CX2300

Active Filter

Installation & User Guide

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CX2300 Active Filter

Installation and operation manual

Contents

1 Introduction

The Cloud CX2300 3 Way Stereo Active Crossover has been designed without compromise to operate with very low levels of noise and distortion as part of a high quality professional sound system. A high degree of security is provided by using fixed frequency plug-in filter cards together with a tamper proof cover for the front panel. Once the unit has been correctly installed, no unauthorised adjustments can be made thus maintaining system integrity and reliability.

Balanced audio connections are used throughout via Neutrik 3 pin XLR type connectors with gold plated pins. We suggest that balanced interface connections are used wherever possible, even for very short interconnections to take advantage of the common mode rejection and freedom from earth loops when wired correctly.

The control layout is very simple and logical with each frequency band having its own stereo controls for gain, phase invert and mute. In addition, a 20Hz high pass filter can be switched in or out of the signal path. All these controls and switches, including the power switch are protected by the security cover supplied with every unit.

Plug-in fixed frequency filter cards determine the frequency characteristics of the CX2300 and these can be specified from the list detailed in section 6.01. To change the frequency of any filter card, refer to the component list in section 6.01 which gives details of resistors which should be fitted to the filter card to achieve a particular frequency.

Experienced installers who are fully conversant with the Active filters and Crossovers skip to section 3 for installation details.

2 Active Filters and Crossovers

2.01 Why use an Active Filter/Crossover ?

Virtually all high quality speaker systems whether domestic or professional use two or three drivers to cover the whole of the audio spectrum with each driver specially designed to reproduce a finite frequency range. In most low to medium power speaker systems, a single full range power amplifier would be used to feed a passive crossover to filter the signals to the two or three speakers within the full range enclosure. There are several disadvantages when using full range amplification and passive filters; any differences in driver efficiency have to be corrected by adding power resistors which is both wasteful and reduces driver damping; High order passive filters with good attenuation levels are expensive and inefficient; Any distortion present in the power amplifier is heard across the whole audio spectrum.

A well designed fully active system will overcome all of the above problems, the sound quality will be improved and the system will be much easier to set up. In a typical active sound system, the bass, middle and treble regions would each have their own speaker drive units which would be wired directly to separate power amplifiers. The bass amplifier would be the most powerful, the amplifier used for the mid range would be around half the power of the bass amplifier and the treble amplifier would be around half to two thirds the power of that of the mid range amplifier.

The active filter/crossover would be used to separate the two or three frequency bands at line level immediately before the signal connects to the power amplifiers.

Some active filters have adjustable crossover frequency controls which can be useful when testing the system to determine the most satisfactory frequency but care must be taken to ensure that any final setting is within the speaker manufacturers specifications.

Once the crossover frequencies have been determined, an active filter with fixed frequencies determined by plug-in cards may be preferable for a fixed installation.

2.02 What are the optimum crossover frequencies?

A professional sound system should have a useful response from below 30Hz to above 20kHz but this overall response is a function of the design of the enclosures and the placement within the building and is beyond the scope of this manual. Wherever possible refer to the manufacturers specification for details of the crossover frequencies. Where no specific details are available, there are practical guidelines which can be used to determine the most suitable crossover frequencies for a particular system.

It is common to find multiples of 38cm and 45cm drivers used in low frequency enclosures where the upper frequency limit of around 800Hz is dictated by a narrowing of the dispersion and a loss of definition. The optimum upper limit is around 250Hz.

Where cone drivers are used for mid range purposes, the lower frequency limit should be no lower than double the resonance of the drive unit and should be compatible with the upper frequency limit of the bass drivers. The upper limit is again dictated by a narrowing of the dispersion and loss of definition. For 30cm drive units the upper limit is 1.5kHz and 2kHz for 25cm units.

The high frequency section would normally use horn loaded compression drivers and manufacturers data would have to be used to determine the most suitable crossover frequency. A higher frequency than that specified by the manufacturer is often chosen to improve the reliability of the compression driver's diaphragm. A system compressor/limiter is also often used to prevent clipping of the power amplifiers output waveform which can cause premature destruction of the diaphragm(s).

