**Consumer
Microcircuits
Limited**

COMMUNICATION SEMICONDUCTORS

EV9800
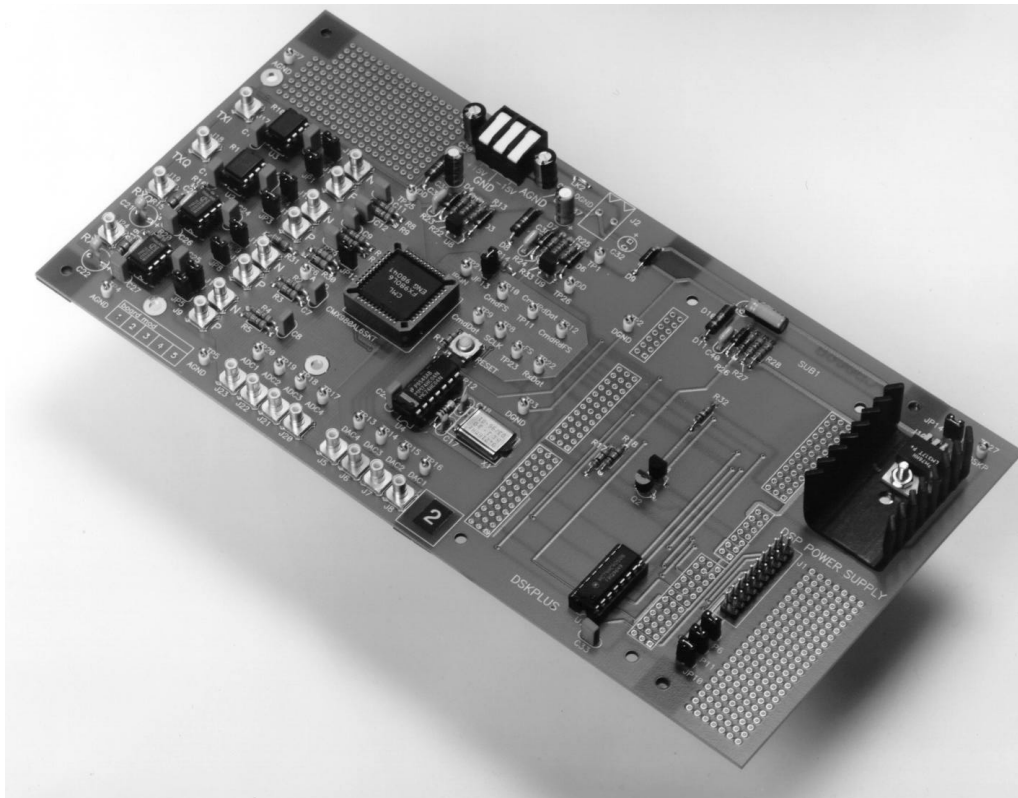## Evaluation Kit
User Manual

1.0   Features

- **Analogue PCB with Low Noise Floor**
- **Controllable from Windows™ Environment**
- **Dual Power Supply Operation**

- **Software Supplied for TI - DSP**
- **Footprint for TI-DSP**
- **Access to all Control Signals**

1.1   Brief Description

This kit comprises a PCB containing the CMX980A TETRA baseband processor and analog interface circuitry plus regulator circuits for analog and digital V_{DD}. There is also a footprint, regulated power supply and level shifting provided for a Texas Instruments DSP starter kit. The software supplied requires the use of a TI DSP. For those not wishing to use the TI DSP kit a connector provides access to the CMX980A control signals.

NOTE: The user must supply the TI - DSP.

CONTENTS

Note: As this product is still in development, it is likely that a number of changes and additions will be made to this specification. Items marked TBD or left blank will be included in later issues. Information in this data sheet should not be relied upon for final product design.
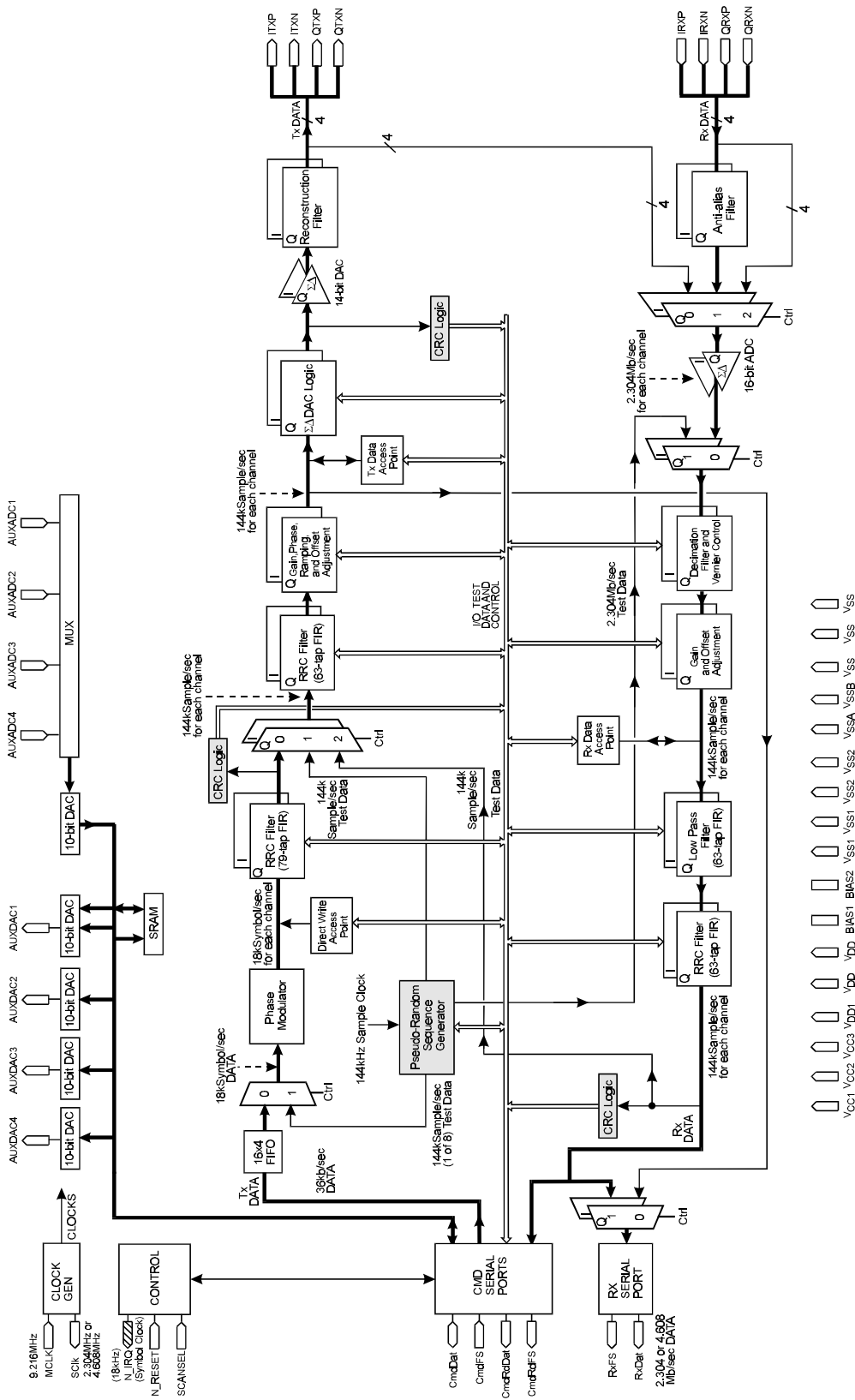
Figure 1 CMX980A Block Diagram

