceller for the purposes of G.168 tests.*

## **10. OPTIONAL MODULES**

### *CONTENTS*

## OPTIONAL MODULES

### CODECS

The *ECT-1* can be used to allow subjective evaluation of echo cancellers in an emulated network connection. The ability to introduce low bit rate codecs into the connection increases the number of network scenarios that can be assessed.

A common requirement is to evaluate performance with GSM coding in the echo path of the canceller. GSM coding is available as an option with the *ECT-1*, and requires one additional DSP card per codec. If the codec is installed, it can be instantly enabled or disabled using the facilities of the Scenario Control Utility window. This allows easy comparison of performance with and without GSM coding.

In addition to GSM coding, other standard codec types are possible on request to DSPG. Such codecs include the G.721, G.726, G.728 and G.729 standards.

### STANDALONE VIEWER SOFTWARE

A software module is available that requires no connection to the *ECT-1* hardware, but will allow earlier test results to be viewed. Using the data from a previous test session, the user can process the data a second time, even on a separate computer. Using this feature, the user can archive different testing sessions of different echo cancellers and compare them using any PC as a notebook.

The software is supplied on CD-ROM, and is simply copied to the main C:\ directory on the PC. A 'short-cut' may be placed on the desktop for convenience, or the \*.exe file may be run directly.

### THE HIGH QUALITY A/D & D/A

Due to clock synchronization considerations, presently, **the optional high quality A/D D/A card can only be used when the PCM I/O interface is configured for the E1 mode of operation, and the *ECT-1* is providing the reference timing.**

The high quality A/D D/A card is used when the *ECT-1* is operated in its subjective evaluation mode, and ensures that subjective opinions or analogue measurements do not suffer the unwanted effects of inferior quality A/D D/A conversion.

The high quality A/D uses delta-sigma modulation with 64x oversampling, followed by linear-phase, digital anti-alias filtering and decimation. Resolution is 16-bits, signal-to-(noise + distortion) is better than 90dB, and total harmonic distortion is typically 0.001%.

The high quality D/A includes an 8x digital interpolation filter followed by a 64x oversampled delta-sigma D/A converter, and an ultra-linear analogue low-pass filter. Resolution is 16-bits, and signal-to-(noise + distortion) is better than 90dB at maximum output level.

#### *The Connectors:*

When the *ECT-1* is configured to use the high quality A/D D/A, the analogue input and output connections to the *ECT-1* must be made to the 'General I/O' section of the instrument's front panel. (For the standard 14-bit A/D D/A, the connections are made to the 'Analogue I/O section' of the front panel.)

The 'General I/O' section of the front panel contains four connectors. Two of the connectors represent the I/O interface at one end of the emulated connection ('Interface C'), and the other two connectors represent the I/O interface at the other end of the connection ('Interface D'). The function of each connector is given by the following:

**Interface C:**

- Connector **G1**: Analogue input to A/D driving 'Echo Card A'  
 Connector **G2**: Analogue output from D/A driven by 'Echo Card A'

**Interface D:**

- Connector **G3**: Analogue input to A/D driving 'Echo Card B'  
 Connector **G4**: Analogue output from D/A driven by 'Echo Card B'

***Selecting the High Quality A/D D/A:***

Following power-up of the unit, run the 'Scenario Control Utility' software in the usual way, i.e. by double-clicking on the 'HW\_setup' icon on the monitor screen.

In the Scenario Control Utility window, use the Interface selection facilities in the 'PCM A' box to select the E1 PCM interface **and** the high quality A/D D/A, by selecting '*E1 Hi ma*'. The *ECT-1* will provide the PCM reference timing, and the high quality A/D D/A will be used instead of the standard 14-bit A/D D/A.

***A/D D/A Calibration:***

The high quality A/D and D/A are calibrated during manufacture, and in normal conditions there is no need for subsequent re-calibration. Furthermore, calibration of the input offset is not critical because of the automatic offset removal in the digital domain, and inexact calibration of the output offset is unlikely to have any significance for subjective evaluation.

If it is considered necessary to calibrate either the gain or the offsets of the A/D D/A card, this may be achieved by following the procedure outlined below:

Instruments required: A signal generator

A calibrated RMS level meter

A very small slot-head screwdriver or a trimmer-adjusting tool

- Make the following connections on the front panel of the *ECT-1* ('PCM I/O' section): Connect "From S out" (E1 B) to "To S in" (E1 A) using a BNC-to-BNC cable link. Then connect "From R out" (E1 A) to "To R in" (E1 B) using another BNC-to-BNC cable link.
- Run the Scenario Control Utility software and select the E1 interface and high quality A/D D/A as described above.
- Run Echo Card A software by double-clicking the 'EchoA' icon on the monitor screen.
- Set Echo Card A parameters as follows:
  - Set all ERL to 100 dB
  - Set all Delays to 0 ms
  - Set Gain In to -60 dB
  - Set Gain Out to -20 dB
  - Set Side Tone to 0 dB
- Run Echo Card B software by double-clicking the 'EchoB' icon on the monitor screen.
- Set Echo Card B parameters as shown above for Card A.
- Run the Level Calibration Utility Card B software by double-clicking the 'Calibrate B' icon. A new window is displayed as shown in Figure 10-1.



Figure 10-1. The Screen Layout of the Level Calibration Software

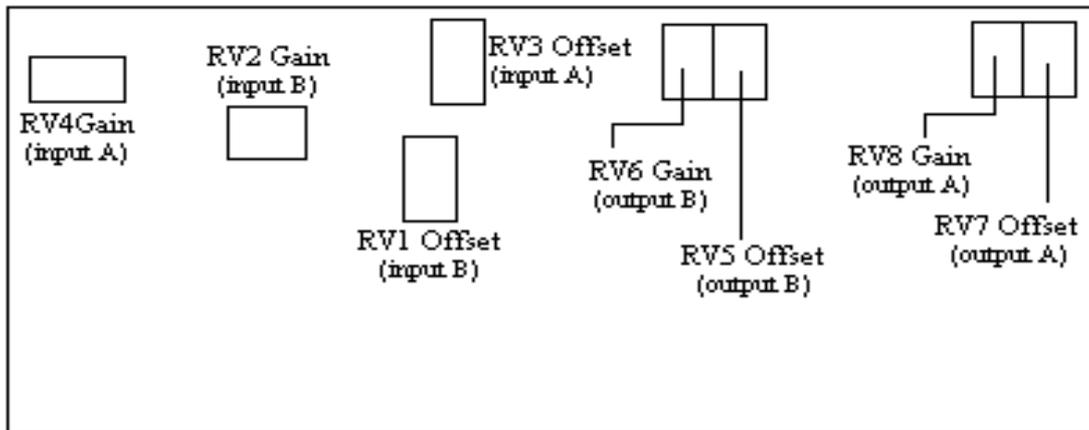


Figure 10-2. Trimmers Layout

- Perform the following 4 steps to adjust the input and output offsets and input and output gains.

*Step 1) Adjust the input offset*

Disconnect all cabling attached to Interface C (connectors G1 and G2) and Interface D (connectors G3 and G4).

Using the screwdriver or trimming tool, rotate the trimmer labelled RV1 (Figure 10-2) until the input offset is zero, as indicated by the upper two rows (*Peak+*, *Peak-*) on the Level Calibration Utility Card B screen display. When correctly set, the display values should be similar to those in Figure 10-1.

*Step 2) Adjust the input gain*

Connect a signal generator to the port 'Interface D G3' (input Card B) on the front panel of the unit.

Generate a sine wave signal at approximately 1 kHz with peak-to-peak amplitude of 1 Volt (0.3536Vrms). If the output level of the signal generator is not accurately calibrated, it will be necessary to confirm this level using the RMS level meter.

Using the screwdriver or trimming tool, rotate the trimmer labelled RV2 until an indication of 1 Volt is obtained in the centre column of the bottom row (*Pk 2 Pk*) on the Level Calibration Utility Card B screen display.

Disconnect the signal generator from the port 'Interface D G3' (input Card B) on the front panel of the unit.

*Step 3) Re-check the input offset*

The adjustment made in step 2 may cause a small change to the input offset. Repeat step 1, readjusting the input offset if necessary.

*Step 4) Adjust the output offset*

Connect the level meter to the 'Interface D G4' (output Card B).

Using the screwdriver or trimming tool, rotate the trimmer labelled RV5 until minimum DC offset is achieved, as indicated on the level meter. (The frequency response of the RMS level meter must extend down to d.c. for this test. Alternatively, a normal oscilloscope (d.c. coupled) can be used.)

*Step 5) Adjust the output gain*

Connect a signal generator to the 'Interface D G3' (input Card B).

Generate a sine wave at approximately 1kHz, and with an amplitude of 1Volt peak-to-peak.

Connect the level meter to the 'Interface D G4' (output Card B).

Using the screwdriver or trimming tool, rotate the trimmer labelled RV6 until the voltage indicated on the level meter is 0.354 Vrms.

- Run the Level Calibration Utility Card A software by double-clicking the 'Calibrate A' icon.
- Perform the following 4 steps to adjust the input and output offsets and input and output gains.

*Step 1) Adjust the input offset*

Disconnect all cabling attached to Interface C (connectors G1 and G2) and Interface D (connectors G3 and G4).

Using the screwdriver or trimming tool, rotate the trimmer labelled RV3 (Figure 10-2) until the input offset is zero, as indicated by the upper two rows (*Peak+*, *Peak-*) on the Level Calibration Utility Card A screen display. When correctly set, the display values should be similar to those in Figure 10-1.

*Step 2) Adjust the input gain*

Connect a signal generator to the port 'Interface C G1' (input Card A) on the front panel of the unit.

