MUSTANG COMMUNICATIONS

MAESTRO DL.500 INDUCTION LOOP AMPLIFIER
INSTALLATION & OPERATION HANDBOOK

Issue No.2

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CE Electromagnetic compatibility (EMC) directive 89/336/EEC and amendment directive 92/31/EEC

This equipment has been designed and manufactured to the highest standards. If connected and operated as set out in this manual, there should be no Electromagnetic Compatibility problems. If any aspect of operation gives rise to concern, then please contact the manufacturer for advice.

List of illustrations

1 INTRODUCTION

Thank you for purchasing this amplifier. You have made a wise choice. It is a purpose designed, British made, induction loop amplifier which, if installed and operated correctly, will give many years of trouble-free and accurate operation.

The MAESTRO range is just one of many amplification ranges amongst the hundreds of items manufactured by Mustang Communications Ltd., to meet the needs of the public address market. Your dealer will be pleased to advise you on the selection of the most suitable equipment from the comprehensive Mustang catalogue should you have further amplification requirements.

The Company and its quality statement

Mustang Communications, is the manufacturing mark of equipment manufactured by Mustang Communications Limited, of Scarborough, England. The company is independent, wholly British, and dedicated to the manufacture and distribution of high-reliability, high performance public address and associated control equipment. Mustang Communications was first registered in 1966, in England.
The Company undertakes to manufacture equipment to the highest standards of workmanship and performance. Our Quality Assurance scheme operates to, or exceeds, the standards set out in British Standard BS.5750, or European standard ISO.9000. If you have cause to doubt at any time that the design, manufacture, or distribution does not comply, then you are invited to write to us with your comments, which will be most welcome.
Please address your correspondence to The Engineering Director.

The equipment and its general application

This comprehensive unit is a dedicated current drive amplifier for use specifically with induction loops in compliance with BS.6083. Its versatile design satisfies the needs of loop systems for the assistance of the hearing impaired, for industrial entertainment, and for simultaneous translation installations, with internal switches available to ensure that each type of application achieves optimum results. The use of personal hearing aids, or dedicated loop headsets enables the wearers to take full advantage of inductive loop transmissions containing educational, entertainment or priority program material.

It is designed to meet internationally agreed standards of signal level, impedance, sensitivity etc., and therefore may be used successfully with all good quality public address systems, microphones, and tape units, of any origin. Advanced signal processing circuitry compensates automatically for a wide variation of input signal characteristics, whilst unusually full bandwidth design ensures crystal-clear reproduction. Sophisticated protection circuits dynamically monitor all critical operating parameters to guarantee a virtually distortion-free, reliable performance and the absence of radio frequency interference - RFI.

The unit is fully compatible with other units from the Maestro amplifier range and simple interconnection results in an attractive and compact audio system.

MAIN FEATURES

- Suitable for loops up to 500sq. metres
- Signal processing meets BS.6083
- Hearing impairment or full bandwidth settings
- Simple and effective automatic operation
- Versatile signal input facilities
- Comprehensive electronic circuitry protection
- Simple interconnection with conventional Maestro audio amplification

Carton contents

On receipt from the manufacturer, this carton will contain:

- 1 DL.500 amplifier
- 1 installation & operation handbook
- 4 DIN input connectors: 5 pin, 180 degree pin format
- 1 XLR connector
- 1 AC mains connection lead
- 3 front panel blanking plugs
- 1 guarantee registration sheet
- 1 Induction loop system announcement card

Options

Rack mount brackets type BRK.20 may be purchased as a separate catalogue item to enable the DL.500 to be fixed in a standard 19" equipment rack, occupying 2U of panel space.
The CC.1 interconnection lead should be used to connect conveniently between the DL.500 and Maestro conventional amplifiers which may be installed to provide conventional audio loudspeaker amplification. The Maestro range is carefully designed and budget priced. The manufacturers are unable to undertake the consideration of any special options or modifications to the standard Maestro format amplifier, as it is probable that an alternative Mustang amplification range may be more appropriate. Your dealer will advise.

Warranty

This unit should operate successfully for many years if installed correctly. However, should any fault occur within 24 months of installation, the manufacturer undertakes to replace parts, or the whole unit, at their discretion, free of all labour or parts charges. However, should investigation of such a fault indicate operation of the unit outside its specification, accidental damage, or unauthorised modifications, then the manufacturer reserves the right to levy an appropriate repair charge.
Should a fault be suspected, your dealer should be notified in the first instance. All returns should be made via your dealer, forward carriage paid, and be accompanied by details of:

- The reported symptoms
- Brief details of the installation.
- Details of the circumstances of failure

Following the routine warranty period, the DL.500 may be returned via your dealer, to the manufacturer for any necessary repairs or refurbishing. Details of the work required/reported fault must accompany the unit, and nominal charges will be levied.

GENERAL SPECIFICATIONS

Mode	Dedicated constant current drive amplification
Loop Current output	10 Amps peak. 2.4 Amp long term average peak. Large terminal posts
Loop capacity	Typically up to 500 sq. metres. 0.1 - 3.5 ohms nominal impedance
Monitor headphone output	Direct loop current monitor. Stereo ¼" jack
Microphone input	Nominally 200uV balanced. Internal bass cut selector. Internal selection of +12V DC phantom supply. XLR connector.
Microphone bass-cut	3dB/octave below 300Hz. Internally selected
Line input	Nominally 50mV @ 22k and 775mV @ 300k balanced/unbalanced. DIN connector
Loudspeaker input	Nominally 5V - 100V @ 2M ohm balanced/unbalanced. Spring terminals
Maestro amplifier interface	Dedicated port to Maestro amplifier. Optional CC.1 connection lead available
Slave connection tor	775mV output @ 600 ohms (0dB). 200-775mV @ 10k ohms slave input. DIN connec-
Pre-amplifier headroom	42dB
Microphone & Line CMRR	Better than 65dB @ 50Hz-2kHz.
Processing compression	30dB @ 1kHz
Tape record/playback	Fully configurable for stand-alone or linking with Maestro amplifiers. DIN connector.
Frequency response and filtering	50Hz - 16kHz ± 3dB ref. 1kHz expressed as resistive loop current. Internal switch for 100Hz - 5kHz ± 1dB
Protection systems	Output voltage clipping, over-temperature, over-current, compression overload
User controls	Microphone level, Line (& loudspeaker) level, output current set. Removable knobs & spindles
Front indicators	Input overload, output current, error check, protection, AC supply
Power supply	220/240V AC 50-60Hz. Maximum 185-250V

PRINCIPLES OF OPERATION OF INDUCTION LOOP SYSTEMS

The operation of an induction loop system is based on simple electromagnetic theory. If an electric current is passed through a conductor, it sets up a magnetic field. If the current is made to vary in strength in the manner of an audio waveform, then the magnetic strength varies similarly. The conductor may take the form of a loop of electrical cable. Conversely, if another loop of cable is placed close to the first, then an electric current is induced which mimics the characteristics of the first current. This induced electrical signal may then be amplified sufficiently to power a pair of headphones or an earpiece, etc.
In practice, we can use an audio amplifier to amplify small signals from a microphone, for example, in order to send a current into a wire loop instead of a loudspeaker. The resultant magnetic field is used to induce a signal into the internal pick-up coil of a hearing aid (when switched to the "T" position), or into the pick-up coil of special loop headsets which are designed for the purpose.
Where an building already has been equipped with a public address system, then it will be possible to use a low-level audio signal from it to drive the dedicated loop driver amplifier. The DL.500 features inputs which will accept any level of audio signal - from microphone through to 100 volt line.

There are many other considerations. The magnetic field must be to a recommended level which has been deemed to be sufficient to overcome the typical stray magnetic interference signals found in all buildings with electrical cabling, the loop height and shape effects the signal strength within the loop, the electrical resistance - which determines the amplifier power required, the amplification needs to present a generally constant level of signal to the loop, and practical problems concerned with routing the cable, for example.
This manual will provide help and guidance with the planning of the loop, its installation, connection and operation of the DL.500, and the prevention of interference and distortion.