1.2   Preliminary Information

1.2.1   Laboratory Equipment

The following laboratory equipment is needed to use this evaluation kit:

1.2.1.1 Power Supplies
         $\pm$15V Regulated laboratory power supplies are required.

If the user wishes to use the supplied software and firmware:

1.2.1.2 DSP development card, specifically the Texas Instruments DSKplus, target processor - TMS320C542, TI part no. - TMDS32000L0.   Documentation for this kit, and the target processor, is available on TI's website.

1.2.1.3 IBM compatible PC, 486DX2-66MHz with 8-bit bi-directional parallel port (EPP or ECP printer ports must be set to standard mode) running Windows 3.1x or Windows 95.

1.2.2   Handling Precautions

Like most evaluation kits, this product is designed for use in office and laboratory environments. The following practices will help ensure its proper operation.

1.2.2.1 Static Protection

This product uses low power CMOS circuits which can be damaged by electrostatic discharge. Partially damaged circuits can function erroneously, leading to misleading results. Observe ESD precautions at all times when handling this product.

1.2.2.2 Contents - Unpacking

Please ensure that you have received all of the items on the separate information sheet (EK9800) and notify CML within 7 working days if the delivery is incomplete.

1.2.3   Approvals

There are no approvals for this product.

1.3   Quick Start

This section provides instructions for users who wish to experiment immediately with the evaluation kit. A fuller description of the kit and its use appears later in this document.

1.3.1   Fitting the TI DSKplus

There are a set of pads on the PCB which match those of the TI DSKplus. The use of commonly available sockets and pin headers will raise the DSKplus board above the adjacent circuitry. It is recommended that the user only fit pins to the pads which are actually used to ease fitting and removal of the DSKplus board, see circuit schematic.

There is a power rail provided for the DSKplus, therefore it is not necessary to use the PSU supplied by TI. If however the PSU supplied by TI is to be used the user should remove jumper JP14.

The DSKplus parallel connection should be used as described in the DSKplus user's guide, TI document SPRU191.

1.3.2   Software

Copy the files ES9800xx.EXE, EF98Kxx.obj and EF9800xx.obj to a single directory.

1.3.3   Operation

Connect the +/-15 Volt supplies and turn on. Run ES9800xx.EXE. This will reset the TI DSKplus, before loading the application firmware. Finally, the CMX980A is reset by this firmware. An optional RESET button allows the manual resetting of the CMX980A.

1.4 Signal Lists

CONNECTOR PINOUT				
Connector Ref.	Connector Pin No.	Signal Name	Signal Type	Description
J1	1, 2, 6, 8, 10, 12, 14, 18, 20.	DGND	Power	Digital ground.
J1	3	/IRQ	O/P	Interrupt request line from CMX980A
J1	4	DVDD	POWER	digital V_{dd}
J1	5	SCMDRDFS	O/P	CMX980A - Command Read Frame Sync
J1	7	SCMDFS	I/P	CMX980A - Command Frame Sync
J1	9	SCMDRDDATA	O/P	CMX980A - Command Read Data
J1	11	SCMDDATA	BI	CMX980A - Command Data
J1	13	SCLK	O/P	CMX980A - Serial Clock
J1	16	VDSKP	POWER	Fixed 5 Volt Rail
J1	15	/RESET	I/P	CMX980A - Reset pin
J1	17	SRXFS	O/P	CMX980A - Receive Frame Sync
J1	19	SRXDATA	O/P	CMX980A - Receive Data
J2	1	DGND	POWER	Alternative power supply for
J2	2	DVIN	POWER	digital circuits only.
J3	1	+15V	POWER	Positive supply
J3	2	GND	POWER	Analog ground.
J3	3	-15V	POWER	Negative supply
J5-J8	1	DAC1-4	O/P	Auxilliary DAC outputs.
J9	1	IRXP	BI	I channel Rx, +ve input.
J10	1	IRXN	BI	I channel Rx, -ve input.
J11	1	QRXP	BI	Q channel Rx, +ve input.
J12	1	QRXN	BI	Q channel Rx, -ve input.
J13	1	QTXN	O/P	Q channel Tx -ve output.
J14	1	QTXP	O/P	Q channel Tx +ve output.
J15	1	ITXN	O/P	I channel Tx -ve output.
J16	1	ITXP	O/P	I channel Tx +ve output.

CONNECTOR PINOUT				
Connector Ref.	**Connector Pin No.**	**Signal Name**	**Signal Type**	**Description**
J17	1	ITx	O/P	I channel Tx, single ended output.
J18	1	QTx	O/P	Q channel Tx, single ended output.
J19	1	QRx	I/P	Q channel Rx, single ended input.
J20-J23	1	ADC1-4	I/P	Auxilliary ADC inputs.
J24	1	IRx	I/P	I channel Rx, single ended input.

TEST POINTS		
Test Point Ref.	**Default Measurement**	**Description**
TP1	-	DV_{IN}
TP2,TP3.	0 Volts	Digital ground.
TP4 - TP7	0 Volts	ANALOG GROUND.
TP8	-	CMX980A - Serial Clock
TP9	-	CMX980A - Command Data
TP10	-	CMX980A - Command Frame Sync
TP11	LO	CMX980A - Command Read Data
TP12	LO	CMX980A - Command Read Frame Sync
TP13-16	0 Volts	DAC4-1
TP17-20	-	ADC4-1
TP21	HI	Interrupt request line from CMX980A
TP22	LO	CMX980A - Receive Data
TP23	LO	CMX980A - Receive Frame Sync
TP25	5 Volts	Analog V_{DD}
TP26	5 Volts	Digital V_{DD}
TP27	5 Volts	DSP power rail, V_{DSKP}

JUMPERS/LINKS			
Link Ref.	Positions	Default Position	Description
JP1-4	sc/oc	sc	Links Tx outputs to single ended convertors.
JP5,7-9	sc/oc	sc	Links Rx single ended inputs to CMX980A differential inputs.
JP6	sc/oc	sc	Links SCLK to second serial port of DSKplus.
JP10,11	sc/oc	sc	Disable analog IC on DSKplus.
JP12	sc/oc	sc	Replace with current meter to monitor CMX980A analog current
JP13	sc/oc	sc	Replace with current meter to monitor CMX980A digital current
JP14	sc/oc	sc	Connects power rail, V_{DSKP}, to DSKplus footprint.
LK1	sc/oc	sc	Links analog and digital ground planes.
LK2	sc/oc	sc	Links +15V rail for digital and analog supplies

Notes: I/P = Input
O/P = Output
BI = Bidirectional
sc = short circuit
oc = open circuit

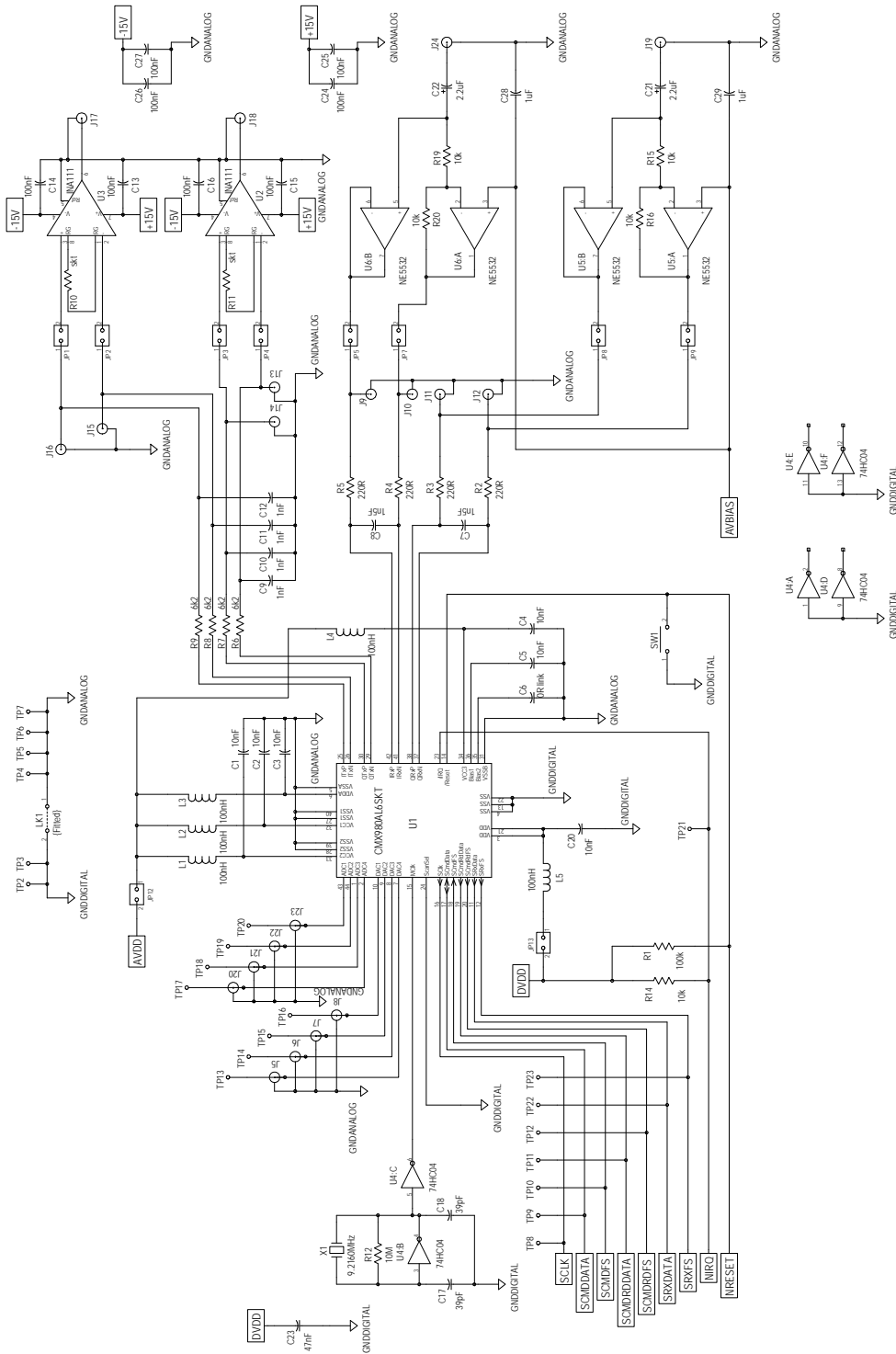## 1.5   Circuit Schematics and Board Layouts

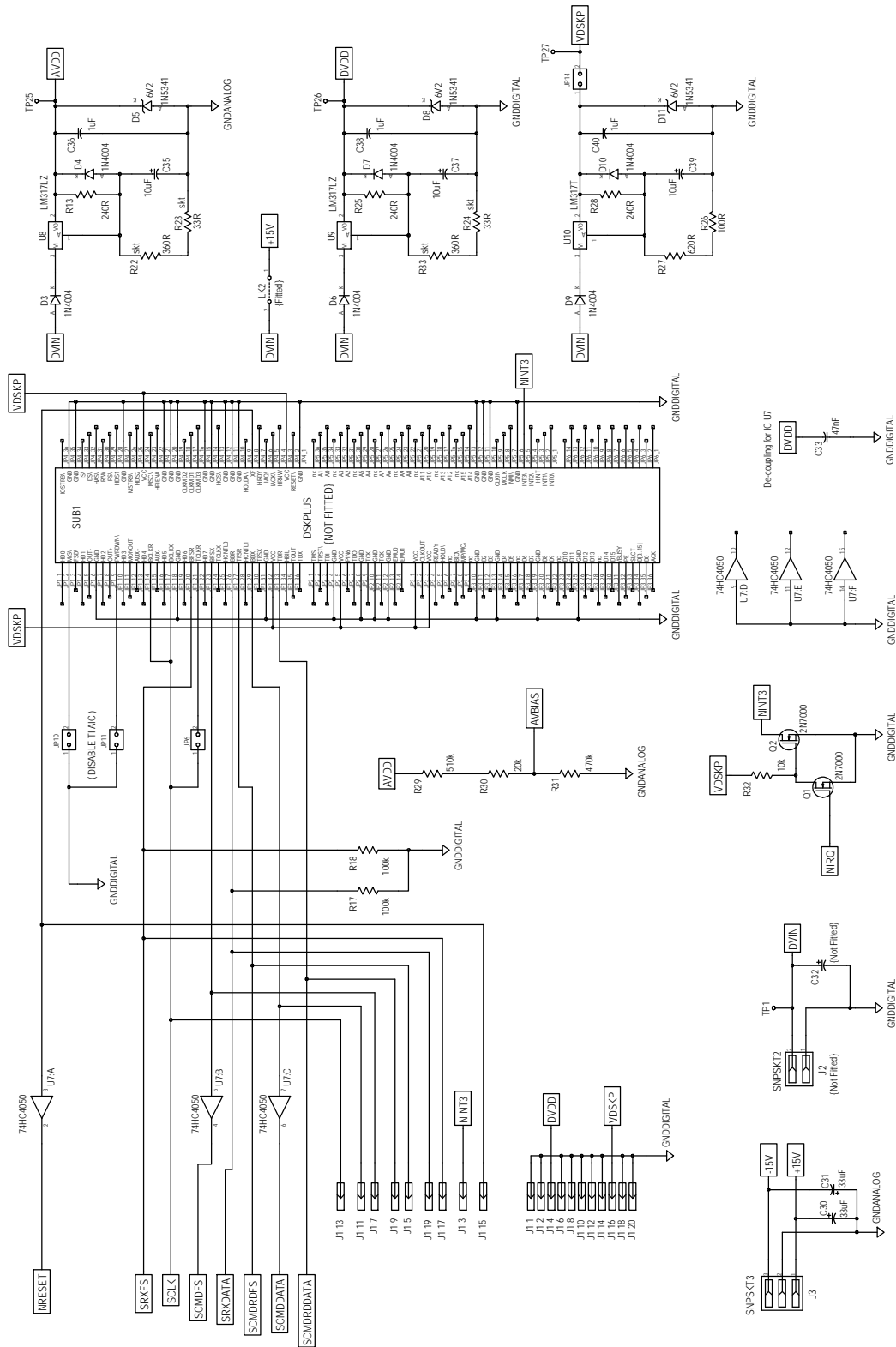

Figure 2 Evaluation Board - Circuit Schematic - Analog
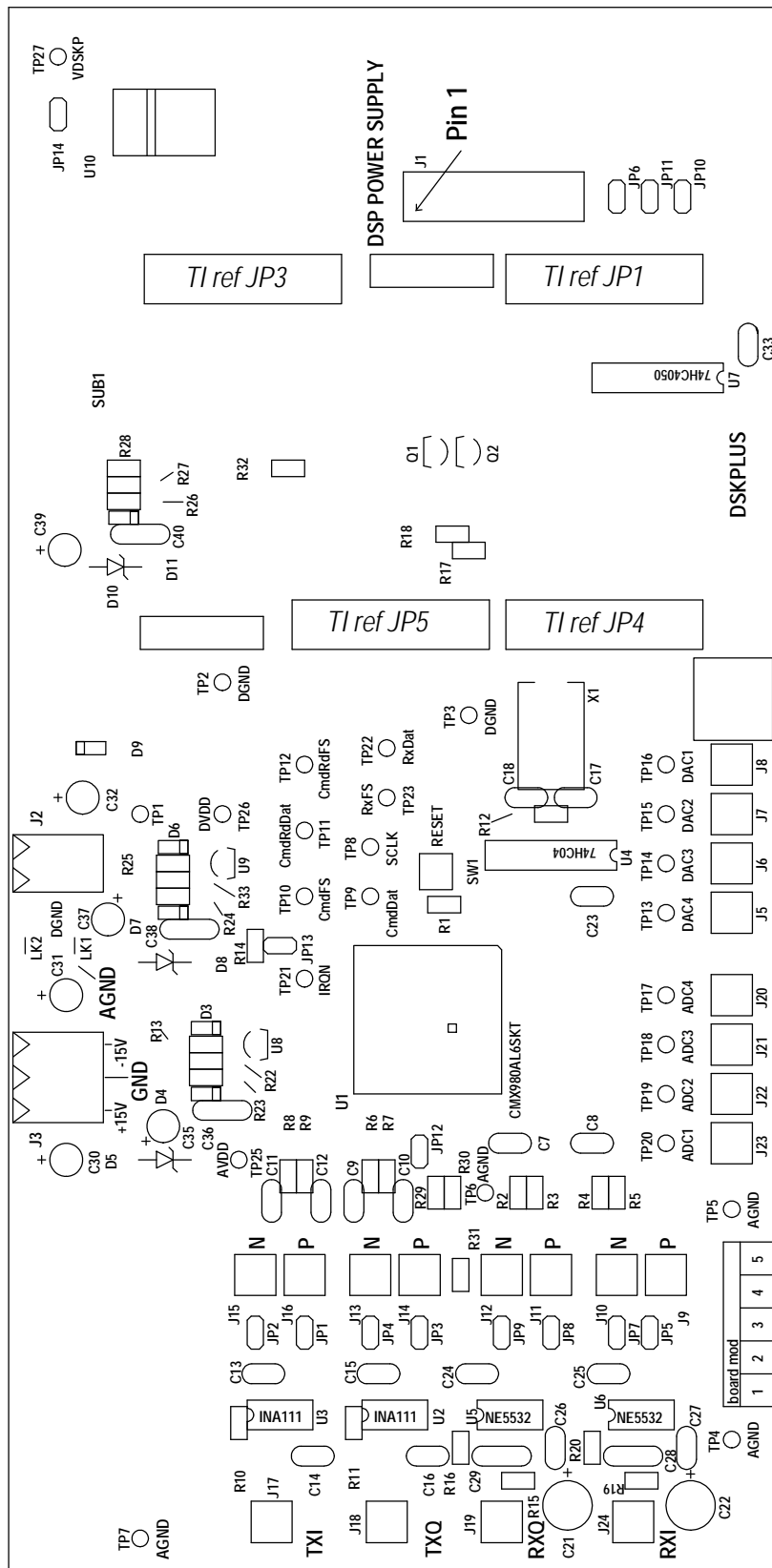
Figure 3 Evaluation Board - Circuit Schematic - Digital

Figure 4 Evaluation Board - Layout

1.6   Detailed Description

1.6.1   Hardware Description

All analog inputs and outputs of the CMX980A are brought to smb sockets.
Separate digital and analog supplies are provided. The ground planes are linked by wire link LK1.
If the user wishes to provide a separate external supply for the digital circuitry, he or she should do the following.

- Remove wire links LK1 and LK2.
- Use socket J2 (unfitted) to attach digital supply between 8 and 15 Volts d.c.
- The supply rail can be de-coupled by fitting capacitor C32.

Circuitry is provided to convert to and from the differential I and Q channel signals of the CMX980A from and to single ended signals. This circuitry may be isolated by removing jumpers JP1 to JP5, JP7, JP8 and JP9.

A 5 Volt power rail and footprint are provided for use with a TI DSKplus.

For those not fitting a DSKplus the serial interface ports for the CMX980A are brought out to a 20 pin header, J1. The digital signals may be monitored using testpoints TP8 to TP12, TP21, TP22 and TP23.

Level shifting is provided between the DSKplus or external, J1, inputs and the CMX980A.

An on-board oscillator circuit provides the 9.216MHz for MCLK of the CMX980A.

1.6.2   Adjustments and Controls

The analog and digital operating voltages (AV_{DD} and DV_{DD}) are set to 3.3V. These may be altered by changing the socketed components R22 and R23 for AV_{DD} and R24 and R33 for DV_{DD}. To select 5.0Volts set R22 and R33 = 620Ω; R23 and R24 = 100Ω. The formula for calculating the values is as follows:-

$$\mathrm{R22 + R23} \ = \ \mathrm{R24 + R33} \ = \ \frac{240\,(V_{DD} - 1.25)}{1.25}$$

Where 240 is the value of R13 or R28 in ohms and V_{DD} is the required supply voltage.

1.6.3   Firmware Description

The DSP firmware consists of two sections: a kernel and application software. This structure is based upon the source code supplied with the Texas Instruments DSP kit.

Operation is only possible via the supplied windows software, ES9800xx.EXE.

When ES9800 is started a kernel program is down-loaded to the DSKplus. Once this has been completed successfully the main windows panel is opened and an application program is downloaded to the DSKplus.

In general, main panel functions are executed in the PC using only the kernel DSP functions, allowing read and write access to the CMX980A.

The application demonstrations are initiated from the DSP kernel but are then executed mainly within the DSP application code.
The files ES9800xx.exe, EF98Kxx.obj and EF9800xx.obj must all be in the same directory on the user's PC.
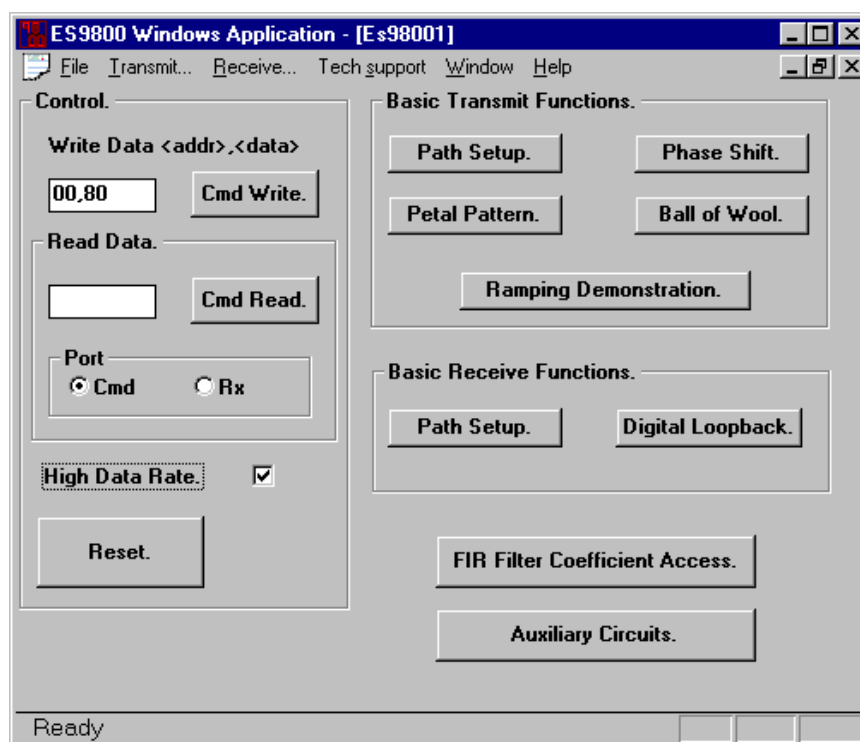
1.6.4   Software Description

1.6.4.1 Initialisation

Follow the instructions given on the PC screen. For a successful initialisation this sequence of dialog boxes will be observed.
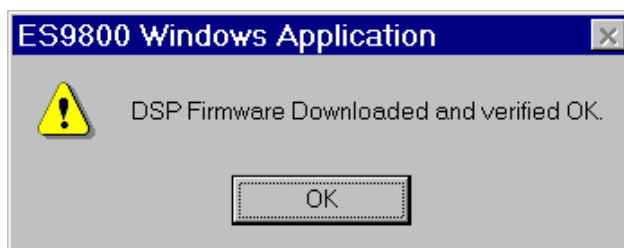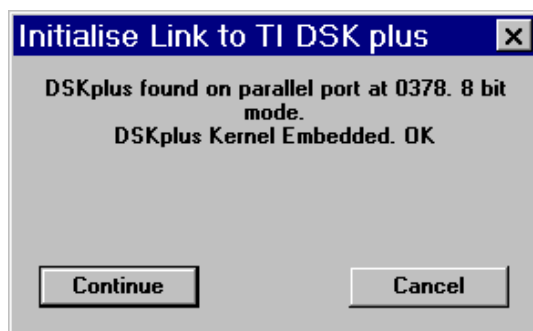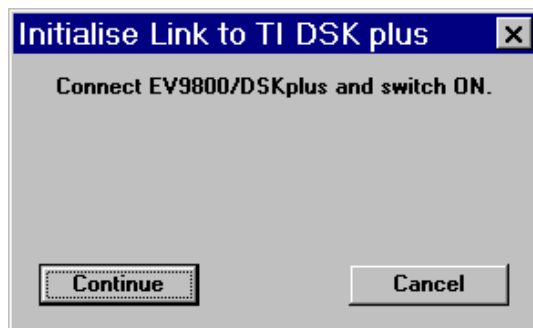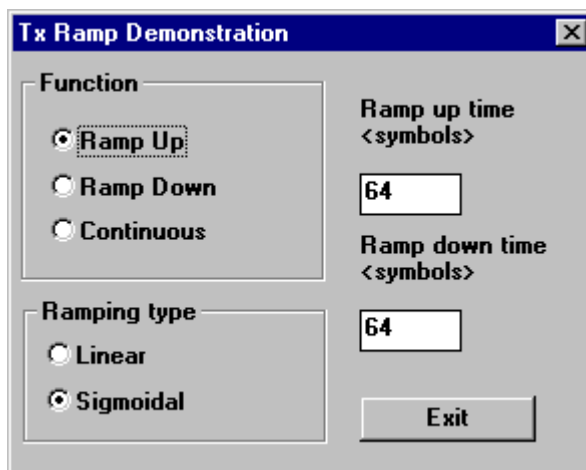
1.6.4.2 Main Panel

Basic Transmit Functions:

- 'Path Setup'. Sets Tx path gain to unity, phase to zero. CMX980A transmits continuous zeros: the π/4DQPSK unit circle when I and Q outputs are observed on an oscilloscope in x-y mode.

Note: In order to run the next four items, 'Path Setup' must have previously been run.
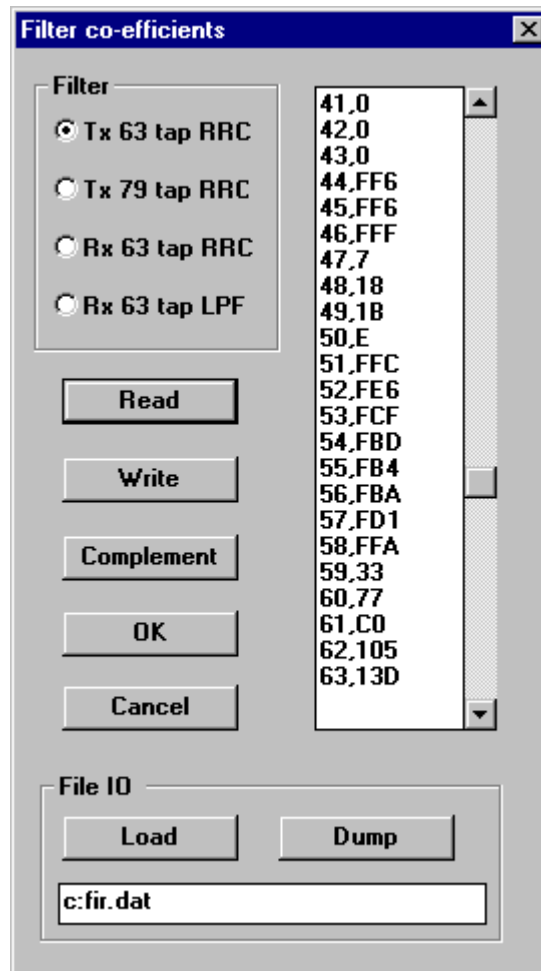
- 'Petal Pattern'. Transmits continuous 145 degree phase shift symbol: a petal pattern when output is observed as an x-y plot.

- 'Phase Shift'. The gain on one channel is reduced by 10dB and the phase shift between each channel is slowly adjusted across the maximum range.

- 'Ball of Wool'. Characteristic π/4DQPSK ball of wool pattern. Generated by routing on-chip BIST pseudo random sequence output through the Tx data path.

- 'Ramping Demonstration'. A pop-up dialog allowing demonstration of Tx ramping.

Tx Ramp Demonstration

Function
- ⦿ Ramp Up
- ○ Ramp Down
- ○ Continuous

Ramp up time <symbols>

`64`

Ramp down time <symbols>

`64`

Ramping type
- ○ Linear
- ⦿ Sigmoidal

[Exit]

Basic Receive Functions:

- 'Path Setup'. Enables the Rx path with gain set to unity.

- 'Digital Loopback'. Enables the Rx digital loopback test path.

Other Controls:

- 'FIR Filter Coefficient Access'. Use this pop-up dialog to change FIR filter coefficients. REMEMBER that if the coefficients are adjusted a subsequent reset will return them to the default values, as will clearing bit 0 of either the TxSetup ($0x03) or the RxSetup1 ($0x08) registers. Filter coefficients may be read from or written to a text file. For file format see the additional information section.

Filter co-efficients

Filter
- ⦿ Tx 63 tap RRC
- ○ Tx 79 tap RRC
- ○ Rx 63 tap RRC
- ○ Rx 63 tap LPF

```
41,0
42,0
43,0
44,FF6
45,FF6
46,FFF
47,7
48,18
49,1B
50,E
51,FFC
52,FE6
53,FCF
54,FBD
55,FB4
56,FBA
57,FD1
58,FFA
59,33
60,77
61,C0
62,105
63,13D
```

Read

Write

Complement

OK

Cancel

File IO
Load   **Dump**

c:fir.dat

Note that coefficient access will not work properly if the associated signal path is active. Also clock stop bits should not be set.

- 'Auxilliary Circuits'. Invokes the auxilliary circuit dialog.
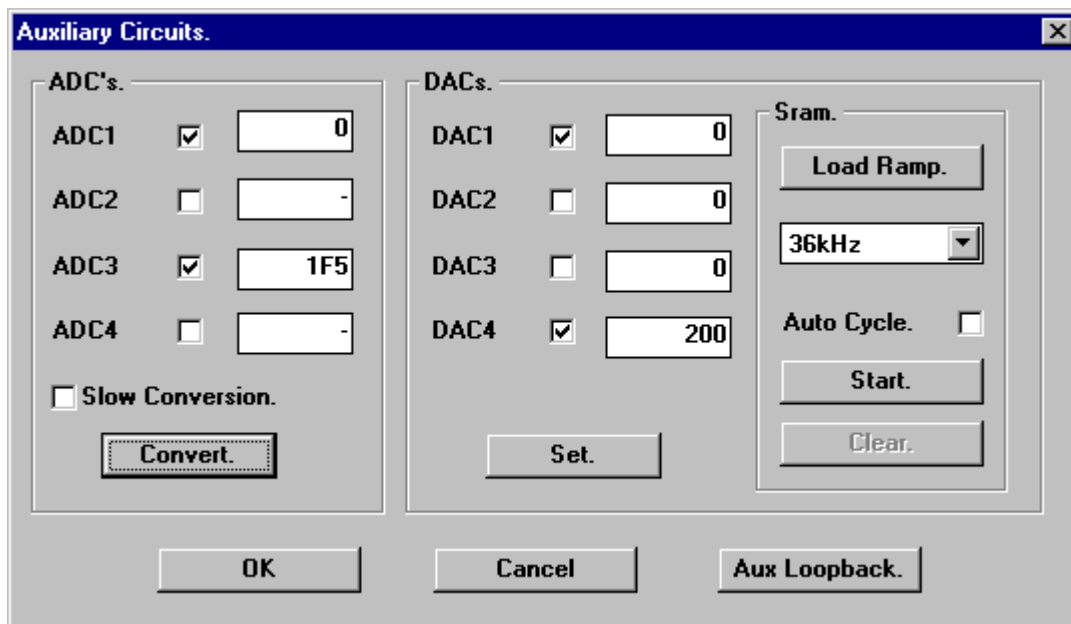
Featuring:

- 'Load Ramp'. Loads the SRAM DAC with a linear ramp between AV_{DD} and AV_{SS}.

- 'Aux Loopback'. Every 50μs a sample will be taken from auxiliary ADC1, inverted about 1/2 V_{DD} and output to auxiliary DAC1.

- 'Auto Cycle'. Continuous ramping up and down, between AV_{DD} and AV_{SS}.

- 'Slow Conversion'. Enables half speed conversion

1.6.4.3 Transmit

Invoked from the menu bar once main panel is open.
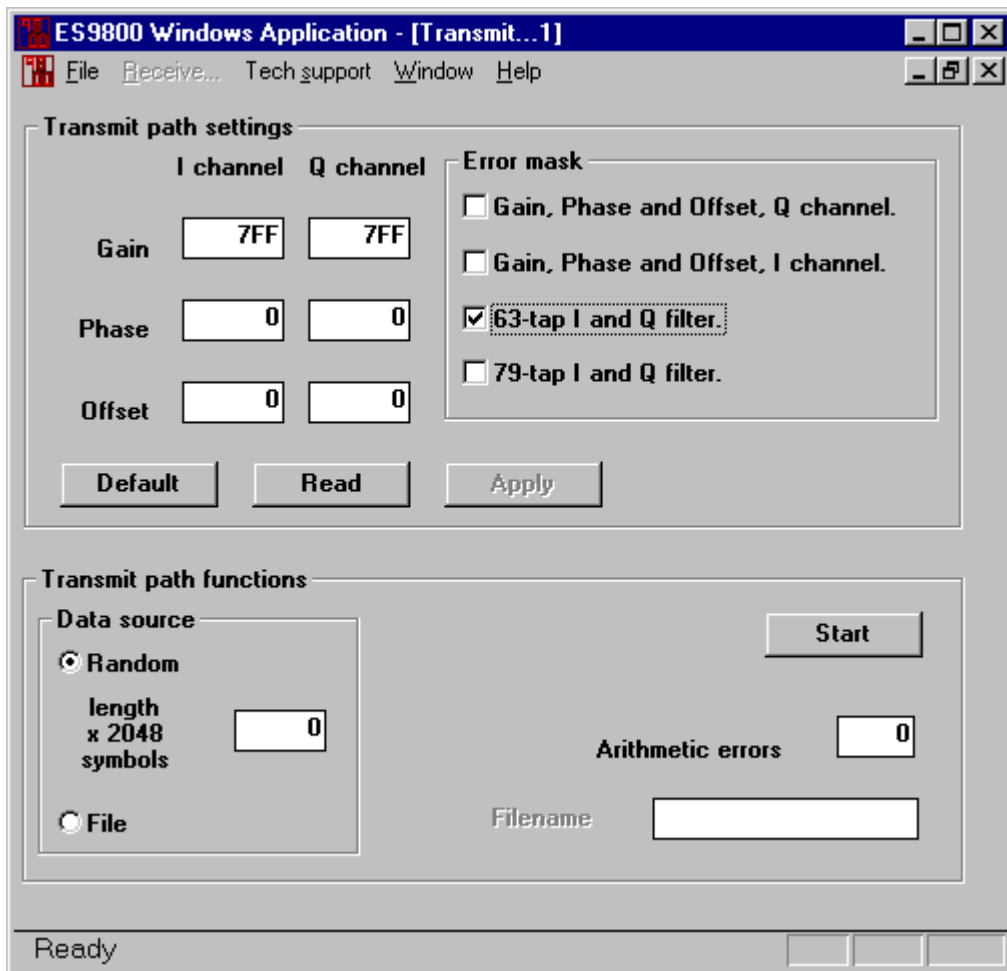
- Transmit Path: Indication and adjustment of Gain, Phase and Offset values.

- Error Mask: Tick the box to un-mask Tx path error status bits. The total number of errors for un-masked conditions is displayed in the 'Arithmetic errors' box when a Tx sequence is completed. The Tx function will be aborted if the error count reaches 255.

- Data Source:
    - The random data is generated from a 15-bit sequence with XOR feedback from bits 14 and 15.
    - Small sequences (<2048 symbols) can be transmitted from a text file. For file format see the additional information section.
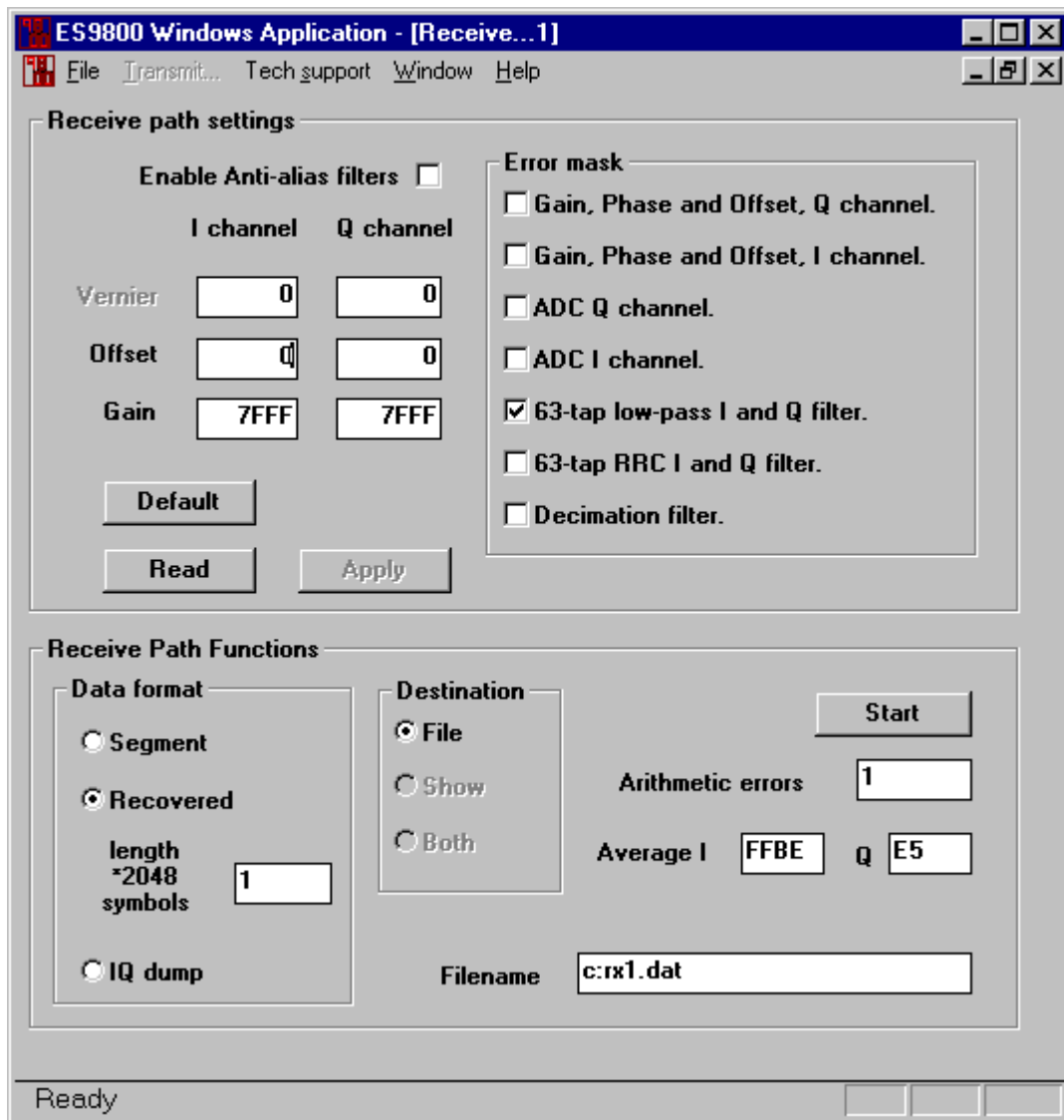
    Data is transferred to the DSKplus in 2048-symbol blocks.

Hints:
- For Tx to work, values must be written to the gain registers.

1.6.4.4 Receive

Invoked from the menu bar once main panel is open.

- Receive Path: Indication and adjustment of Gain and Offset values. The Rx anti-alias filters can be selected. There is also an indication of the I and Q vernier settings.

- Error Mask: Tick the box to un-mask the Rx path error status bits. The total number of errors for un-masked conditions is displayed in the 'Arithmetic errors' box when a Rx sequence is completed. The Rx function will be aborted if the error count reaches 255.

- Data Format:
    - An 8-bit segment value (dividing the unit circle into 256 equal segments) is output for each sample period.
    - The recovered symbol data is output. Only valid if high data rate has been selected from the main panel.
    - IQ dump. One block of 2048 ∗ 16 bit values from the CMX980A rx data pin is output.

    Data is transferred from the DSKplus in 2048-sample or -symbol blocks.

- Destination: At present, receive data may only be output to a file. For file formats see additional information section.
- Averages: Displays average I and Q values when a receive sequence is completed.

Hints:

- For Rx to work, values must be written to the gain registers.
- If one EV9800 which is transmitting, is connected to a second EV9800 which is receiving, using the single ended connections for I and Q, the transmit ouput must be attenuated by at least 6dB to avoid over-driving the receiver.
- For data recovery at low signal levels it is necessary to null out any system or device offsets. This can be achieved using the average I and Q values for no signal then adjusting the offset register values accordingly. It should be noted that for the CMX980A there is a total gain of 1.55 through the 63 tap low pass and 63 tap RRC filters, therefore any offset adjustment will need to be divided by 1.55. Also, any subsequent adjustment in the gain registers will require scaling of the offset values.

1.6.4.5 Notes on recovered symbol data

Note that the algorithm used is not a 'total' solution. It is designed to show that real data can be recovered from the Rx data stream *but, for a good signal, should give reasonable BER over a dynamic range of about 60dB on the Rev B printed circuit boards, slightly less on the Rev A boards.*

At present there is no adjustment of offsets or of I and Q vernier settings. The Average I and Q can be used to manually adjust offsets in the I and Q channels. This becomes necessary when receive levels fall below approximately 25mVrms.

1.6.5 Additional Information

1.6.5.1 Text File Formats

- Tx symbol data

```
0,000027<CR,LF>
11<CR,LF>
10<CR,LF>
00<CR,LF>      ; etc with one symbol in binary format on each line until the last line, line 27
               ; in this case, with one binary symbol and no carriage return.
01
```

- Rx segment information

```
2,024576<CR,LF>
52<CR,LF>
5A<CR,LF>
89<CR,LF>      ; etc with one segment value in hex on each line until the last line, line 24576
               ; in this case, with one segment value and no carriage return.
46
```

- Tx or Rx symbol data

```
1,001024<CR,LF>
6D<CR,LF>
AA<CR,LF>
C8<CR,LF>      ; etc with four symbols as an 8-bit value in hex on each line until the last line,
               ; line 1024 in this case, with an 8-bit hex value and no carriage return.
27
```

- Rx I and Q values.

```
3,002048<CR,LF>
FFE2<CR,LF>  ; First I value.
02D3<CR,LF>  ; First Q value.
```

```
FFA0<CR,LF>  ; etc with one 16 bit signed I or Q value in hex on each line until the last line, line
             ; 2048 in this case, with the last Q value and no carriage return.
34E1
```

- Filter Coefficients.

```
4,000063<CR,LF>
0<CR,LF>
0<CR,LF>
FFE6<CR,LF>
FFD9<CR,LF>  ; etc with one 16 or 12 bit signed value in hex on each line until the last line, line
             ; 63 in this case, with the last coefficient and no carriage return.
17D4
```

In all cases the 6-character value on the first line is the number of lines of data in decimal.

1.6.6   Troubleshooting

This software will NOT run with Windows NT.

1.6.6.1 PC Requirements

The ES9800 software has been verified on a limited group of machine and operating system combinations as follows.

486DX2-66, Windows 95.
P133, Windows 3.11.
P200, Windows 95.

Note: Operation has not been verified under Windows 98.

There are traps for possible DSKplus firmware download problems. If the user wishes to try again when a problem is flagged, a System..Initialise function is available from the mainframe menu, if the 'main panel' is closed down.

If there are problems communicating with the DSKplus a selftest utility is available. This can be accessed when the main panel and Tx or Rx panels are closed. From the menu bar, System… HPI selftest.

Note: The selftest function loads the DSKplus with different firmware. Therefore, to restart the evaluation software select 'System... Initialise'. The option 'System... Open Main Panel' allows the main GUIs to be viewed without the hardware being present.

1.6.6.2 Resetting the DSKplus

If the ES9800 windows application is exited abnormally, the DSKplus will not be left in the correct state for re-starting. In this situation it will be necessary to power-down the DSKplus and power-up again before attempting to restart the ES9800 windows software. If the power-down is not performed, a 'DSKplus not found !!' message will be displayed.

1.6.6.3 Window Activity and Screensavers

If transmitting random data continuously from the PC it will probably be necessary to disable the windows screen saver. The processor activity required to invoke the screen saver will prevent data

from being down loaded to the DSP frequently enough to maintain continuous transmit. In this case the transmit sequence will be terminated. It is likely that the re-sizing or moving of windows during continuous transmit will have the same effect.

1.7   Performance Specification

1.7.1   Electrical Performance

Absolute Maximum Ratings
Exceeding these maximum ratings can result in damage to the Evaluation Kit.

	Min.	Max.	Units
Supply			
+15V	-0.3	22.0	
-15V	+0.3	-22.0	V
Voltage on any connector pin to V_{SS}	-0.3	V_{DD} + 0.3	V
Current into or out of +15V or -15V and V_{SS} pins	0	500	mA
Storage Temperature	-10	+70	°C
Operating Temperature	+10	+35	°C

Operating Limits
Correct operation of the Evaluation Kit outside these limits is not implied.

	Notes	Min.	Max.	Units
Supply (15V - V_{SS})		14.5	15.5	V
(-15V - V_{SS})		-14.5	-15.5	V
Operating Temperature		+10	+35	°C

Operating Characteristics
For the following conditions unless otherwise specified:
V_{DD} = 5.0V, Tamb = +25°C.

	Notes	Min.	Typ.	Max.	Units
DC Parameters					
I_{15V}	1,2		65	100	mA
I_{-15V}			20	25	mA

Notes: 1.   Not including any current drawn from the board connector pins by external circuitry.
2.   Fitting a DSKplus and using the power rail provided on-board will increase the current consumption by approximately 250mA.

Operating Characteristics - Timing Diagrams

For CMX980A timing information and operating characteristics, refer to the relevant CML Data Sheet.