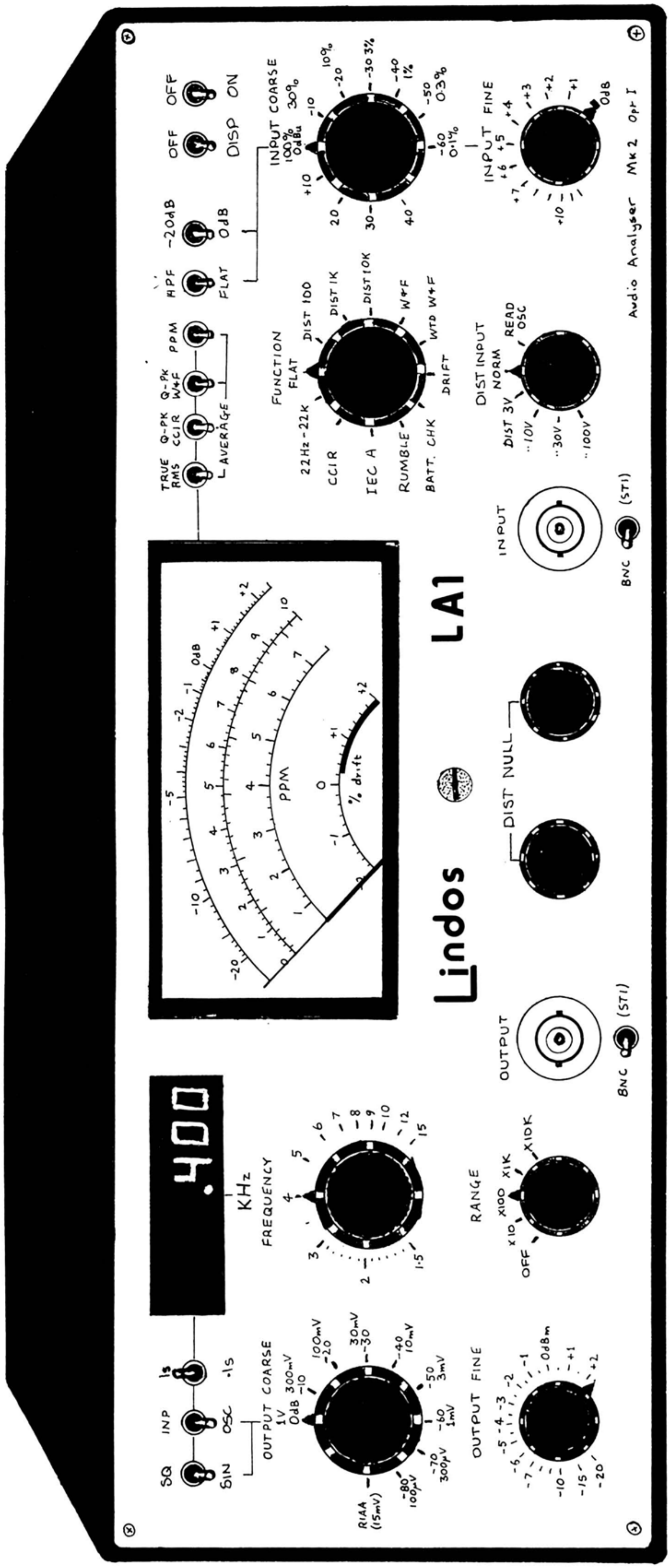


LA1 Audio Analyser

User Manual

Lindos

INDEX

Introduction

The Lindos LA1 Mk2 is a compact, easy to use, multi-function test set for use in the development, testing and maintenance of all professional and domestic audio equipment. It incorporates a wide range low distortion signal generator of exceptional stability together with an accurate measuring system which will quickly check signal levels, frequency response, noise, rumble, crosstalk, wow and flutter, and distortion. The six digit frequency counter displays the oscillator frequency, or it can be switched to the output of the measuring section for use with incoming signals of any level. This provides an instant check of tape or disc speed when used in conjunction with a standard frequency recording.

Separate selection of weighting filters and meter characteristics makes it possible to measure to almost any of the existing standards. Noise can be measured with three different filters and four different meter characteristics, and wow and flutter can be measured using rms or quasi-pk meter characteristics.

Users can choose one of the three add-on units to suit their needs. These clamp on the back of the LA1 and can be supplied fitted or added later:

THE ST1 STUDIO INTERFACE offers full facilities to the professional user. These include: low impedance balanced outputs to +26dbm; balanced inputs with channel switching; mains operation (power is supplied to the LA1); and audible monitoring of inputs via a small speaker.

THE MA2 HI-FI INTERFACE is a reduced version of the ST1 without the balanced inputs and outputs. Like the ST1 it can also provide rechargeable operation of the LA1 if a nickel cadmium battery is fitted.

THE MA1 MAINS ADAPTER is a simple mains adapter constituting a replacement back panel with IEC mains connector and a power supply that occupies the battery compartment. It does not add to the size of the LA1, but cannot be used with a battery in place.

Operation

2.1 USING THE INSTRUMENT FOR THE FIRST TIME

ZERO THE METER if necessary, with the instrument switched off, using a screwdriver beneath the meter. CHECK MAINS VOLTAGE SETTING (where ST1,MA1 or MA2 is fitted). Units are supplied for 200-250V unless labelled otherwise. If no backpack is fitted, remove the back and fit a PP9 battery alongside the foam block. CHECK BATTERY CONDITION (if applicable) by selecting BATT CHK on the FUNCTION switch and setting the meter toggle switches to AVERAGE. The meter reading should fall within the limits shown by the thick bar on the bottom scale.

CHECK BASIC OPERATION by generating and measuring 1V at 1KHz. To do this you should set the controls as follows:

ALL TOGGLE SWITCHES (in top row)-	DOWN
OUTPUT COARSE -	0dB
OUTPUT FINE -	MAX
FREQUENCY -	10
RANGE -	x100
FUNCTION -	FLAT
INPUT COARSE -	0dBu
INPUT FINE -	MAX
DIST INPUT -	READ OSC

The meter should read close to full scale and the digital display close to 1.00. As the oscillator output is very accurate and stable the above procedure can be used to check the basic accuracy of the instrument throughout its life. If this check gives a meter reading of 1.00 within 1% it is highly unlikely that a serious calibration error exists. Most other functions of the LA1 can similarly be self-checked with a little thought. The input and output coarse attenuators can be checked against each other by turning them together step by step and watching for deviations from 1.00 on the meter. The various filters can be checked at spot frequencies and their responses compared with the tables in Section 5. The user will find this sort of exercise useful in getting to know the instrument.

ALL TOGGLE SWITCHES DOWN is a useful rule when starting to measure with the LA1 as this gives the standard average responding meter characteristic. For a different meter characteristic place the relevant toggle switch in the up position. Combinations of more than one meter characteristic are not valid.

2.1.1 CONNECTING UP THE INSTRUMENT - THE ST1 INTERFACE

Equipment to be tested may be connected to the LA1 either directly, via the input and output BNC sockets, or indirectly, via the Jack Sockets (or XLRs) on the ST1 STUDIO INTERFACE where this is fitted. The two toggle switches at the bottom of the LA1 panel select the two modes of operation. The BNC sockets provide the highest accuracy and lowest noise and are often best and most convenient for bench measurements on equipment. The Jack Sockets provide balanced inputs and outputs and the possibility of generating signals at levels up to +26dBu, as well as channel selection and a variety of input and output impedances. They will generally be found most convenient for broadcast and recording studio work. The ST1 also provides for mains operation, and incorporates a small monitoring speaker with sliding volume control for listening to whatever is being measured.

The row of push buttons on top of the ST1 select (from left to right) 600ohm output impedance, 75ohm output impedance, 600hm input impedance, and left or right input sockets. The low impedance output setting is most useful as it delivers a precise output voltage fairly unaffected by loading, and this requires both push buttons to be OUT. READ OSC connects the ST1 input to its output for a direct check of what is going out, and the two remaining switches boost the oscillator output by 6dB and 20dB providing a maximum level of +26dBu. The ST1 provides no additional gain when measuring signals, but it does incorporate a differential input amplifier for good rejection of common-mode interfering signals. Further details of the input and output characteristics of the ST1 and notes on its use with a rechargeable battery are included in the appendix.

2.2 GENERATING SIGNALS

All controls for the signal generator are grouped on the left side of the instrument together with the output socket. Any frequency between 15Hz and 150KHz may be selected using the calibrated FREQ control in conjunction with the RANGE switch, and any output level between 0 and 1V ($-\infty$ and +2dBu) may be selected using the OUTPUT COARSE and OUTPUT FINE controls. The LA1 is calibrated into an open circuit at the BNC output, and is particularly accurate when generating 1V. Any level can be set with reasonable accuracy without using the meter, provided that the load impedance is high ($>$10k). If an ST1 Studio Interface is fitted, its output jack sockets can be brought into use by setting the toggle switch under the output BNC socket to 'ST1'. Three output impedances may be selected on the ST1 and they are all calibrated accurately into a 600ohm load, so the output will be greater into a high impedance. The two output Jack sockets (PO type small tip) are connected in parallel. Other controls on the ST1 provide for boosting the output level by 20dB, or by 6dB so a maximum output level of +26dBu is possible.

The calibrated frequency scale is useful for quick setting, but its accuracy falls above 50kHz. For high accuracy the digital frequency readout should be used. Square waves may be selected with the SIN/SQ toggle switch, but only when the OSC/INPUT switch is set to OSC. In the INP position a squared version of the input signal is generated. The square wave amplitude is only 0.6 of the set level, so setting 1.00V will give 600mV pk.

2.3 MEASURING SIGNAL LEVELS/FREQUENCY RESPONSE

With the FUNCTION switch set to FLAT the right hand half of the instrument operates as a millivoltmeter with wide bandwidth and a full scale sensitivity from 100V down to 1mV selectable by means of the INPUT COARSE control. The -20dB toggle switch increases sensitivity by ten, extending the range to 100µV full scale. It is normally only used in conjunction with the -50 and -60dB ranges. For calibrated measurement the DIST INPUT control must be set to NORMAL and the INPUT FINE control turned fully up.

The row of toggle switches to the right of the meter are normally all set in the 'down' position giving an average-responding, rms-reading, function as provided by most multimeters. Setting up the TRUE RMS switch gives a true rms measurement on non-sinusoidal waveforms, and this is to be preferred when measuring distortion for example. The quasi-peak meter characteristics are for noise and flutter measurement and are referred to later.

The switch marked HPF can be used to introduce a high pass filter with a 12db/octave rolloff below 315Hz. This provides high attenuation at 50Hz but has little effect above 500Hz, so it can be used to test for the presence of mains hum.

To measure the frequency response of, say, an amplifier, it should be driven from the oscillator output at a suitable level, and the meter reading set to 0dB by using the INPUT FINE control together with the appropriate choice of INPUT COARSE attenuation. The oscillator frequency is then varied and any change in reading noted. It is not normally necessary to check the oscillator level as this is extremely stable and will vary by only about 0.1dB over the audio band. It also settles very quickly, but for accurate readings it is better to pause and let the reading settle than to sweep continuously.

When measuring the response of tape machines it is sometimes necessary to filter out bias breakthrough, and this is easily done by selecting 22Hz-22k on the function switch. This selects a filter having 18dB/octave rolloff at both ends but only 0.5dB attenuation at 20kHz (see Fig 2), so its effect on the measured response can usually be ignored. Though this filter complies with the requirements of CCIR recommendation 468-2 for wideband noise measurement it has deliberately been kept on the wide side, within the tolerances laid down, so that it can be used in this way.

2.3.1. CHECKING RIAA EQUALISATION

The frequency response of disc equalisers can be measured as above, but the drive level must be carefully set to avoid clipping at low frequencies or noise at high frequencies. A better method is to drive the equaliser through a network which has the inverse of the required characteristic and read off the errors. Such a network is introduced into the LA1 output when the OUTPUT COARSE control is set to RIAA, and the output level can be varied between 0 and 15mV (at 1KHz) by use of the OUTPUT FINE control. A useful additional test is to check the frequency response with a 47K resistor in series with the LA1 output. This should cause a 6dB drop in output at all frequencies (assuming a standard 50K input impedance) and any deviation from this indicates that the input impedance is changing with frequency. This is a common problem which causes frequency response errors because most pickup cartridges have a complex source impedance and are specified for use into 50K ohms. It should be noted that the current IEC requirement for disc equalisation incorporates an extra 6dB/octave rolloff below 20Hz in the reproducing characteristic, but this is not matched by the recording characteristic and so should be regarded as a rather crude rumble filter. The LA1 generates the recommended record characteristic, not the inverse of the replay characteristic, this being regarded as more useful since the true response of the system is then seen, whatever rumble filter is employed.