If compression drivers with horns are used to handle the high frequencies, it is common practice to improve the ultra high frequencies by adding horn loaded tweeters to the same circuit by using passive filters usually at frequencies above 5kHz.

2.03 Why 3 pole filters ?

When designing the CX2300, we were mindful of the requirement that the unit should sound good. It is generally accepted that odd order filters sound more musical than their even order counterparts and our own tests confirm this. The use of third order Butterworth filters gives a high 18dB/octave roll off which relates to a power reduction of 85% per octave.

3 Installation

3.01 Installation notes for the experienced installation engineer

The Cloud CX2300 is a stereo three way active crossover designed primarily for use as part of a professional sound system. The use of plug-in fixed frequency filter cards and the supplied anti-tamper cover provides a high level of security and helps to preserve the control settings and system reliability. The unit can be used in the two way mode if required by using one filter card and positioning the PC mounted switch in the two way mode (see section 4.01).

The CX2300 would normally have been supplied as a fully tested unit with the filter cards fitted at the factory. For details of the crossover frequencies, see the documentation that was supplied with the unit or alternatively, details are given on the plug-in cards.

For optimum performance and low noise operation, we strongly advise the use of balanced interconnections with high quality XLR type connectors and two core screened cables. If you experience low frequency 'hum loops' we suggest that you connect the cable screen at the input end (amplifier) only and any common mode signal should be rejected.

The CX2300 should be rack mounted close to the system power amplifiers but care should be taken to avoid mounting the unit in close proximity to any power amplifier which may radiate a high magnetic field from the core of its power transformer. It is good practice to distance the line level wiring from the speaker wiring.

The CX2300 should be connected into the audio chain between the full range signal processing equipment (such as mixers, equalisers and compressors etc) and the power amplifiers.

When setting up the sound system, we suggest that the CX2300 level controls are set before any other equalisation adjustments are made. The 20Hz high pass filter is provided to protect speakers from excessive cone excursion in reflex enclosures but may not be required if similar filters are present in other equipment (Cloud CXF & CXM mixers have fixed 20Hz high pass filters).

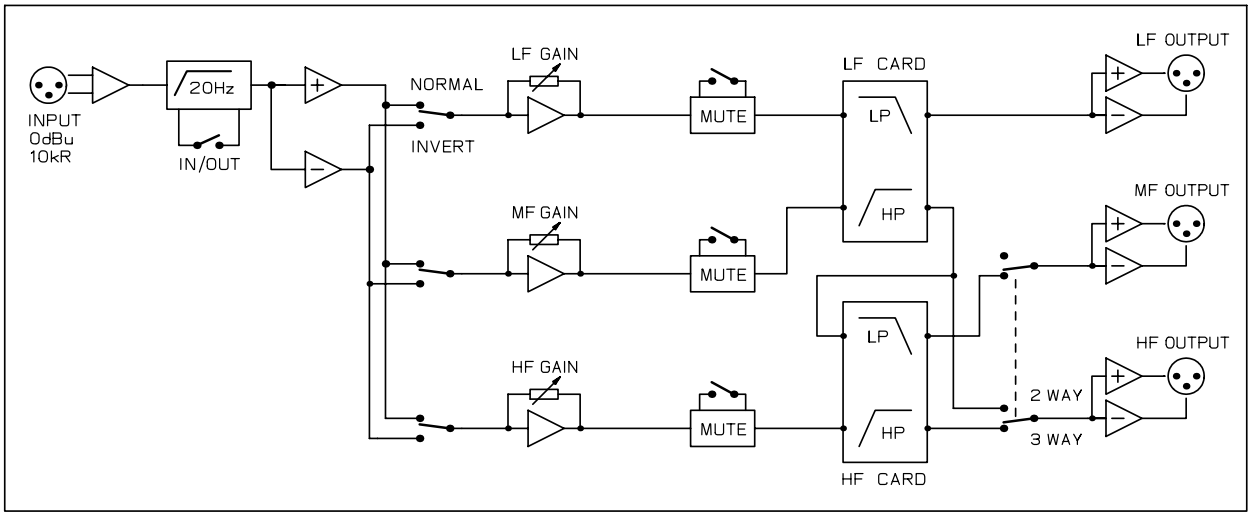
3.02 Mounting

The CX2300 is designed for standard 19" rack mounting and occupies 1U of rack space. Avoid mounting the unit directly above or below power amplifiers or power supplies that radiate significant amounts of heat and strong magnetic fields. Fibre or plastic washers may be used to prevent the front panel becoming marked by the mounting screws.