Generate a sine wave signal at approximately 1 kHz with peak-to-peak amplitude of 1Volt (0.3536Vrms). If the output level of the signal generator is not accurately calibrated, it will be necessary to confirm this level using the RMS level meter.

Using the screwdriver or trimming tool, rotate the trimmer labelled RV4 until an indication of 1 Volt is obtained in the centre column of the bottom row (*Pk 2 Pk*) on the Level Calibration Utility Card A screen display.

Disconnect the signal generator from the port 'Interface C G1' (input Card A) on the front panel of the unit.

*Step 3) Re-check the input offset*

The adjustment made in step 2 may cause a small change to the input offset. Repeat step 1, readjusting the input offset if necessary.

#### *Step 4) Adjust the output offset*

Connect the level meter to the 'Interface C G2' (output Card A).

Using the screwdriver or trimming tool, rotate the trimmer labelled RV7 until minimum DC offset is achieved, as indicated on the level meter. (The frequency response of the RMS level meter must extend down to d.c. for this test. Alternatively, a normal oscilloscope (d.c. coupled) can be used.)

#### *Step 5) Adjust the output gain*

Connect a signal generator to the 'Interface C G1' (input Card A).

Generate a sine wave at approximately 1kHz, and with an amplitude of 1Volt peak-to-peak.

Connect the level meter to the 'Interface C G2' (output Card A).

Using the screwdriver or trimming tool, rotate the trimmer labelled RV8 until the voltage indicated on the level meter is 0.354 Vrms.

[Note: The minimum values that the level meter measures can be lower than -66 dBm0, because of incorrect calibration. This can be solved by implementing a high pass filter just before the output: (Filter2 on Echo Card A, or Echo Card B). Users must define their own filters, as they are not provided by DSPG.]

## **THE COMPLEX HYBRID MODEL**

### ***Introduction:***

The standard echo model supplied with the *ECT-1* conforms to the requirements of G.168, and must be used when performing the G.168 tests in order for the results to be valid. The G.168 model consists of three separate echo paths, each with its own delay and simple attenuation. There is some concern that this echo model may not adequately represent real networks, therefore echo canceller objective test results may not reflect performance in the network.

Because of these concerns, the ITU have proposed an alternative, more realistic hybrid model that can be used when performing tests according to G.168(2000). This new Recommendation is still in draft status, and full details of the hybrid model are not yet finalized. However the basic structure of the hybrid model is known, and consists of three elements: delay, attenuation, and an FIR filter.

In readiness for the G.168(2000) Recommendation, DSPG have developed software to implement the model on the *ECT-1*. One additional DSP card is required per hybrid. All parameters are configurable, so it will be a simple matter to set them for the G.168(2000) model as soon as the details are available. The procedure to run G.168(2000) tests on the *ECT-1* is described in section 7 of this manual.

In the mean time, users may wish to conduct their own experiments using the *ECT-1* with the complex hybrid option. For example, the hybrid could be configured to be typical for a particular network, allowing echo canceller performance to be investigated with direct relevance to that network. The objective tests should be conducted as described in section 7, "*Objective Testing Mode – G.168(2000)*".

For subjective test purposes, two of the complex hybrid cards are required – one for each end of the emulated connection. By conversing over the emulated connection, the performance of the echo canceller can be investigated with realistic hybrid models.

The basic delay of the hybrid emulation is only one sample period of the PCM bit stream (0.125ms), and so adds very little to the total internal delay of the *ECT-1*.

### ***Enabling the complex hybrid model:***

The Scenario Control Utility window is displayed when the user double-clicks on the 'HW\_setup' icon, and this action resets the *ECT-1* hardware configuration to its default status. In the Scenario Control Utility window, the first step is to use the Interface selection facilities in the 'PCM A' box to select either the E1 or T1 PCM interface. Master mode ('E1ma' or 'T1ma') or slave mode ('E1sl' or 'T1sl') may be selected. (In master mode the PCM reference timing is provided by the *ECT-1*, and in slave mode the reference timing is provided by the echo canceller.)

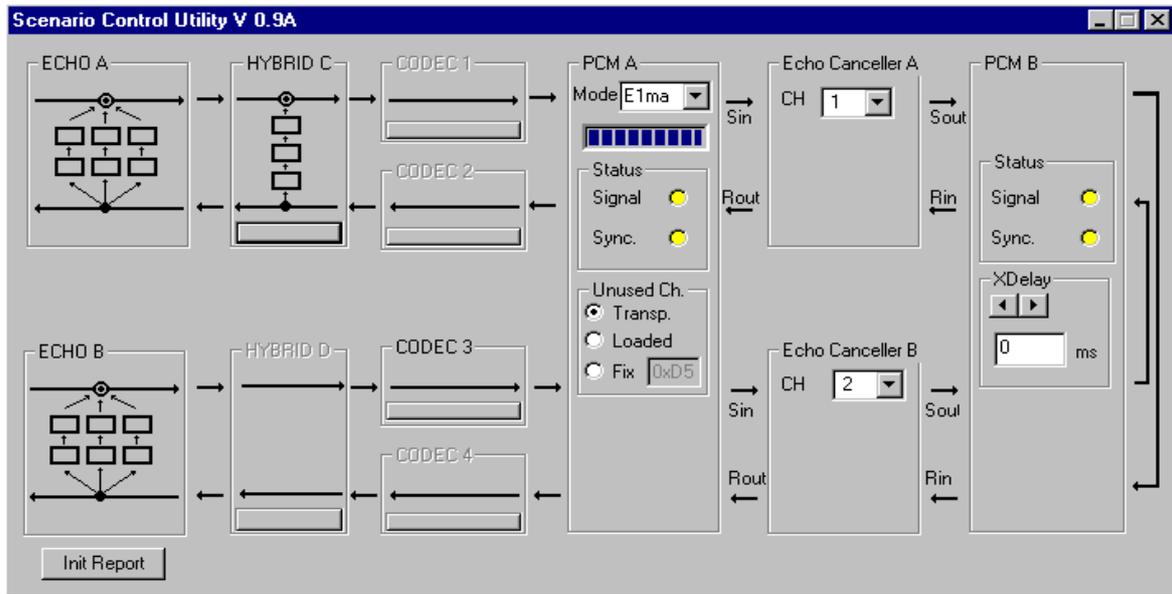


Figure 10-3. The Scenario Control Utility

The Scenario Control Utility detects and indicates the presence of the hardware contained in the *ECT-1*. If complex hybrids are installed, simply clicking on the ‘Hybrid C’ and ‘Hybrid D’ buttons (Figure 10-3) will enable/disable them.

Note that it is **not** possible to disable the standard (G.168) echo model in the Scenario Control Utility window. To eliminate this source of echo, the ERL parameters should be set to a high value on Echo Card A and Echo Card B. (Double-click on the ‘EchoA’ and ‘EchoB’ icons to access the configuration windows.) If desired, the standard echo model can be set to contribute an additional source to that provided by the complex hybrid.

**Configuring the hybrid model:**

To configure the hybrid model click the ‘Hybrid C’ or ‘Hybrid D’ icon on the computer desktop; (if both hybrids are present, they will need to be configured separately). A new window is displayed (Figure 10-4) that allows the parameters of the model to be configured.

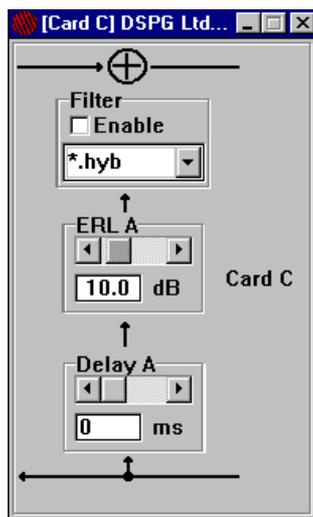


Figure 10-4. Setting the Parameters of the Hybrid Model



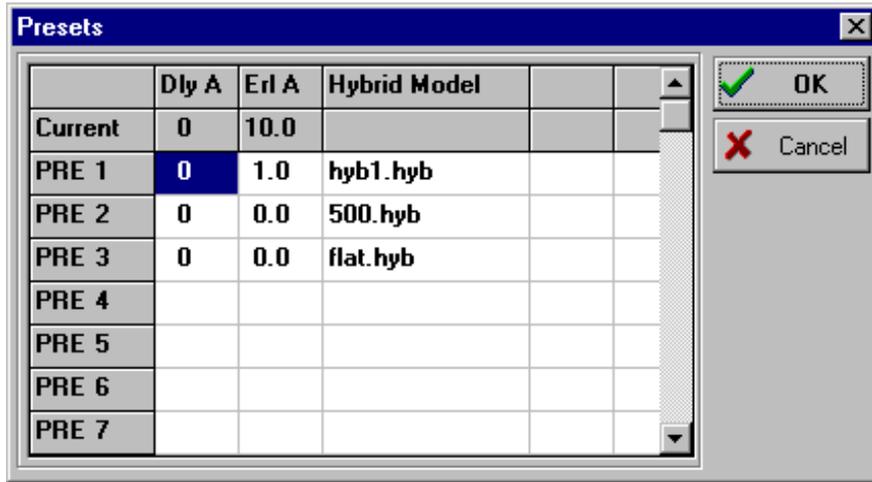


Figure 10-6. Selecting a Previous Configuration

In a similar way, a set of parameters chosen for the current test may be saved as a new preset. The user will see that the current values of Delay and ERL, and the currently selected hybrid filter are displayed in the ‘Current’ line of the table. When any of the three parameters (filter, ERL, delay) are changed in the ‘Card C’ or ‘Card D’ window, the readings in the ‘Current’ line of the presets table will change accordingly. To store a set of values from the ‘Current’ line to any of the presets lines (PRE 1, PRE 2 etc., up to a maximum of fifty), the user simply clicks on, drags and drops the whole of the ‘Current’ line into any empty pre-set line. To make changes, the user may click on any value to select it, then click on it again before editing the value.