2.3.2 PPM PROGRAMME MEASUREMENT

When varying programme levels are to be measured the ballistics of the meter, ie its speed of response and degree of overshoot are important. Setting up the switch marked PPM on the LA1 gives the meter the precise characteristics required by IEC publication 268-10 for a type 2 Peak Programme Meter. This complies with the requirements of the IBA and BBC for programme measurement, and for noise measurement. The LA1 does not provide for accurate VU measurement, but its characteristics in the AVERAGE mode are very close to those of a true VU meter. Likewise, a PPM type 1 is not provided, but if scale details are ignored the PPM type 2 can be expected to give fairly similar readings. The following notes explain the differences.

The VU (Volume Unit) Meter, as defined by ANSI C16.5-1954 and various other standards, is required to have average or near average responding characteristics and to reach 99% of its final deflection in 300mS and overshoots by 1 to 1.5%. The LA1 has a similar response time, but lacks the required overshoot.

The Peak Programme Meter (PPM) IEC type 1 has a fast attack slow decay characteristic and is scaled -40dB to +3dB. It is less closely specified than the type 2, and is used mainly on the continent.

The PPM IEC type 2 has a slower attack time than type one and a tightly controlled range of ±12dB marked at 4dB intervals, which are numbered 1 to 7. PPM4 corresponds to 0dBu (0.775V) rms on sine waves. IEC Publication 268-10 is based on BS4297-1968 which in turn was based on BBC specification ED1477. All these specifications are essentially the same whilst differing in minor details; in particular the required temperature range varies, and there is some confusion over the nature of the response to signals below PPM1, which is of no consequence for measurement purposes. The LA1 employs a log amplifier rather than a diode compressor, and so maintains an accurate log law over the whole of its scale.

2.4 MEASURING FREQUENCY

The digital frequency counter in the LA1 is quartz crystal controlled and very accurate. It counts the number of cycles in a set period which may be 0.1, 1 or 10 seconds, selected by the toggle switch to the left of the display. Only 0.1s and 1s are marked. The 10s period, being rarely used except for accurately setting tape machine servo systems, is selected by 'balancing' the toggle into a central position. The 0.1s setting provides quicker updating, but on low frequencies the 1s period may be necessary to obtain greater resolution. The counter is driven either from the oscillator or from the LA1 input for measuring external frequencies. In the latter case it is connected to the meter amplifier before the weighting filters and will trigger on any INPUT or FUNCTION setting provided that the meter reads at least a quarter of full scale.

2.5 MEASURING NOISE

Any specification of noise level must include the measurement bandwidth, rectifier type and meter ballistic. CCIR Recommendation 468 is rapidly gaining universal acceptance but unfortunately a number of standards are still in use and these are explained below.

To measure noise at the output from a tape machine, mixer etc. the required weighting filter is first selected on the FUNCTION switch, typically CCIR. The required meter characteristic is then selected on the toggle switches, typically CCIR Q-Pk. With INPUT FINE turned fully clockwise, INPUT COARSE is adjusted until the meter reads as close to 0db as possible. Adding the INPUT COARSE setting to the meter reading will then give the absolute noise level, typically around -60dBu.

Measuring noise at a microphone input is slightly different, in that the measurement is normally made at the mixer output. Either it is then 'referred back' to the input, by taking into account the channel gain, or it is specified as it appears at the output, along with a note of the channel gain. The second method is probably better, since noise levels can change with gain settings. A typical measurement therefore requires the gain to be set, say to 60dB, by injecting a signal from the LA1 at -60dBu and adjusting the mixer to read 0dBu on the LA1. Errors are minimised if this is done in the FLAT position, at 1KHz , using the meter characteristic required for the noise measurement. The signal is then removed, the input terminated with a resistor (200ohm - 600ohm as specified), and the noise level measured as above.

The IBA and BBC specify that the gain of the measuring set should be adjusted (using INPUT FINE) until a noise reading of 0dB is obtained on the meter, and this method has the advantage of eliminating errors due to non-linearity or varying ballistics at different meter readings. With the LA1 we would suggest that a straight meter reading is more accurate, and quicker. This is because the meter characteristics are more accurate than the INPUT FINE control calibration. Both methods should give much the same result.

2.5.1 CCIR Rec 468

This specifies the characteristics of a weighting filter with a peak at 6KHz, which is meant to take account of the subjective annoyance value of each noise component. This, it will be noted, is not necessarily the same as its subjective loudness, which is why the filter differs from the 'A' weighting filter. A Quasi peak meter characeristic is also specified, and this gives a measure of the subjective importance of short bursts of noise such as may occur on telephone lines. It consists of a nominally peak-responding circuit with some carefully devised time constants to reduce its response to short bursts. The meter is rms-reading, so it will read the same as the average or rms characteristics on sine waves, but about 6dB higher on white noise.

CCIR Recommendation 468-1 was revised to 468-2 in 1978 and to 468-3 in 1982. All three are essentially the same, but with a gradual tightening of tolerances. Thus, 468-2 specifies the response of the quasi-pk circuit to shorter tone bursts of 1,2,and 5ms where formerly only 10 to 200ms bursts were covered. 468-3 changes the tolerances on the weighting filter at five points, the most important being from ±0.5dB to ±0.2dB at 1kHz. The LA1 meets the requirements of CCIR468-1,2 and 3.

CCIR 468-2 and 3 incorporate an Annex which specifies a filter characteristic for Unweighted noise measurement. This is met by the 22Hz to 22k filter in the LA1. The meter characteristic is not made clear, but the use of the quasi-pk characteristic is probably most sensible.

The IBA and BBC have for a long time specified the use of a PPM characteristic for noise measurement, but this is likely to change soon with the adoption of CCIR 468-3. Selecting PPM instead of CCIR-QPk meets the former requirement, and the two methods generally agree within 1dB.

2.5.2 IEC-A Weighted

This is one of four weighting curves specified in IEC PUB 179 for use in sound level meters, and based on the Fletcher-Munson subjective loudness curves. It is universally used for environmental noise specification and occasionally used in equipment noise specifications. The LA1 incorporates the A-weighting network, and provides the true-rms rectification called for.

2.5.3 CCIR/ARM 2k Weighted

This refers to a recommendation brought in by Dolby Labs to encourage the use of the CCIR weighting curve in noise measurement because it gave a meaningful measure of the improvement brought about by the introduction of Dolby B noise reduction. Because quasi-pk characteristics were expensive to implement, an average responding meter was specified, together with a shift in gain so that the weighting filter gave 0dB gain at 2kHz instead of 1kHz. The method gained universal acceptance by reviewers of home audio equipment, but it is important to realise that it gives figures that are generally 11dB better than the true CCIR method (assuming non-impulsive noise). Selecting CCIR and AVERAGE on the LA1 automatically changes the filter gain and gives Dolby type measurements.

2.5.4 DIN 45405

This standard called for a different weighting filter, together with the same quasi-peak meter as CCIR 468-1. It is now obsolete, and not available on the LA1.

2.6 MEASURING RUMBLE

The LA1 can measure both weighted and unweighted rumble according to IEC publication 98-1964. This is essentially the same as, but more stringent than, DIN45539 and BS4852, see Fig 4. Setting RUMBLE on the LA1 selects the unweighted curve which filters out surface noise above 315Hz and attenuates below 10Hz. This gives a measure of the low frequency rumble present, important, even though it may be inaudible, because it may be emphasised by arm resonance and lead to flutter or intermodulation through complex interactions at the cartridge. To measure weighted rumble it is necessary also to switch in the HP filter as well as selecting RUMBLE. The resulting curve emphasises frequencies around 315Hz and indicates the subjective audibility of the rumble.

To measure rumble the LA1 is first set to read 0dB on a test record cut to a specified level, using INPUT COARSE and INPUT FINE controls. The relative rumble level is then measured on a quiet groove with the FUNCTION switch set to RUMBLE, the HPF selected (weighted measurement only), and AVERAGE meter characteristics selected.

Differences exist between the standards, which can be important. IEC PUB 98 specifies a 315Hz test tone cut at 2.71 cm/s rms or 1KHz at 5cm/s rms on L and R channels separately. BS4852 requires four similar tones - Left, Right, Lateral and Vertical and four corresponding rumble measurements. Of these the worst must be quoted - an important difference because vertical rumble usually predominates. DIN45539 requires a 10cm/s pk lateral cut at 1KHz which is equivalent to 5cm/s rms simultaneously on both channels, and in this case the worst of the L and R readings must be taken. Further ambiguities exist over equalisation. BS4852 makes no mention of this and it is assumed that RIAA equalisation to BS1928 is used. IEC PUB 98 also ignores this point, but IEC PUB 98 Amendment 4 incorporates an added rolloff below 20Hz into the standard disc reproducing characteristic. DIN45539 specifies RIAA equalisation plus an added rolloff of 6dB/octave or more, below 31.5Hz. These differences affect unweighted measurement, and it is to be hoped that the standards will be brought into line and clarified.

Differences of meter characteristics also exist. IEC PUB 98 specifies a standard VU meter. BS4852 specifies a slow average reading meter. DIN45539 does not specify the meter. Tests have shown that the AVERAGE responding meter in the LA1 gives exactly the same results as the slow characteristic of BS4852, although the latter eliminates the task of visually averaging the meter fluctuations.

2.7 MEASURING WOW AND FLUTTER

Wow and flutter is now generally measured according to IEC PUB 386 which is essentially the same as DIN45507 and BS4847/1972 and defines a special quasi-peak meter characteristic together with the weighting curve shown in Fig 5.

To measure weighted wow and flutter the function switch is set to WTD W&F and the toggle switch marked Q-Pk W&F is set up. The signal from a test record or tape recorded with a 3.15KHz tone is then fed to the LA1 input and the appropriate range (0.01% to 10%) selected on the input coarse control. A signal level of 100mV to 1V is preferred, and it is wise to check the level before proceeding. The input fine control must be turned fully up to obtain calibrated readings. The LA1 remains accurate when used with any carrier frequency between 3.00KHz and 3.2KHz, enabling older test tapes to be used. Although the use of a perfect test tape gives more meaningful results in theory, tape machines have now been perfected to the point where it is difficult to obtain a test tape that is better than the machine being tested. In this case it is better to record a 3.15kHz tone from the LA1 (this must be set up, it is not generated automatically), and then stop and start the machine several times while replaying. If successive readings differ, it is because of low frequency wow components which may add or cancel between record and replay depending on the point at which the tape is started. The worst figure should be quoted as the 'record and replay' flutter. To measure unweighted W&F select W&F on the FUNCTION switch. Never measure flutter while recording and replaying simultaneously, as a high degree of cancellation will occur.

2.7.1 NAB MEASUREMENT

The LA1 can also measure rms wow and flutter as required by NAB and other standards. The NAB weighting curve is the same as that in IEC 386, but the TRUE RMS meter characteristic should be selected. A 3KHz tone is normally specified, but use of a 3.15kHz tone will make no difference.

2.7.2 DRIFT MEASUREMENT

The DRIFT position on the function switch provides for ±2% frequency indication about a centre zero position which corresponds to 3.15KHz. It can be used to measure slow speed variations or changes in speed between the start and finish of a tape, but as its accuracy is limited the use of the digital frequency readout is recommended for absolute tape speed measurement. In the absence of a carrier the meter will read full scale and for frequencies below -2% the meter characteristic 'doubles back on itself' and zeros again at about 3KHz. This again permits the use of 3kHz test tapes provided that positive and negative readings are interchanged.

2.8 MEASURING DISTORTION

Total harmonic distortion can be measured at three frequencies with the LA1 by selecting DIST 100, DIST 1k or DIST 10k. The measurement involves driving the amplifier or device under test with a very pure sine wave and then measuring what remains in the output of the device when the fundamental frequency is filtered out.