3.03 Audio Connections

Always use balanced interconnections wherever possible using high quality 2 core screened cable. The wiring convention is: pin 2 hot (+ phase), pin 3 cold (- phase) and pin 1 signal ground. The shell of the XLR type connector is connected to the chassis (see section 5.04 'Signal connections and EMC').
The CX2300 is designed as a stereo active crossover and the front panel controls and internal circuitry operate as a two channel stereo device. If the audio system is configured for mono operation, only one channel should be used.

3.04 Schematic Diagram



3.05 Power connections

The unit will have left the factory configured to operate from a power input of 230V ?10% at 40 to 60Hz. If the unit is required to operate from a 115V ?10% follow the following instructions:

1 Disconnect the power lead from the power input connector.

2 Using a number 2 pozidrive screwdriver, remove the six self tapping screws retaining the top panel of the unit.

3 Using a number 1 pozidrive screwdriver, remove the 5 M3 machine screws that retain the PCB to the bottom panel. These can be located:
Adjacent to IC10.
Next to R33.
Near C16.
Two screws near the power transformer.

4 From the under side of the unit, remove the 6 self tapping screws retaining the bottom panel, using the number 2 pozidrive.

5 If the unit is currently configured for 230V operation, one zero ohm link should be fitted into the 230V position adjacent to the power transformer. Remove this link and fit two links into the positions marked '115V'.

6 Change the power fuse to a T100mA type.

7 Mark the rear panel of the unit to indicate the revised input voltage and fuse rating.

8 Re-fit the two covers and secure the PCB in reverse order.

3.06 Plug-in Filter Cards

Access to the filter card

1 Disconnect the power cable from the CX2300.

2 Using a number 2 pozidrive screwdriver, remove the six screws which retain the top panel in place.

3 Locate the two plug-in cards mounted on the mother board. The low frequency card is nearest the power transformer.

4 Remove the two M3 machine screws which hold the plug-in card in place, then withdraw the card vertically.

5 Replace the card with care, ensuring that the mounting holes align perfectly with the threaded mounting posts.

6 Replace the top panel.

4 Operation and Controls

4.01 Two Way Operation

Whilst the CX2300 will be used predominantly in the three way mode, the unit can be used on two way systems. In this mode of operation, just one filter card, the low frequency card, is used and the mode switch (mounted on the PCB) should be in the 'two way' mode. LED's on the front panel indicate the mode of operation. When operating in the two way mode, the high frequency output is used and the middle frequency output is muted. The two bands are controlled on the front panel by the low frequency and middle frequency sections with the high frequency section inoperative.

4.02 Do I use the 20Hz high pass filter ?

The ported reflex bass enclosure is used extensively in professional sound systems and a characteristic of this design is that the cone of the LF driver is not loaded below the tuned frequency of the enclosure and some form of excursion protection must be provided to prevent the driver from possible physical destruction. The 20Hz high pass filter in the CX2300 can be used to provide this protection at the rate of 18dB/octave. An additional advantage of the filter is to help reduce acoustic feedback derived from turntable pickups but only if the feedback occurs below 20Hz. Care must be taken to make sure that the signal has not been processed by other filters in the signal chain (the Cloud CXM & CXF mixers both have fixed 20Hz high pass 3 pole filters) unless double protection is desired.

4.03 The Invert Switch

It is often not practical to align the diaphragms and voice coils of the many drivers such that they are all coincident and in addition, both equalisation and filter circuits can cause small amounts of phase shift. The phase reverse switch will introduce a phase shift of 180 degrees and the most suitable position of the switch is best found by subjective tests when the system is set up.