To delete a complete line, click on, drag and drop an empty line into one containing values. Alternatively, click on each value and press *Delete* on the keyboard.

## FUTURE MODULES

### PAMS Module for Quality Assessment

The Perceptual Analysis Measurement System (PAMS) is an objective test method developed by BT Laboratories for determining speech quality over both linear and non-linear telephony networks. Traditional objective measurements do not provide a reliable indication of subjective performance, particularly in the case of complex non-linear processes such as low-bit-rate speech codecs. The great value of PAMS is that it predicts the mean subjective opinion score for the network under test, with high accuracy, and without the considerable time, trouble and expense necessary to conduct a subjective test.

In a PAMS measurement, a speech-like test signal is injected into the network under test. A quality prediction is then derived from a mathematical comparison between the transmitted test signal and the received, degraded signal.

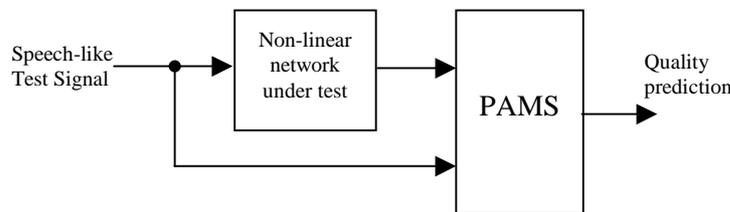


Figure 10-7. Principle of PAMS Testing

To make the comparison between the two signals, PAMS models all the main psychophysical effects of human hearing, and calculates a measure of the audible error. It then interprets the subjectivity of the error signal to predict the mean opinion score of real customers.

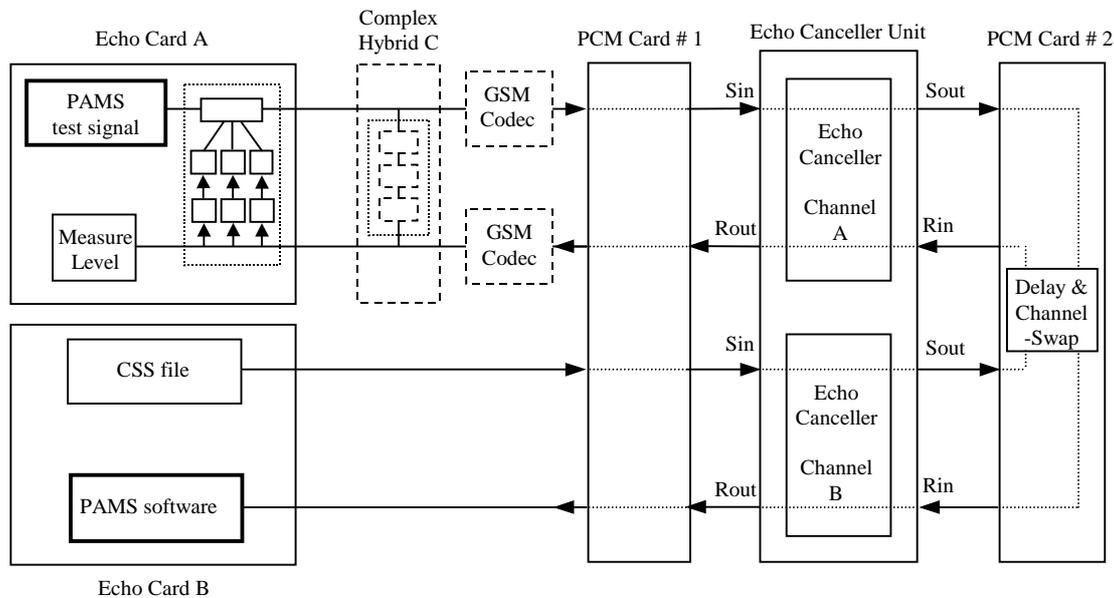
To complement the PAMS algorithm, BT Laboratories developed a new speech-like test signal designed to produce quicker, more accurate results. The PAMS test signal is 30 seconds in duration for combined male and female voices.

PAMS is a fundamentally robust approach for predicting quality of any speech transmission network. By comparing PAMS results with a database of subjective test results, the accuracy of PAMS has been proven for many speech carrier technologies, both individually and in combinations. The ability to rapidly evaluate speech quality performance of equipment or systems, makes PAMS a powerful new tool for both equipment designers and network operators.

**PAMS and the ECT-1:**

For an echo canceller, compliance with G.168 should ensure at least a minimum level of performance when installed in the network. However, G.168 tests do not replace or eliminate the need for subjective tests to measure the perceived quality of echo cancellers. This is because echo cancellers are complex devices with multiple parameters, and the interaction of the different parameters will affect subjective quality in various ways. Furthermore, all network echo cancellers feature a non-linear processor (NLP) of some form, to eliminate residual echo. The NLP operating threshold is usually adjusted dynamically, making the influence of this device on speech quality particularly difficult to quantify by traditional objective methods.

To help assess the speech quality of echo cancellers without subjective testing, DSPG have obtained a licence for the PAMS software from BT, and propose to offer a PAMS facility as an option with the ECT-1. The hardware configuration of the proposed system is shown in Figure 10-8.



**Figure 10-8. Hardware Configuration for PAMS Testing**

For PAMS testing, the ECT-1 Echo Cards are configured as shown in the Figure. Channel A of the echo canceller unit is the echo canceller under test, and channel B of the echo canceller unit is set to bypass mode. The first stage of the test ensures that the echo canceller under test is fully converged. Then a stored file representing the PAMS speech-like test signal is sent from Echo Card A; it passes through the send path of the echo canceller under test, and is received by the PAMS analysis software on Echo Card B. The PAMS software compares the degraded, received signal with a copy of the original test file, and computes the predicted subjective opinion score.

The degradation of the received signal is primarily due to the creation of a double-talk scenario by simultaneously replaying the CSS in the opposite direction of transmission to the PAMS test signal. An attenuated echo of the CSS (as determined by the emulated echo path) mixes with the PAMS test signal, and is applied to ‘Sin’ of the echo canceller under test. After echo cancellation, a residual echo signal remains, and will degrade the PAMS test signal. However, depending on the relative levels of the PAMS and CSS test signals, the NLP in the echo canceller under test may activate. The centre-clipping action of the NLP will remove all, or part, of the residual echo signal, but will also distort the PAMS test signal.

The degradation, and hence the predicted opinion score, will be dependent on the levels of the PAMS and CSS test signals and their relative levels with respect to each other. The loss and frequency characteristics of the echo path will also affect the result. As the double-talk situation continues throughout the test, it allows the subjective impact of this particular aspect of echo canceller performance to be assessed. This is very useful when evaluating design changes, or making comparisons between different echo cancellers.

Due to the general applicability of the PAMS test method, if they wish, users may include other functions in the network under test. For example, the GSM codecs shown in Figure 10-8 may be enabled, and the PAMS predicted opinion score will then relate to the combined effects of the GSM codecs and the echo canceller.

The test described above predicts subjective opinion during periods of prolonged double-talk. Although the first release of the PAMS module will operate only in the manner described above, DSPG plans to develop a PAMS-based test that will closely relate to performance during a natural conversation. The predicted opinion score should then be very close to the mean opinion score derived from a true subjective conversation test. The new test will be made available in a later release of the PAMS module, and existing users will be able to upgrade to the new version.

### Extended Recording Facility

Another module that will shortly be available is a dual-channel, digital, extended recording facility. The standard facility will allow the signals at ‘Rin’ and ‘Sout’ of the echo canceller under test to be recorded, but the monitor points could be customized to the requirements of individual users. The digital recordings will be stored on the *ECT-1* hard disk drive, so recording time may be up to several hours.

The recording facility will require one DS-2181 DSP card, in addition to the cards of the basic *ECT-1* configuration. If the user has the GSM codec option, then one of the DS-2181 cards needed for the GSM codecs can be re-configured for the recording facility; in this case no additional cards would be required for the recording facility.