To measure distortion on signal levels between 1V and 3V, select DIST 1k (or DIST 100 or DIST 10k) and set INPUT COARSE to 100%. Then adjust INPUT FINE for a full scale reading on the meter. This adjusts for the signal level with the notch filter out. Then set INPUT COARSE to 30%, which brings in the notch filter and should give a reduction in reading, and adjust the two ten-turn controls in succession for minimum reading. Repeat this process, switching to more sensitive ranges on the INPUT COARSE control as appropriate, until the minimum reading is obtained. The distortion level can then be read from the 0-3 or 0-10 meter scale, taking into account the percentage full scale as indicated by the INPUT COARSE control setting. An alternative method, useful if the signal level is 0dBu, is to set 0dB instead of 100% initially, and later read off the distortion in dB below 100%. With practise the nulling process becomes very fast, and it is possible to do most of the nulling on the 30% range and then jump to the most sensitive range for a final adjustment.

Signal levels above 3V will require aditional attenuation before a 100% setting can be achieved, and the DIST INPUT control provides additional steps of 10dB attenuation to cope with levels up to 100V. It also lowers the input impedance to 10k, though this will not generally matter.

Signal levels below 1V (or 0dBu) will require extra gain before a 100% setting can be achieved, and the -20dB switch should be operated. If this produces too high a reading the DIST INPUT control should again be used. Whatever settings are needed to obtain a 100% reading, they should of course be left in throughout the measurement, and ignored in the final reading.

If either null control reaches its limit, the test frequency is outside the +2% adjustment range, and will have to be adjusted accordingly. It is often quicker to start by tuning the oscillator frequency for a minimum on the 30% range, and this is especially true when measuring distortion at 10kHz where stray capacitance causes the centre frequency of the notch to be less accurate. When measuring very low levels of distortion at 1kHz it is a good idea to check for interfering mains hum by switching in the HPF and noting whether the level drops.

Appendix

Some Points in Further Detail:

3.1 OSCILLOSCOPE CONNECTION

A 7-way DIN socket at the back of the LA1 provides an AC output, an AC input, and a DC output. AC out and AC in are normally linked, but it is possible to insert an external weighting filter between them. If an ST1 is fitted, this provides the link, and AC out (100mV rms full scale) is available at the rear BNC socket. It can be connected to an oscilloscope to display whatever is being measured, such as distortion or flutter waveforms. It is normal for the scope trace to look rather noisy because it emphasises the noise peaks, if this is a problem it is possible to obtain a higher signal level by reducing the input range. DC out provides 1V DC full scale to drive an external meter, or chart recorder.

3.2 INPUT CHARACTERISTICS

The LA1 input is single ended, 100k impedance, and can measure up to 100V, making it suitable for general circuit development work. The ST1 incorporates a differential amplifier with input resistors chosen for good common-mode rejection and a well balanced differential impedance of 20k when driven with a balanced signal. It is ideal for easy connection to studio systems but cannot handle signals in excess of +20dBu without clipping. Single ended outputs should be connected between ring and sleeve of the Jack socket for maximum input impedance (15k).

3.3 OUTPUT CHARACTERISTICS

The LA1 output comes from a potentiometer and has an impedance which varies between 0 and 600 ohms depending on attenuator settings. It is less suitable for driving low impedance inputs than the ST1, which has selectable constant impedances. The ST1 employs a resistive attenuator in its output so the oscillator signal is boosted 20dB and then attenuated again when the ST1 is in its 0dB gain setting. This can result in internal clipping under circumstances where the internal level exceeds +25dBu. This problem only arises when the +6dB switch is used, or when 600ohm output impedance is selected. If in doubt stick to the 20dB gain setting except when very low noise outputs are required. The output impedances are accurate in the 20dB setting, but will increase by 20ohms in the 0dB setting because of the attenuator.

3.4 PROTECTION CIRCUITS

All inputs are protected up to 100V (limited duration on some ranges) by diode clamping circuits. All outputs are protected by Zener diodes followed by fuses. No DC isolation is employed, and excessive current fed back into an output will blow the fuse. The LA1 has one fuse situated at the bottom of the front board when the cover is removed. The ST1 has two fuses situated by the Jack sockets when the cover is removed.

3.5 USE OF THE -20dB SWITCH

This functions on all ranges and all functions but it is intended mainly for extending the sensitivity to -70 or -80dB on the two lowest ranges. On other ranges it will introduce noise and cause a zero offset on the meter. It should not be used on the DIST 10k setting.

3.6 MEASURING TAPE SPEED

The digital display will read carrier frequency on the DRIFT range provided that it is set to read INP and the INPUT COARSE control is set to suit the carrier level present at the input. When W&F is selected the counter reads not carrier frequency, but the frequency of the W&F components. It may therefore read rather irregularly.

3.7 THE CONNECTOR SWITCHES

These permit measurement via either the BNC sockets or the ST1 (if fitted). The BNC output is permanently connected, so it may be used, for triggering for example, when the ST1 is selected. On units fitted with DIN sockets in place of BNCs the switches are wired for L or R channel selection on domestic equipment. An ST1 is not normally fitted when DIN sockets are used, if it is fitted it will drive the R channel of the DIN input socket, so it must be removed for proper functioning of the DIN sockets.

3.8 USE ON 100-120V MAINS

The ST1 is normally supplied for 200-240V operation unless marked otherwise. Changing the mains setting requires removal of the cover to gain access to a wire link. A diagram on the circuit board indicates where two alternative links must be soldered in. Before removing the cover make sure that all the switch buttons are removed and the switches latched in or damage can result (see maintenance section).

3.9 RECHARGEABLE BATTERY OPERATION

A Nickel-Cadmium Rechargeable PP9-size battery can be fitted in the battery compartment by removing the two large screws holding the ST1 in place, and lifting the ST1 clear. The battery connector will be found inside a protective insulating sleeve. The ST1 incorporates current and voltage limiting so no damage can result from continuous overcharging, but leaving the unit switched on when the battery is flat will shorten the life of the battery. With the LA1 switched on the battery charges slowly at about 20mA. For quicker charging switch off the LA1 and leave the ST1 switched on. The battery should then charge in 14 hours (at 100-120mA). Do not connect mains with an ordinary PP9 battery fitted as charging may cause it to leak or explode.

The ST1 inputs and outputs only function when mains is connected so battery operation is limited to the front BNC sockets. The monitor speaker is battery powered however.

3.10 GUARANTEE AND SERVICING

The unit is guaranteed for one year from despatch. This covers parts, labour, and return postage provided that we consider the unit to have been fairly treated and not damaged by misuse. We provide a continuing repair and recalibration service and can usually assist by telephone where users wish to do their own repairs. Please telephone before returning units, as we can sometimes advise if we think the unit is not at fault.

Maintenance

4.1 DISMANTLING AND REASSEMBLING

The LA1 is easily dismantled provided that the correct sequence is adhered to. Most work involving access to the main PCBs can be carried out by proceding to stage 3.

STAGE 1 - REMOVING THE LA1 CASE
(1) Unscrew the two large (M5) screws holding the back or ST1 in place. The ST1 has captive screws which should not be pulled out. Unplug and remove the ST1. (2) Remove the two (M5) screws at the sides and take away the handle. Slide the unit forward out of its case.

STAGE 2 - REMOVING THE CHASSIS (for board access)
(1) Remove the four (M2.5) screws at the corners of the front panel. (2) Pull off the Molex connector linking the rear card to the rear socket, and remove tape attaching screened leads underneath. (3) Lift the panel assembly clear of the chassis. To operate the unit in this state it will be necessary to link pins 8 and 9 (counting from left to right) on the rear Molex connector.

STAGE 3 - REMOVAL OF THE REAR BOARD
(1) Turn the function switch fully anticlockwise. (2) Take out the two (M3) screws holding the rear card, and withdraw the card backwards. The oscillator and counter will still function at this stage and can be accessed for fault-finding.

STAGE 4 - REMOVAL OF THE FRONT BOARD
(1) Turn all rotary switches fully anticlockwise. (2) Unscrew the short support pillars using pliers to grip them. (3) Pull off the three Molex connectors from the bottom edge of the card. (4) Carefully withdraw the card backwards a little at time avoiding damage to switch wafers.

STAGE 5 - REPLACEMENT OF CONTROLS OR SMALL BOARDS
(1) Prize off the caps from the control knobs using a finger nail or knife. This exposes the collet fixing nuts which can be loosened (preferrably using a special tool from Sifam). Remove knobs. (2) remove fascia panel.

REASSEMBLY

Reassembly is the reverse of dismantling with the proviso that special care must be taken to line up all rotary switch wafers correctly. If they have become misaligned set them all with the notch in the centre hole pointing accurately downwards and turn all switch mechanisms fully anticlockwise. All knobs should then be aligned with the most anticlockwise panel mark. (The FUNCTION switch should be set to BATT CHK, the RANGE switch should be two clicks anticlockwise from OFF).

ST1 DISMANTLING

(1) Remove from the LA1 by loosening the two large (M5) screws, withdrawing a little way, and pulling off the Molex connector.
(2) Ensure that all the switch buttons are OUT and pull off all the switch (and volume) caps by gripping them carefully with broad-nosed pliers.
(3) Push all switches in. The two end ones must be pressed together using tweezers. If this is not done damage will result when the cover is removed.
(4) Remove the four (M3) corner screws on the printed side of the ST1 and lift off the cover.
(5) Unplug the internal Molex connector before removing the cover completely.

4.2 RECALIBRATION

There are only six preset potentiometers to adjust when setting up the LA1. Full testing requires specialised equipment especially on W&F and for testing PPM and Q-Pk responses, but all presets give only fine adjustment, and if care is taken not to disturb them recalibration can be avoided. If it is attempted the following sequence should be followed:

(1) Apply 100.0mV 1kHz to the rear socket AC input and adjust the preset on the small toggle switch card for full scale on AVERAGE.
(2) Replace the shorting link or ST1 and apply 1.000V 1kH to the input. Adjust GAIN preset for full scale on the 0dB (1V) range.
(3) Apply 1V 3.150kHz to the input and select DRIFT. Adjust DRIFT for centre zero on the bottom scale.
(4) Apply 1V 3.150kHz carrier with ±1% sinusoidal flutter at 4Hz and select WTD W&F and Q-Pk W&F. Adjust the preset marked SUPPLY for full scale on the 1% range.
(5) Repeat (3) As the SUPPLY preset will have affected it.
(6) Connect an oscilloscope to display the oscillator output with the second channel connected to the oscillator test pin using a 10M probe. The test pin is on the front board to the right of and just below the preset marked O.P. The preset marked OSC FB (feedback) should now be adjusted for -700mV on the test pin when generating 1kHz. A larger voltage at the test pin will reduce output variation and settling time but increase distortion. A lower voltage may result in excessive output variation over the frequency range. A degree of optimisation is therefore possible on each unit, depending on how well its frequency potentiometer tracks.
(7) Select READ OSC and adjust OSC OP for 1.000V at 1kHz. Note that any subsequent alteration to the SUPPLY preset will affect oscillator output.