4.04 The Mute Switch

This facility would normally be used during initial testing/setting up or perhaps when fault finding. Operating the mute switch will totally silence the respective frequency band on

both left and right channel. Operating each band in isolation can be very revealing if you wish to focus your attention on a particular driver(s).

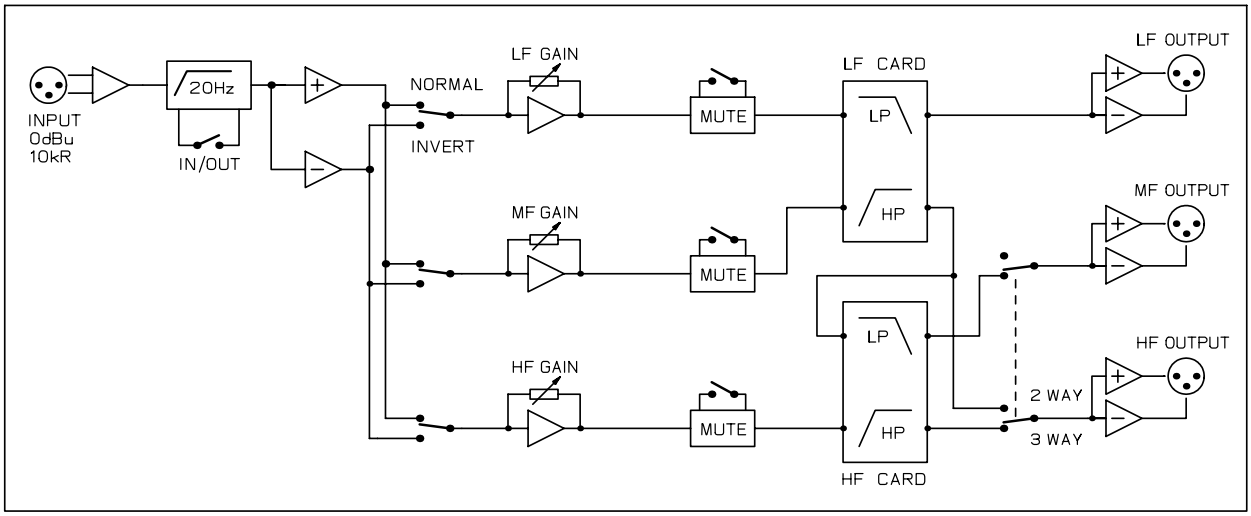
4.05 The Gain Controls

All three bands have their own stereo gain control with a range of gain from a centre unity position (0dB) to -12dB of attenuation in the anti-clockwise position and up to 6dB of gain in the clockwise position. When setting up the sound system, all equalisation controls should be in the flat position, including any Graphic Equalisers.

Using a pink noise source, the system should be set up using a spectrum analyser and the level controls should be adjusted by leaving the LF gain in the centre (0dB) position and adjusting the mid and HF gain controls to give a response as close as possible to a falling response of around 3dB/octave as the frequency increases. Fine adjustments should then be made via the system equaliser.

5 Circuit Description

5.01 Schematic diagram



5.02 The Audio Path

Both left and right input circuits feature an electronically balanced input stage with a gain of -6dB which feed a bandpass filter with a switchable 20Hz highpass section and a fixed 50kHz lowpass filter. The filter output is routed to the 'in-phase' side of the phase invert switches and the same signal is inverted and fed to the other side of the phase invert switches. The output of these switches is connected to the three variable gain stages including the mute switches. The low frequency section then routes the signal through the low pass section of the low frequency card to the balanced output stage which has a gain of 6dB. The mid frequency section feeds the signal through the high pass section of the LF Card and then through the low pass section of the HF Card before reaching the balanced output stage. The high frequency section uses the high pass section of the HF Card and its balanced output stage.