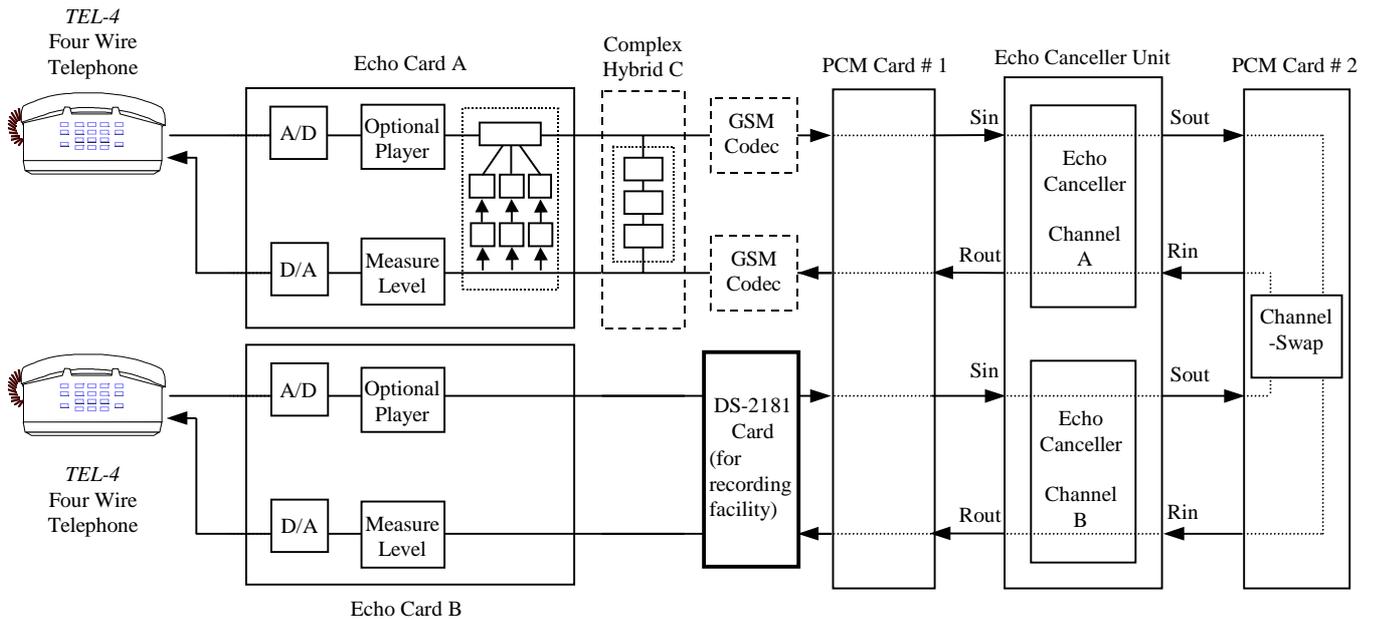


Figure 10-9. Hardware Configuration of the ECT-1 for Recording Facility

Figure 10-9 illustrates the hardware configuration of the *ECT-1* when the recording facility is enabled. Channel A of the echo canceller unit is the echo canceller under test. The recording takes place on the send and receive paths at the point at which the DS-2181 card is shown located. However, channel B of the echo canceller unit should be placed in bypass mode by the user, so the monitor points are effectively connected to ‘Rin’ and ‘Sout’ of the echo canceller under test. The echo path is disabled on Echo Card B, so there will be no echo from this end of the connection (apart from possible low-level acoustic echo from the telephone instrument).

The recordings made at ‘Sout’ will include the wanted signal on the send path of the echo canceller, together with the residual echo (uncancelled part of the echo signal) arising from the signal at ‘Rin’ and the echo path on Echo Card A (or Hybrid C). Therefore, recording the two signals ‘Rin’ and ‘Sout’ will allow the performance of the echo canceller to be analyzed.



## **11. SPECIFICATION**

### ***CONTENTS***

## SPECIFICATION

### Function

Fully automated tester, allowing echo canceller objective measurements in compliance with ITU-T G.168 and G.168(2000) Recommendations.

May be used to allow subjective evaluation of echo cancellers in an emulated network connection. Emulation of the echo path and trunk/satellite delay is provided; emulation of codecs (such as the GSM codec) is available as an option.

### Interfaces

#### PCM interface to echo canceller:

Either E1 or T1 PCM interface cards are fitted. There is an option to have both types of interface card fitted, allowing echo cancellers with either interface to be tested.

**PCM features** CEPT/E1 (2.048 MHz) or T1 (1.544 MHz) Primary Rate interface. Full CCITT specification to G.704 and G.732. Jitter attenuation to G.735 and G.742. Support for CRC4-based framing standards and CAS and CCS signalling standards for E1 and 193S or 193E for T1.

**E1 Line impedance** 75 ohm unbalanced. (Connect to the *ECT-1* using standard 75 ohm BNC coaxial cables.)

**T1 Line impedance** 100 ohm balanced. (Connect to the *ECT-1* using standard 100 ohm twisted-pair type cables fitted with BR2 connectors.)

Note: In response to feedback from current users, there are plans to use RJ45 connectors in preference to BR2 connectors in future production of the *ECT-1*.

#### Control interface to echo canceller:

**V.24** Serial communications in accordance with ITU-T Recommendation V.24.  
RS232 compatible. Fully configurable.  
Connector: DB 9 (male)  
Port: COM1, COM2  
Baud rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400  
Data bits: 4, 5, 6, 7, 8  
Parity bit: none, odd, even, mark, space  
Stop bits: 1, 1.5, 2

**TTL** Direct (parallel) output lines for control of echo canceller convergence, non-linear processor, and H-register.

Connector: DB 9 (female) on front panel, or  
DB 25 (female) PC parallel port connector on rear panel.

Logic levels: TTL/CMOS compatible.

Logic levels depend on loading;

typically: 0 volts < output low < 0.4 volts

2.4 volts < output high < 5 volts

The *active* logic state (high or low) is independently selectable for each control line.

**Analogue interface to ECT-1:**

<b>Quantity</b>	2 input/output interfaces	
<b>Type</b>	4-wire unbalanced	{2-wire can be provided on request}
<b>Connectors</b>	BNC	
<b>Input impedance</b>	600 ohm	
<b>Output impedance</b>	600 ohm	
<b>Max. input level</b>	4 volts peak-to-peak (A/D clipping point)	] Nominal values. Actual values depend on A/D & D/A gain error ( $\pm 1$ dB max.).
<b>Max. output level</b>	4 volts peak-to-peak	
<b>Input gain control</b>	Range -60dB to +20dB in 0.1dB steps	
<b>Output gain control</b>	Range -20dB to +20dB in 0.1dB steps	

**Single-Board Computer**

<b>Model:</b>	SSC-5x86HVGA™ from Acquire Inc.
<b>RAM:</b>	32 Mbyte installed
<b>Hard disk drive:</b>	2 Gbyte PCI Ehnace IDE drive installed
<b>Parallel port:</b>	Bi-directional
<b>Serial ports:</b>	Two $\pm 15$ kV ESD protected ports; NS16C550 compatible UARTs
<b>Mouse port:</b>	PS/2

**General**

*Model: ECT-1 .....*

<b>Housing:</b>	portable 3U	
<b>Dimensions:</b>	180 * 420 * 375 mm (h*w*d)	Including handle.
	7.1 * 16.5 * 14.8 inches	
<b>Weight:</b>	10kg (22 pounds) approx.	with all current upgrade options installed.

*Model: ECT-1 .....*

<b>Housing:</b>	19 inch rack	
<b>Dimensions:</b>	195 * 480 * 470 mm (h*w*d)	Including handles
	7.7 * 18.9 * 18.5 inches	
<b>Weight:</b>	15kg (33 pounds) approx.	with all current upgrade options installed.

**Power**

<b>Supply voltage:</b>	83 to 135 volts, 60Hz; 180 to 265 volts, 50Hz
<b>Power consumption:</b>	20 watts (typical) for standard unit.
	28 watts (typical) with all current upgrade options installed.

## 12. APPENDIX A: MEASUREMENT SOFTWARE

### **Generated Test Signal Levels:**

Part of the software acts as a signal generator. Various types of signal (CSS, noise, etc.) are generated, each with its own fixed power.

The CSS is a copy of the signal found on the ITU P.501 CD ROM (ITU-T Rec. P501 08/96).

The *ECT-1* uses an RMS method to calculate the power of its internally generated test signals.

The power of the signal is calculated using one of the following formulae:

**For A-Law:**

$$S = 3.14 + 20 \log \left[ \frac{\sqrt{\frac{2}{n} \sum_{i=0}^{n-1} e_i^2}}{4096} \right]$$

**For  $\mu$ -Law:**

$$S = 3.17 + 20 \log \left[ \frac{\sqrt{\frac{2}{n} \sum_{i=0}^{n-1} e_i^2}}{8159} \right]$$

**Figure 12-1. Formula to Calculate RMS Power of a Signal, Expressed in dBm0**

S = signal level in dBm0

$e_i$  = linear equivalent of the PCM encoded signal at time i

n = number of samples over which the RMS calculation is made (5600 for the single-talk version of CSS and 6400 for the double talk version of CSS).

Note: For tests 2A & 2B, pauses in the single-talk version of CSS are excluded from the RMS calculation.

To perform G.168 tests, it is necessary to be able to set the test signal level to a chosen value within the range specified for the test being performed. To set the level, the DSP software amplifies or attenuates the original signal by the required amount.

The level adjustment process is similar for all test signals, except that the size of the window used for the RMS calculation may differ. For the single-talk version of CSS, the process may be summarized as follows:

- ◆ The original CSS signal is stored in the DSP memory.
- ◆ The power (css1\_level) is calculated using the RMS method.
- ◆ The active power (css1\_level\_no\_pause) is calculated using the RMS method, modified to exclude the pauses in CSS.
- ◆ The DSP software performs a gain adjustment to set the output level to the required value.

The DSP performs the following instruction to implement the level adjustment:

$$\text{Sample\_out}[n] = \text{Sample\_original}[n] * 10^{(\text{Lrin}-\text{css1\_level})/20}$$

or

$$\text{Sample\_out}[n] = \text{Sample\_original}[n] * 10^{(\text{Lrin}-\text{css1\_level\_no\_pause})/20} \quad \text{in the case of tests 2A and 2B.}$$

where:

Sample\_out[n] = sample at the time n to be sent to the echo canceller.

Sample\_original[n] = sample at the time n of the original signal.

Lrin = desired power level in dB to be sent to the echo canceller.

css1\_level = power of the original signal in dB, calculated using the RMS method (700ms window).

css1\_level\_no\_pause = power of the original signal in dB, calculated using the RMS method modified to skip the pauses (700ms window).

[The values of 'css1\_level' and 'css1\_level\_no\_pause' are displayed during the initialization procedure (black report board).]

### ***Level Measurement:***

The DSP software works as a recorder during the testing session. The signal received from the echo canceller is stored in the DSP memory and copied into the PC memory afterwards.

The calculation of the levels is done off-line on the PC side.

Two different window sizes are used in the measurement of received signal power.

For any test that requires a representation using the time scale (e.g. the convergence test), the RMS method with a window of 35ms is used. An array of values is used to generate the representation in the time/level scale.

