MARTIN AUDIO LTD

MX4 SYSTEM CONTROLLER - USER'S GUIDE

1. INTRODUCTION

The MX4 is an advanced electronic crossover which may be used either as a 2-way stereo or a 3 or 4 way mono unit. Crossover frequencies, relative output levels, and phase adjustments are all preset for a given MARTIN loudspeaker system by the use of a dedicated plug-in board supplied for use with that system.

General-purpose adjustable boards are available as an alternative.

In mono mode the spare input may be used to drive a sub-bass channel independently of the main system, e.g. for special effects.

In addition to the crossover board, two further sub-boards are optionally available.

MX4-06 provides system equalisation. Typical applications include provision of power response compensation for compression drivers on constant-directivity horns, and adding boost to flat-response bass units for discotheque bass effects.

MX4-07 is a "group delay" board which provides driver offset compensation (often referred to as "time alignment"). This facility permits precise alignment of the BSX sub-bass loudspeaker when it is to be stacked with horn-loaded bass units.

Very low system noise makes the MX4 especially suited to theatre and other critical applications, whilst the use of relays in the direct signal path has been avoided for maximum long-term reliability.

Each channel is fitted with a low-distortion output limiter which may be adjusted to provide loudspeaker protection.

2. MECHANICAL

The MX4 is housed in a 1-unit 19" rack mounting case. In permanent installations, the MX4 should be rack-mounted using the four holes in the front panel, no additional support being required. As with all such units, side runners are recommended when racking for heavy-duty road use.

3. POWER

To change the mains voltage, remove the rectangular fuse cap and replace it so that the correct voltage is indicated by the arrow on the body of the receptacle. The earth terminal on the IEC input connector is permanently connected to the metal case. The electronic reference ground is taken to the case via the rear panel "signal ground" switch, which inserts a 47 ohm ground-lift resistor when it is set to "off".

This provides some flexibility in the unlikely event of ground loop hum occurring in the system.

4. INPUTS

The MX4 inputs are electronically balanced via XLR connectors. Pin 1 is always the screen (ground) connection, and the signal is applied between pins 2 and 3. Although the rear panel is marked ''pin 3 hot, pin 2 cold'', the signal pin polarity may be chosen by the user, provided that all inputs and outputs are wired to a consistent standard.

Always use 2-core + screen (i.e. ''balanced'' type) signal leads, even for unbalanced circuits. The screen should be regarded as separate from the signal return, even if they are connected together at one end of the line.

For either balanced or unbalanced operation, always connect the signal between pins 2 and 3, and connect the cable screen to pin 1. The screen should be lifted at the source, provided that normal safety requirements are met (i.e. the mains earths are correctly connected). Figs 1 and 2 refer.

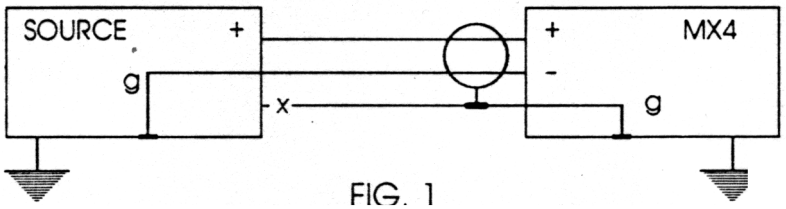

FIG. 1

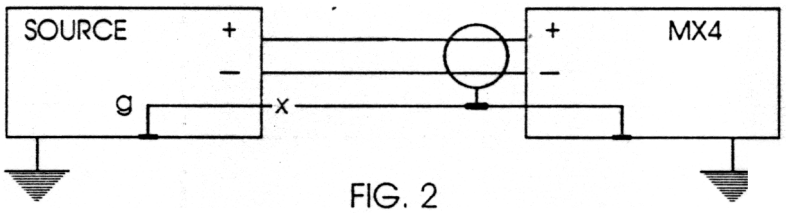

FIG. 2

5. OUTPUTS

The MX4 outputs are electronically balanced via XLR connectors. Pin 1 is always the screen (ground) connection, and the signal appears between pins 2 and 3.

Always use 2-core + screen (i.e. ''balanced'' type) signal leads, even for unbalanced circuits. The screen should be regarded as separate from the signal return, even if they are connected together at one end of the line.

For unbalanced use, having decided which pin is ''hot'' (see above), connect the ''cold'' pin and the cable screen to the ground of the driven amplifier (at the amp input). The screen should be lifted at the MX4 output. This method takes advantage of the hum rejection properties of the output stage which permit the amplifier to be locally grounded (as required for safety reasons) without causing a hum loop (Fig 3 refers). If the signal is merely taken between either pin 2 or 3, and pin 1, a level loss and response degradation will occur.