INTERFERENCE AND HOW TO AVOID IT

Interference may be caused to and by inductive loop systems, and in certain circumstances, the system may even be subjected to self-inflicted problems.
There are many possible sources of interference that may cause interference to an audio system. The very nature of the loop receiving device renders it liable to receive not only the wanted magnetic signals but also those generated by other electrical devices and wiring. The interference will take the form of a low level buzzing or hum which will increase with closer proximity to the source of the interference. The most likely sources are heavy electrical machinery, high power AC mains cabling, fluorescent light fittings, lighting dimmer equipment, TV receivers, electricity sub-stations, and computer terminals and screens. There is every possibility that it may not be practical to move the interference source, so it is important that a site survey is carried out to ascertain that the proposed site of the loop is not in a "noisy" area. A dedicated loop headset may be used to provide a subjective assessment, and if doubt persists, then a rudimentary wire loop may be set up in order to assess the relative strengths of interference and audio signals. Such interference is likely to be most intrusive in quiet installations such as churches and theatres. The circuitry of the DL.500 maintains a constant level of signal strength, even during quiet program passages, which is particularly effective in minimising interference problems of this type. It is also possible to induce interference on other audio equipment, such as telephones, public address equipment, guitar amplifiers, and hi-fi equipment. The only precaution that may be taken is to ensure that the location of the loop does not encompass any area where such sensitive equipment is likely to be used. In particular, some dynamic microphones used in public address amplification

systems are particularly susceptible if used in an induction loop area.
It should also be borne in mind that the signal sources used to drive the inductive loop amplifier may themselves be operated in the vicinity of the loop area. In extreme cases this may give rise to a mysterious form of fee-back when volume controls are advanced. The magnetic field induces small electrical signals in the equipment which are then in turn re-amplified causing a greater magnetic field. This whole process is perpetuated, quickly giving rise to symptoms of squealing or distortion. Be sure therefore to plan for the loop driving equipment to be located well clear of the loop area.

DESIGNING AND INSTALLING AN INDUCTION LOOP CABLE

The basic electromagnetic theory governing the design of a loop is straightforward, but in practice becomes so complex due to practical issues concerning precise shape, height, adjacent steelwork, and impedance, etc., that it is outside the scope of this manual. The notes given here are intended as a guide to establish whether or not an intended loop will be a practical proposition and whether or not the performance will be satisfactory.
The main technical considerations are that the loop must achieve the recommended magnetic field strength over the area required, and that the electrical resistance - or impedance - must be within the limits of the loop amplifier.
The loop itself is no more than a piece of wire which is routed to the area to be covered, round it, and back again to the loop driver amplifier thus making a complete circuit. It is preferable to consider using just the one circuit of wire - a single turn loop - as this facilitates the best possible all round performance. The loop must cover the whole area in which the receivers will need to receive the program material. Ideally, it should be slightly larger, skirting the area by about 15%.
There are, however, many practical considerations concerning the position and shape of the loop, and it is first necessary to confirm that the intended area is not subject to unusually high levels of interference - see the preceding section.
For simplicity, most magnetic field strength calculations are based on a hypothetical single wire, square loop, fixed at shoulder height for optimum performance. However, for aesthetic reasons the cable may need to be at floor or ceiling height, or follow a tortuous route round doorways and windows. This is unlikely to cause undue problems unless the “open” area of the loop is severely restricted.
It is also important to avoid running cables adjacent to steel girders, even though they may be concealed, or in close proximity to re-inforced concrete floors, as the magnetic field strength will be severely impaired.
Once the intended location and cable route has been established, a calculation may be made to determine the loop current requirement.
The long-term average current required by a single-turn square loop with a side of L Metres is given by the equation

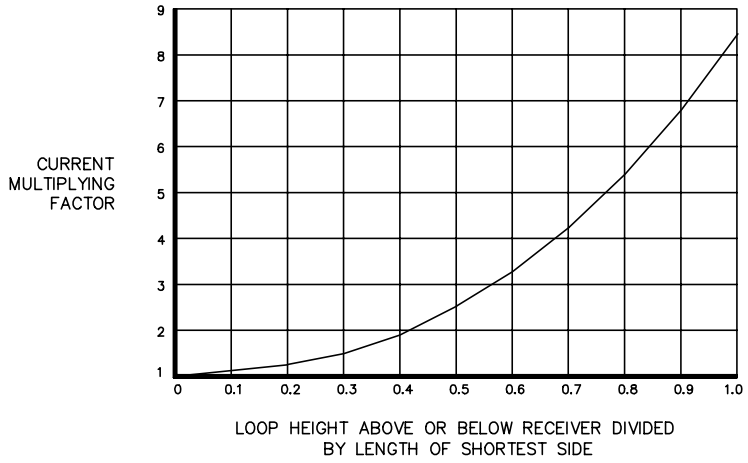
$$\text{Current} = \frac{L}{9} \text{ Amperes}$$

However, BS.6083 recommends that the loop driving equipment should be able to amplify peak short-term signals which are 4 times greater than the long term average figure given above. Most loop driving amplifiers are rated in this manner. The DL.500 is rated at 10 Amperes peak with a long term average of 2.4 Amperes which is sufficient for a loop area of about 500 square Metres. Therefore, if the equation above yields a result greater than 2.4 Amperes, then one DL.500 driving a single turn loop will be unable to respond sufficiently to peaks of speech or music, especially at high frequencies, without causing distortion. Other than reducing the loop size, the only alternatives are to use two separate, phased loops - each with a driver amplifier, or to use a two-turn loop. A two turn loop may be installed conveniently by using twin conductor cable with the individual conductors wired in series.
The long-term average current required by a square shaped, two turn loop with a side of L Metres is given by the equation

$$\text{Current} = \frac{L}{18} \text{ Amperes}$$

It may seem like a good idea to install a two-turn loop anyway, but unfortunately the high frequency performance of such multi-turn loops is likely to be unavoidably restricted by loop amplifier performance and therefore likely to give rise to distortion and limiting problems, so this should only be considered if there is no alternative.

The current figures produced with the above equations must now be adjusted to take account of the vertical distance between the loop and the receiving position.



As can be seen, the effect of height on loop current is progressively dramatic. Similarly, the ratio of length to width of the loop effects the loop current requirements, and the effects of height are even further compounded. If the ratio of length to width of a single rectangular loop is greater that about 6:1 then the loop height will be a critical issue that may render the proposal to be impractical.

So now we have established the interference-free location, the dimensions of the loop area, the height multiplying factor and the total loop current required and hence ascertained that the DL.500 will adequately drive it. We now need to select a diameter of cable which will enable the DL.500 to deliver the correct loop current. The specification shows that the DL.500 will drive a loop with a resistance of between 0.1 and 3.5 ohms. By calculating the total length of the cable route i.e. the perimeter of the loop area plus the distance to and from it, a suitable cable may be selected from the table below.

Resistance of single core plain copper wire per 100 Metre length	
Wire size	Wire resistance
- 2.5mm²	0.8 ohms
30/0.25mm = 1.5mm²	1.3 ohms
32/0.2mm = 1mm²	2.0 ohms
24/0.2mm = 0.75mm²	2.7 ohms
16/0.2mm = 0.5mm²	4.0 ohms
13/0.2mm	4.9 ohms
7/0.2mm	9.1 ohms

It is prudent to select a cable which will provide a nominal resistance of say 1½ to 2½ ohms, thus ensuring that routine miscalculations will not take the loop outside the limits of the amplification.

Bearing in mind that the loop will probably not be a perfect square, nor routed at shoulder height, and that the building will have structural steelwork, the magnetic field strength will be somewhat less than calculated. Whilst the foregoing will determine the basic practicalities of the loop, the only way to confirm that the field strength is within acceptable limits is by the use of a hand-held field strength meter which will display the actual long-term average value. Mustang Communications will be pleased to suggest sources of supply.

FRONT PANEL CONTROLS AND INDICATORS

Microphone input

This sets the level of sensitivity to microphone signals arriving via the rear XLR connector. The control knob markings are arbitrary. Once the DL.500 has been set up, this control knob may be removed to prevent tampering.

Line input

This sets the level of sensitivity to signals arriving at the amplifier via the following:

- The spring loaded 'Loudspeaker Input' terminals
- The 'Line input' DIN connector
- The 'Maestro Interface' DIN connector
- The 'Tape' DIN connector (playback only)

The various inputs are not inter-active, and control knob markings are arbitrary. Once the DL.500 has been set up, this control knob may be removed to prevent tampering.