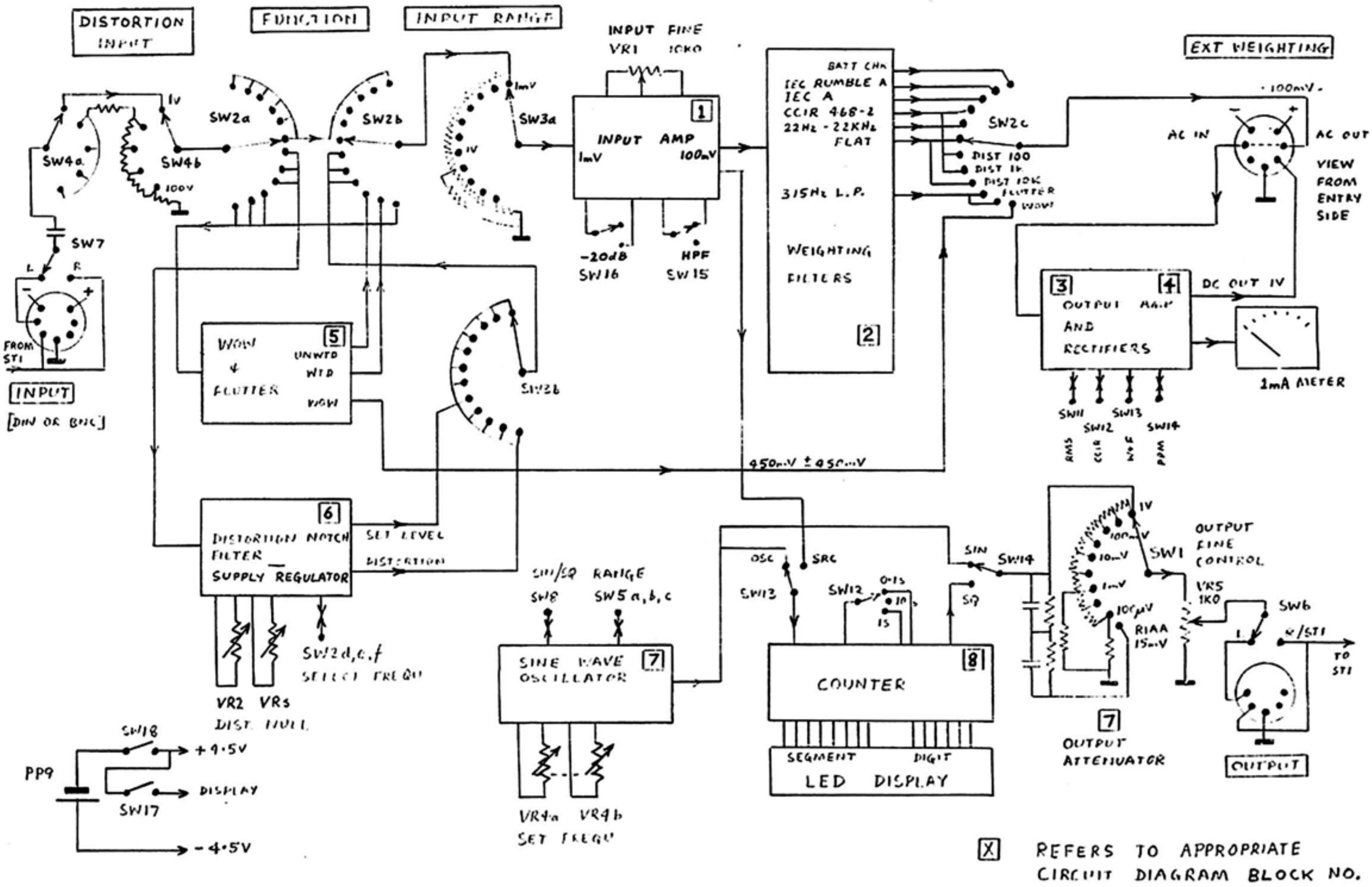
4.3 CIRCUIT NOTES

Only brief details are given here to assist those who feel competent to carry out repairs or modifications. Efficient testing of a unit as complex as the LA1 is very difficult and best carried out using specially designed test equipment capable of generating all the required test signals instantly and accurately. We therefore recommend that units be returned to us for checking if problems arise.

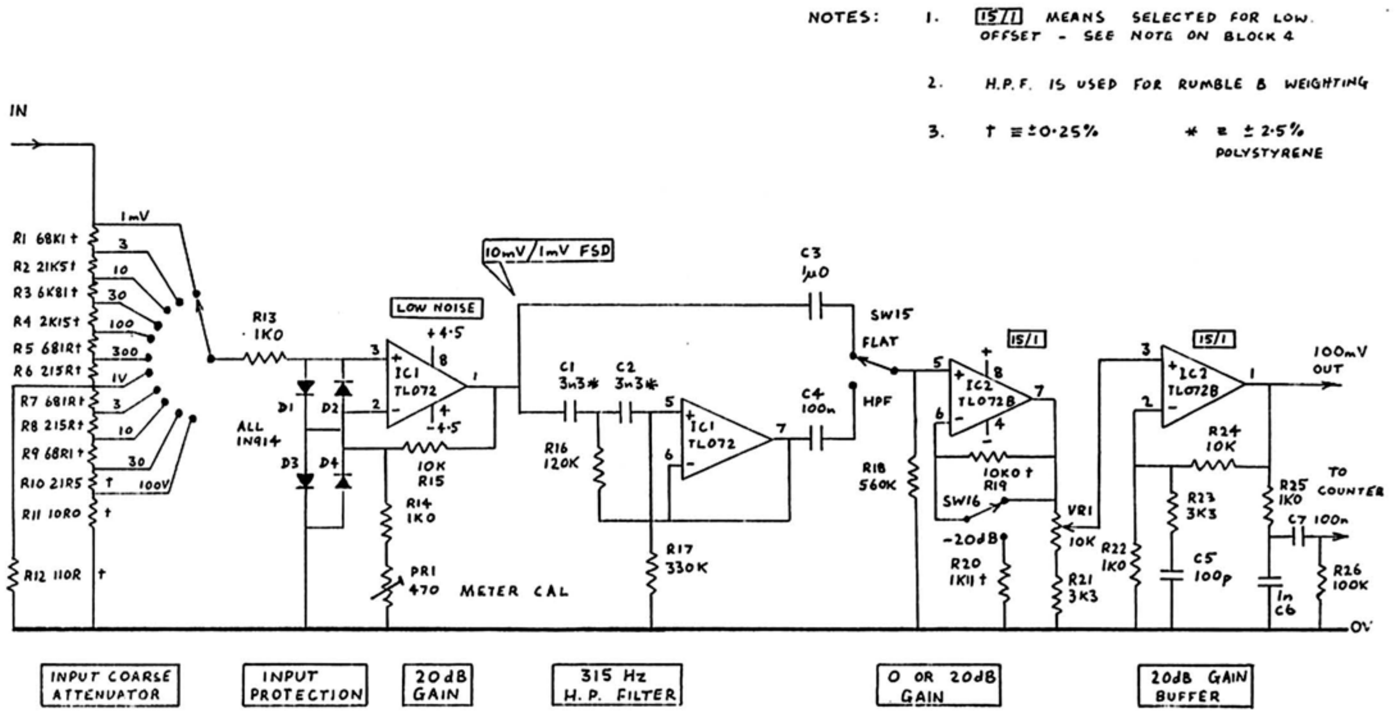
POWER SUPPLIES: The LA1 is unusual in operating from ±4.5V rails. These are obtained from a 9V battery or floating supply from the ST1. Reference to circuit block 6 shows that an operational amplifier is used to clamp the 0V ground rail at around 4.5V relative to the negative battery supply, and the remainder is left as the positive supply. The negative supply, being derived from a band gap reference is very stable and is used as a reference in the oscillator level control circuits and in the flutter detector circuit. This is why W&F calibration involves power rail adjustment. Care should be taken never to short the positive battery rail to 0V (or chassis) as this is very likely to damage the regulator op-amp IC3. If an external supply is used it must be 9 to 10V and floating.

COMPONENT SELECTION: Some components require critical matching, as shown on the diagrams, and some TL072 op-amps require selection for low offset voltage. Critical op-amps are marked with a box showing the maximum permissible offset voltage (in either direction) for the first and second devices on the chip respectively. While low-offset versions of the TL072 can be obtained, selection is much more economical. In general the use of unsatisfactory chips will simply cause an offset of a few percent on the meter.