When a test needs a single value representing the power level (e.g. after convergence), the dimension of the window is 700ms.

Both methods are used during most tests.

### ***Convergence Time:***

The convergence time measurement is necessary in certain tests.

In these cases the software (using the RMS 35ms method) finds the last window where the level is more than a defined value (convergence level).

The value in milliseconds representing the start of the next window is taken to be the convergence time.

The resolution of this method is 35ms.

Note: This value is not guaranteed because the G.168 specification is not sufficiently clear about the convergence value for each test.

### 13. APPENDIX B: THE G.168 ECHO PATH MODEL

The G.168 specification allows a lot of freedom to choose the values of the echo path.

The problem is that the complete echo generator needs the setting of six parameters: three gains and three delays. The G.168 Specification describes how to choose only two parameters: 1 gain and 1 delay. The only rule when choosing the six parameters is this:

*The sum of the absolute values of the gains  $G_A$ ,  $G_B$ ,  $G_C$  that correspond to ERL A, B, C, respectively, taken in dB, should be less than or equal to -6 dB (i.e.  $20\log(|G_A| + |G_B| + |G_C|) \leq -6$  dB), and echo path delay  $A \leq \Delta$  ms, echo path delay  $B \leq \Delta$  ms, and echo path delay  $C \leq \Delta$  ms, (where  $\Delta$  represents the maximum echo path delay for which the echo canceller is designed).*

The ECT-1 software respects this rule, but the adopted method is just one of unlimited possibilities.

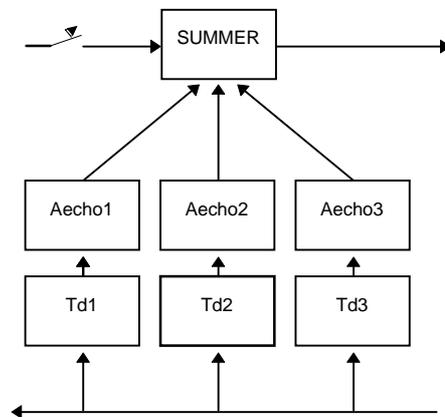


Figure 13-1. Echo Path Block Diagram

- Assuming: Td = the selected echo path delay.
- Aecho = the selected attenuation for the echo expressed as the equivalent linear value of gain.
- Where: Td1 = delay of the first branch.
- Td2 = delay of the second branch.
- Td3 = delay of the third branch.
- Aecho1 = attenuation of the first branch (expressed as the equivalent linear value of gain).
- Aecho 2 = attenuation of the second branch (expressed as the equivalent linear value of gain).
- Aecho 3 = attenuation of the third branch (expressed as the equivalent linear value of gain).

$$Td1 = Td$$

$$Td2 = Td / 8 * 5$$

$$Td3 = Td / 8 * 3$$

$$Aecho1 = Aecho / 6 * 3$$

$$Aecho 2 = Aecho / 6 * 2$$

$$Aecho 3 = Aecho / 6 * 1$$

## 14. APPENDIX C: SPECIAL MODES OF OPERATION

### THE ECT-1 HARDWARE CONFIGURATION

To perform G.168 objective tests on an echo canceller, it is not necessary to emulate the features of a full network connection. There is an obvious need to generate defined test signals, make level and time measurements, and control parameters of the echo canceller under test, but regarding network emulation aspects, it is only necessary to consider one end of a connection. Therefore, only a single echo canceller is required for the tests, together with emulation of the echo path according to the G.168 model.

To perform conversational, subjective tests on an echo canceller, it is clearly essential to emulate all the major features of a full network connection. These features must include the cancellers at opposite ends of the connection, the transmission delay between the cancellers, and representation of the echo path at the two ends.

It can be seen that, in terms of hardware for network emulation, subjective testing is more demanding than objective testing. At first sight, it appears that two separate E1 or T1 echo canceller units are needed for subjective testing (as in the case of a real connection). From this perspective, Figure 14-1 illustrates the basic hardware configuration that would be necessary for the *ECT-1* and the echo cancellers under test.

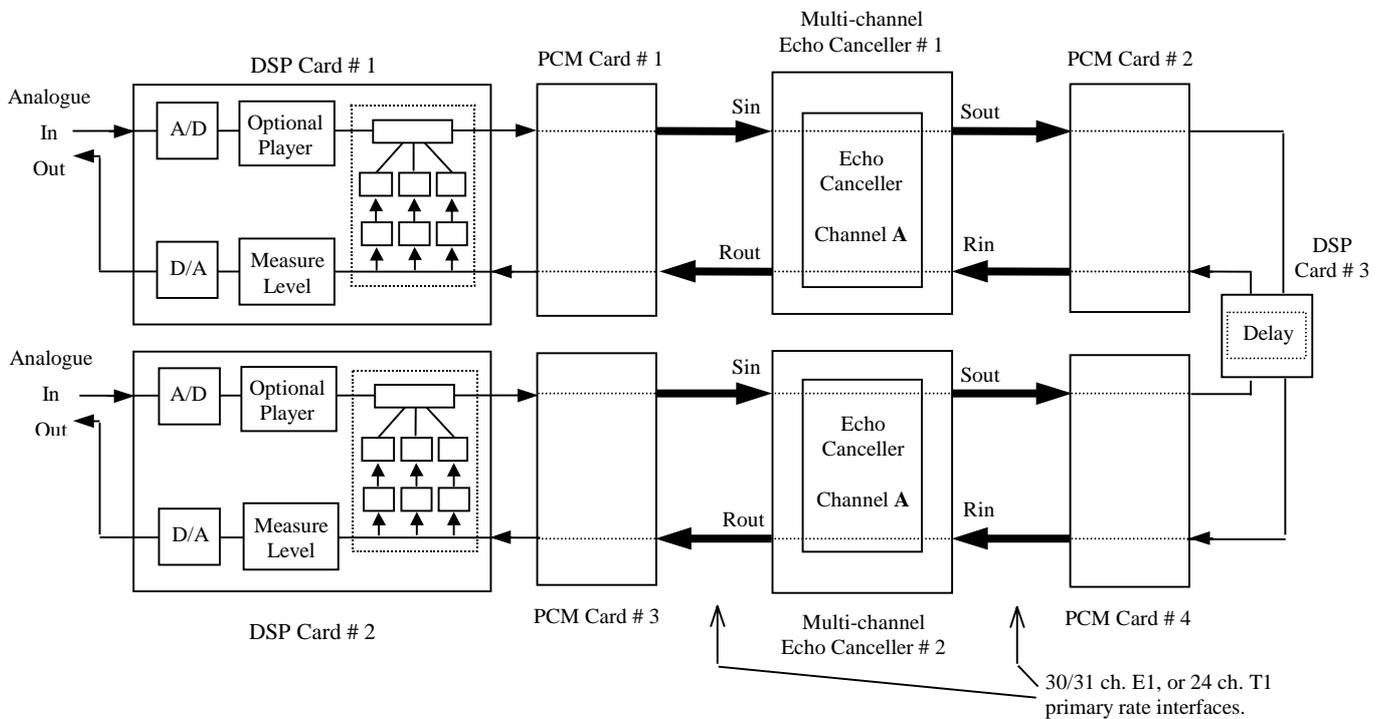


Figure 14-1. Hardware Configuration with a Single Timeslot

However, it is possible to emulate a full connection using only a single E1 or T1 echo canceller unit. In the *ECT-1*, different channels on the *same* echo canceller unit are used to represent the two echo cancellers at opposite ends of the emulated connection. This eases the burden on the user to supply echo cancellers for the tests. A second major benefit of configuring the connection in this way is that fewer PCM cards are needed to interface to the echo cancellers. Figure 14-2 shows that only two PCM cards are now required, compared to four in the configuration of Figure 14-1. This helps to keep down the cost of the unit, and leaves more card-slots available for other functions (e.g. complex hybrid cards, GSM codec cards, etc.). As shown in Figure 14-2, a further saving is made in the *ECT-1* by implementing the emulated trunk/satellite delay on one of the PCM cards, rather than a separate DSP card.