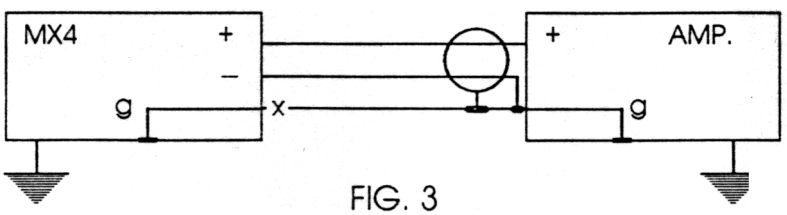

FIG. 3

For balanced operation, the screen should be connected to pin 1 (ground) at the receiving end. To eliminate ground current loops, it should be lifted at the MX4 output provided normal safety requirements have been met (i.e. the mains earths are correctly connected). Fig 4 refers.

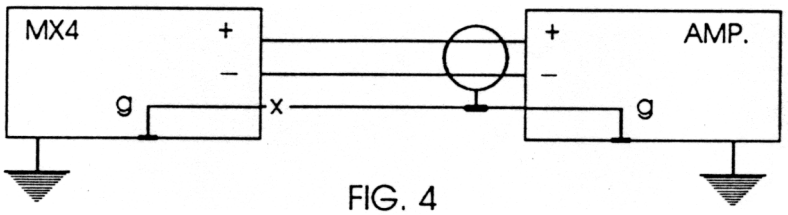

FIG. 4

6. INITIAL SETTINGS

MX4 units are supplied with adjustments set as follows:

Mains Voltage: 240V

Ground switch: ON

Limiter thresholds: maximum (3 volts, switch position 'F')

7. FREQUENCIES

Crossover frequencies are determined by the resistor and capacitor values on plug-in filter board MX4-04. This board may be either a "system" board or a "general-purpose" (GP) board. A "system" board is supplied with hard-wired components set up correctly for a specified loudspeaker system. The alternative GP board is supplied with filter frequencies initially specified by the user, but these are determined by banks of resistors on plug-in DIL headers and may be easily changed at any time.

To change a crossover frequency on a GP board, the appropriate plug-in DIL header must be replaced. New DIL headers may easily be made up according to the information in Table 1.

Unless otherwise specified at the time of ordering, all filters on GP boards will be supplied with fourth order Linkwitz-Riley alignments. The filter alignments on "system" boards are matched to the requirements of the loudspeakers for which they are designed, and do not always correspond to simple theoretical models.

8. LEVELS

Each output level may be adjusted over a 10 dB range, from -4 to +6 dB relative to its nominal level.

"System" filter boards include attenuation to provide level matching for approximate system balance when all controls are set to 0dB, assuming the use of amplifiers with identical gains. In this case, front panel calibration will not necessarily indicate absolute channel gains within the MX4.

With a GP filter board, input to output gain is nominally unity with level controls set to 0dB.

When setting up a system for the first time, MX4 channel levels should be adjusted for desired balance, and the settings noted for future reference.

9. LIMITERS

Each output is fitted with a limiter which provides momentary gain reduction when the signal level exceeds a preset threshold value. Triggering of the limiter is indicated by a red LED on the front panel.

Limiter settings may be altered only after removing the top panel of the MX4 case (two screws each side) to gain access to the circuit boards. This provides a reasonable level of security from unauthorised adjustment.

The limiter threshold is set by a 16-way switch on each channel. This is located on the main circuit board behind the LED driver module. Setting the limiter threshold automatically sets a matching range for the LED display. Threshold values corresponding to the switch settings are printed on the main circuit board for easy reference when making adjustments.

Each channel limiter sets a maximum drive level from the MX4, which in turn sets the maximum continuous voltage that the following amplifier can present to its load. If correctly set up, this will provide a high degree of protection against overdriving the loudspeakers.

For maximum protection, particularly where technically inexperienced operators are in control of system levels (e.g. discotheque installations), the limiters should be adjusted so that the maximum output voltage of each amplifier corresponds to the continuous power rating of the loudspeaker it is driving. This may be calculated from Ohm's Law where:

$$\text{Maximum Voltage} = \sqrt{\text{Rated Power} \times \text{Impedance}}$$

The amplifier gain or sensitivity specifications may then be used to determine correct limiter settings. For greater accuracy, or in cases of doubt, the limiters should be set up using a signal generator, oscilloscope and audio voltmeter, with the amplifier driving a dummy load resistance equal to the loudspeaker's nominal impedance.

Alternatively, if the speakers will handle the full amplifier rated power or if maximum system headroom is required, the limiters may be set to prevent the amplifiers from being driven into hard clipping. This also provides loudspeaker protection, as an amplifier driven into continuous clipping will deliver considerably more than its rated power. Although the high level of distortion will normally provide an audible warning of overloading, the operator's reaction time may be too long to avoid damage. Correct adjustment of the limiters will avoid this problem, and requires a signal generator, oscilloscope, and dummy load resistance equal to the loudspeaker's nominal impedance. The amplifier is driven to just below its clipping point, and the limiter set to prevent it from being driven any harder.

Each limiter may be completely defeated, if desired, by setting a jumper located in the centre of the "level control" circuitry.

If another MX4 is to be driven from any of the output channels (e.g. where one MX4 splits the signal between sub-bass loudspeakers and the main system crossovers), then the limiters should be defeated on those channels to prevent them from operating before the limiters in the following units.

10. PHASE CORRECTORS

Phase correction adjustment is available for each crossover point. This may be set to optimise the on-axis frequency response of the loudspeaker system through the crossover region and help to minimise phase-induced anomolies in the system dispersion pattern.

Although the outputs from the MX4 are normally in phase at the crossover points, the acoustic outputs from the associated drive units may not be. Correct adjustment of the MX4 can compensate for the phase characteristics of the drive units and associated protective filter circuitry.

Phase alignment on an MX4 "system" board is accurately set for the speaker system for which it is supplied, and is not adjustable.

The MX4-04 "GP" filter board provides two phase adjustments for each crossover point. The first is a switch marked "invert", which provides 180° of phase shift, i.e. complete polarity inversion. The second is a potentiometer marked "ϕH", "ϕM", or "ϕL" which applies a variable (0 to 0 -175°) phase shift to the low-pass slope of each pair of filters. The nominal setting for these controls, for no phase shift, is fully anti-clockwise. Full clockwise rotation results in -175° of phase shift.

Setting up the phase correctors accurately requires a measuring microphone, plus an audio frequency oscillator linked to a chart recorder, or alternatively a TEF Analyser. A simple "real-time analyser" will not give sufficient resolution for this purpose. This type of adjustment is not as simple as is often believed, and is best made under laboratory conditions, but useful results may be obtained by the following method:

1) The complete sound system is set up (preferably outdoors or in a similarly non-reverberant acoustic environment), well clear of the ground and any other reflecting surfaces.

2) Using the MX4 front panel controls, each band is individually set for the same measured acoustic output over its operating range.

3) Phase adjustment is then carried out on each band, starting with the highest.

4) The microphone must be equidistant from each pair of units to be aligned. If possible, (e.g. if using a TEF Analyser), the measuring distance should be large as this will minimise any difference in the path lengths.

5) The system is adjusted in each case for flattest response through the crossover region, sweeping the oscillator over a suitable range. This may usually best be accomplished by adjusting for a maximum cancellation or dip in the response, at which point reversing the ''invert'' switch will be found to provide the correct setting.

It is important to note that spurious dips in the response may result from room or ground reflections or interference between multiple drive units. If this occurs, each adjustment should be carried out with the microphone close to, and equidistant from, a pair of adjacent speakers covering the appropriate two bands, with all other signals muted.

Note also that both channels of a stereo sound system must be precisely matched, otherwise it will be impossible to achieve accurate stereo image localisation.

11. EQUALISATION

Optional plug-in board MX4-06 provides system equalisation. It should only be used with the loudspeaker system types for which it was designed.

Typical applications of the MX4-06 include equalisation of constant-directivity horns for flat power response, and electronic alignment of vented bass boxes.

12. GROUP DELAY

Optional plug-in board MX4-07 provides driver offset compensation, and is capable of delaying the signal to low-frequency speakers. This permits accurate spatial alignment of different types of bass unit in a stack, particularly where vented cabinets such as the BSX Sub-Bass are used in conjunction with horns.

13. SUB-BASS

When using an MX4 as a dedicated ''add on'' sub-bass controller, it should be connected ahead of the main system crossovers, which are then driven from outputs 2 and 4 (left and right ''high'') of the MX4. To preserve system headroom, the limiters on these channels should be completely disabled by setting the appropriate Limit Defeat jumpers on the main circuit board. (Section 9, limiters, refers).

14. 3-WAY / 4-WAY USE

If the internal switch on a mono MX4-04 plug-in card is set to 3-way, then band 3 (''mid'') will function up to 20kHz. Band 4 (''high'') remains available and may be used, if desired, for driving additional VHF units in ''overlap'' mode. This may be of benefit in a large arena or outdoor festival use.

MX4 SPECIFICATIONS

MAINS SUPPLY:	IEC mains connector with integral fuseholder and voltage selector switch
MAINS VOLTAGE:	Selectable 100, 120, 220, 240 VAC 50-60 Hz
INPUTS:	XLR3-31 or equivalent >10kΩ electronically balanced CMRR >60dB @ <10kHz Maximum level +20 dBu
OUTPUTS:	XLR3-32 or equivalent <50 ohms electronically balanced, with auto-correction for unbalanced termination Maximum level +20 dBu into 1kΩ (with limiter defeated)
HUM & NOISE:	-90dBm 20Hz to 20kHz unweighted
FIXED FILTERS:	Lowpass -3 dB @ 38kHz Highpass -3 dB @ 25Hz or as defined by Option Board MX4-06
SYSTEM PARAMETERS:	Crossover frequencies and slopes, level matching and phase adjustments defined by Option Board MX4-04
OFFSET COMPENSATION:	Driver offset compensation available on Group Delay Board MX4-07
LIMITERS:	Individual band limiters with switchable threshold and programme related dual attack time Limit ratio 20:1
INDICATORS:	10-LED display per channel; Limiter attack, 8 x level indicators (in 3dB steps below threshold); output mute
FRONT PANEL FACILITIES:	Mains switch, power & system status indicator, mechanically latching mute switches, 4 x level controls (-4, +6 dB)
PROTECTION:	Auto-muting relays and soft-start
GROUNDING:	IEC connector direct to chassis Signal ground switchable direct or via 47 ohm lift resistor
DIMENSIONS:	44 x 480 x 241 mm (1.75'' x 19'' x 9.5'')
SHIPPING DIMENSIONS:	112 x 530 x 335 mm (4.5'' x 21'' x 13'')
WEIGHT:	4.2 kg (9 lbs)
SHIPPING WEIGHT:	5 kg (11 lbs)

TABLE 1

MX4-04 FILTER BOARD - Resistor values for Linkwitz-Riley filters

CAPACITOR	.1µF		.022µF		.01µF		.0022µF	
BOARD TYPE								
GP 3/4 WAY (L)	CL 1-11		CM 1-11		CH 1-11		-	
GP 3/4 WAY (H)	-		CL 1-11		CM 1-11		CH 1-11	
GP 2 WAY (L)	CL 1-11 CH 1-11		-		-		-	
GP 2 WAY (M)	-		CL 1-11 CH 1-11		-		-	
GP 2 WAY (H)	-		-		CL 1-11 CH 1-11		-	
FREQUENCY Hz	R*1,2,4 5,7,8 kΩ	R*3,6 kΩ	R*1,2,4 5,7,8 kΩ	R*3,6 kΩ	R*1,2,4 5,7,8 kΩ	R*3,6 kΩ	R*1,2,4 5,7,8 kΩ	R*3,6 kΩ
40	28.0	56.2	-	-	-	-	-	-
50	22.6	45.3	-	-	-	-	-	-
60	18.7	37.4	-	-	-	-	-	-
70	16.2	32.4	-	-	-	-	-	-
80	14.0	28.0	-	-	-	-	-	-
90	12.7	25.5	-	-	-	-	-	-
100	11.3	22.6	51.1	102	-	-	-	-
120	9.5	19.1	42.2	84.5	-	-	-	-
200	5.62	11.3	25.5	51.1	-	-	-	-
220	5.11	10.2	23.2	46.4	51.1	102	-	-
250	-	-	20.5	41.2	45.3	90.9	-	-
280	-	-	18.2	36.5	40.2	80.6	-	-
300	-	-	16.9	34.0	37.4	75.0	-	-
1000	-	-	5.11	10.2	11.3	22.6	51.0	102
1200	-	-	-	-	9.53	19.1	42.2	84.5
1300	-	-	-	-	8.66	17.4	39.2	78.7
1400	-	-	-	-	8.06	16.2	36.5	73.2
1500	-	-	-	-	7.50	15.0	34.0	68.1
1650	-	-	-	-	6.81	13.7	30.9	61.9
1800	-	-	-	-	6.34	12.7	28.7	57.6
2000	-	-	-	-	5.62	11.3	25.5	51.1
3200	-	-	-	-	-	-	16.2	32.4
5000	-	-	-	-	-	-	10.2	20.5
6000	-	-	-	-	-	-	8.66	17.4
7000	-	-	-	-	-	-	7.32	14.7
8000	-	-	-	-	-	-	6.34	12.7