Input Overload indicator

This LED illuminates on peaks of signal which are exceeding the capacity of the signal limiting and compression circuitry.

Output Current Set control

Advance this control to a point where the incoming programme signals develop the recommended current to flow in the loop. This current is a function of the loop shape, loop size, wire type, etc., so once set, there should be no reason to adjust this control. We strongly recommend that the control knob be removed and the panel hole plugged with the insert supplied.

Protection indicator

In normal operation, this LED will illuminate spasmodically, on signal peaks, when the protection circuitry is operating to prevent the output stage being stressed to excess current drive, or when the DL.500 is driving a loop of inappropriately high impedance. It will also illuminate for a few seconds at switch-on if the DL.500 is receiving an audio input signal, and this is perfectly in order.

Output current meter

This is a flying spot display of the current actually flowing in the loop. With an appropriate input signal and the DL.500 adjusted correctly, the average position of the spot should coincide with the intended loop current, whilst spasmodic signal peaks will cause an indication of several spots higher depending on the type of signal.

Error Check indicator

This indicator is triggered as a result of the following error situations:

- The loop being subject to a DC offset voltage
- Failure of one of the two low-level DC stabilisers (open or short circuit)
- Collapse of one of the low-level DC supply rails.
- Failure of one of the two internal DC supply fuses
- Failure of LF filter

It is normal for the lamp to illuminate at switch-on for approximately 5 seconds whilst the sensing circuitry confirms that no fault exists.

The LED operates in synchronisation with a disconnection solenoid to minimise damage to the DL.500 or the loop. If the illumination is continuous, please consult your dealer.

AC ON indicator

This LED illuminates to confirm that the unit is switched on, the AC power connected, and the unit is fully functioning. Should the lamp extinguish unexpectedly in use, then either a major fault has occurred within the DL.500, or the over-temperature sensor has been triggered. If the latter, the indication will be restored once the DL.500 has had a chance to cool.

REAR PANEL SIGNAL INPUT AND OUTPUT CONNECTIONS

Microphone input

Use this connection with a low impedance balanced microphone. It may be a standard dynamic type or a phantom powered type. The internal signal processing circuitry will automatically accommodate a wide variety of microphone types and operating techniques, and the 'Microphone Level' control is used to set the general level of sensitivity. The phantom powering may be switched off if required, and a bass cut filter may be switched in to optimise intelligibility, These are both internal settings.

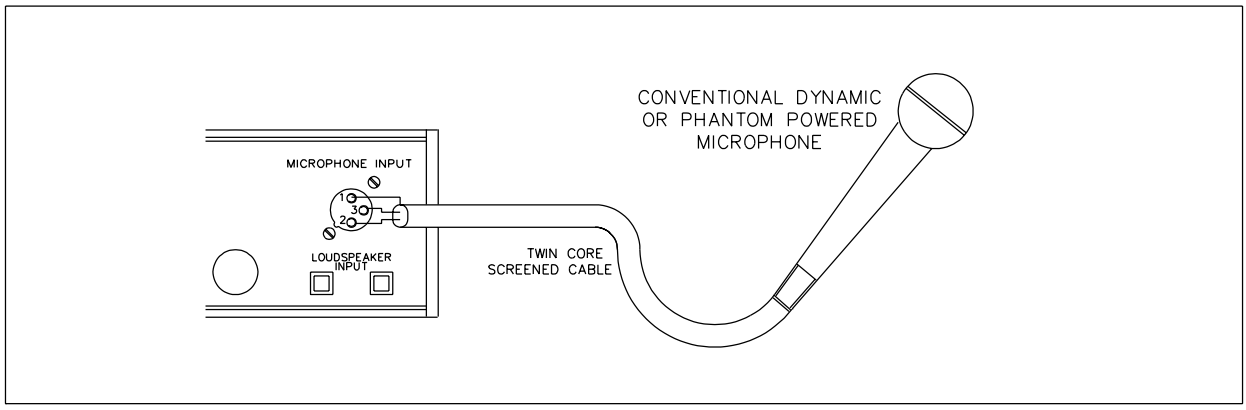


Fig. 1 Microphone input connections

Line level input

This is a universal input for low level line or high level line signals, either balanced or unbalanced, and may be used therefore, with any type of CD player, tape deck, automatic message or alarm system, remote amplification system, 0dB signal source, etc. The balanced input connections should not be misunderstood as a stereo capability. In common with all professional

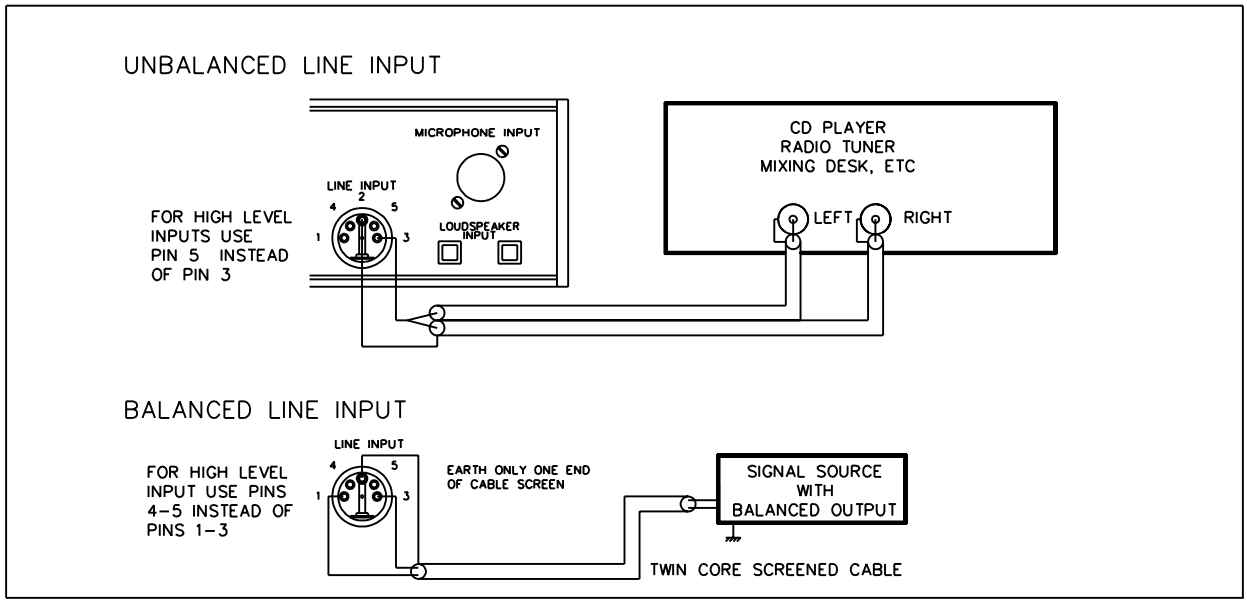


Fig. 2 Line input connections

amplification products of this type, the DL.500 operates only in mono. If only a stereo signal is available for amplification by the DL.500, the two channels should first be combined as shown.

Loudspeaker input

Where an existing amplification system is to be connected to the DL.500, it is possible to use a signal sampled from the loudspeaker line. Whilst this will not provide optimum quality of reproduction, it may be the most convenient method. The unit will accept signals from either low impedance outputs of a minimum of approximately 5 Watts @ 4 ohms right through to 100V line signals. No audio power is taken from the existing amplifier, and the terminals are not polarity conscious, but bear in mind that some control adjustments at the originating amplifier are liable to have a similar effect at the DL.500 output.
This input connection cannot be used to sample both channels of a stereo system.