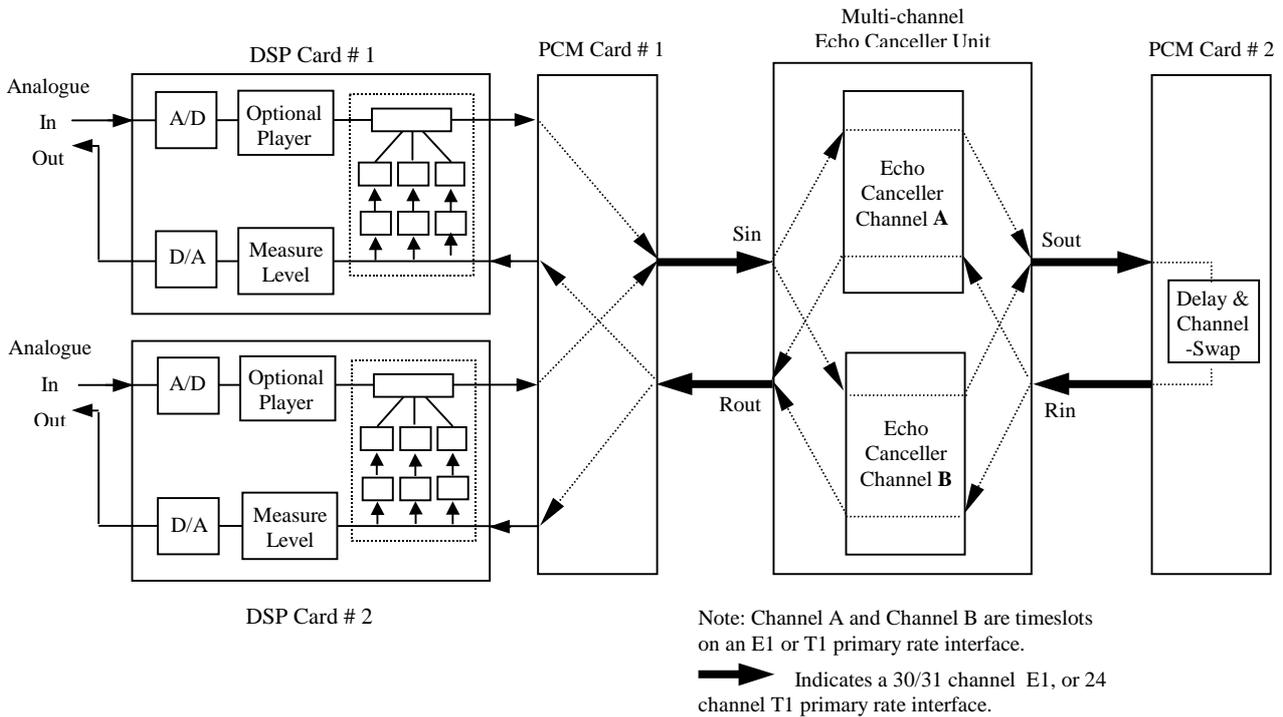


Figure 14-2. Hardware Configuration of the ECT-1 for Subjective Tests

### ADVANTAGES OF THE HARDWARE CONFIGURATION

As well as the substantial economic advantages mentioned above, the chosen hardware configuration offers benefits of a practical nature arising from the use of different channels at opposite ends of the connection. There are benefits for both objective and subjective test modes, and these are described in the following sub-sections.

#### Subjective Test Mode

Although the ECT-1 hardware configuration allows the two echo cancellers needed for an emulated connection to be derived from different channels on the same multi-channel echo canceller unit, it is still possible to use different echo canceller units (e.g. from different manufacturers) at the two ends of the link. This is possible because of the channel selection facility provided by the Scenario Control Utility of the ECT-1, and because individual channels of a multi-channel echo canceller can be set to 'bypass' mode.

Figure 14-3 in conjunction with Table 14-1 shows how to select any combination of two different cancellers at the two ends of the link. Channels 1, 2, 3 and 4 are used in the example shown in the table, but any of the other echo canceller channels could be used instead. Having pre-set the appropriate channels to bypass mode at the echo cancellers, switching between cancellers is achieved simply by selecting channels within the Scenario Control Utility window. This simple operation allows rapid switching between echo cancellers, which is very useful when comparing the subjective performance of different cancellers.

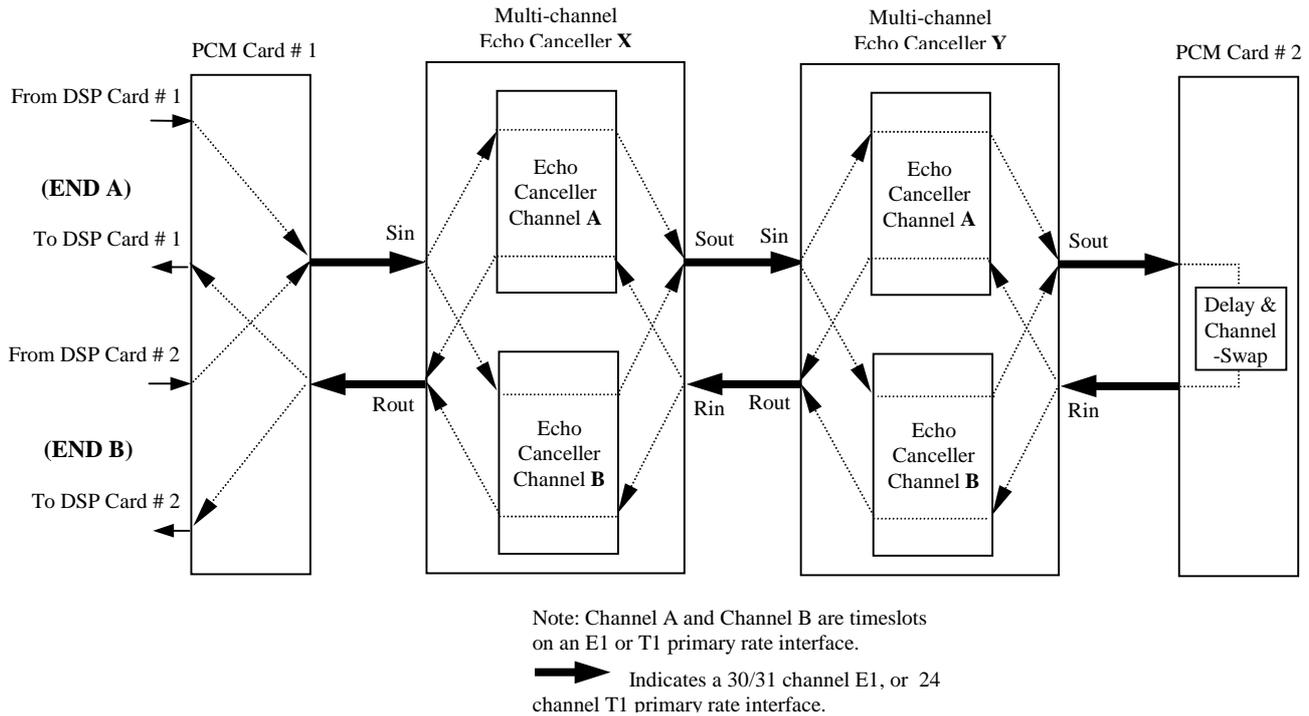


Figure 14-3. Connecting Two Echo Cancellers so that Either can be Selected

Table 14-1. Switching Between Echo Cancellers by Changing Channels

Test Condition	Selected channel for 'Channel A'	Selected channel for 'Channel B'	Active canceller at End A	Active canceller at End B	Preset channel status of Cancellor X	Preset channel status of Cancellor Y
1	1	2	Cancellor X	Cancellor X	Channels 3 & 4 set to bypass mode.	Channels 1 & 2 set to bypass mode.
2	3	4	Cancellor Y	Cancellor Y		
3	1 or 2	3 or 4	Cancellor X	Cancellor Y	Channels 1 & 2 enabled.	Channels 3 & 4 enabled.
4	3 or 4	1 or 2	Cancellor Y	Cancellor X		

The principle can easily be extended to any number of cancellers, limited only by the number of available channels. Thus, for an E1 interface, up to 15 cancellers could be independently selected at the two ends of the link; for a T1 interface, up to 12 cancellers could be selected in this way.

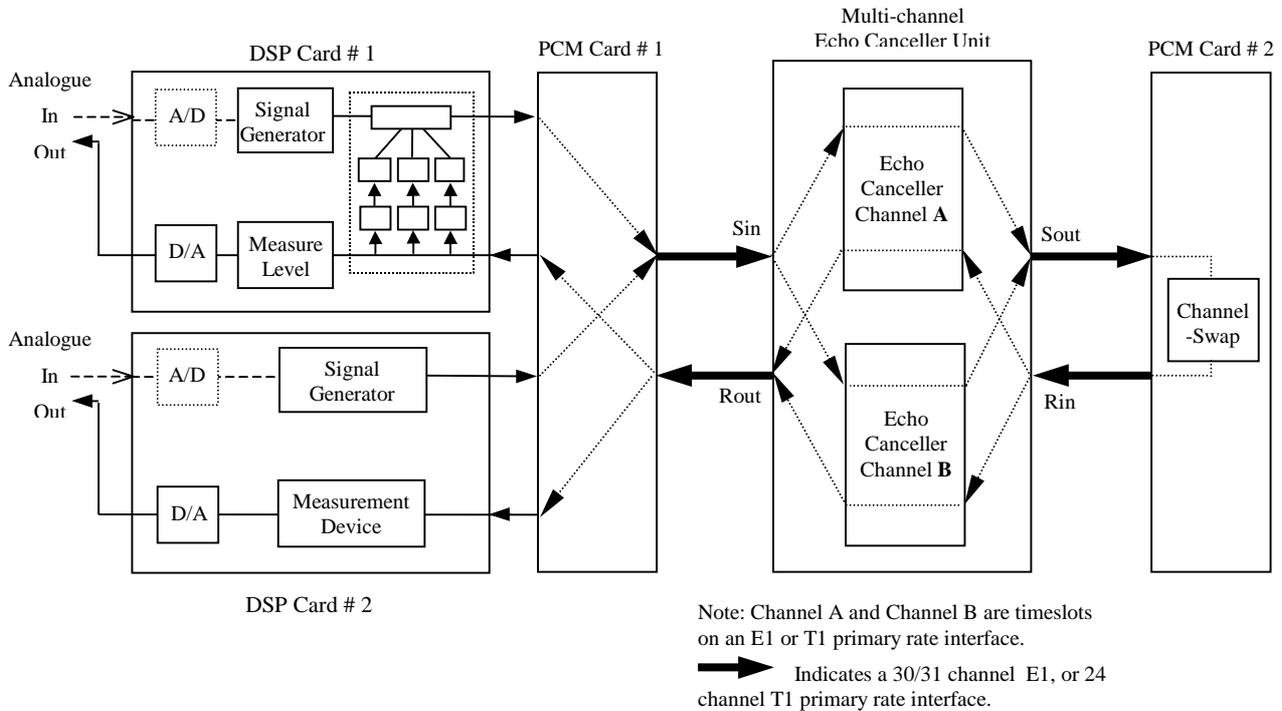
Table 14-2 illustrates the principle extended to three different echo cancellers units, but for simplicity, the table only shows the cases where the same type of echo canceller is selected at both ends of the link.