5.03 The Power Supply

The CX2300 has a standard bi-polar 15-0-15 volt power supply derived from the two adjustable regulators. This enables a smooth power-on as the circuitry has a slow rise characteristic thus reducing power supply derived thumps and other extraneous signals which often find their way on to the audio signal.

5.04 Signal Connections and EMC

The CX2300 is fully compatible with the Electromagnetic Compatibility standards and if you propose to use the unit where it may be exposed to high levels of disturbance such as may be found close to a TV or radio transmitter we suggest that the screen of the signal cables should be connected to the chassis connection on the XLR type connector. To avoid any ground loops, the signal earth (pin 1) should only be connected at the receiving end of the cable when the common mode rejection should reduce any unwanted signals to a negligible level.

5.05 The benefits of balanced interconnections.

Most professional audio equipment utilise balanced inputs and outputs using the familiar 3 pin XLR type connector or perhaps a 3 pole 6.3mm phone jack. A balanced output stage will normally have a very low output impedance and will happily drive a line with a load as low as 600Ω. The interconnecting cable should have two twisted cores with an overall screen and any interference that may penetrate the screen would be picked up by the two inner cores and appear as a common mode signal. The balanced input stage is sensitive to differential signals only and features a high rejection of the common mode signal (Common Mode Rejection or CMR) which may be interference or ground loop hums. We therefore strongly suggest that balanced interconnections are used by default.

5.06 Using the CX2300 with unbalanced equipment.

The CX2300 can be used with any equipment with unbalanced signal ports. Where the signal source is unbalanced, connect the signal ground to pins 1 & 3 and use pin 2 as the hot signal input. This will result in no signal loss and will operate normally but without the benefits of noise and interference cancellation.

If the output of the CX2300 is driving an unbalanced load, connect the screen to pin 1 and the hot signal output to pin 2. Do not make any connection to pin 3 whatsoever. The system will operate with a gain loss of 6dB which can be recovered by rotating the front panel gain controls clockwise.

5.07 40Hz - the minimum frequency.

The circuitry of the CX2300 is arranged so that the mother board is fitted with two low pass filters and two high pass filters which operate at the low frequency of 40Hz with no plug-in card fitted. The filter cards are fitted with resistors which connect in parallel to the resistors on the mother board and increase the operating frequency of the filters. The minimum crossover frequency is therefore determined by the fixed 40Hz with no card fitted and the practical upper limit is 8kHz.

6 How to change the frequency of the filter card.

The frequency of the filter cards supplied with the unit will probably have been specified at the time of ordering. If the frequency requires to be changed, please refer to the table of resistor values in section 6.01. The filter card has a total of 24 resistors fitted but for some frequencies not all 24 are required to be fitted.

It is important to make a note of the frequency on the card for future reference.

6.01 Table of resistor values for the filter card

	Low Pass		**High Pass**					
Freq	R1 R3 R5 R20 22 24	R2 R4 R6 R19 21 23	R9 R16	R10 R15	R11 R18	R12 R17	R7 R14	R8 R13
40Hz	No Card	No Card	No Card	No Card	No Card	No Card	No Card	No Card
50Hz	1M6	2M4	1M2	-----	620k	1M5	8M2	-----
60Hz	910k	1M	1M2	1M2	220K		6M8	10M
70Hz	750k	560k	620k	1M1	220k	430k	5M1	5M6
80Hz	240k	-----	300k	-----	110k	-----	2M	-----
90Hz	330k	470k	240k	-----	130k	270k	1M6	-----
100Hz	160k	-----	200k	-----	110k	220k	2M4	3M
110Hz	220k	360k	330k	360k	120k	130k	2M2	2M4
120Hz	120k	-----	150k	-----	110k	110k	1M	-----
125Hz	180k	300k	270k	300k	91k	120k	1M8	2M
130Hz	150k	360k	240k	300k	82k	120k	1M6	2M
140Hz	240k	160k	120k	-----	62k	150k	1M6	1M6
150Hz	130k	270k	110k	-----	62k	110k	2M7	1M
160Hz	160k	160k	100k	-----	62k	91k	1M2	1M5
170Hz	110k	220k	160k	220k	62k	75k	620k	-----
175Hz	160k	130k	160k	200k	62k	68k	1M1	1M3
180Hz	68k	-----	150k	200k	51k	82k	1M1	1M2
190Hz	110k	150k	160k	160k	56k	62k	910k	1M3
200Hz	120k	120k	150k	150k	43k	75k	1M	1M
210Hz	56k	-----	110k	200k	39k	75k	470k	-----
220Hz	130k	91k	120k	150k	47k	51k	750k	1M1
225Hz	120k	91k	110k	160k	39k	62k	430k	-----
230Hz	51k	-----	110k	150k	30k	100k	680k	1M1
240Hz	91k	100k	120k	120k	22k	-----	620k	1M1
250Hz	91k	91k	110k	120k	33k	56k	620k	1M
260Hz	68k	120k	100k	120k	20k	-----	510k	1M3