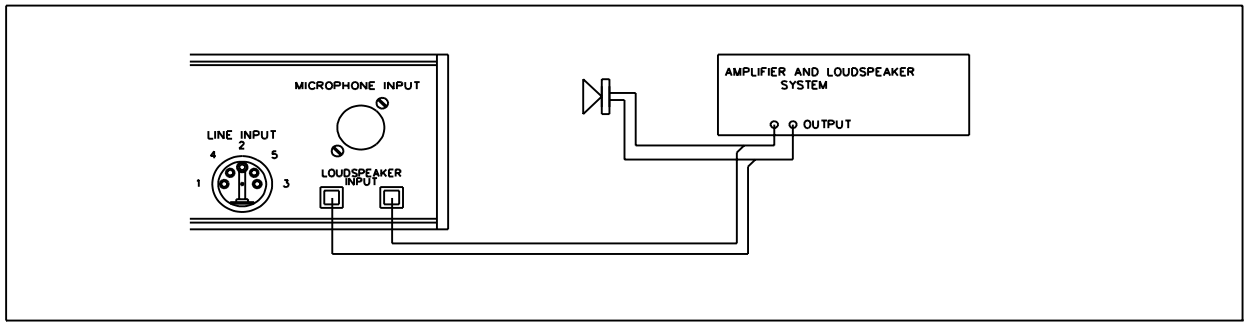


Fig. 3 Connecting to the loudspeaker output of a PA system

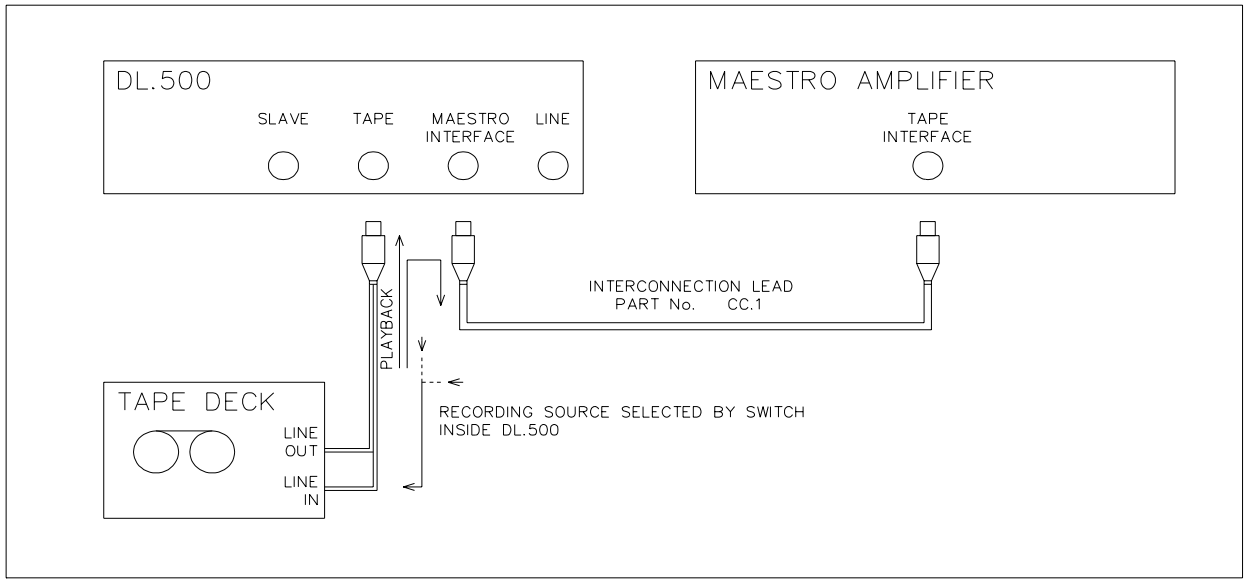


Fig. 4 Tape recording and playback arrangements - and the Maestro Interface

Maestro Interface

The DL.500 is part of the Mustang Maestro range and has been designed to facilitate a simple interconnection with the standard Maestro amplifiers.
By the use of a simple connector lead (optional extra part No. CC.1) between this dedicated socket and the Maestro 'Tape Interface' socket, all sound signals provided by the amplifier system will be passed automatically to the DL.500. Tape record/playback facilities will then be transferred to the DL.500 - see Fig. 4. See also page 12 - Using the DL.500 with a Maestro Amplifier system.

Tape recording/playback
By means of a single connection lead, the DL.500 may be connected to a standard tape recorder/player (assuming such a facility is provided) so as to provide the following:

1.Signals which are destined for the loop may be recorded. Adjust the recorder's input level control to suit.
2. Recorded programmes may be processed and sent to the loop. Adjust the DL.500 Line Input control in the normal way.
3. If the DL.500 is interconnected to a Maestro amplifier as described above, the amplifier's 'Tape Interface' connection is used. The DL.500 'Tape' connection fully replicates this facility. See Fig. 4 above. Further, by means of an internal switch setting (see Fig. 5 below) the recording source may be selected from either:-

EXT: The Maestro amplifier programme only, or
INT: The fully mixed DL.500 loop programme - which may therefore include signals from the Maestro amplifier.

Tape playback signals will be directed simultaneously to both the DL.500 and the Maestro amplifier.

Stereo recordings are processed automatically for playback in mono through the Maestro equipment, and programme material being recorded from the system will be in mono and use both channels of a stereo recorder.

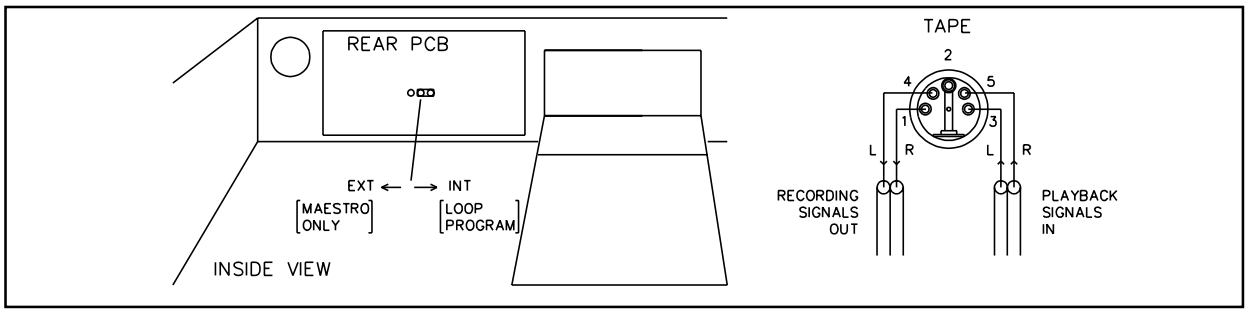


Fig. 5 Recording selector switch location & tape connection detail

Slave input/output

There are two different applications for this connector:

Firstly - very large loop installations may require the interconnection of several loop driver amplifiers, each delivering the same programme material. This connection facilitates the DL.500 to be used to provide the source programme for several DL.500's used as slaves. See Fig. 6 below.

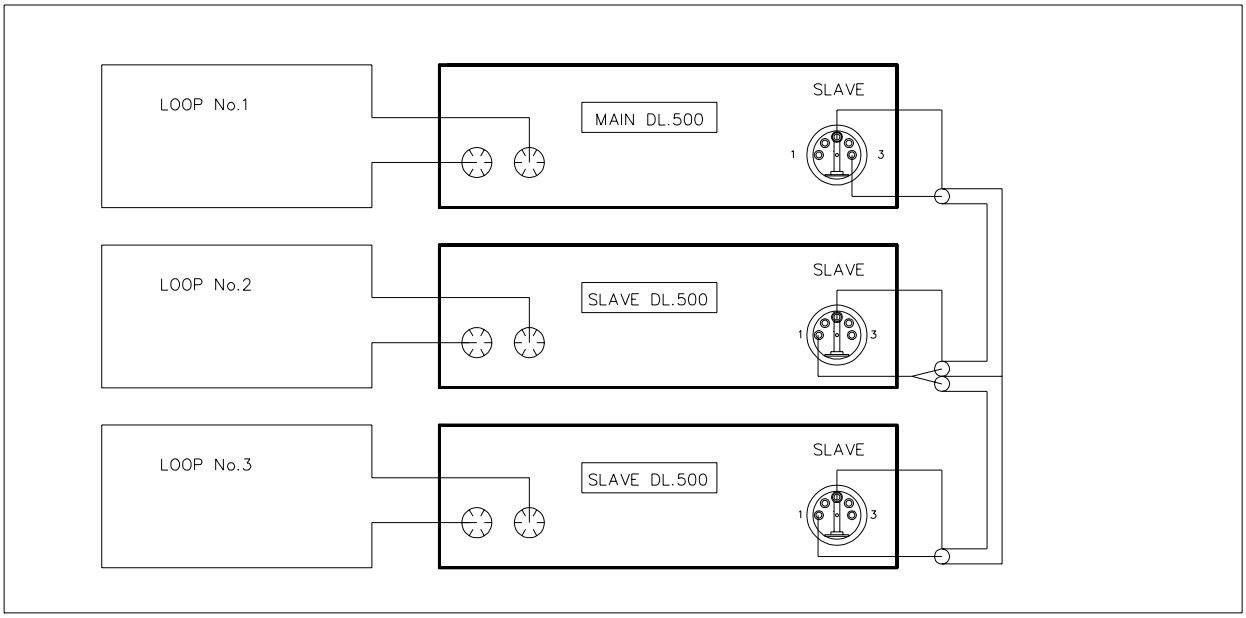


Fig.6 Interconnection of several DL.500 units using the Slave connection

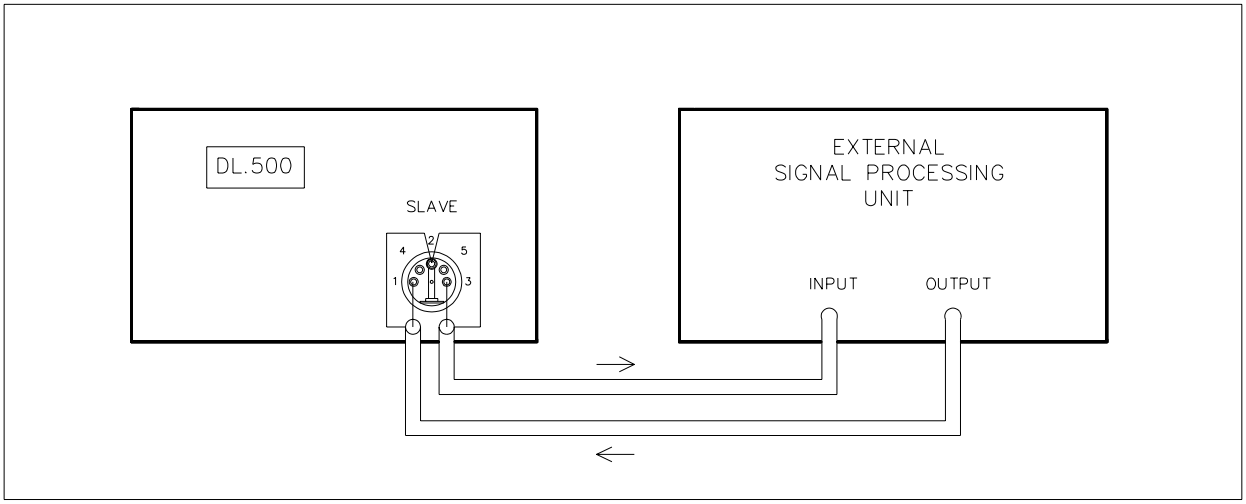


Fig. 7 Connection of external signal processing equipment

Alternatively, there may be applications where additional signal processing may be necessary, such as that provided by a digital delay system. In this case, the 'Slave' input/output connector offers a conventional signal send/signal return connection at standard 0dB level. See Fig. 7. If this facility is required, then it will also be necessary to set the internal 'slave link' switch (see Fig. 8 below) to the 'OFF' position. The normal signal path of the DL.500 is thus interrupted and re-routed via the external processor.

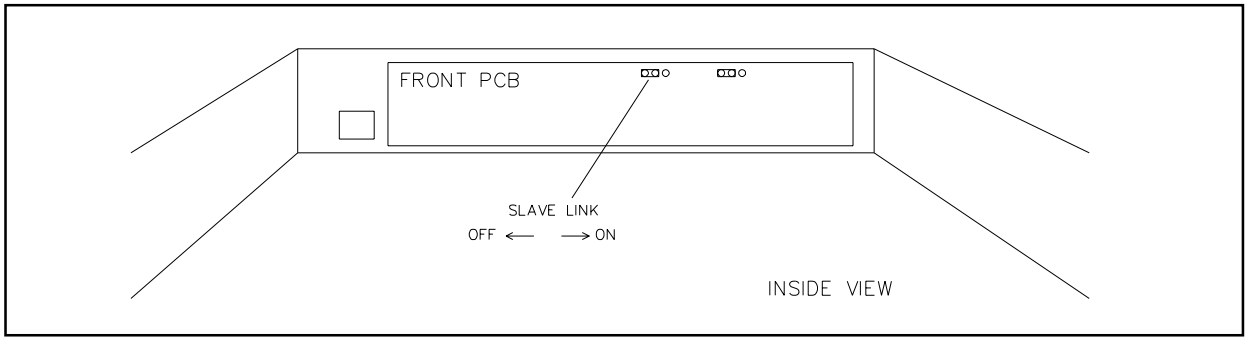


Fig. 8 Locating the Slave Link switch

Loop output

Use these two terminals to connect the induction loop to the DL.500. They may be fully unscrewed to to reveal a cross-hole in the threaded shank to accommodate wire up to 3mm diameter. Alternatively, the hollow shank will accept standard 4mm plugs. For single DL.500 installations the polarity of the connections is irrelevant (only when several loops and amplifiers are configured in a phased array system does it become critical).

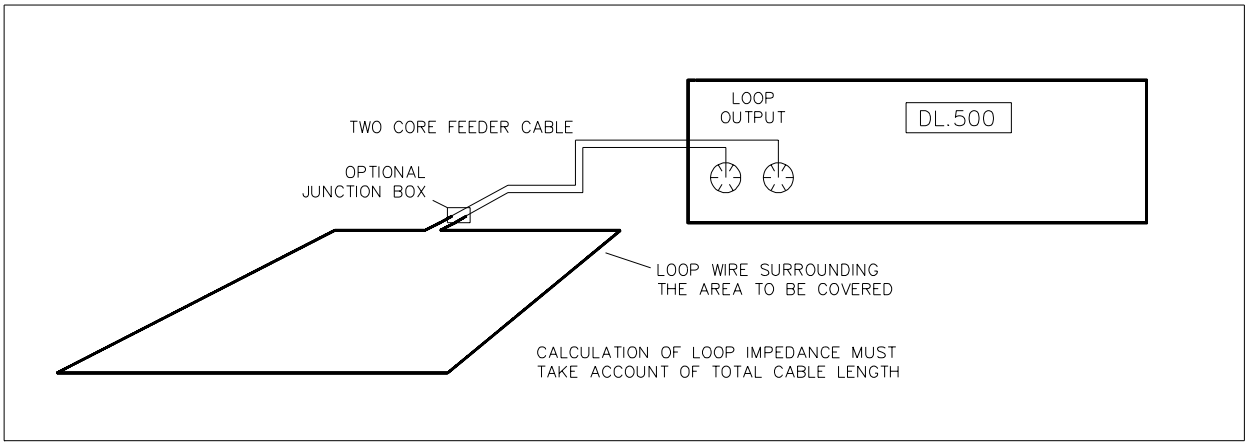


Fig. 9 Connecting a single turn loop

Monitor Headphones

The Monitor Headphone jack socket will accept standard headphones fitted with a ¼" stereo jack plug (the signals received will be mono). The output is sampled from the current flowing in the loop and will be tonally accurate, and give a useful indication of any distortion. If the loop is faulty i.e. open circuit, then there will be no monitor output.

APPLYING THE DL.500

Selection of input signals

Many factors will influence the choice of input signal(s), and some will be outside the scope of this manual. The design of the input circuitry however, is such that any level of audio signal may be accepted from microphones, line inputs, and loudspeaker lines including 100V systems. It will be necessary to refer to the general specifications on page 6 to select the most appropriate input channel, and to the pin connection details on pages 9 - 10.

Using the DL.500 with a Maestro Amplifier system

An optional extra cable type CC.1 is available to interconnect between a conventional Maestro loudspeaker amplifier 'Tape Interface' socket and the DL.500 'Maestro Interface' socket. The choice of input sources will then be determined by that unit rather than the DL.500, as all signals being processed by the Maestro will be passed automatically to the DL.500. The point in the signal chain at which the signal is sampled within the amplifier is determined by an internal selector switch - consult the amplifier manual for its location and setting.

The conventional microphone or line inputs connected exclusively to the DL.500 are mixed with the Maestro amplifier signals, thus providing very considerable system design flexibility. For example, users of the loop system may receive alternative or prior emergency announcements to those received by listeners to the loudspeaker system.

When using this interconnection method, the tape recording/playback connection facility which is lost from the amplifier is transferred to the DL.500. For full details of the connections and facilities, refer to pages 10 and 13.

Multiple input mixing and priority

The input signal circuitry of the DL.500 includes averaging and limiting processors which inter-react to ensure that a relatively constant signal is passed to the loop driving circuit. In normal usage, wide adjustment of the microphone or line input front controls will appear to make negligible difference to the loop current. However, as a consequence of this circuitry, the relative settings of these two controls will enable one signal to appear to take precedence over the other. For example - if a music signal is being accepted via the line input connections, and a paging microphone via the microphone connector, advance the 'Microphone Input' control relative to the 'Line Input' control. The effect will be such that music is received by the loop users at normal levels, but as soon as the paging microphone is operated, the music will immediately drop in level. The microphone will then be audible at normal level without interference. When the paging ceases, the music will automatically return to normal level over a period of several seconds.
Inputs may be connected from several sources at once. Tape playback, Maestro amplifier, and line inputs may be used simultaneously, and are mixed automatically in fixed proportions. The 'Line Input' control adjusts all three simultaneously. The dedicated microphone input may be adjusted for sensitivity relative to the line input.

INTERNAL SWITCH SETTINGS

Several switches are accessible by the installation engineer so that the system may be configured precisely to the requirements of the client. Once set, these switches would not normally need to be disturbed. Unauthorised use would be inappropriate.

Phantom powering of microphones

Certain professional microphones require a small DC current to power a pre-amplifier within the microphone housing. The technique normally adopted is known as phantom powering, whereby both of the two conductors of the standard two core microphone cable carry a small DC voltage generated in the amplifier, as well as the normal audio signal. The DC circuit is completed by the screening shield of the cable. The phantom power stabilised voltage is nominally +12 Volts.
The phantom powering aspect should not normally interfere with correct operation of a dynamic type unless the microphone is regularly plugged or un-plugged in use, or perhaps if a switch is used. If this is the case, and heavy clicks or thumps are heard through the system, then disable the phantom supply by setting the internal switch on the front PCB to 'OFF'. The DL.500 is supplied with this switch set to 'ON'. See Fig. 10

Microphone bass cut filter

For paging microphone applications, it is usually advantageous to introduce a small amount of attenuation of the bass frequencies - bass cut - for increased clarity. DL.500 units leave the factory with the microphone input channel amplifying the full frequency range. Bass cut is introduced by setting the internal switch on the rear PCB to 'CUT'. See Fig. 10

Slave link

Under certain circumstances, it may be necessary to interrupt the normal signal path of the DL.500, so that the unit may be used with external signal processors connected to the 'Slave input/output' socket. In this case locate the internal switch on the front PCB and set it to 'OFF'. See Fig. 10

Setting the bandwidth filter

The DL.500 may be used either in hearing assisted applications or in musical entertainment applications. The former requires that the bandwidth is restricted in order that optimum intelligibility is achieved - in accordance with BS.6083. As supplied, the internal bandwidth switch on the front PCB is set for full bandwidth 'F' reproduction. For hearing assisted - narrow bandwidth applications - set this switch to position 'N'. See Fig. 10

Selection of tape recording source

The tape recording/playback socket enables simple interconnection with a tape recorder/player. As supplied, the signal passed to the recorder will be the internal program that is delivered to the loop.
If the DL.500 is to be used in conjunction with a Maestro amplifier or other external amplifier connected via the 'Maestro Interface' connector, the client may wish that only signals from this unit are recorded. The record selector switch located on the rear PCB should be reset to 'EXT'. See Fig. 10

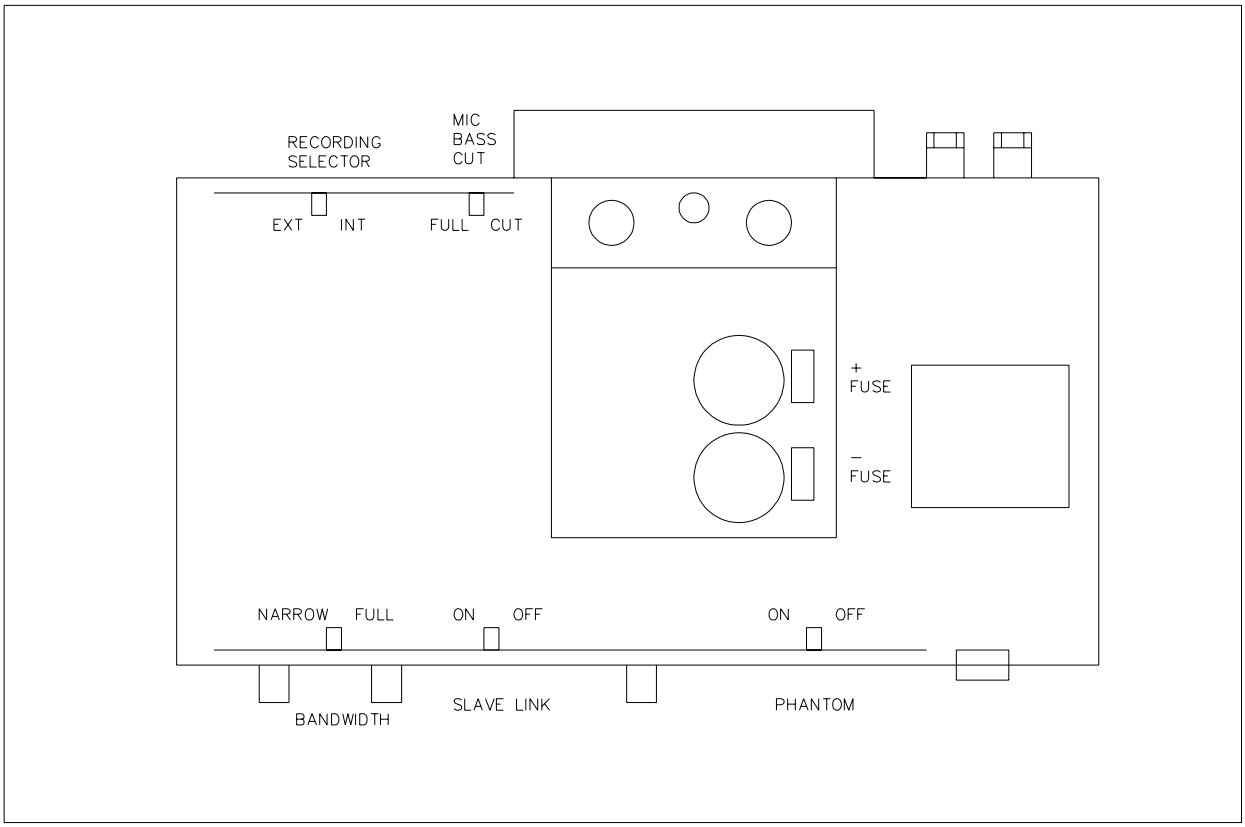


Fig. 10 Locating the internal switches

AC MAINS POWER INPUT

The standard UK power requirement for the Maestro range is 240V 50Hz though correct operation is possible between 180-250V and 50-60Hz.
No special consideration of the power supply is necessary though it is good safety practice to fit a small AC fuse in the supply to the unit. The amplifier may be switched on/off remotely, by interruption of the supply, without any adverse effects.
Mains power transformers for supply voltages other than the UK standard are available to order.

DL.500 INSTALLATION

No two installations are identical. We recommend that all aspects of installation should be carried out by a competent engineer or dealer who will have the experience to enable him to recognise potential trouble spots, and the symptoms of existing ones. He will be able to advise on loop design and location for optimum results. The use of a dealer will also provide the user of the system with a contact should a problem occur in the future.

Case removal

To gain access to the inside of the amplifier for any adjustments which may be required, firstly remove the AC mains supply to the unit, then remove the 9 securing screws holding the top cover. The cover is earthed by a push-on tab connector which must always be in place when the AC supply is connected.

Selection of signal input cables

It is essential that input connections are made carefully, using appropriate screened cable, soldered to the connector plugs supplied, and using the appropriate pin numbers indicated on pages 9 - 10.
Unscreened “telephone” type cables are NOT suitable. Either twin conductor, or single conductor types may be used depending upon the application. For long fixed cable runs, a cable with a conventionally braided outer shield is preferable to a lap-screened type. A conductive plastic shield type is ideal for cables which will be subject to constant flexing such as those connected directly to microphones. Failure to meet these requirements may result in inferior performance, and at worst, damage to the amplifier.
It is not possible in this manual to be specific about the exact types of input cable for use in any particular amplification system, as many practical factors will need to be taken into account. However, as a guide, we would recommend the following:

Balanced microphone lines should be wired in twin, twisted core, screened cable with a conductor size of at least 0.22sq.mm., and preferably 0.5sq.mm. This is equally valid for dynamic or phantom-powered microphones.
Line level cables, such as those between a tape recorder and the amplifier, which may be up to a few metres in length are less critical and may be run using lap-screened, single or twin cable with conductors of 7/0.1mm or 7./0.2mm.

Control knob removal

Each of the three front panel level controls and associated spindles may be removed, by pulling, to prevent unauthorised tampering. Blanking plugs are provided which are of a snap-in style. At any time in the future, the situation may be reversed, but care should be exercised in correctly locating the spindle splines.

Siting

The installation environment for the DL.500 is not critical but in general we would recommend a location that will:-

- separate microphone cables from the induction loop cable route
- separate microphone cables from mains cables
- prevent unauthorised adjustment
- prevent heat build-up around the amplifier casing or heatsink
- prevent microphone cables passing other strong magnetic fields
- avoid long microphone leads - over 50 Metres
- avoid dampness or heavy vibration

When the DL.500 is fitted into a 19” cubicle, we recommend that the cubicle is ventilated to assist heat dissipation.

Ventilation

In use the DL.500 will develop heat which is dissipated by the rear heatsink. In quiescent mode, the heatsink will be little warmer than room temperature, but the heavier the loop current setting and the more constant the programme material, the more heat will be dissipated. At maximum rating, the heatsink will be extremely hot to the touch, and this is perfectly in order. It is important therefore to ensure that sufficient space surrounds the heatsink in order that cooling air can be drawn over it. Do not stack objects on the top of the unit so as to overlap the heatsink, and do not allow the side ventilation holes to be covered. Whilst a thermostatic safety switch is fixed internally to the heatsink assembly, if this ventilation requirement is not met, the amplifier may sustain considerable damage.

Installation Checklist

During the commissioning of the unit, various options are available to the engineer to enable him to meet various technical requirements and the operating requirements of the user:

- Setting the bandwidth filter (normally full bandwidth)
- Bass cut for microphone input (normally full bandwidth setting)
- Setting priorities levels for microphone and line inputs
- Phantom microphone supply (normally on)
- Record selector for internal or external signal (normally internal)
- Slave link (normally on)
- Removal of front control knobs

Finally, furnish client with the loop system announcement card, and demonstrate the controls and operation of the system.

USING THE INTERNAL TEST OSCILLATOR TO SET THE LOOP CURRENT

As most signal input sources provide signal levels which exhibit differing characteristics of amplitude peaks and troughs, the accurate setting of the loop current to the long-term average - as required by BS.6083 - is tricky. The DL.500 includes a precision oscillator, of constant amplitude which may be used in setting the loop current to the calculated requirement, very easily accurately, and quickly.
With audio inputs muted, bridge pins 2 and 4 of the 'Slave' socket to trigger the test oscillator. If the current 'Set' control is adjusted, the LED current output meter will provide a steady display of the resulting loop current. Adjust this to the calculated required value, or use a hand-held magnetic field strength meter to check the actual result, and then remove the bridge. Line and microphone signals will then automatically produce the equivalent average value of loop current. The LED output current meter, is a partial peak-reading meter whose dynamics have been configured to give a realistic representation of a 'long-term average' value as required by BS.6083, from a compromise between typical speech and music signals.
The oscillator has been designed such that the maximum long-term average current level of 2.4 Amps cannot be exceeded. Even at this level, the heat generated by the current driving circuitry is considerable, particularly at low loop impedances, so the oscillator should be used for short periods of no more than a few minutes only.
To prevent unauthorised use, the oscillator facility is not referred to on the rear panel.

PROCEDURE FOR SETTING UP THE INPUT SIGNAL LEVELS

Whilst the nature of a loop induction system represents various unfamiliar concepts and considerations, the design of the circuitry of the DL.500 greatly simplifies the setting up procedure to achieve optimum results.
Firstly, it is necessary to have selected and connected the signal input source, set the 'bandwidth' selection switch if appropriate, set the microphone 'bass-cut' switch if appropriate, connected any external signal processing unit and set the 'slave link' switch if appropriate, set the 'phantom DC supply' switch if appropriate, and connected the correctly designed induction loop wire, and the AC supply. Set the loop current as described above.
Whilst monitoring the loop current at the LED Output Current meter, advance the 'Microphone Input' control (or 'Line Input control) slowly until further advancement causes no increase in loop current indication. The use of monitor headphones may be useful at this point. Advance the input control further by between one and two units. Re-check this by returning the control to zero, waiting 5 seconds and then re-advancing. Greatly excess advancement will cause background interference noise to be processed during programme troughs and the 'Input Overload' LED to illuminate during programme peaks indicating the onset of distortion.
If both line and microphone signals are to be used such that the microphone will have signal priority, it would be greatly advantageous to monitor the loop programme with a pair of monitor headphones plugged into the 'Monitor Headphone' socket. Carry out the above procedure firstly on the line input with the 'Microphone Input' control at zero. Then advance the 'Microphone Input' control slowly whilst making test announcements at the microphone. At some point, it will become apparent that speech peaks are causing the line input signal to reduce. Adjust the 'Microphone Input' further until the desired effect is achieved, but not such that the 'Input Overload' LED illuminates. Remember that the line input will take several seconds to restore to normal level.

PROTECTION CIRCUITRY AND INDICATION

For technical and operational reasons it is necessary to include various types of automatic protection circuitry in a current driven induction loop system. The various features included in the DL.500 design specification operate as follows:

Input overload Input signals are processed by a limiter and averaging circuit to accommodate a very broad span of signal level variations so that the unit may be left unattended. At the point where the limiter is unable to adjust to any greater level, the 'Input Overload' indicator will flash on signal peaks, and distortion may be apparent to listeners. Resolve the problem by reducing the 'Microphone Input' or 'Line Input' control accordingly, or reduce the source signal.
Protection Should the unit be operated into a loop whose impedance is in excess of the specification limits, the output section voltage amplitude is controlled dynamically to reduce clipping. Similarly, peaks of excess output current are limited by the same circuit. The LED indicates the onset of the excesses by flashing on signal peaks, and if the problem persists, the sensitivity of the output stage is subject to a 12dB reduction for the duration of the problem. Check that the loop impedance is within the capability of the DL.500, or that the the loop current 'Set' control is not too high. With an input signal connected, the LED will be illuminated for the duration of the Error Check process at switch-on. This is perfectly in order.
Error Check Following initial switch on, various DC operational aspects of the unit are checked for malfunction, with the loop automatically disconnected. The LED will be indicating at this point. If all is in order, the loop will be connected after about 5 seconds and the LED extinguished. The DC monitoring then continues and if at any time an error is detected, the loop will be disconnected again instantly and the lamp illuminated. The aspects monitored are:- failure of either internal DC fuse, failure of either low-level DC regulator, failure of output circuitry, DC offset falling outside pre-determined limits, failure of Error-Check circuit. The LED will illuminate permanently, and the matter should be referred to a qualified dealer.
Thermal overload Should the temperature of the rear heatsink rise beyond a pre-determined (safe) limit, an associated temperature switch will operate to disconnect the AC supply until such time as the heatsink has cooled to within limit. During this time, all indicators will be extinguished including the 'AC On' indicator, and the unit will appear to be 'dead'. There are several possible causes for excess temperature rise:-

Operation in an inappropriately hot location
Insufficient ventilation around the heatsink
Unusually substantial programme material whilst the unit is operating close to its current limit
Partial DC error or incorrect internal settings in the output circuitry

FUSES

Fuses are fitted to electronic equipment to isolate damaged circuitry thus preventing further consequent damage, and to avoid excess consumption from the AC supply. The failure of a fuse is far more likely to indicate a problem with the amplifier circuitry rather than a 'weak' fuse.
In the unlikely event of the 'AC Fuse' failure (rear panel), it is acceptable to replace the fuse using the correct type, and try to run the amplifier again. If the fuse fails again, refer to your dealer.
If an internal DC fuse is found to have failed, an electronic failure is the most likely cause and it is pointless and possibly dangerous to attempt replacement. Consult your dealer. UNDER NO CIRCUMSTANCES use fuses of a higher value than those specified. Fuses fitted to the DL.500 are:

AC mains input supply: rear panel: 2A anti-surge, 20mm
Positive DC supply rail: internal: 6.3A fast-blow, 20mm
Negative DC supply rail: internal: 6.3A fast-blow, 20mm

The DC fuses are identified in Fig. 10 on page 13.

EARTHING & HUM LOOPS

If the DL.500 is interconnected with other earthed equipment using unbalanced screened connections, it may be possible to form an earth hum loop. The symptoms would be that of a soft low-level humming audible on the loop programme, which is uneffected by the front control settings.

Such problems may be resolved easily by the use of the balanced line input signal connections. If the interconnection is via the 'Slave' or 'Tape' sockets - which do not feature a balanced input connection - then it should be possible to resolve the hum loop by lifting the internal signal earth of either the DL.500 or the other unit. The signal circuitry within the case is earthed to the chassis via an internal green wire signal earth link. This is located between the rear lower case rail adjacent to the cableform, and the rear PCB.

As supplied, the DL.500 chassis and casing is electrically earthed via the AC supply lead and connector. THE INTERNAL WIRING TO THIS CONNECTOR SHOULD NEVER BE DISTURBED.
Where the unit is to be powered from a two-wire AC supply, the rear screw earth terminal must be permanently connected to a suitable earth point.
This terminal is indicated by the symbol - 

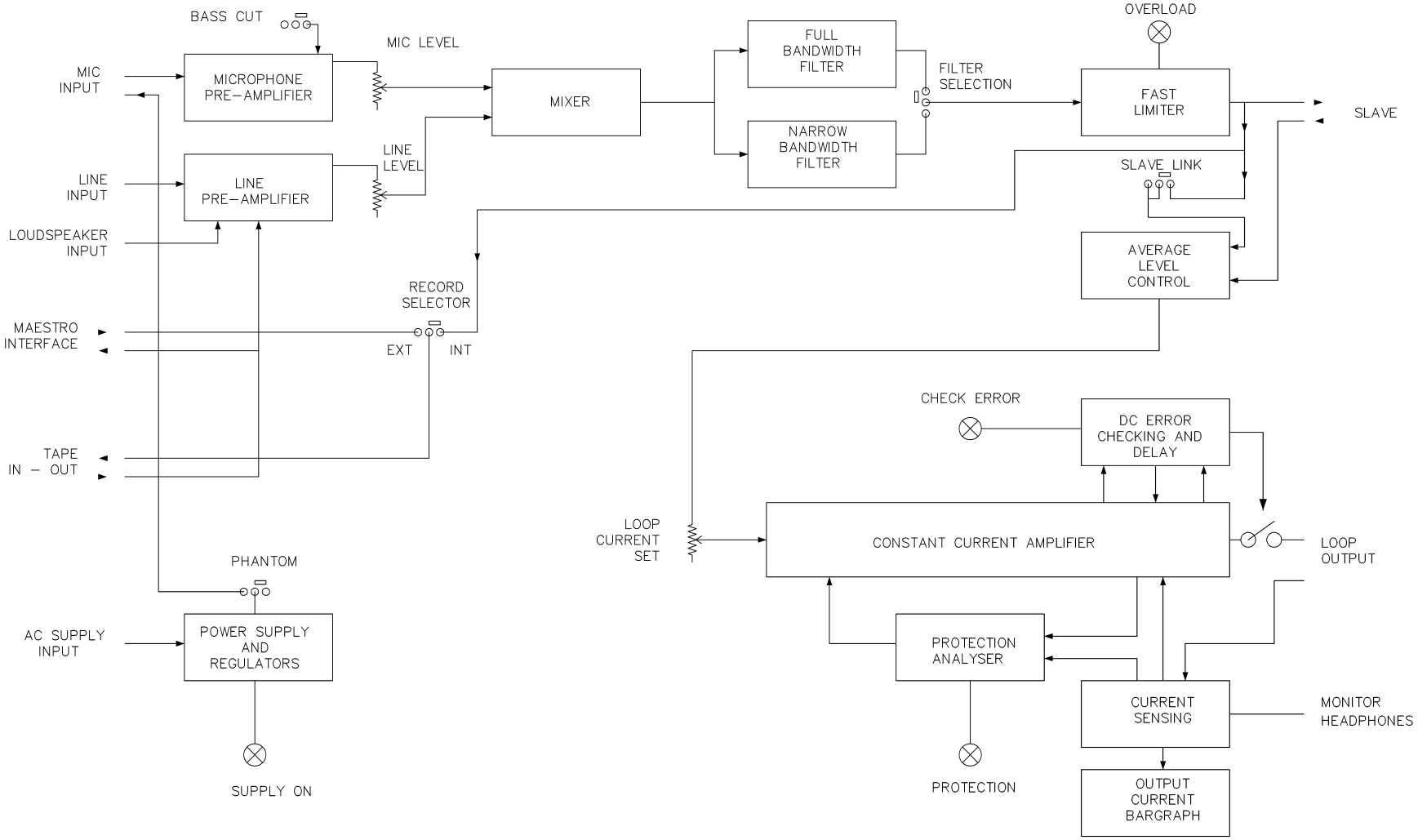
FAULTS - SYMPTOMS AND CHECKLIST

We would always recommend calling your dealer if any problem is experienced though an initial check through the following list may enable you to provide him with valuable time saving information.
The references to "sound" should be taken to mean the programme material received via the loop.

FAULT SYMPTOM	CHECK POINTS
1 Sound off, power lamp off	Mains supply Mains fuse mains switch over-temperature safety switch trip
2 Sound off, power lamp on	Input level controls rotated Input connections secure Loop disconnected Internal DC fuse fail: consult dealer
3 Sound faint	Input level controls rotated Inappropriate input signal Incorrect input connection Incorrect loop design Incorrect loop current setting
4 Sound distorted	Inappropriate input connection point Incorrect loop design Distorted input signal Faulty receiving equipment
5 Sound distorted, even with input control set low	Inappropriately high input signal for the input in use. Distorted input signal Faulty receiving equipment
6 Extreme case temperature	System oscillating: consult dealer 'Heavy' programme material and low impedance loop Insufficient cooling air around heatsink Internal circuit fault: consult dealer
7 Persistent hum, input controls set normal	Incorrect input cables used Incorrect input connections Nearby electrical appliance interference Earthing hum loop: consult dealer
8 Persistent hum, input controls set to off	Earthing hum loop. Consult dealer Nearby electrical appliance interference
9 Persistent faint buzz	Nearby faulty electrical appliance Interference from lighting dimmer Interference to sensitive input cables Nearby electrical appliance interference
10 Intermittent loud crack	Faulty AC supply connection Input connector security Faulty input signal

REPAIRS AND MAINTENANCE

We would strongly recommend that all repairs and maintenance be undertaken by your dealer, who will have access to all necessary information, and who will be fully supported by the Mustang Communications service department.



REV	DESCRIPTION	APPD	DATE

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Phone 01723–582555 Fax 01723–581673
data@mustang.co.uk www.mustang.co.uk

CUSTOMER REF

DRAWING TITLE

MAESTRO DL.500
BLOCK SCHEMATIC

DRAWN	TRACED	CHECKED	APPRVD	DATE
MRT				03–03–92

DRAWING No. DL–M100