Table 14-2. Switching Between Three Echo Cancellers Units

Test Condition	Selected channel for 'Channel A'	Selected channel for 'Channel B'	Active canceller at End A	Active canceller at End B	Preset channel status of Cancellor X	Preset channel status of Cancellor Y	Preset channel status of Cancellor Z
1	1	2	Cancellor X	Cancellor X	Channels 3, 4, 5 & 6 set to bypass mode.	Channels 1, 2, 5 & 6 set to bypass mode.	Channels 1, 2, 3 & 4 set to bypass mode.
2	3	4	Cancellor Y	Cancellor Y			
3	5	6	Cancellor Z	Cancellor Z	Channels 1 & 2 enabled.	Channels 3 & 4 enabled.	Channels 5 & 6 enabled.

**Objective Test Mode**

Figure 14-4 illustrates the hardware configuration of the ECT-1 when performing G.168 objective tests. It may be seen that this is very similar to the configuration in Figure 14-2, used for subjective tests. A consequence of this similarity is that the user must normally set channel B of the echo canceller to bypass mode before running objective tests. However, channel B can be used to advantage when testing 'full' echo cancellers; further details are presented in one of the sub-sections below.



**Figure 14-4. Hardware Configuration of the ECT-1 for G.168 Objective Tests**

**Comparing two cancellers:**

The ability to select different cancellers simply by changing the channel selection in the Scenario Control Utility window (as described above for the subjective test mode) is also useful when comparing the *objective* performance of two echo cancellers. The two different multi-channel echo cancellers are connected in cascade, as shown in Figure 14-3. However, for objective tests on the cancellers, channel B of both the echo cancellers must be set to bypass mode. Therefore, having set the appropriate channels to bypass mode at the echo cancellers, when switching between cancellers it is only necessary to change the channel number assigned to channel A. A suitable channel allocation is shown in Table 14-3.

**Table 14-3. Switching Between Echo Cancellers during Objective Tests**

Test Condition	Selected channel for 'Channel A'	Selected channel for 'Channel B'	Active canceller at End A	Active canceller at End B	Preset channel status of Canceller X	Preset channel status of Canceller Y
1	1	2	Canceller X	—	Channels 2 & 3 set to bypass mode.	Channels 1 & 2 set to bypass mode.
2	3	2	Canceller Y	—	Channel 1 enabled.	Channel 3 enabled.

When switching between echo cancellers for the purposes of *objective* tests, it is also necessary to switch the *ECT-1* control signals to the appropriate canceller. The *ECT-1* has two serial ports, a TTL port and the PC printer port, and each can be configured as the control port of the tester. Therefore, the two echo cancellers can be connected to separate control ports on the *ECT-1*. The control signals can then be directed to one canceller or the other by changing the active control port in the 'Connections' page of the *ECT-1* 'Configuration Options' window.

In this way, switching between echo cancellers can be controlled entirely from the *ECT-1*, or from a remote PC using an Ethernet link and software packages such as 'Reach Out' and 'PC Anywhere'. (The communication software is not supplied by DSPG.)

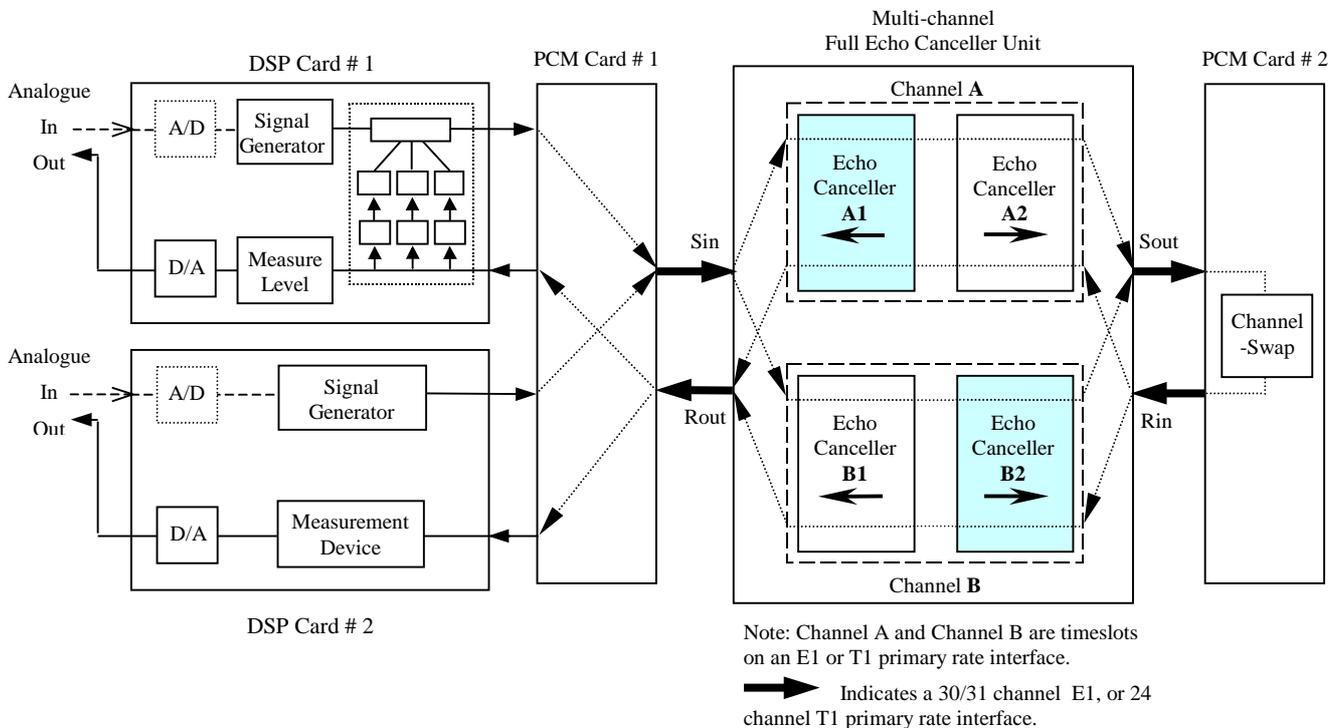
**Full echo cancellers:**

The particular hardware configuration of the *ECT-1* offers increased flexibility when it comes to testing 'full' echo cancellers.

Most echo cancellers in common use are 'half' echo cancellers, i.e. they are designed to cancel echo in one direction of transmission only. Normally, a half echo canceller is sited at each end of a long-distance connection, with each echo canceller cancelling echo returned from the local 2-4 wire hybrid.

A 'full' echo canceller is designed to cancel echo in both directions of transmission, and is, effectively, two half echo cancellers connected back-to-back, such that they are pointing in opposite directions. Full echo cancellers tend to be used for applications such as mobile-radio, or other cases where it is uncertain whether an echo canceller exists at the distant end of a connection. (Note that for mobile-radio, the echo canceller pointing towards the mobile is designed to cancel *acoustic* echo, and G.168 tests are not relevant for such a device. However, it is appropriate to perform G.168 tests on the echo canceller pointing towards the network.)

Figure 14-5 illustrates a full echo canceller unit connected to the *ECT-1* for testing. As can be seen from the Figure, effectively, there are four *half* echo cancellers in the test circuit. The arrow drawn on each half echo canceller indicates the direction the canceller is 'pointing', (i.e. the half echo canceller will attempt to cancel echo returned from the indicated direction).



**Figure 14-5. A Full Echo Canceller connected to the ECT-1**

The half echo cancellers labelled 'A1' and 'B2' are shown shaded in Figure 14-5. Without changing physical connections, objective tests can be performed on either of these two echo cancellers. However, of the four half echo cancellers shown in Figure 14-5, only the one currently being tested should be enabled; the other three must be set to bypass mode.

By separately testing the half echo cancellers 'A1' and 'B2', both halves of a *full* echo canceller will have been tested. Table 14-4 shows how the half echo cancellers can be selected for testing.

**Table 14-4. Testing the Two Halves of a Full Echo Cancellor**

Test Condition	Selected channel for 'Channel A'	Selected channel for 'Channel B'	Echo canceller under test	Preset channel status of full echo canceller unit
1	1	2	<b>A1</b>	Channel 2 set to full bypass mode. Channel 1 set to bypass echo canceller <b>A2</b> only.
2	2	3	<b>B2</b>	Channel 3 set to bypass echo canceller <b>B1</b> only.

## 15. APPENDIX D: CABLING

### THE CONTROL INTERFACE

#### *TTL Connection Using the Parallel Port:*

Some echo cancellers can be controlled using direct TTL connections. In these cases it is possible to make direct connections between the appropriate pins of the PC parallel port and the control port of the echo canceller. The following table explains how to make the connection:

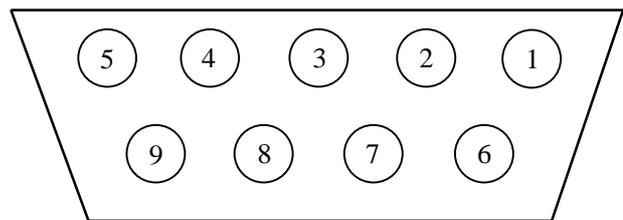
Printer Port Pin	Echo Cancellor Connection
4	convergence
3	non-linear processor
2	reset H register
18	ground

#### *TTL Connection Using the Front TTL Connector:*

As an alternative to the parallel port, a dedicated TTL port is available on the *ECT-1*. The active logic state (high or low) is configurable using the configuration dialogue box.

DB 9 Way Connector (Female)

Pin	Connection
1	ground
2	boot sequence
3	convergence
4	reset H register
5	testing
6	ground
7	-
8	non-linear processor
9	-



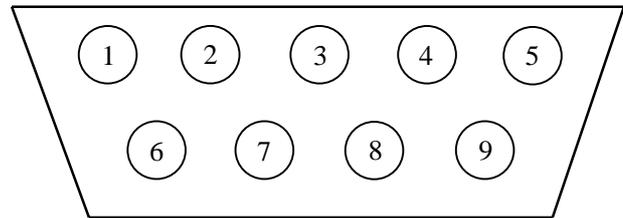
**Figure 15-1. Front View of 'TTL' Connector (female) on ECT-1 Front Panel**

**Serial V24 Connection:**

The majority of echo cancellers have an RS232 port allowing control of the parameters.

The following table illustrates the type of cable required by certain echo canceller models to connect to the *ECT-1*:

Echo Canceller	Connector	Cable Type
Coherent 7000	DB 9	Direct 9
Tellabs	DB 25	Direct 25



**Figure 15-2. Front View of 'V24' Connector (male) on ECT-1 Front Panel**

The following table illustrates the Direct 9 cable:

Direct 9		
PC pin	EC pin	Description
1	1	DCD (Data Carrier Detect)
2	2	RX (Receive Data)
3	3	TX (Transmit Data)
4	4	DTR (Data Terminal Ready)
5	5	GND (Signal Ground)
6	6	DSR (Data Set Ready)
7	7	RTS (Request To Send)
8	8	CTS (Clear To Send)
9	9	RI (Ring Indicator)

The following table illustrates the Direct 25 cable:

Direct 25		
PC pin	EC pin	Description
1	8	DCD (Data Carrier Detect)
2	3	RX (Receive Data)
3	2	TX (Transmit Data)
4	20	DTR (Data Terminal Ready)
5	7	GND (Signal Ground)
6	6	DSR (Data Set Ready)
7	4	RTS (Request To Send)
8	5	CTS (Clear To Send)
9	22	RI (Ring Indicator)

Not every connection is required; usually, the only essential connections are RX, TX and GND. (The other lines are available if the echo canceller requires more complex RS232 control.)

## **THE PCM I/O INTERFACE**

### ***E1 interface:***

Connect to the *ECT-1* using standard 75 ohm BNC coaxial cables.

### ***T1 interface:***

Connect to the *ECT-1* using standard 100 ohm twisted-pair type cables fitted with BR2 connectors.

Note: In response to feedback from current users, there are plans to use RJ45 connectors in preference to BR2 connectors in future production of the *ECT-1*.

## 16. APPENDIX E: DS PCM1 CARD

### DS PCM1 card

The DS PCM1 card is a complete Primary Rate interface incorporating an advanced chipset and is aimed at telecommunications applications. It allows direct access to the PCM network for test and evaluation. The card contains a 12.5 MHz ADSP2101 control processor with external Program and Data memory. All DSP and PCM I/O connections are user defined via a Xilinx FPGA configuration which can be dynamically downloaded via the ISA bus. An inter-board custom bus allows interfacing to other *ECT-1* boards.

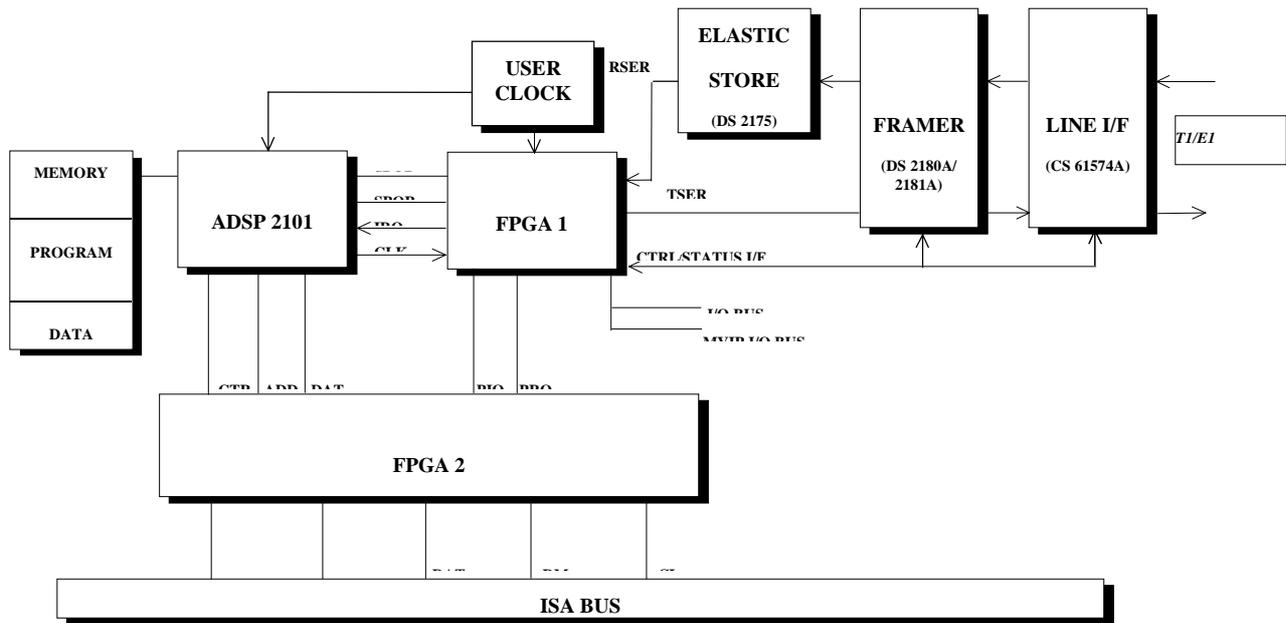


Figure 16-1. Block Diagram of the DS PCM1 Card

### Technical Specification

<b>Control Processor</b>	Analog Devices ADSP 2101
<b>Clock</b>	12.288 MHz (E1) or 12.352 MHz (T1)
<b>Memory</b>	Internal:       2k word Program RAM (6 kbyte) 1k word Data RAM (2 kbyte) External:       16k word Data RAM (32 kbyte) 16k word Program RAM (48 kbyte) 64k byte Boot memory, EPROM
<b>PCM interface</b>	Line interface   CS 61574A Framer           DS2181A (E1) / DS2180A (T1) Elastic store    DS2175
<b>PCM features</b>	CEPT/E1 (2.048 MHz) or T1 (1.544 MHz) Primary Rate interface. Full CCITT specification to G.704 and G.732. Jitter attenuation to G.735 and G.742, support for CRC4-

based framing standards and CAS and CCS signalling standards for E1 and 193S or 193E for T1. Contains a built-in elastic store, comprehensive slip control, alarm generation and detection and extensive error logging.

<b>PCM I/O</b>	PCM G.703 line terminates on two SMB connectors for coaxial cables or single RJ45 connector for twisted-pair cables.
<b>E1 Line impedance</b>	75 ohms unbalanced (optional 120 ohms balanced)
<b>T1 Line impedance</b>	100 ohms balanced
<b>User Gate Array</b>	Xilinx XC3000A family FPGA or equivalent part in an 84-pin PLCC package.
<b>Digital I/O on 60-</b>	10 user configurable fast I/O lines available on 34-way bus header. Additional 25 I/O lines way header with MVIP compatible pin-out.
<b>PC Interface channels 2 or 3).</b>	Standard configuration is 8-bit software controlled I/O (with 8-bit PC DMA option on Implemented on single XC3030A FPGA.
<b>Power Consumption</b>	Max. 450 mA @ +5v
<b>Size</b>	PC AT card, 228.5 mm x 114.3 mm (9.0 in x 4.2 in)

### ***Firmware***

The DS PCM1 card is equipped with an operating kernel (firmware) for the on-board control processor ADSP2101. It is stored in the boot EPROM (U10) and loaded into the internal program memory at power up or after hardware reset. The kernel is responsible for handling the communication protocol between the host PC and DSP processor - including loading of the application software. This is used when some form of on-board signal processing is required for specific applications of the DS PCM1 card. Also, PC-based development tools like Workbench II utilize the operating kernel to access the DSP subsystem for debugging or monitoring.

### ***Basic Utility Software***

There are two utility programs provided with the DS PCM1 card, both running under MS DOS: FPGA configuration loader and PCM interface initializer.

#### **FPGA loader**

The FPGA configuration file defines most of the application specific hardware features of the card and must be loaded first, before the card can be used. One or several configuration files are provided with the loader program, according to the application. The loader expects two parameters to be specified in the command line as follows:

**lcacfg.exe file address**

where:

**file** FPGA configuration file in Intel hex format (extension .mcs) hexadecimal.

**address** Base address of the card as set by JP2 (see Appendix A).

Example: **lcacfg.exe dp\_t1n.mcs 0x200**

#### **PCM initializer**

The PCM interface is highly programmable, featuring various framing, signalling and line coding modes and has to be initialized according to the application. The initializer program provided with DS PCM1 sets the card into default mode. For the E1 version this means CCS signalling, no CRC4 multi-framing, HDB3 line coding. For the T1 version this means '193S' framing, B8ZS line coding and Network Interface mode as per FCC part 68, option A. The program expects one parameter to be specified in the command line - the base address in hexadecimal format.

Example:                   **pcmini.exe 0x200** (for E1 version)

Or                           **pcminit1.exe 0x200** (for T1 version)

Note: An interactive version of this program is also available on request which allows the user to program all of the features and interrogate status and error conditions according to the PCM interface chipset's specifications.

## **17. APPENDIX F: DS 32C CARD**

## **18. APPENDIX G: DS 2181 CARD**

## **19. APPENDIX H: DS AD2 CARD**

## **20. APPENDIX I: SINGLE BOARD COMPUTER**