	Low Pass		High Pass					
Freq	R1 R3 R5 R20 22 24	R2 R4 R6 R19 21 23	R9 R16	R10 R15	R11 R18	R12 R17	R7 R14	R8 R13
270Hz	110k	68k	91k	120k	24k	91k	560k	910k
275Hz	91k	75k	75k	160k	36k	39k	680k	680k
280Hz	110k	62k	100k	100k	30k	47k	560k	820k
290Hz	100k	62k	91k	100k	30k	43k	560k	750k
300Hz	82k	68k	75k	120k	30k	39k	620k	620k
325Hz	75k	62k	68k	110k	27k	36k	560k	560k
350Hz	62k	62k	39k	-----	27k	30k	390k	750k
375Hz	75k	47k	36k	-----	22k	33k	240k	-----
400Hz	56k	51k	56k	82k	22k	27k	390k	510k
425Hz	39k	68k	51k	82k	22k	24k	330k	560k
450Hz	47k	47k	51k	68k	18k	27k	390k	390k
475Hz	39k	51k	47k	68k	16k	27k	300k	470k
500Hz	33k	56k	43k	68k	16k	24k	240k	620k
525Hz	36k	43k	39k	68k	9k1	-----	330k	330k
550Hz	27k	62k	47k	47k	15k	20k	220k	560k
575Hz	18k	-----	43k	47k	8k2	-----	150k	-----
600Hz	33k	36k	43k	43k	13k	20k	270k	300k
625Hz	33k	33k	39k	43k	7k5	-----	220k	360k
650Hz	30k	33k	39k	39k	13k	16k	130k	-----
675Hz	15k	-----	36k	39k	13k	15k	240k	270k
700Hz	22k	43k	30k	47k	12k	15k	220k	270k
725Hz	24k	33k	30k	43k	10k	18k	180k	330k
750Hz	27k	27k	30k	39k	6k2	-----	180k	300k
775Hz	13k	-----	24k	51k	11k	13k	240k	200k
800Hz	24k	27k	30k	33k	11k	12k	200k	220k
900Hz	16k	36k	24k	33k	5k1	-----	160k	220k
1kHz	10k	-----	20k	33k	9k1	9k1	120k	270k
1.1kHz	9k1	-----	18k	30k	7k5	9k1	75k	-----
1.2kHz	8k2	-----	18k	24k	5k6	12k	130k	150k
1.3kHz	15k	15k	18k	20k	5k6	9k1	110k	150k
1.4kHz	11k	20k	16k	20k	6k2	6k8	75k	270k
1.5kHz	11k	16k	8k2	-----	3k	-----	110k	110k
1.6kHz	10k	16k	15k	16k	5k6	5k6	91k	120k