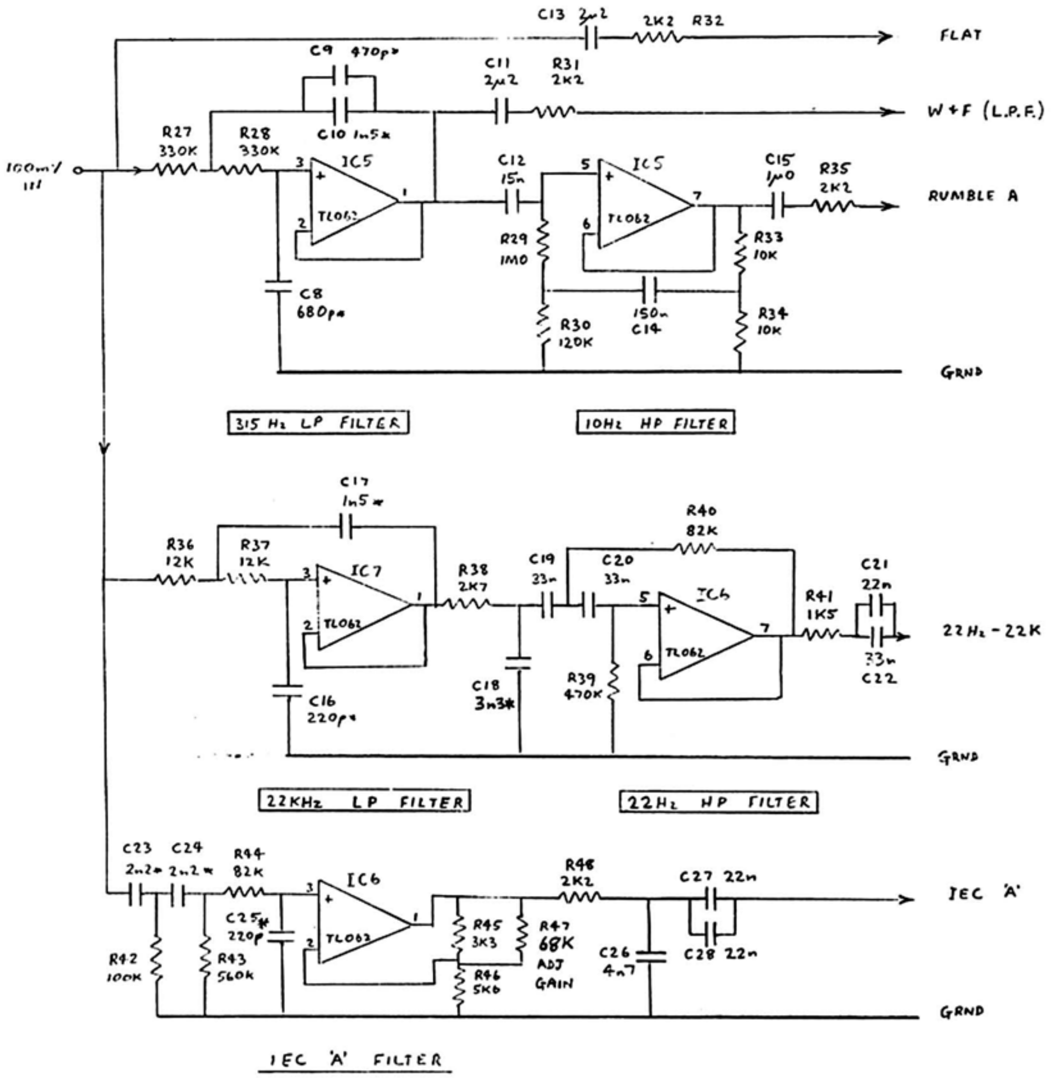
Circuit Diagrams

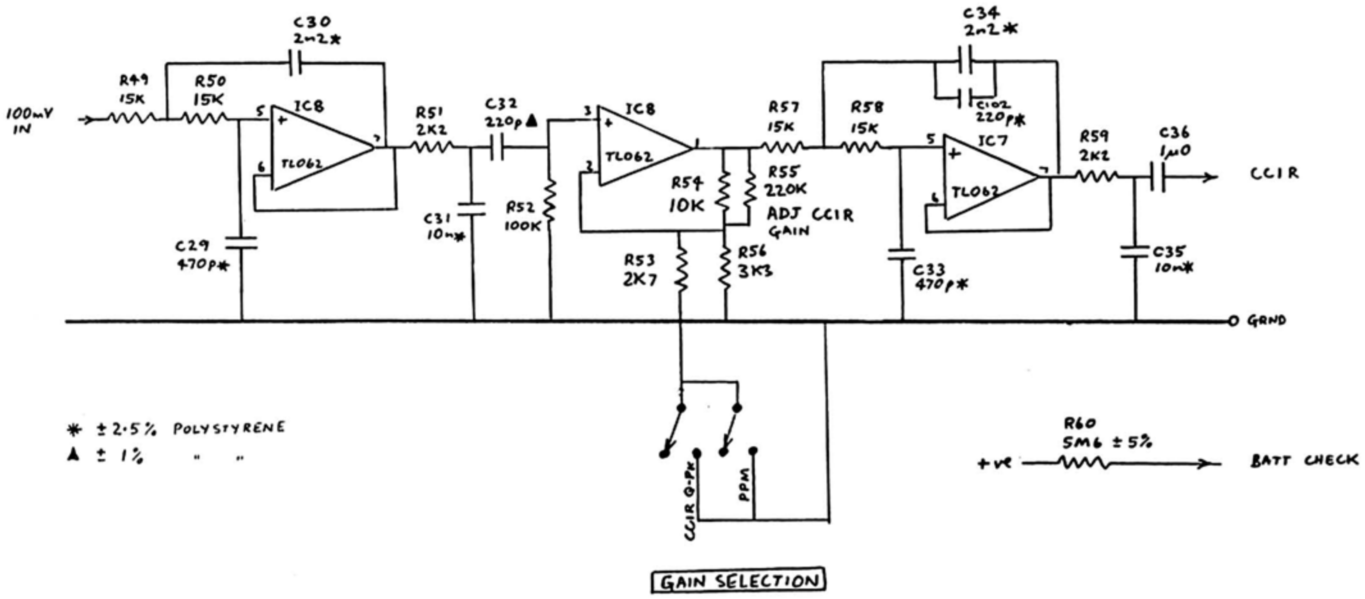


LA1 BLOCK DIAGRAM

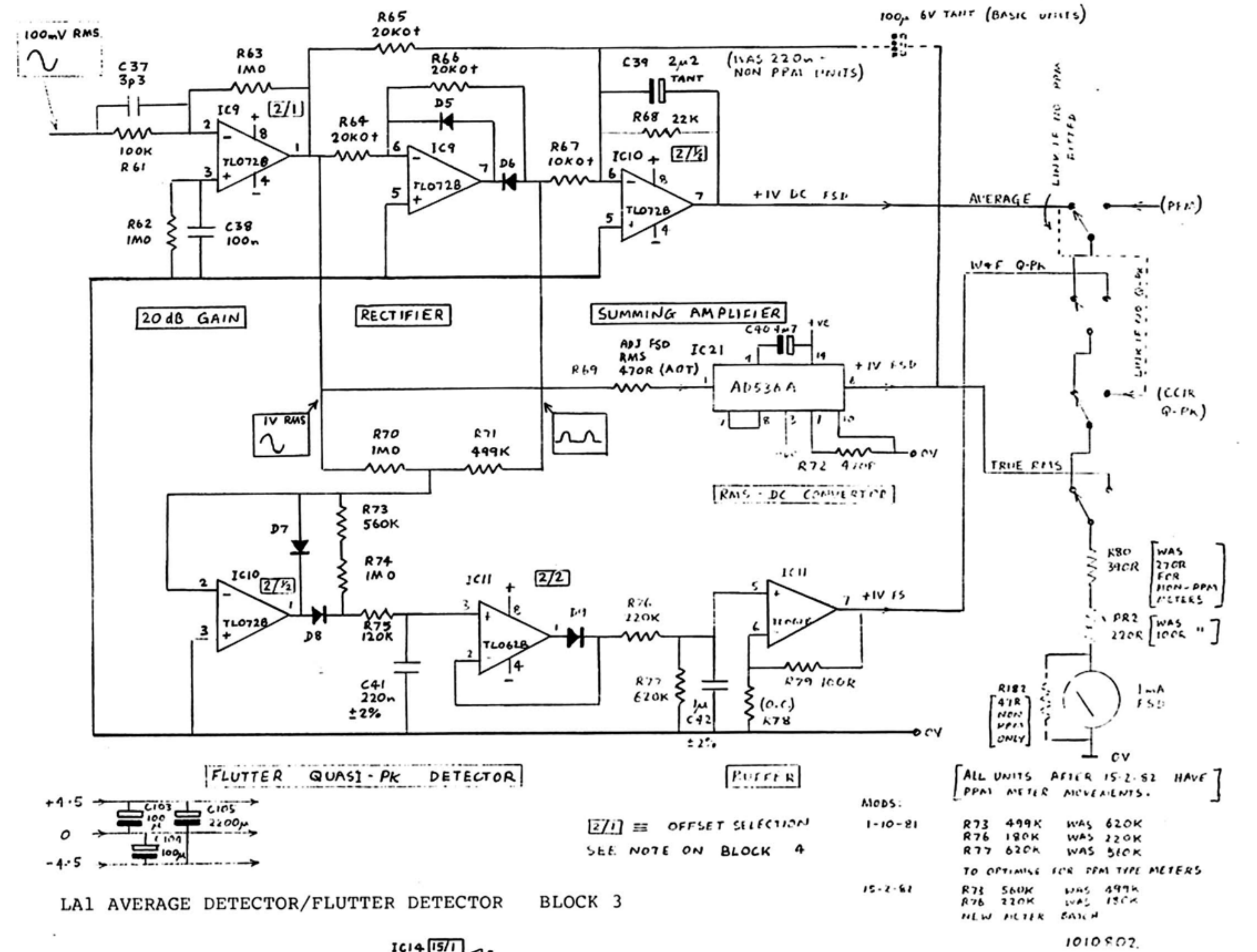


LA1 INPUT AMPLIFIER/HIGH PASS FILTER BLOCK 1

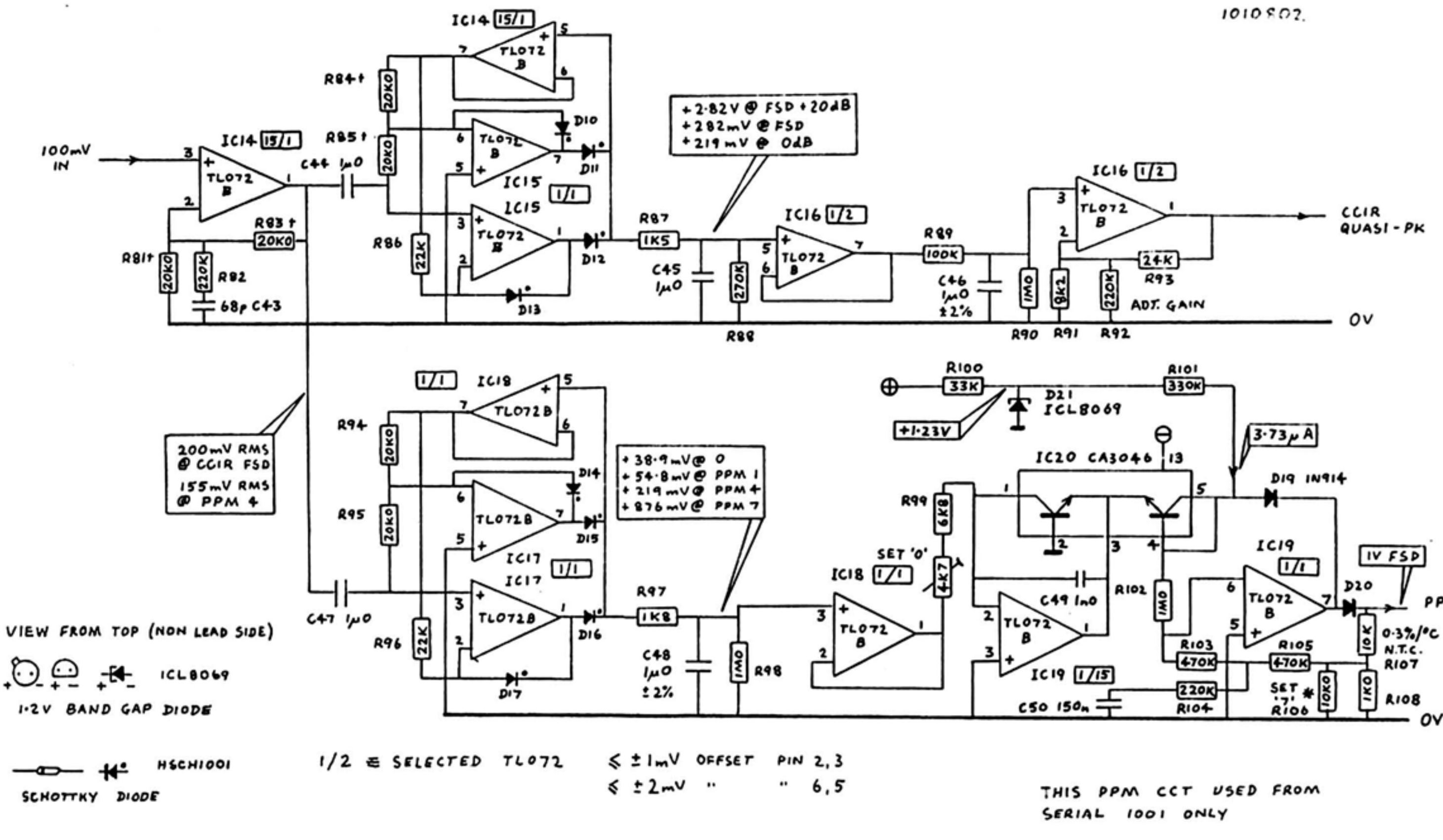




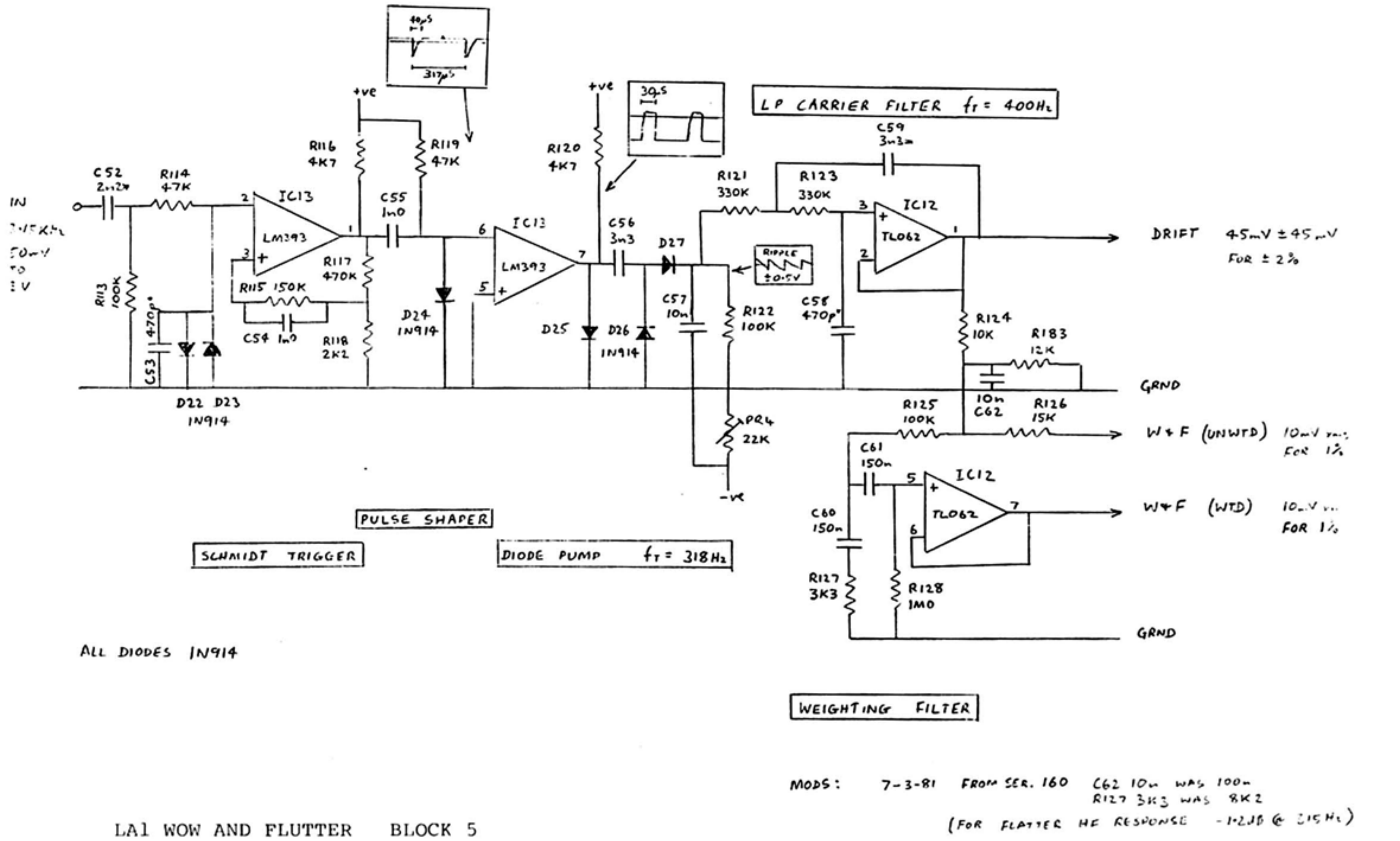
LA1 WEIGHTING FILTERS BLOCK2



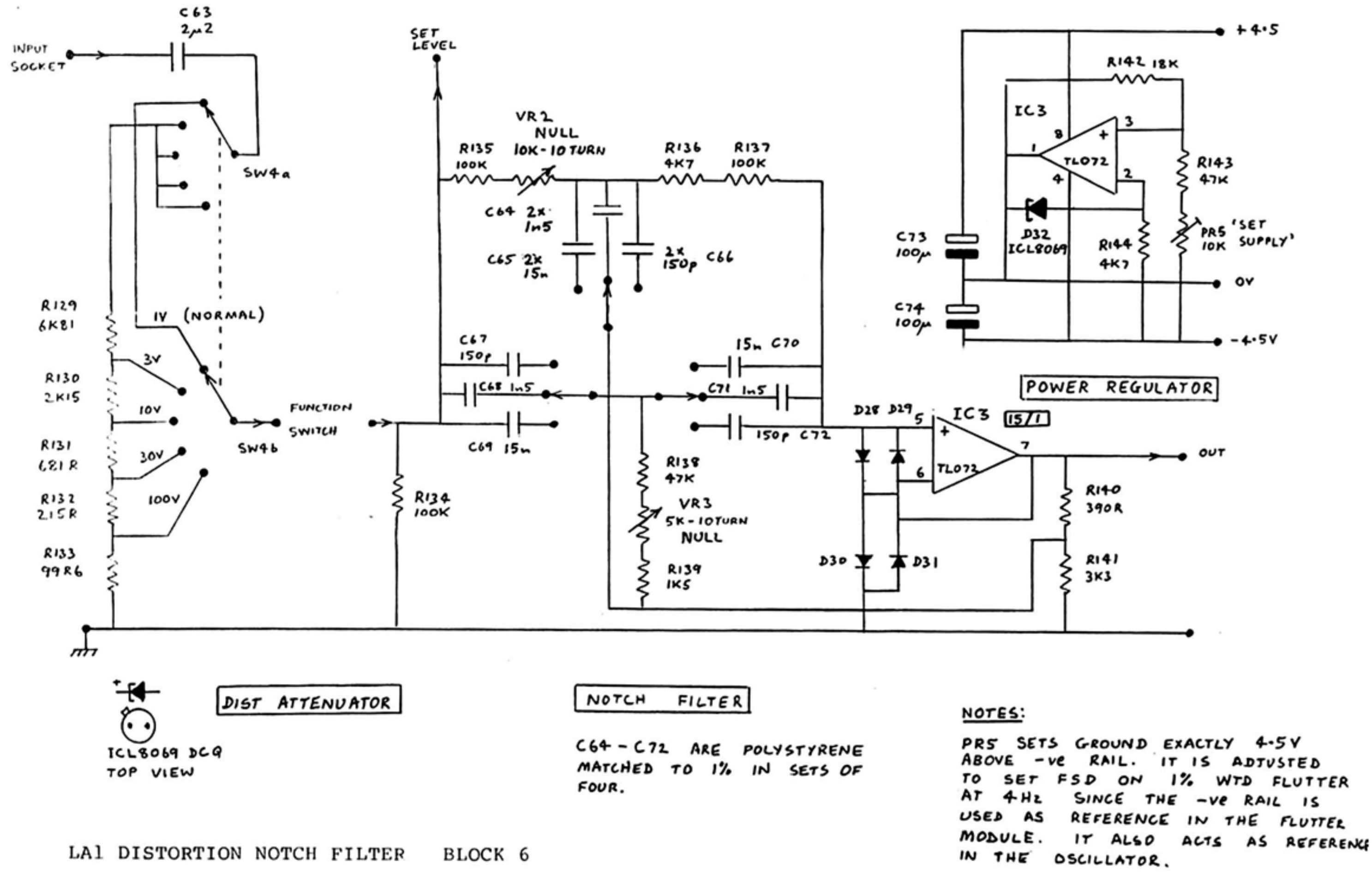
LA1 AVERAGE DETECTOR/FLUTTER DETECTOR BLOCK 3



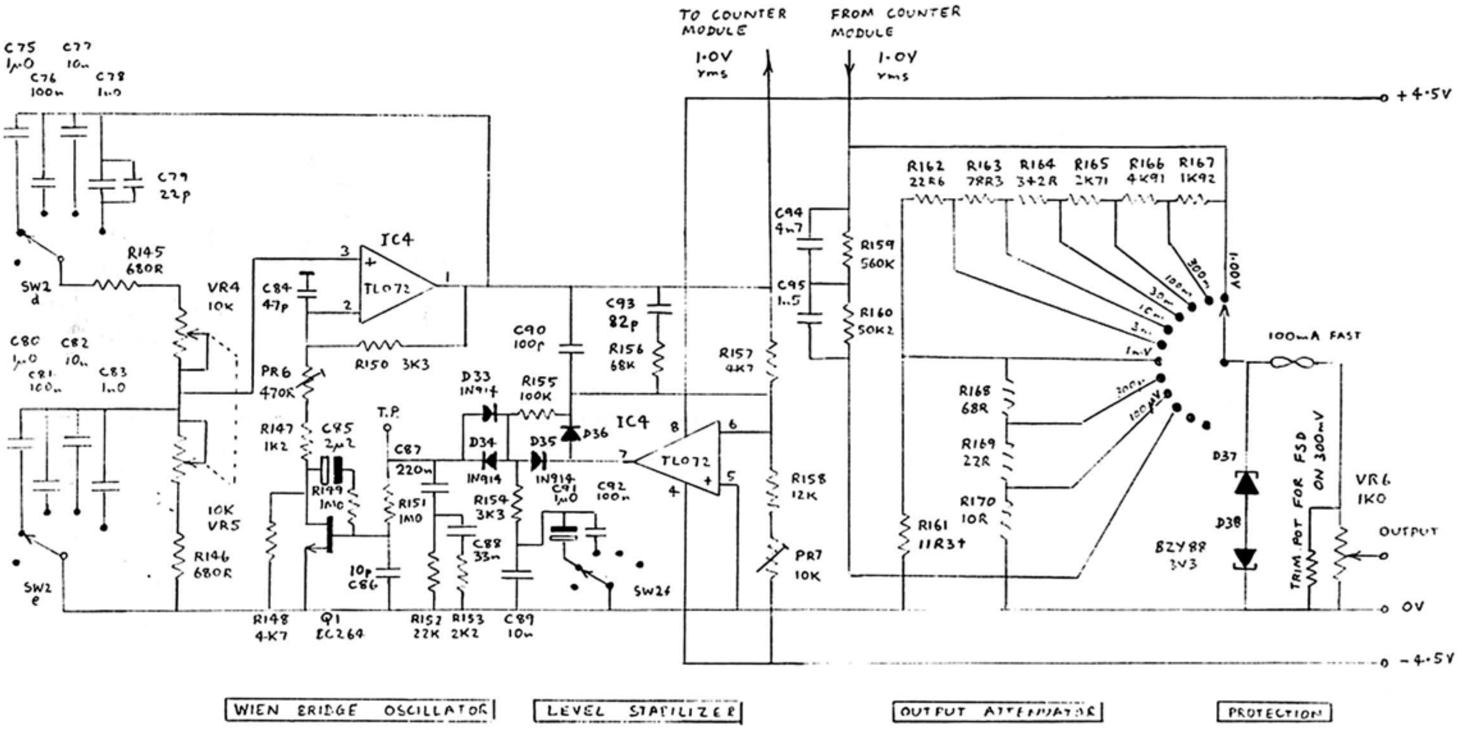
LA1 CCIR QUASI-PEAK AND PPM DETECTORS BLOCK 4



LA1 WOW AND FLUTTER BLOCK 5



LA1 DISTORTION NOTCH FILTER BLOCK 6



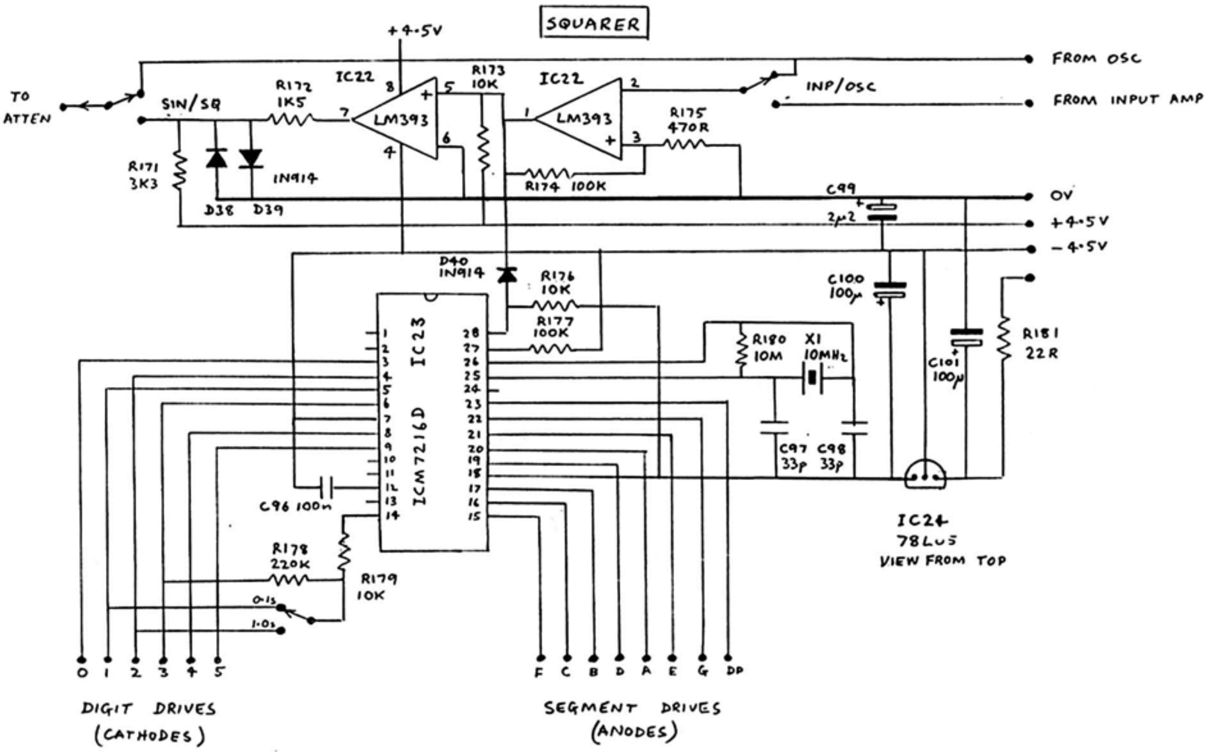
NOTES:

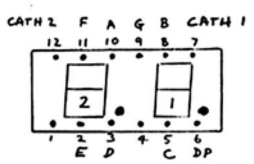
1. SET PR6 FOR −700mV AVERAGE OVER FREQUENCY RANGE.
2. C93 MAY BE TRIMMED FOR FLAT OUTPUT AT 15KHz ON ×1K.
3. C79 MAY BE INCREASED TO INCREASE TEST POINT VOLTAGE TO 700mV AT 20KHz ON ×10K RANGE.
4. SET 1·00V OUT AT 1KHz WITH PR7

MODS:

30-4-81 C93 WAS 68p NOW 100p FOR 0·1% [illegible] @ 15K
20-3-82 C93 WAS 100p NOW 82p

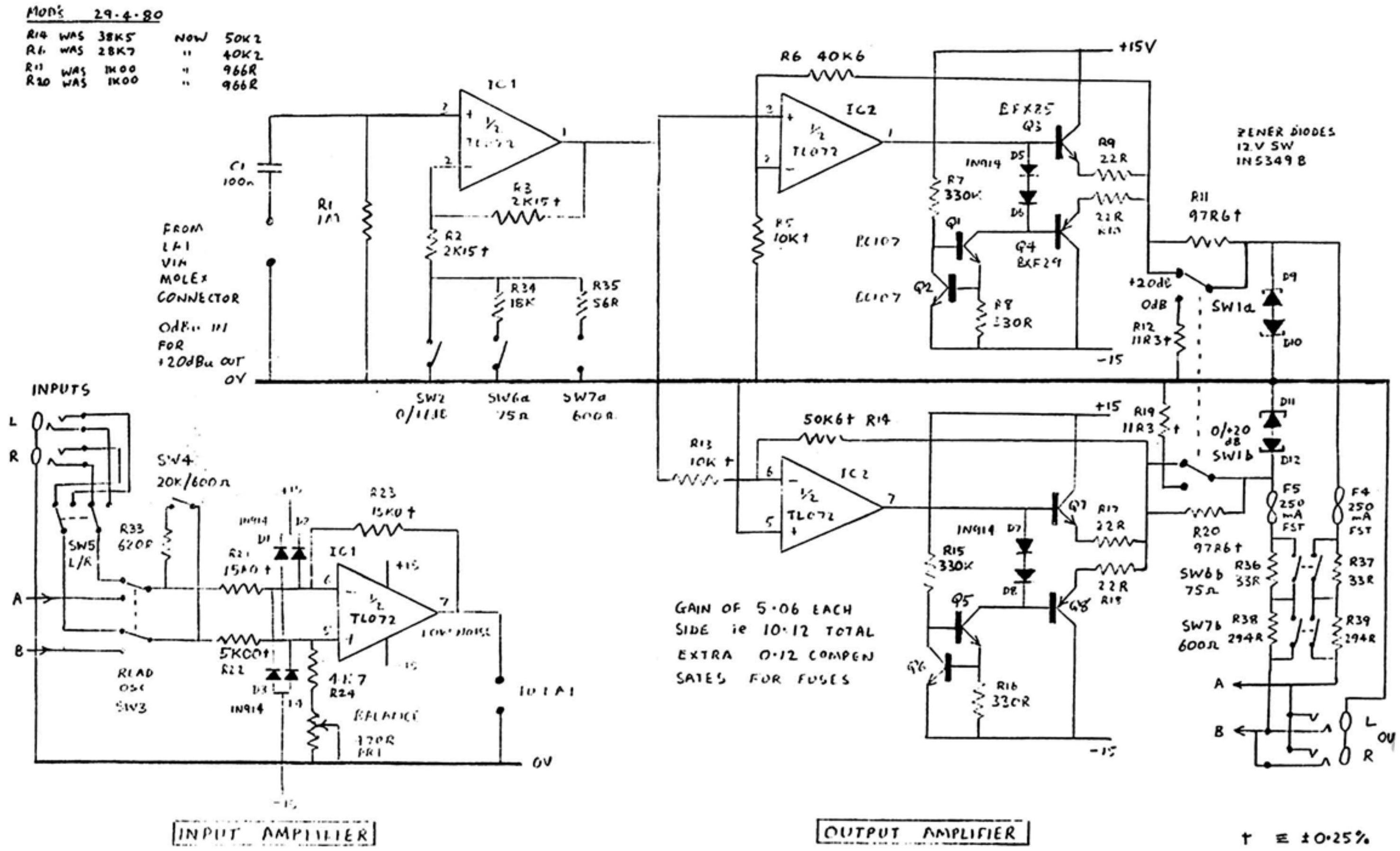
LA1 LOW DISTORTION OSCILLATOR BLOCK 7



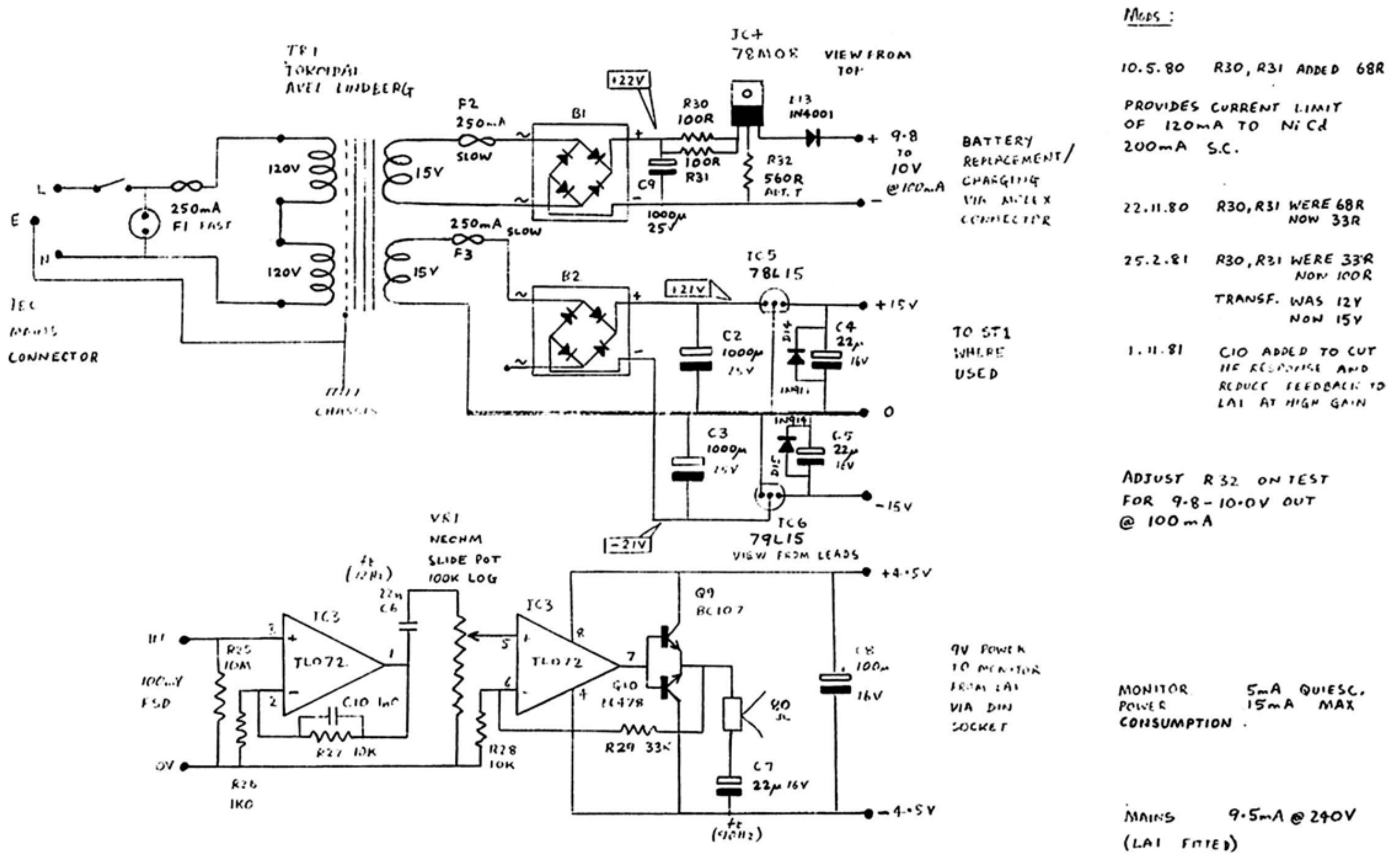


DL44M DISPLAY
IC25, 26

LA1 FREQUENCY COUNTER BLOCK 8 CONSTRUCTED ON SMALL PCB



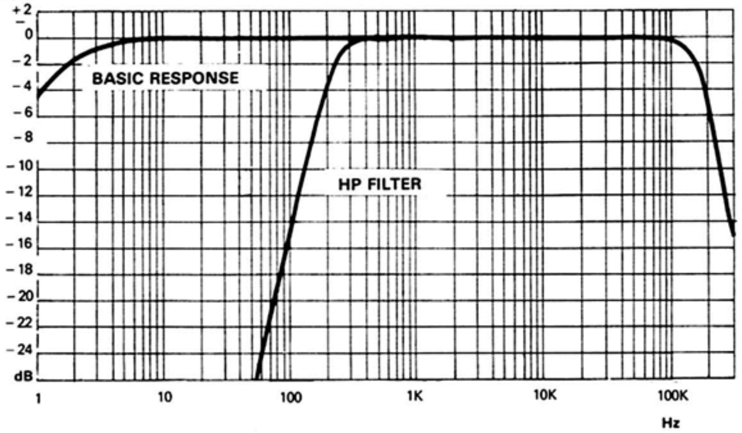
ST1 STUDIO INTERFACE BLOCK 9



MAINS POWER SUPPLY AND MONITOR SPEAKER BLOCK 10 (ST1 AND MA2)

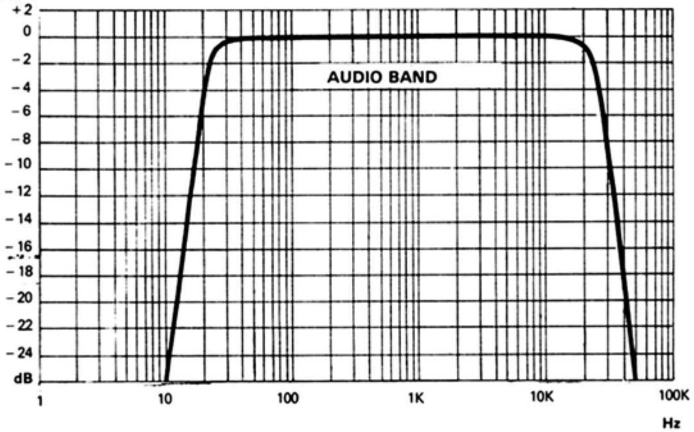
Frequency Response Curves

FIG 1



Hz	dB	Tol
1·5	-3	±1
20	0	±·1
1K	0	0
20K	0	±·1
100K	-·3	±·5

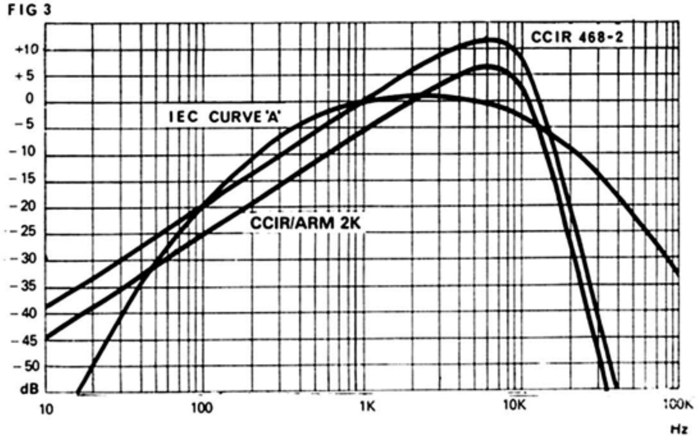
FIG 2



Hz	dB	Tol
15	-12·5	±1
22	-3	±0·5
31·5	-0·3	±0·2
40	0	±0·2
100	0	±0·2
1K	0	0
10K	0	±0·2
16K	0	±0·2
20K	-0·5	±0·5
24K	-3	±1
30K	-8	±1
50K	-27	±2

MEETS CCIR 468-2/3
DIN 45500

FIG 3



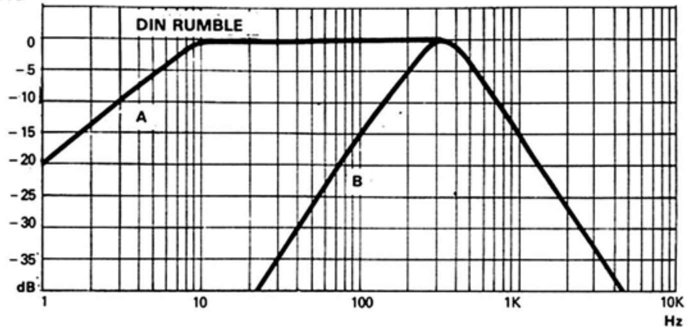
Hz	CCIR dB	/ARM dB	Tol
31·5	-29·9	-35·5	±2
63	-23·9	-29·5	±1·4
100	-19·8	-25·4	±1
200	-13·8	-19·4	±0·8
400	-7·8	-13·4	±0·5
800	-1·9	-7·5	±0·3
1K	0	-5·6	±0·2
2K	+5·6	0	±0·5
3K15	+9·0	+3·4	±0·5
4K	+10·5	+4·9	±0·5
5K	+11·7	+6·1	±0·5
6K3	+12·2	+6·6	0
7K1	+12·0	+6·4	±0·2
8K	+11·4	+5·8	±0·4
9K	+10·1	+4·5	±0·6
10K	+8·1	+2·5	±0·8
12K5	0	-5·6	±1·2
14K	-5·3	-10·9	±1·4
16K	-11·7	-17·3	±1·65
20K	-22·2	-27·8	±2
31K5	-42·7	-48·3	+2·8 -∞

MEETS CCIR 468-2/3

Hz	dB	Tol
20	-50·5	±2·0
40	-34·6	±1·0
80	-22·5	±1·0
100	-19·1	±0·5
200	-10·9	±0·5
400	-4·8	±0·5
800	-0·8	±0·5
1K0	0	0
1K6	+1·0	±0·5
2K5	+1·3	±0·5
4K0	+1·0	±0·5
8K0	-1·1	±0·5
10K	-2·5	±0·5
12K5	-4·3	±1·0
20K	-9·3	±1·0
50K	-22	±1·0

MEETS IEC 179 CURVE 'A'

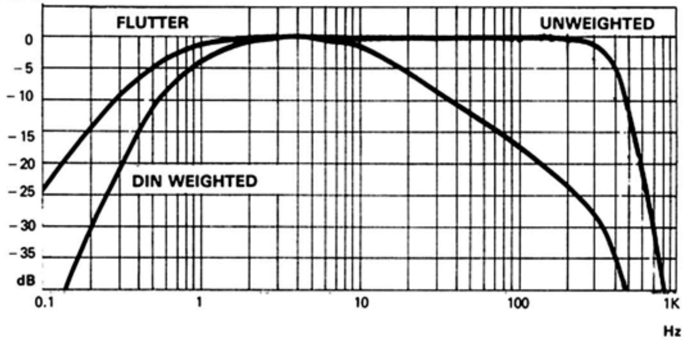
FIG 4



Hz	dB	Tol
B CURVE:-		
31·5	-35	±1
100	-15	±1
160	-7	±1
250	-1	±1
315	0	0
400	-1	±1
630	-7	±1
1K	-15	±1
3K15	-35	±1
A CURVE:-		
2	-15	±1·5
10	-0·5	±0·5
20	0	±0·5

MEETS IEC 98
DIN 45539
BS 4852

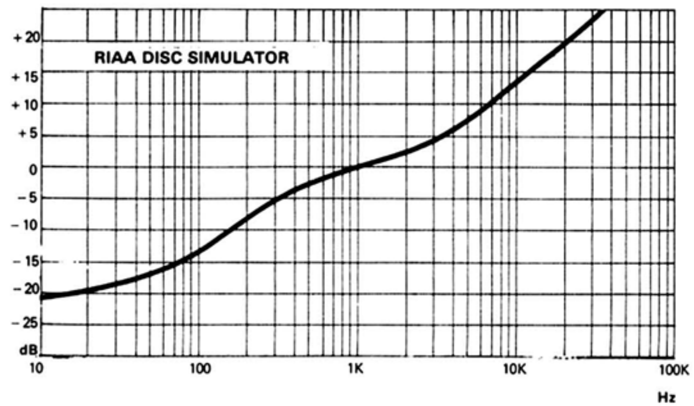
FIG 5



Hz	dB	Tol
0·2	-30·6	+10 -4
0·315	-19·7	±4
0·4	-15·0	±4
0·63	-8·4	±2
0·8	-6·0	±2
1	-4·2	±2
1·6	-1·8	±2
2	-0·9	±2
4	0	0
6·3	-0·9	±2
10	-2·1	±2
20	-5·9	±2
40	-10·4	±2
63	-14·2	±4
100	-17·3	±4
200	-23·0	±4

MEETS IEC 386
DIN 45507
BS 4847
CCIR 409-3
NAB/ANSI

FIG 6



Hz	BS1928 dB	Tol	IEC 98 dB
20	-19·3	±1	-16·3
30	-18·6	±1	-17·0
40	-17·8	±1	-16·8
50	-17·0	±0·5	-16·3
60	-16·1	±0·5	-15·5
70	-15·3	±0·5	-14·9
80	-14·5	±0·5	-14·2
100	-13·1	±0·5	-12·9
200	-8·3	±0·5	-8·2
500	-2·6	±0·5	-2·6
1K	0	0	0
2K	+2·6	±0·5	
3K	+4·7	±0·5	
4K	+6·6	±0·5	
5K	+8·2	±0·5	
6K	+9·6	±0·5	
8K	+11·0	±0·5	
10K	+13·7	±0·5	
12K	+15·3	±0·5	
14K	+16·6	±0·5	
16K	+17·7	±0·5	
18K	+18·7	±0·5	
20K	+19·6	±0·5	

RIAA / BS1928/1965 / IEC 98

LA1 Mk2 AUDIO ANALYSER

SPECIFICATION

SIGNAL GENERATOR

Frequency Coverage	15Hz—150kHz in 4 ranges.
Output Voltage	100µV—1V rms (−80 to +2dBu) in 10dB steps with fine control reducing to zero.
Accuracy	±2% on 1V setting at 1kHz (Calibration)
Attenuator Errors	±1% max into open circuit (±5% on 100µV range).
Flatness	±0.2dB max 15Hz—20kHz fast settling—no overshoot ±0.5dB max to 100kHz
Output Impedance	0 to 600 ohm depending on output setting.
Distortion	0.008% typical at 1kHz 0.01% max 0.03% typical at 50Hz and 10kHz 0.05% max.
Square Waves	Max output is 600mV pk ±10% on 1V range Rise/fall time 200nS typical (10—90%) Mark-space error 1% typical.
RIAA Output	Equalised for checking disc inputs to BS1928/1965 Nominal 15mV max at 1kHz.

FREQUENCY METER

Frequency Range	10Hz to 200kHz min.
Display	6 digit LED 0.15" high brightness. Can be switched off separately.
Counting Period	100mS 1s or 10s selectable.
Input (ext. mode)	Triggers above 25% on any range.

WOW & FLUTTER

Carrier Frequency	3.15kHz nom. (3.0 to 3.2kHz) without adjustment.
Ranges	0.01%—10% FSD
Frequency Response	Unweighted 0.6Hz to 350Hz (−3dB) Weighted—to IEC386/DIN45507/CCIR409-3/BS4847/NAB
Indication	Quasi-Pk to IEC386/DIN/CCIR/BS RMS (to NAB) also available.
Input Voltage Range	30mV—10V (100mV—1V optimum for AM rejection)
Accuracy	±2% FSD meets above standards.
Residual Reading	Unweighted 0.006% Weighted 0.002%
AM Rejection	30% square wave modulation at 4Hz gives less than 10% error on 0.1% reading—meets IEC386.
LF Rejection	20% at 180Hz gives less than 1% error on 0.1%—meets IEC386.
Drift Meter	±2% speed change directly indicated with centre zero.

MILLIVOLTMETER

Voltage Range	100µV—100V FSD (−80dBu to −40dBu)
Fine Input Control	Gives up to 12dB attentuation.
Linearity	±1% of FSD down to 10% FSD
Attenuator Errors	±0.5% max below 20kHz. Calibrated at 1.000V
Frequency Response	±0.1dB max 20Hz—20kHz −3dB at 1Hz and 150kHz typical.
Meter Response	Mean—calibrated in rms equivalent to sine waves. True rms (LA1-P only).
Intrinsic Noise	6µV typical wideband (−104dBu) 3µV typical 22Hz—22kHz (−108dBu)
Input Impedance	100k ohms ±0.25% AC coupled, overload protected.
Overload Margin	23dB headroom available when using weighting filters, 33dB on Rumble and High Pass filters.

NOISE MEASUREMENT

Unweighted	22Hz—22kHz 18dB/octave rolloffs, meets CCIR 468-2
Weighted CCIR/ARM	Meets Rec. 468-2 but with 0dB at 2kHz as recommended by Dolby Laboratories for Average Reading Meter.
Weighted CCIR/Q-Pk	Meets CCIR Rec. 468-2 fully, including quasi-peak meter characteristic for impulsive noise assessment.
Weighted IEC 'A'	Meets IEC 179 curve A for Sound Level Meters. LA1 also includes true rms measurements as specified.

RUMBLE MEASUREMENT

Unweighted	Meets IEC 98, DIN 45539.
Weighted	Operating the High Pass Filter switch adds the required rolloff below 315Hz. Meets above standards.

PROGRAMME MEASUREMENT

PPM	Complies with IEC268-10 type 2, BS4297-1968, and BBC ED1477 except for scale details.

DISTORTION MEASUREMENT

Fundamental notch filter type operating at three selectable frequencies and nulled by two ten-turn precision controls.

Spot Frequencies	100Hz, 1kHz, 10kHz nominal, with ±2% adjustment.
Distortion Range	0.01%—100% FSD at 1kHz and 100Hz 0.1%—100% FSD at 10kHz
Min. Resolvable	0.005% typical on distortionless signal. 0.01% with 100mV input.
Input Voltage	100mV—100V rms
Input Impedance	50k ohms approx. 10k ohms for inputs above 3V
Accuracy	±4% of reading ±1% of FSD at 1kHz. Second harmonic attenuation is 0.5dB
Bandwidth	22Hz—22kHz at 100Hz and 1kHz. 1Hz—200kHz at 10kHz.

ADDITIONAL FACILITIES

Oscilloscope Output	100mV rms FSD at rear socket (all modes).
DC Output	1.0V FSD at rear socket (meter drive).
External Weighting	Can be added at rear socket.
Power Out	±4.5V at rear socket.
Battery Check	Scale shows limits of operation.
HP Filter	12dB/octave below 215Hz (−3dB) (any mode).

GENERAL

Dimensions	318 x 114 x 165mm deep Weight—3kg inc. battery.
Battery	One PP9 (not supplied) consumption 70mA with display, 33mA display off.
Connectors	BNC 50 ohm input and output. 7-way DIN rear.
Operating Temperature	10°—40°C for full specification 0—50°C reduced specification.
Safety	Designed to meet IEC 348.

ST1 STUDIO INTERFACE/MAINS ADAPTOR

SPECIFICATION

OUTPUT AMPLIFIER

Input Impedance	1M ohm for negligible loading of LA1.
Gain	0dB or +20dB with independent +6dB.
Output Impedance	10, 75 or 600 ohms selectable, with automatic gain correction into 600 ohm load.
Minimum Load Impedance	600 ohms at +26dBm, 300 ohms at +20dBu, 50 ohms below 0dBu.
Output Noise	−86dBu (+20dB gain), −106dBu (0dB gain) 22Hz—22kHz rms.
Frequency Response	± 0.1dB 20Hz—20kHz.
Distortion	Below 0.01% THD up to 10kHz all levels.

INPUT AMPLIFIER

Input Impedance	20K ohms balanced, 600 ohm switchable.
Max Input	+20dBu
Noise Level	−100dBu 22Hz—22kHz rms.
Frequency Response	± 0.1dB DC—100kHz
Distortion	Below 0.01% THD up to 10kHz
Connectors	Four PO type Jack Sockets.
POWER SUPPLY	200—250V, 10mA or 100—125V by internal link change.
DIMENSIONS	300 x 107 x 50mm.

Lindos Electronics, Sandy Lane, Bromeswell, Woodbridge, Suffolk IP12 2PR England Tel: Eyke (03947) 432