	Low Pass		High Pass					
Freq	R1 R3 R5 R20 22 24	R2 R4 R6 R19 21 23	R9 R16	R10 R15	R11 R18	R12 R17	R7 R14	R8 R13
1.7kHz	9k1	16k	13k	16k	4k7	6k2	68k	160k
1.8kHz	8k2	16k	6k8	-----	3k9	6k8	91k	91k
1.9kHz	6k8	22k	13k	13k	4k7	4k7	43k	-----
2kHz	8k2	12k	10k	16k	4k3	4k7	82k	82k
2.25kHz	8k2	9k1	10k	12k	2k	-----	36k	-----
2.5kHz	3k9	-----	8k2	12k	1k8	-----	62k	68k
2.75kHz	6k8	7k5	7k5	11k	3k	3k6	56k	62k
3kHz	6k2	6k8	6k8	10k	1k5	-----	27k	-----
3.25kHz	4k7	8k2	7k5	7k5	2k2	3k6	39k	68k
3.5kHz	5k1	6k2	5k6	9k1	2k4	2k7	43k	51k
3.75kHz	3k9	7k5	-----	6k2	1k6	4k7	43k	43k--
4kHz	4k7	5k1	7k5	5k1	1k6	3k6	36k	47k
4.25kHz	3k9	5k6	3k3	20k	2k	2k2	30k	51k
4.5kHz	4k3	4k3	5k1	5k6	1k8	2k2	18k	-----
4.75kHz	3k9	4k3	5k1	5k1	1k6	2k2	27k	47k
5kHz	3k9	3k9	4k3	5k6	1k6	2k	16k	-----
5.25kHz	3k	4k7	3k9	5k6	1k6	1k8	27k	36k
5.5kHz	3k	4k3	3k9	5k1	820R	68k	22k	43k
6kHz	1k6	-----	2k	-----	1k1	2k2	27k	27k
6.5kHz	3k	3k	3k6	3k9	680R	-----	20k	33k
7kHz	2k4	3k3	3k3	3k6	1k1	1k5	22k	24k
8kHz	1k2	-----	1k5	-----	1k1	1k1	20k	20k

Note: All resistors are 1% tolerance unless marked * which denotes 5% tolerance.
With no card fitted, the filter operates at 40Hz.

7 Technical Specification

Frequency Response	20Hz – 20kHz ± 0.25db
Distortion (THD+N)	0.005% typ 20Hz - 20kHz 0dBu
Noise	-91dB 22Hz - 22kHz RMS -92dB A weighted -90dB CCIR-ARM
Nominal input level	0dBu
Headroom	26dB
Input Impedance	10kΩ balanced - 5KΩ unbalanced

Common Mode Rejection	-65dB / 10kHz
Crosstalk	-70dB / 10kHz
Gain Range	+6dB / -12dB
Sub-sonic Filter	-3dB 20Hz 18dB/oct Butterworth
Crossover Filters	18dB/oct Butterworth
Nominal output level	0dBu balanced / -6dBu unbalanced
Minimum load impedance	600Ω
Maximium output level	+26dBu balanced / +20dBu unbalanced
Power consumption	7.5 VA
Power requirements	230V ± 10% / 115V ±10% 40-60Hz AC
Fuse ratings	230V – T50mA 115V - T100mA
Dimensions	Width 482.6mm (19" rack mtg) Height 44.0mm (1U) Depth 175.0mm
Weight	3Kgs

This product conforms to the following European Standards
EN 50081-1: 1992
EN 50082-1: 1992
EN 60065 : 1994

CE

SAFETY CONSIDERATIONS

CAUTION - MAINS FUSE
TO REDUCE THE RISK OF FIRE REPLACE THE MAINS FUSE ONLY WITH THE SAME TYPE, WHICH MUST BE A CLASS 3, 240 VOLT, TIME DELAY TYPE, RATED AT 50mA WHERE THE MAINS INPUT VOLTAGE IS SET TO 230 Volts ± 5% AC. FOR A MAINS VOLTAGE OF 115 Volts ± 5% AC. THE FUSE SHOULD BE RATED AT 100mA THE FUSE BODY SIZE IS 20mm x 5mm.

CAUTION - SERVICING
THIS UNIT CONTAINS NO USER SERVICEABLE PARTS. REFER ALL SERVICING TO QUALIFIED SERVICE PERSONNEL. DO NOT PERFORM ANY SERVICING UNLESS YOU ARE QUALIFIED TO DO SO.

WARNING
TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE.