105/CA 3587

Low Distortion Oscillator

9085

Technical Manual

Racal-Dana Instruments Ltd.

Duke Street, Windsor, Berkshire, SL4 1SB

Tel: Windsor (07535) 68101 Telex: 847013

Prepared by Group Technical Handbooks Department, Racal Group Services Limited

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The Electronics Group

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1.0 General Description

The LDO is a Low Distortion Oscillator covering the frequency range 9Hz to 330 kHz.

The MAIN output provides sinewave signals from 0.66 mV to 7 V RMS in amplitude.

The AUXiliary output provides rectangular pulses suitable for triggering both TTL and CMOS logic. It can also be used as a low current variable D.C. source.

A QUADRATURE output is available at the back panel of the instrument.

A Liquid Crystal Display shows the operating conditions. Frequency and Voltage are displayed simultaneously. Each can have up to four digits. Annunciators indicate the units. The Display is used extensively to guide the user through the instruments functions.

RS232 and IEEE488 interfaces allow remote programming of all the instruments facilities.

Ten non-volatile memory locations are available for storing the instrument's settings.

Self-calibration of the frequency ranges can be initiated from the front panel or remotely.

Although all the oscillator hardware is microprocessor controlled, the ergonomics of a traditional bench instrument have been preserved.

1.1. Technical Specification

FREQUENCY RANGES:-

1	9	-	101 Hz
2	95	-	332 Hz
3	300	-	1050 Hz
4	950	-	3320 Hz
5	3.0	-	10.5 kHz
6	9.5	-	33.2 kHz
7	30	-	105 kHz
8	95	-	332 kHz

FREQUENCY ACCURACY AND STABILITY:-

Load Condition : 600 ohms and less than 50pf

20 Hz - 100 kHz :-

+/- 0.5%, +/- 1 display digit

9 Hz - 332 kHz:-

+/- 3%, +/- 1 display digit

Frequency Resolution:-

Better than 1 part in 3000 of full scale in each frequency range.

Temperature coefficient:-

Better than 350 ppm per degree centigrade.

Thermal time constant:-

90 minutes.

MAIN OUTPUT

AMPLITUDE RANGES:- rms, output unloaded

1	0.665mV	-	2.21mV
2	2.10mV	-	7.00mV
3	6.65mV	-	22.1mV
4	21.0mV	-	70.0mV
5	66.5mV	-	221mV
6	210mV	-	700mV
7	0.665V	-	2.21V
8	2.10V	-	7.00V

DISTORTION AND NOISE:-

Freq-range	Value	Load Condition	
20 Hz - 20 kHz	less than 0.01%	600 OHMS	See note 1
9 Hz - 50 kHz	" " 0.03%	600 OHMS	See note 2
50 kHz - 100 kHz	" " 0.1%	600 OHMS	See note 3
100 kHz - 332 kHz	" " 1%	600 OHMS	" " 4

AMPLITUDE ACCURACY AND STABILITY:-

Load Condition : 600 ohms and less than 50pf

Accuracy betwen display and output:-

+/- least significant display increment,
+/- 0.25 dB at 1 kHz

Deviation with changing frequency, with reference to 1 kHz:-

20 Hz - 20 kHz	+/-	0.1 dB
9 Hz - 100 kHz	+/-	0.25 dB
9 Hz - 330 kHz	+/-	0.5 dB

Settling Time:- Less than 50 Hz-sec

Temperature coefficient:-

Better than 300 ppm per degree centigrade.

Output Impedance:-

600 ohms +/- 1% unbalanced

AUXILIARY OUTPUT:-

TTL:-

1:3 mark-space rectangular pulse.

Rising edge coincident with rising zero crossing of main output.

Falling edge coincident with positive peak of main output.

Output Voltage:-

4.25 volts, +/- 0.25 volts

Output Impedance:-

50 ohms, +/- 10%

Rise and Fall Times:-

Better than 100 nS

Maximum short circuit output current:-

300 mA approximately

VARIABLE:-

1:3 mark-space rectangular pulse

Rising edge coincident with rising zero crossing of main output.

Falling edge coincident with positive peak of main output.

Output Voltage Range:-

0.1 to 12 volts peak, unloaded.

Output Impedance:-

50 ohms, +/- 10%

Rise and Fall Times:-

Better than 100 nS

Accuracy betwen Display and Output:-

+/- 1 digit, +/- 0.5% of full scale.

Maximum short circuit current:-

300 mA approximately

Maximum current at 12 volts peak output

10 mA approximately

D.C:-

Output Voltage Range:-

0.1 to 12 volts peak unloaded.

Output Impedance:-

50 ohms, +/- 5%

Accuracy between Display and Output:-

+/- 1 digit, +/- 0.5% of full scale.

Maximum short circuit current:-

145 mA +/- 10%

Maximum current at 12 volts output:-

10 mA approximately.

QUADRATURE OUTPUT:-

Output Voltage Range:-

69 - 229 mV, +/- 6% following the fine setting of the Main Output

Output Impedance:-

600 ohms +/- 5%

OPERATING TEMPERATURE RANGE:-

0 - 35 degrees centigrade.

POWER REQUIREMENTS:-

100 - 130 V RMS, 50/60 Hz @ 35 VA

MAINS FUSE:

1 AT

PHYSICAL DIMENSIONS:-

WEIGHT:-

6.8 kgs

DIMENSIONS:-

95 mm. Height
360 mm. Width
295 mm. Depth

excluding the handle.

Note 1 - Bandwidth limited to 80 kHz
amplitude ranges 5 - 8

Note 2 - Bandwidth limited to 200 kHz
amplitude ranges 5 - 8

Note 3 - Bandwidth limited to 1 MHz
amplitude ranges 5 - 8

2.0 OPERATING INSTRUCTIONS

2.1 Introduction

This Section of the manual contains information for the correct operation of the LDO 9085. It is recommended that the contents of this Section are read and understood before attempting to operate the instrument. Should any difficulties arise during operation please contact your nearest Racal Dana representative or:

Racal Dana Instruments,
Duke Street,
Windsor,
Berks. SL4 1SB
Telephone: (07535) 69811
Telex: 847013

2.2 Packing

The LDO 9085 was shipped in a heavy duty cardboard container with shock absorbent, foam rubber spacers, especially designed to provide adequate protection. On receipt, please inspect the instrument for possible transit damage.

If reshipment of the instrument is ever necessary, it is advisable to use the original packing. If this is not available, a new pack can be obtained from Racal Dana Instruments Ltd.

2.3 Preparation for Use

Remove the LDO9085 from its packing and connect a suitable three pin mains plug to the cable, taking care to observe the connection colour code:

LIVE	-	Brown
NEUTRAL	-	Blue
EARTH	-	Green with Yellow stripe

The handle of the LDO can be used either as a carrying handle, or it can be folded under the instrument in order to tilt the front panel for convenience in use.

2.4 Supply requirements and mains fusing

The LDO is supplied for operation on nominal 240v mains. The mains transformer can be wired to permit operation from 120 volts or 240 volts. The wiring of the transformer is intended to be done only at the production stage and not by the user.

For 240 volt operation the two primary windings of the transformer should be wired in series, as shown below:-

```
        ---------- 240 VOLTS 50/60 Hz ----------
       !                                        !
       !               ---------                !
       !              !         !               !
       !              !         !               !
      ---            ---       ---             ---
     !   !          !   !     !   !           !   !
     !   !          !   !     !   !           !   !
 ------------------------------------------------------
!                                                      !
!      0            120         0             120      !
!                                                      !
!------- PRIMARY 1 -------    ------- PRIMARY 2 -------!
```

VIEW OF MAINS TRANSFORMER PRIMARY TERMINALS

For 240 volt operation, the mains fuse should be a 250 mA slow blow, no other type or rating should be fitted.

The mains fuse is positioned upon the back panel. Isolate the LDO from the mains before removing or replacing the mains fuse.

2.4.1 Switching On

After having connected a suitable mains plug to the Mains Input Lead, connect the instrument to the mains. To switch the instrument ON, press the red push button located on the front right hand side of the instrument. The LDO turns ON all the segments of the display for a period of 1 second as a display check, normal operation then proceeds with the frequency and amplitude set upon the lowest range, and the Auxiliary Output set to TTL.

2.5 The Controls

2.5.0 Introduction

The push button controls can be functionally divided into two groups:-

a) Those beneath and to the right of the display, that have a consistent single function.

b) Those to the left of the display, in a 3 by 4 array, that have multiple functions according to the selected PAGE.

A PAGEing system has been adopted in order to simplify access to extra functions without having a complex front panel. Two keys affect page selection, those below "PAGE", marked (O) and (N).

PAGE 0 is the basic Oscillator, and gives the functions shown over the keys marked 0-9,.,*.

Range keys give coarse setting of amplitude and frequency. Two rotary controls allow fine adjustment of frequency and amplitude, within each range.

The PAGE dependent buttons fall into three broad groups:-

1) Those that modify the display, but do not control outputs.

2) Those that control outputs.

3) Those that alter the function of the frequency rotary control.

Inside the first group:-

FREQ, PER, NOR FREQ, modify the upper four digits of the display.

VOLTS, dBm, dB REL, modify the lower four digits of the display.

REF is used with NOR FREQ, and dB REL.

In the second group:-

TTL, VAR and DC, control the AUXiliary output.

In the third group:-

COARSE and FINE affect the action of the frequency rotary control.

2.5.1 The Single Function Keys

2.5.1.1 PAGE 0

This key returns the Oscillator to PAGE 0 operation except where remote programming has locked out all front panel functions. Operating the PAGE 0 key provides a quick access to the standard Oscillator functions, from any other PAGE.

2.5.1.2 PAGE N

This is the key that accesses other pages of functions and allows the user to find the current active page. The first press of the button shows the current active page on the display in the form P = XX where XX is the page number. The page number can now be changed using the keys marked 0 to 4. The next press of this key will set operation in the PAGE number that was displayed after selection. Thus pressing the page key twice, without touching any others, displays the current active page without altering it.

2.5.1.3 LOCAL

When the Oscillator is being used Remotely from either the IEEE488 or RS232 ports, the REM annunciator is displayed. In this condition only the LOCAL button on the front panel is operative. Pressing the LOCAL button will cause the momentary display of the IEEE488 bus address, remove the REM annunciator and return the Oscillator to front panel control.

N.B. The LOCAL key will be disabled if the Oscillator has been issued with a LOCAL LOCKOUT command.

2.5.1.4 RANGE

These allow selection of the operating ranges for amplitude and frequency.

Operation of the amplitude range keys will increase or decrease the sinewave output level in 10dB steps.

Course frequency ranges are selected by the upper pair of keys. With the exception of the lowest, the frequency ranges are related to one another in a 3.16:1, ratio. Thus when operating in the top seven frequency ranges, the frequency is changed by a ratio of ten for two operations of the same range key.

2.5.2 Multifunction Keys in PAGE 0

2.5.2.1 FREQ

Causes the upper display digits to show the Oscillator frequency, in Hz or kHz as indicated by an annunciator to the right of the display.

2.5.2.2 PERIOD

Causes the upper display to show the Oscillator output period in ms or us as indicated by an annunciator to the right of the display.

2.5.2.3 FREQ NORM

Operation of this key sets the frequency reading to 1.000 and turns on the NHz annunciator. The frequency at the time of operating this key is taken as a reference. Changes in frequency are then shown as a ratio to the reference frequency.

The relationship is:-

$$\text{FREQ NORM} = \left[\frac{\text{Oscillator operating frequency}}{\text{reference frequency}}\right]$$

The display thus shows the normalised frequency. This function is useful in interpreting the data from standard filter tables.

2.5.2.4 VOLTS

Causes the lower four digits of the display to show the sinewave output as an absolute value in volts or millivolts r.m.s.

2.5.2.5 dBm

Causes the lower four digits of the display to show the sinewave output voltage in terms of that voltage required to produce 1mW into a reference impedance. The reference impedance is selected by a PAGE 3 function. PAGE 3 operation is covered in section 2.5.5.

The displayed output is given by:-

$$20 * \log \left[\frac{\text{output voltage}}{\left[10^{-3} \times \text{ref impedance} \right]^{-\frac{1}{2}}} \right] \text{ dB}$$

2.5.2.6 dB REL

Causes the display to show 0.0 dB and to show any changes in output voltage as a logarithmic ratio referenced to the display voltage at the time of operating the key.

The display will show:-

$$20 * \log \left[\frac{\text{output voltage}}{\text{reference voltage}} \right] \text{ dB}$$

2.5.2.7 TTL

Sets the auxiliary output to a fixed 4.25 volt peak. TTL compatible, rectangular pulse. The mark-space ratio is 1:3, with the rising edge coinciding with the rising zero crossing of the Main Output, and the falling edge coincident with the positive peak of the Main Output.

2.5.2.8 VAR

Allows the front panel rotary control to vary the Auxiliary Output from 0.1 volts to 12 volts peak. The level is displayed, using the last 3 digits of the lower display. The first digit displays the prompt "U".

2.5.2.9 DC

Allows the amplitude rotary control to set a DC level from the Auxiliary Output from 0.1 volts up to a maximum of 12 volts. The lower four digits are used to display the output level starting with the prompt "d" in the first digit position.

2.5.2.10 FINE

This key reduces the range of the rotary frequency control to approximately +/-5% of the frequency displayed at the time of operation. If the frequency is within 5% of either of the extremes of the range, then the frequency control will provide 10% of the adjustment from the appropriate extreme limit. The rotational law of the frequency control is approximately logarithmic, therefore the centre frequency does not coincide with the mechanical centre of rotation.

2.5.2.11 COARSE

Returns the frequency rotary control to normal operation, after having used FINE.

2.5.2.12 REF

This allows a momentary display of the reference levels and frequency when the FREQ NORM and dB REL functions have been selected. If either of these functions is inactive the key has no effect on the appropriate display.

2.5.3 PAGE 1 Operations

This PAGE is used for storing the Status of the Oscillator. The Status consists of the conditions set from PAGE 0 and PAGE 3. Ten Status settings can be stored. PAGE 0 must be used to set display and output modes. In PAGE 1 the Multifunction Keys 0-9 become storage locations. The frequency and amplitude rotary controls and range keys, operate as in PAGE 0. Pressing any of the Multifunction keys will store the Oscillators Status overwriting any previously recorded conditions. To allow the frequency to be easily set the PAGE 0 functions of frequency COARSE and FINE are available using keys "." and "*".

2.5.4 PAGE 2 Operations

Page 2 is used to recall the instrument Status, stored into the ten memory locations, as described in paragraph 2.5.3.

The frequency and amplitude, fine control and range buttons will be inoperative.

2.5.5 PAGE 3 Operations

Page 3 has two distinct functions:-

1) To tell the Oscillator what reference is to be used in calculating the dBm display mode selected in PAGE 0.

2) To describe to the Oscillator the loading conditions of the sinewave output.

The display voltage is calculated from the e.m.f. and specified loading conditions. The Oscillator does not directly measure the output voltage, but from a knowledge of its own source impedance, open circuit voltage or e.m.f. and the loading conditions, it can calculate the loaded output voltage.

In order to avoid unnecessary complexity it is assumed that only a limited number of loading conditions will be used, where a true display of output voltage is required. The reference impedances available are:-

50, 75, 93, 100, 150, 200, 600, 1200 ohms

There are four configurations of loading conditions that can be specified:-

1) Open Circuit

2) 10K ohms

3) Uncorrected: Operation into the Reference impedance alone.

4) Corrected: The 600 ohm output has parallel or series resistance added so that the combined impedance is equal to the reference impedance, the Output is then operated into the reference impedance.

The upper four digits of the Display show the reference impedance. The lower four digits are used to indicate the loading conditions.

2.5.6 Page 4 Operations

Selection of Page 4 causes the LDO to calibrate its frequency ranges. See Section 4.8.

The button functions and displays are as follows:-

Select Reference Impedance on Upper Display

Key	Function	Display
1	50	50
2	75	75
3	93	93
4	100	100
5	150	150
6	200	200
7	600	600
8	1200	1200

Select Loading Conditions on Lower Display

Key	Function	Display
9	cond. 1	----
.	" 2	10-4
0	" 3	uncr
*	" 4	corr

2.6 Theory of Operation

2.6.1 Introduction

The Oscillator consists of four main blocks:-

```
                  :         :
             ----------------------
             :         :          :
             :  RS232  :  IEEE488 :
             :         :          :
             :--------------------:
             :                    :
             :    BIDIRECTIONAL   :
             :      INTERFACE     :
             ----------------------
                       :
                       :       BIDIRECTIONAL
                   ====:     OPTO-ISOLATED DATA
                   :               LINK
                   :
             -------------
             :           :
             : CONTROLLER :
             :  COMPUTER  :
             :           :
             -------------
                   :   :
                   :   :
                   :  -------------
                   : :            :  MAIN OUTPUT
                   : : OSCILLATOR :  AUX  OUTPUT
                   : :            :  QUADRATURE OUTPUT
                   :  -------------
                   :
                   :
             --------------
             :            :
             :  KEYBOARD  :
             : AND DISPLAY :
             :            :
             --------------
```

The Controller/Computer accepts Commands and sends Data to the front panel keyboard and display or to external devices via the RS232/IEEE interface.

The RS232/IEEE488 interface employs its own microprocessor to give a high level of sophistication to the processing of Data to and from the Main Controller. Single point grounding is used to reduce earth loop currents.

The Controller/Computer is described as such because it has the following Control functions:-

1) Monitoring the front panel switches.
2) Measuring the front panel potentiometer positions.
3) Monitoring Commands from the interface.
4) Outputing Data to the display.
5) Outputing control Data to the Oscillator.

Plus the following computing functions:-

1) Formatting Data for the display
2) Calculating and using calibration constants from the SELF-CAL mode.
3) Calculating and using calibration constants for the front panel potentiometers.

2.6.2 Autocalibration

The unit exploits the ease with which microprocessor systems can make accurate measurements of time and frequency.

There are two areas where calibration is made against the microprocessors own system clock. Firstly, for the analogue to digital converters that read the front panel frequency and amplitude potentiometers and secondly, for each of the Oscillators frequency ranges.

Auto-calibration ensures consistent performance to specification, throughout the lifetime of the instrument, without the need of periodic recalibration and adjustment by a service engineer. While calibration is in progress the message SELF-CAL is shown on the display.

2.6.3 Principles of Operation of the Analogue Board

The Oscillator is based upon a feedback system commonly called the Two Integrator Loop (formed by A1, A2, A3). This forms a second order oscillatory system. The operating frequency is determined by the time constants of integrators based around A2 and A3. The coarse operating ranges are provided by switching the integration capacitors.

Fine frequency control uses 12 bit multiplying DACs at the input of each integrator. Amplitude is controlled by varying the feedback around A1 and A2.

This Oscillator configuration lends itself to providing the timing signals for a synchronous precision rectifier. The output of this rectifier is a D.C. proportional to the peak to peak signal at the output of A3. This is compared with a D.C. reference and the error signal fed back to the amplitude control, to form a closed loop control system. A window comparator at the input of the error amplifier A5, supplies a logic output to the microprocessor to indicate that the amplitude has settled to within a predetermined operating level.

The timing signals provide an internal, TTL compatible output, that is sent to the microprocessor board for measurement of the Oscillator frequency and period during calibration, as well as control pulses for operation of the auxiliary output.

Fine control of amplitude operates by varying the D.C. reference that sets the level to which the Oscillator stabilises. The coarse control operates through a series of cascaded switched attentuators. The first uses solid state switching and is placed before the final amplifier A4. The second and third attenuators use relay switching and are designed to operate from a 600 ohm source, and present an output impedance of 600 ohms.

The Auxiliary and Sinewave outputs can both be varied via the 8 bit DAC. When one is under control of this DAC the other is operated from a fixed reference. The fixed level from the auxiliary output is internally adjustable but is factory preset for TTL compatibility.

When the Auxiliary Output is under variable control, the Sinewave Output goes to a level that corresponds to the minimum of the current fine adjustment range. Coarse attenuation using the range keys is still available.

A quadrature output comes directly from the internal oscillator loop via a resistive attentuator that gives an output impedance of 600 ohms and a level approximately 30dB below the Sine Output on the highest amplitude range. The quadrature output will follow the fine level control, but will not be altered by the coarse range keys.

3.3 Detailed Circuit Description

3.3.1 The Analogue Board

This consists of the oscillator, level control and stabilisation, output attenuators, frequency control and initialisation circuit. The following description refers to drawing A410-088 sheets 1 and 2.

3.3.1.1 Initialisation

IC424A and IC424D together with C468 and part of RP403 set the inhibit input of IC430 'HIGH' when power is first applied to the board. This opens all transmission gates in IC434 ensuring no oscillator output. The input control gates, IC425B,C,D, for the auxiliary output are also disabled by the same signal. This inhibit function gives the microprocessor time to initialise output ports. When this task is completed the inhibit is removed by strobing HIGH the input to TR411.

The Oscillator frequency is determined by the time constants in the integrators formed around IC414 and IC423. The range capacitors are switched by the transmission gates IC413, IC422. Fine frequency control is achieved with the twelve bit multiplying digital to analog convertors IC412, IC419. The control range is increased on the lowest range by switching in transmission gates IC415C, IC415D, IC421C, IC321D. The amplitude stabilisation circuit controls the signal level at the output of IC423. The signal at this point is attenuated by R434, R418, and is passed directly to IC404 and via phase inverter IC402 to IC403. Integrated circuits 403, 404, 431, 432, 408A, 408C, 405A, 405B form a precision rectifier that operates on the peak to peak amplitude of the signal. IC403, IC431, IC408A, IC405A form one half of the rectifier sampling the negative peaks by virtue of the inverter IC402. The remaining integrated circuits, 404, 432, 408C, 405B operate similarly but on positive peaks. It is only necessary to describe one of the two sections. IC403 and IC431 form a "follow and hold" function. C420 is the storage capacitor. IC409E has an open collector transistor that behaves as a switch across this capacitor. During the first positive quarter cycle in any complete cycle IC409E is high impedance and C240 follows the incoming signal to IC403. At the peak of the signal D411 will cease to conduct leaving C420 charged to the peak voltage. During the second quarter of the cycle, the sample and hold formed by IC408A, C402 and buffer IC405A samples the stored voltage upon C420 via buffer IC431. In the third quarter of the cycle the storage capacitor C420 is discharged by the transistor at the open collector output of IC409E. The timing signals for this process come from integrated circuits 427, 420, 426A, 426B and monostable 1 and 2 in IC417. Comparators IC427, IC420 use the quadrature relationship between the outputs of the two integrators, together with the D type bistables of IC426 to provide a positive going rectangular pulse during the first quarter cycle of both positive and negative excursions of the output.

This rectangular pulse is used to discharge the follow and hold capacitor of one of the peak rectifiers while initiating a sample pulse from the monostable on its trailing edge, to the other peak rectifier.

IC409A and IC409F are level converters between the TTL outputs of IC417 and the logic levels required by IC408 of 0V and 15V.

The DC outputs of each half of the rectifier system are summed together at the junction of R416 and R415, and pass to the non-inverting input of IC401B. IC401B compares the output of the precision rectifier with a D.C. reference from the output of IC438C. It also behaves as a low pass filter that provides the dominant stabilisation pole in the amplitude control loop. To ensure maximum speed of stabilisation in each frequency operating range, the time constant of this pole is switched by IC406 which is controlled in parallel with range switches IC413, IC422.

The output of IC401 controls the gain of the transconductance amplifiers IC407A and B. IC401A is a phase inverter and IC400 a transistor array that level shifts the control voltages that swing either side of 0V to control currents referred to the -15 volt rail required by IC407. IC400 generates control signals for IC407 A and B in such a way that the two transconductance amplifiers are not operative at the same time. When IC407B is operating, negative feedback is produced, that reduces the amplitude of oscillation. When IC407A operates, positive feedback is produced and increases the amplitude of oscillation. Ideally, when the oscillator amplitude is stable, IC407A and B would be non conducting, but positive and negative feedback is required throughout the oscillators operating range to compensate for circuit layout and component losses.

The reference voltage from the output of IC438C is derived from the band-gap voltage reference D412 and the eight bit digital to analog coverter IC433. The output of DAC, IC433 is buffered and amplified by IC438A and by taking a proportion of this voltage and the reference voltage directly and summing them at the input of IC438D, a control voltage is derived for the required upper and lower limits of the fine amplitude control range. These upper and lower limits can be adjusted and are preset at the time of manufacture. The lower limit is set by SOT (select-on-test) resistors R513, R544. The upper limit is set by SOT resistors R511, R512. If the adjustments are made on the lower limit first, with the ZN429 output set to zero they are not interactive. When the auxiliary output is required to be variable, the output of DAC, IC433, is removed from control of the oscillator amplitude by the opening of switch IC439A and B. The control voltage is determined by the lower limit setting alone.

The auxiliary output is made up of variable DC source, IC437A, switch TR402 and emitter follower buffer, TR405. When transmission gate switch, IC436, is open, pulses from IC426 turn TR402 ON and OFF at the oscillator frequency. The amplitude of the rectangular pulse produced at the collector of TR402 is controlled by varying the output level from IC437A. The input to IC437A is derived from one of two sources. For TTL level Auxilliary output, IC436D is open and IC436C is closed. The input to IC437A is set by potential divider R496, R493 across the reference D412. When variable auxillary output is required IC436D closes, IC436C opens and the DAC controlled output of IC438A feeds the input to IC437A. Select on test resistors R483, R480 set the full scale output voltage in variable output mode. Output drive capability is ensured by using emitter follower TR402 to pull down via D410. This system ensures adequate drive into capacitive loads. The effect of diode drops in the VBE junction of TR405 and D410 are bypassed by R482. This leads to some rounding of the top and bottom of leading and trailing edges, but gives compatibility between drive requirement of TTL and 5v cmos. IC416 connects C481 across the output of IC437 to maintain a low impedance at high frequencies at this point. When a D.C. auxilliary output is selected, C481 is disconnected. Transmission gates IC416 A and C move the feedback point from before, to after the emitter follower output stage. This removes the effects of varying VBE drop with load. The output impedance is determined by R484.

The output buffer amplifier IC435 is preceded by a CMOS switch system that has three positions, 0dB - 10dB, and OFF. A 0, 10dB attenuator is provided by CMOS switches in IC429, IC434 selecting a signal path through either R472 or R473 to the input of IC435. The path through R473 provides 10 dB less output than that through R472. The unused path is grounded. Transmission gates are paired to reduce the effects of their ON resistance.

Following IC435 there are two cascaded attenuators giving 20 dB and 40dB attenuation. These are designed to be operated from a 600 ohm source and have an output impedance of 600 ohms. The output of IC435 is padded to 600 ohms with R500. The impedance at the main output is 600 ohm irrespective of attenuation. The attenuator networks are switched in and out using relays RLY400 and RLY401. These latching relays have their operating coils driven by TR407 thru TR410.

IC430 decodes the control from the microprocessor board and level shifts to + and - 7.5 volts. Input buffers IC428E and IC428F have open collector outputs and perform a level shift from TTL to 0,+7.5v required by IC430. When the board is first powered, the INH input of IC430 is held high. This causes all of the switches in IC434 to be OFF, ensuring that no signal can pass to the input of IC435.

IC437C and IC437D form a window comparator that compres the output of the precision rectifier and the amplitude reference voltage. Provided the two are within a range determined by potential dividers R522, R527, R528, R523 the outputs of IC437D and IC437C will be low.

The window is set at approximately plus and minus 45mV. Normally the window comparator will not provide a positive output. This will only occur briefly while the amplitude is settling as a result of range switching or amplitude changes. Outputs from the window comparator and initialisation circuit are summed together at the base of TR406. If the initialisation circuit has failed to reset or the amplitude failed to stabilise to the correct value, the condition will be flagged back to the processor with a low voltage at the collector of TR510.

3.3.2.1 The Microprocessor and Peripheral Interface

Drawing A410-087, sheet 1 shows the microprocessor system. This comprises of a 6502 microprocessor running at 1 MHz, with 16k of programme in two 8K EPROMS, IC106 and IC105. IC104 provides operating RAM and is normally fitted with battery backed memory. The software is capable of detecting whether volatile or non-volatile memory is present. When volatile memory is fitted, the microprocessor clears all memory storage locations, and performs a calibration. With non-volatile memory, the microprocessor performs basic initialisation, displays all segments of the LCD and passes almost immediately to PAGE 0 operation. Interfacing is achieved with the 6821 and 6522, IC101 and IC102, as described in section 3.3.2.2.

All the devices on the microprocessor bus are memory mapped, decoding is performed by IC108.

3.3.2.2 The Digital Interface

Interfacing to the microprocessor bus is performed by a 6522 and 6821. (see drawing A410-087 sheet 2). Port A of the 6821 provides a 4 bit bus from which a number of CD4042 latches receive data.

IC117 directs the data latch strobe pulse from CA2 to the required latch in accordance with the address set upon PA4, PA5, PA6, of IC102.

The 6522, IC101 has internal counter timer facilities that are used for auto calibration and performing front panel potentiometer position measurement. PB6 is set by firmwave to count incoming pulses.

Transmission gates IC118A and IC118B, select as input either the 1MHz system clock or a TTL output from the analogue oscillator board, synchronous with the frequency of oscillation.

IC119 divides the frequency of signals to be measured by four. It also gates these signals ON and OFF in accordance with the status of reset inputs R. With this system, there are the facilities to count a numbers of cycles from the oscillator for the gate period set by the status of R input to IC119 or to measure the period of a signal by using IC119 to pass 1MHz system clock pulses, when IC118B is ON.

Both modes of operation are used in order to calibrate the oscillator over the entire operating frequency range. The latter facility of counting system clock pulses (divided by four) is used in the position measurement of the potentiometers. IC125 is a dual 555 timer with one half devoted to each potentiometer.

The potentiometer is used to vary the current available to charge capacitors C127 or C128. The microprocessor can trigger the timer, allowing the capacitor to charge at a rate determined by the potentiometer position.

During the charging period, IC119 will be enabled via IC121A, IC121B and either IC123C or IC124C depending upon the potentiometer under measurement. When the timing capacitor reaches the voltage at the VC input, IC119 will be disabled and the counter in IC101 will have accumulated a value dependent upon the chargng time of the capacitor C127 or C128 and hence upon the position of the potentiometer.

To allow for component tolerances the potentiometer measurement circuits are calibrated when the oscillator is initially powered. This is performed with the transmission gate system IC123 IC124 sections A,B and D of each. After calibration switches B are closed and the others open, this connects the wiper track through to the IC125 measurement system.

At calibration, transmission gates A and D are used to make measurements at each end of the potentiometer. This approximates to a measurement with the potentiometer set at its maximum and minimum position.

A serial data link with handshake is provided by PBO, PB2, CB1 and CB2. Data passes in and out under the control ofd externally generated clock pulses. IC120A synchronises the edges of the external clock with phase 2 of the system clock.

3.3.3 <u>The Power Supply and Reset Circuit, Drawing A410-087 sheet 3.</u>

Monolithic regulators provide +15, -15 and 5V.

System reset is provided by IC129, TR100 AND TR101. IC129 provides, in effect, a dual comparator with a defined wide hysteris. C126 and R140 provide the reset time constant. When C126 is discharged, the output from pin 5 of IC129 is high, TR101 conducts and the RESET line is held low, its active state. When C126 is allowed to charge through R140, the potential across it reaches that required to operated the upper comparator with input at pin 2. TR101 is turned off, the RESET line goes high and the microprocessor begins to run. C126 is held low by a second comparator system that looks at the incoming voltage to the 5v regulator IC127. If this voltage drops below 7 volts C126 is discharged by TR100 and the RESET line is pulled low.

This system ensures that the microprocesor is never allowed to run at a reduced supply voltage, that could corrupt memory.

The IEEE interface is powered separately from the main oscillator from an additional secondary winding on the mains transformer. This enables a single point earthing system.

3.3.4 Front Panel Circuit Functions

The front panel schematic is shown in drawing A410-091. It can be divided into three main functional areas:-

1) The Keyboard
2) The Display
3) Potentiometer and IEEE interface status LEDs.

3.3.4.1 The Keyboard

The keyboard status is interrogated from firmwave via the 6522 and 6821 ports, IC101 and IC102. The technique used is a simple matrix encoded system. Switches S300 - S315 and S316 - S318 are dealt with as two separate groups.

Taking the group S300 - S315. In the quiescent state PB0-3 are set to low level outputs, PB4-7 are set to inputs. Thus all inputs to IC300A are pulled high by R300 - R303, and the output from IC300A to input CB1 of the 6821 will be at 0V.

Pressing any of the switches in the group S300 - S315 will connect one of the inputs to IC300A to a low level on PB0-3. The output of IC300A will go high. The input transition to CA1 causes an internal flag within IC102 to be set. This is polled by the microprocessor. When the flag indicates a key is operated, the microprocessor reads PB4-7 of IC102 to find in which column of the matrix contain the operated key. It then writes zeros to PB4-7 and reads them in from PB0-3 to find which row contains the operated key.

Keys S316 - S318 are read by a simplified system of that mentioned above. PB3 - PB5 of IC101 are configured as inputs. Pressing any switches S316 - S318 will cause the output of IC300B to go high, signalling to the processor, in a similar way to that described for CA1, that a key is being operated. The microprocessor then reads PB3 - PB5 to find which key has been operated.

3.3.4.2 The Display

The Liquid crystal display is driven from a dedicated controller IC301. This receives data from the microprocessor via a serial interface.

Data is shifted in on S1, eight bits at a time under control of an externally generated clock input on SCK. The C/D line indicates whether the information is to be interpreted as commands or data.

The BUSY line controls the acceptance of data. R318 and C303 are used to pull the reset input low at power up.

3.3.4.3 Potentiometer and IEEE Interface LEDS

These portions of the PCB are isolated to avoid current loops.

3.3.5 RS232-IEEE488 Interface Ports

Communication between the two boards takes place via an optically coupled serial data link, that enables a single point earthing system to be used.

The interface is microprocessor based, using a 6502 microprocesor with a 2764 Eprom carrying the program and 2K x 8 of operating RAM. The IEEE 488 bus protocol and electrical interface requirements are handled by IC203, IC204 and IC205.

IC209 is a serial interface adaptor handling the RS232 port via level shifting buffers IC212 and IC213, IC210 handles serial communication with the oscillator main board. This IC generates the clock used for the data transfer.

Port A, inputs 1-7 read the status of the back panel switch bank that sets the IEEE interface adress and the start bit, stop bit and the parity of the serial interface. Port B bits 2, 3, 4 directly operated the front panel LEDS indicating the IEEE bus status. Bit 7 output, supplies the clock required by the RS232 interface IC209.

The main interface devices are all memory mapped. The address decoding is provided by IC208.

The power supply provides a stabilised 5v and nominal plus and minus 12V supplies for the RS232 interface, IC212, IC213.

The reset is similar to that on the oscillator controller board. It uses a dual comparator system, IC201, to monitor the incoming unregulated supply voltage and provide a delayed reset only when this voltage is above a defined minimum.

3.3.5.1 RS232 - IEEE488 Communications Requirements

Communications with the oscillator, via either of these ports, takes place by sending and receiving strings of ASCII characters. The format of this data is the same for both ports. Alphabetic characters can be upper or lower case.

Information passes back and forth as a series of messages. There may be one or more messages together in a block of information called a Record. The end of a Record sent to the oscillator is indicated by a CR (Carriage Return) and LF (Line Feed). Records from the oscillator have messages separated by CR and LF and will be terminated by CR LF and in the case of the IEEE488 port, EOI.

3.3.5.2 Message Format

Messages consist of the following sections:-

1. Command Word
2. Data Field
3. Units Field

They are sent or received in this order, without any spaces between them. For example, take the message:-

F100HZ

Here we have:-

F - Command word
100 - Data field
HZ - Units field

The only exceptions to this format are for baud rate and Error messages where there is no Units field applicable.

Messages from the oscillator consist of a null string (ASCII code '0') if the oscillator has no data to send.

If the LDO is sent more than one message in a Record, for example:-

A;F;I(CR LF)

Then the reply will have more than one message. For example, the reply to the above Record may be:-

A1.00V(CR LF)F1.00KHZ(CR LF)I.775VREF(CR LF)(EOI)

How this reply is handled by the controller will depend upon the programming language in use. When using BASIC, an ENTER or INPUT command is used to gather data from the IEEE488 bus. With a CONTROLLER that does not use EOI for indication of the end of a STRING, the gathering of incoming data will terminate at the receipt of the first CR LF. This results in the rest of the data being left in the oscillators' output buffer. If unused messages remain in the buffer then confusion can arise when LDO replies do not correspond with the requests. When this buffer is empty, the LDO has no information to send and it will output a null string. This can be used as a means to verify the end of a message or group of messages.

3.3.5.3 The Command Word

Table 1.0 shows the acceptable Command Words. They each consist of a single alphabetical character in upper or lower case. If a Command Word is followed directly by a Message Separator or Record Terminator, then it is interpreted by the oscillator as a request for data.

If a Command Word is followed directly by a valid Data Field and valid Units Field, then it is interpreted by the oscillator as a Command to alter its operation in accordance with the data.

3.3.5.4 The Data Field

The data field will be received in ASCII format, decimal, numbers, in one of two formats.

1. Fixed point e.g. 23.75, 2. Floating point e.g. 2.375E+1.

'E' represents the exponent and can be in upper or lower case ASCII. The sign can be '+' or '-' e.g.

2.375E-1 represents 0.2375 in Fixed Point.

The data can be expressed to a maximum of seven significant digits. If the Data Field is over 7 digits, the overspill is ignored with no error routines raised i.e.:-

23.756249 is taken as 23.75624
2.3756249E+1 is taken as 2.375624E+1

3.3.5.5 Transmissions from the Oscillator IEEE-488 or RS232C Port

The data field will be transmitted in ASCII format, decimal, fixed point numbers.

3.3.5.6 The Units Field

Table 1 shows the units associated with each Command. When a Command is followed by Data and where units are indicated by Table 1, they must be added. If they are omitted the message is ignored and an Error Message returned.

3.3.5.7 The Message Separator

If more than one Message is to be included in a Record, they must be separated by a comma or semicolon. If a Message is not terminated with a Message Separator or a Record Terminator then the whole Message up to the next valid Message Separator will be ignored, and an Error Message returned.

3.3.5.8 Interface Messages

The interface messages consist of Commands that set operating conditions, and request operating conditions. Where Commands or Data are invalid, an error code will be returned. These are defined in TABLE 3.

The Commands are:-

F+data+units	- sets the operating frequency in accordance with with the Data and Units specified.
F	- requests the operating frequency. The reply is of the form F+data+units.
A+data+units	- sets the amplitude of the Main Ouput in accordance with the data and units specified.
A	- requests the amplitude of the Main Output. The reply is of the form A+data+units.
I+data+VREF	- sets the reference voltage used in dBm calculations, in accordance with the data field. Note that the units field is always the characters "VREF".
I	- requests the reference voltage. The reply is in the form I+data+VREF.
P+data+units	- sets the operating period in accordance with the data and units field.
P	- requests the operating period. The reply is in the form P+data+units.
D+data+units	- sets the Auxiliary Output to DC to the voltage defined by the Data and Units.
D	- requests the status of the Auxiliary Output. The reply is in the form:- T+4.24+V - if the AUX Ouput is in TTL V+data+units - if the AUX Output is in VAR D+data+units - If the AUX Output is in DC
V+data+units	- sets the Auxiliary Output to VAR, at the voltage defined by the Data and Units.
V	- requests the status of the Auxiliary Output, with replies the same as described for D.
T	- sets the Auxiliary Output to TTL operation, there is no reply condition.
M+data	- stores the status of the Oscillator into the memory location indicated by the data field.

R+data	- sets the status of the Oscillator to that stored in the memory location indicated by the data field.
U	- sets the oscillator to front panel control.
L	- sets the oscillator to remote operation - this condition is indicated by display of the "REM" annunciator
O	- defines the Main Output loading conditions to be an open circuit.
K	- defines the Main Output loading conditions to be 10 kilohms.
N	- defines the Main Output loading conditions to be such that the source impedance is CORRected to equal the reference impedance, and loaded with the reference impedance. (see section 4.7)
E	- defines the Main Output loading conditions to be equal to the reference impedance with UNCoRrected source impedance. (see section 4.7)
C	- sets the Oscillator to the PAGE 4 function of self calibration. When this is completed, operation will return to PAGE 0.
B+data	- sets the RS232 interface BAUD rate to that indicated in the data field. See TABLE 1 and Note 2 for the permitted values.

3.3.5.9 IEEE488 Address Selection

A rear panel switch bank is used to set the IEEE488 port address. The five switches have two positions 0 and 1, with binary weights from 1 to 16 giving address values from 0 to 31. The setting of this switch can be interrogated from the front panel by operating the LOCAL key.

3.3.5.10 GPIB Subsets Implemented

The LDO IEEE488 interface implements a subset of the IEEE488 specifications.

These are: SH1, AH1, T2, L2, SR1, RL1, DC1, DT0

See the specification IEEE488 1978 Appendix C for an explanation of these abbreviations.

3.3.5.11 Secondary Address Implementation

The LDO does not make any use of seconday addresses and will ignore all portions of an address other than the primary.

3.3.5.12 RS232C Port Configuration

The default baud rate is 1200. This rate can be set to another value from the RS232C port or from the IEEE488 port. The back panel switch, shared with IEEE488 address selection, can be used to set the number of data, parity and stop bits. The settings are shown in Table 2. Characters are echoed back. A CR is echoed back as CR/LF.

3.3.5.13 TABLE 1

RS232-IEEE488 Commands and Data Format

COMMAND	FUNCTION	ALLOWANCE MAX	RANGE MIN	ALLOWABLE UNITS
F	Frequency	332000Hz	9Hz	kHz, Hz
A	Sine Amplitude	7V	.665mV	mV, V
I	Impedance	see note one		VREF
P	Period	3.03uS	111mS	uS,mS
D	Aux-DC	12V	0V	mV, V
V	Aux-Variable	12V	0V	mV, V
T	Aux-TTL	-	-	-
M	Mem Store	10	1	-
R	Mem Recall	10	1	-
U	Manual	-	-	-
L	Remote	-	-	-
O	Open Circuit	-	-	-
K	10 K load	-	-	-
N	Corrected l.	-	-	-
E	Uncor. load	-	-	-
B	Baud Rate	9600	110	see note 2
C	Auto-cal	-	-	-

Note 1: The reference impedance can be in the range 50 - 1200 ohms.

The data sent to the oscillator must be in the form of the reference voltage. This is given by the expression :-

$$\left[\frac{R}{1000}\right]^{\frac{1}{2}}$$

where R = reference impedance in ohms.

If the impedance is requested from the oscillator it will be transmitted in this format.

Note 2: Available baud rates are 110, 600, 1200, 9600.

3.3.5.14

TABLE 2

RS232 DATA FORMAT

SWITCH 6	7	8	Data Format Parity	bits	stop bits
0	0	0	none	8	2
1	0	0	none	8	1
0	1	0	even	8	1
1	1	0	odd	8	1
0	0	1	even	7	2
1	0	1	odd	7	2
0	1	1	even	7	1
1	1	1	odd	7	1

3.3.5.15

TABLE 3

ERROR CODES

	CODE	MEANING
Command error	E10	Unrecognised Command
	E11	Missing Parameter
	E12	Illegal or Missing Multiplier
	E13	Unrecognised Units
	E14	Syntax error in mantissa
	E15	Syntax error in exponent
	E16	-ve mantissa illegal
	E17	Value out of range
	E18	Invalid Baud Rate
Input - Output errors	E30	Device in local mode
	E31	Buffer in local mode
	E32	RS232C parity error
	E33	RS232C framing error
	E34	RS232C overrun error

4.0 OPERATING INSTRUCTIONS

4.1 Introduction

This section of the manual "talks you through" the operation of the LDO, covering all the functions of the keys. Ideally you should have the instrument operating in front of you, so that each step can be followed and the results observed.

4.2 Connections to the LDO

After reading section 2.3 of this manual, connect the LDO to a suitable mains outlet and switch the instrument ON by operating the red push button on the extreme right hand side of the front panel.

Connect the two inputs of a dual trace oscilloscope to the MAIN and AUXILIARY outputs. (see section 4.9 for particular reference to using these Outputs.)

4.3 Operating in PAGE 0

Initially the LDO will turn ON the whole of the display, for a period of one second. You can check the display against that shown in figure 1. of this Handbook.

4.3.1 The range keys and rotary controls

Set the oscilloscope amplitude sensitivities to 1V per division, and the timebase speed to 100 mS per division. You'll see that the AUXILIARY output is a rectangular waveform between 4 and 5 divisions high. Note that its baseline is at zero volts, this is so that you can use it for directly triggering digital circuits. The operating frequency is at the oscillators lowest range, between 9 Hz and 110 Hz. The upper four display digits tell you precisely the frequency. Press the upper Frequency Range key, the operating frequency moves into the next operating range. Operate the upper range key twice more and the range is 0.95 kHz to 3.32 kHz. Set the oscilloscope speed to view a few cycles. You're probably wondering where the MAIN output is - it's there, but outside the viewing resolution of the oscilloscope. The precise level is indicated on the lower four display digits and will be between 0.6 and 2.2 mV, In the same way as for frequency range, use the upper amplitude range key to bring the MAIN output level to between 1 and 2 divisions height on the oscilloscope display.

Turn the rotary controls, and see that you have fine control over the amplitude and frequency just as you'd expect in a conventional, all analog, instrument. Turn them rapidly and there is a tendency for the parameter being controlled to move in steps, a reminder that between you and the analog circuits there is a microprocessor.

4.3.2 Coarse and Fine keys

Try setting the frequency display to exactly 1 kHz. You may find that it's difficult, to make it easy, operate the fine key to the left of the display when you are within 30 or 40 Hz of 1 1kHz. Now turning the frequency control allows you precise setting. Turn the control from end to end and you can see that the control span has been limited to about 100 Hz. To return to the full control range press the COARSE key. When passing control betweeen these two keys the display and output will change frequency depending upon the effect of the rotary control in each mode. You may also notice that the numerical centre of an operating range does not occur in the mechanical centre of rotation. This is because the potentiometer has a logarithmic control law.

4.3.3 FREQ, PERIOD, FREQ NORM and REF keys

So far we have dealt with keys that directly or indirectly affect the output. The keys described in this section and the following two, change the way in which the display shows what the outputs are doing, and nothing else.

Set the frequency to 2.000 kHz. Operate the PERIOD key and the display will show 500 microseconds, the reciprocal of the fr quency. Note that you can still use the FREQUENCY RANGE keys, and the rotary control in FINE and COARSE mode as before. Press the FREQ key and the display returns to frequency in Hz.

Now let's see the effect of the FREQ NORM key. Notice that when ever you press this key, the upper display sets itse¯f to 1.000 no matter where the rotary control is set or which range has been selected. Thus any frequency in the LDO operating range can be set as a reference. After setting the frequency display to 1.000, turn the frequency control or change the range. Each time, the display shows the operating frequency as a ratio to the reference. If you've forgotten what that referene was, press the REF key, and the upper display will show it for a period of one second. The FREQ NORM operation is useful when making frequency response measurements. In many applications, especially that of filters, the characteristics are independent of the absolute frequency and can be plotted against an arbitrary reference. That reference may be a 3 dB point in the case of a low pass, or high pass filter, or the centre frequency of a bandpass filter. If it's within the operating range of the LDO, the FREQ REF key can make it the reference, and make many measurement tasks much easier.

4.3.4 VOLTS, dBm, dB REL and REF keys

These keys let you choose the way in which the MAIN output level is displayed. At switch-on the instrument sets itself to VOLTS, but selection of dBm and dB REL can give a logarithmic display with a choice of reference voltages.

The dBm key uses a reference voltage derived from a standard operating system impedance. This impedance is selected using the Paging function decribed in 4.4 and 4.7. When the instrument is first switched on the reference impedance is 600 hms. In this case the reference voltage for 0dBm is 775 millivolts. The reference voltage is the level required to dissipate 1 mW in the reference impedance.

The dB REL key allows you to set any voltage level inside the operating range of the LDO as a reference. Operate the dB key and no matter what the output level, the lower display will show:-

0.0 dB

Use the amplitude range keys, and you'll see that the display increments up or down in 10 dB steps. The rotary control gives fine adjustment. Again, the REF key can be used to show what the voltage was at the time the dB REL key was operated.

4.3.5 TTL, VAR, DC

These keys affect the levels at both the MAIN and AUX outputs. First let's examine what happens to the MAIN output when the VAR, and DC keys are used.

Operate the TTL key. You'll see that the LDO display confirms the operation, by briefly showing:-

ttl

Set the amplitude range to give a reasonable size oscilloscope display. Turn the amplitude rotary control to give minimum amplitude within the range.

Press the VAR key. The display shows briefly:-

var

Note that the amplitude of the MAIN output has remained unchanged. Turn the amplitude rotary control, see that it has no effect upon the MAIN output. The amplitude of the MAIN output is at the lowest voltage of the present range. The RANGE keys are still operative, they can be used to alter the MAIN output amplitude in 10 dB steps.

By now you've noticed that the amplitude rotary control is altering the output from the AUX output. To remind you of the mode of operation the display is now showing a "U" in the first digit position of the lower idsplay. The rotary control varies the amplitude of the rectangular pulse from the AUX output between 0 and 12 volts.

Operate the DC key, the display briefly shows:-

dC

and the first digit of the lower display is now "d". The AUX output now provides DC at a voltage that is set by the amplitude rotary control.

N.B. In order to return the LDO to normal MAIN and AUX (TTL) operation from VAR or DC it is necessary to operate the TTL key. This returns the function of the amplitude rotary control to control of the MAIN output.

4.3.6 LOCAL

This key concerns the computer interface via R5232 and IEEE488 ports. When the LDO501 is operated remotely through these ports, the "rem" annunciator will appear, and all the front panel functions except LOCAL cease to operate. Providing the local lockout instruction has not been sent, the LOCAL key can be used to regain front panel control. The key also serves as a means of displaying the IEEE488 address set by the rear panel switches. Each time the key is operated, it performs the command to regain local control and then displays:-

Addr
=XX

Where XX is the address.

4.4 PAGE keys, (O) and (N)

We're now ready to move out of PAGE 0 operations. Press FREQ, COARSE, VOLTS, and TTL to return the instrument to its basic state. When we go to another PAGE of operation, the functions of the 3X4 pad of keys will change.

Press the PAGE (N) key. The lower display now shows:-

P= 0

This is the current active PAGE. Now press any key in the 3X4 pad in the range (0) to (4). You'll see that you can change the number displayed on the lower display. This is how you set the new PAGE number that you want to go to. Set the PAGE number to 3 and press the (N) key again. The LDO is now operating in PAGE 3. and should be displaying:-

600

If some other message is shown it means that the LDO has already been set to some other loading condition.

So what this means is, the first operation of the (N) key always displays the current active PAGE, the second will cause functioning of the instrument to pass to the displayed PAGE number. If you want to see what PAGE you are in, without leaving it, just press the PAGE (N) key twice.

Assuming that you've left the instrument in PAGE 3, how do you get back to PAGE 0 ? You could use the (N) key; press it once, enter "0", press it again; three operations. Because PAGE 0 is so important, a quick way has been provided to get back to it from any other PAGE. This is by using the PAGE (O) key, the equivalent of the sequence of three key presses described above.

4.5 PAGE 1 - Memory Store

Use the PAGE (N) key to set the LDO into PAGE 1 operation. You'll find that the frequency and amplitude keys and controls still function as in PAGE 0. However keys 0 to 9, now give control of ten storage locations. Press one of these and you'll see the display blink, confirmation of the key operation and resulting storage. Try setting some conveniently associated parameters into the first few memories, for example, 1 kHz and 1 volt into memory 1, 2 kHz and 2 volts into memory 2, etc. WARNING - the storing of settings will write over any previously stored data. The FINE frequency control available in PAGE 0 is available in PAGE 1, COARSE and FINE have been moved to keys "." and "*" respectively. This avoids conflict with the memory store keys 0 - 9.

4.6 PAGE 2 - Memory Recall

Use the PAGE (N) key to go to PAGE 2. The keys 0 to 9 can be used to recall the settings assigned to them. This PAGE demonstrates the power of the PAGING system over that using a "shift" key. The settings that you stored under PAGE 1 operation can each be recalled with a single key press.

N.B. It is not simply amplitude and frequency that are stored, but the complete STATUS of the instrument. Thus if a setting is made using PERIOD and VAR from AUX, then that is what you will get at recall. All this means is that a mixture of modes can be stored. This allows great flexibility in setting up small test systems. For example, AUX can be set to a different DC level for each of a number of different MAIN output frequencies. Feeding AUX into a series of window comparators, allows it to be used as a digital control for, say, routing the MAIN output to different test points.

4.7 PAGE 3 - Set reference impedance and describe output load

Page 3 has two specific uses, and it is important to realise that they are quite separate.

The first function of PAGE 3 is to set the voltage reference used when displaying output voltage in dBm. The dBm annunciator when present indicates that the output voltage is being logarithmically related to a reference voltage that will dissipate 1 milliwatt into the reference impedance. PAGE 3 gives a choice among the most commonly used reference impedances. Operate the keys 1 to 8 and you'll run through all of them. These impedances, you'll see, are shown upon the upper display.

After selecting each impedance, if you go back to PAGE 0, you'll find no change in the displayed MAIN output voltage. The only change is in the value shown when you have selected dBm. Also the MAIN output impedance of 600 ohms remains the same, no matter what reference impedance has been selected. All that has happened is that we've told the LDO to make some of its display calculations from a different point of view.

The second function of PAGE 3 is to describe to the LDO the load conditions into which the MAIN output is to operate. The details of the display for each choice are to be found in section 2.5.5 of this manual.

Again it must be understood that describing to the instrument the load conditions makes no change in its output impedance or unloaded output voltage, only to the displayed voltage.

The first two load conditions are easily dealt with. They are an infinite load impedance (in other words an unloaded output) and 10 kilohms.

If you put a high impedance AC voltmeter across the output and specify operation into an infinite load impedance, then within the specification limits the voltmeter and LDO display would agree. Now use PAGE 3 to specify operation into 10 kilohms. Note that the LDO display is lower than that of the voltmeter. It is only when a 10 kilohm resistor is placed in parallel with the voltmeter across the LDO output that their two readings agree. A 10 kilohm load specification will often be convenient when testing and developing individual circuit blocks. In these circumstances it will not matter what the source impedance of the signal source is, though in reality 600 ohms is a good figure to live with. The remaining load choices are CORRected and UNCoRrected. These relate to keys 1 to 8 of PAGE 3.

It is sometimes important for the source impedance of the signal to be the same as that of the load impedance. This is often so with systems that contain passive components, such as transformers, and inductance/capacitance filters, that have critical frequency, phase and amplitude response. So suppose the LDO is to be used to test just such a system that operates from 100 ohms. What we would like to do is to tell the LDO that it must allow for a 100 ohm load, but at the same time turn its 600 ohm output impedance into 100 ohms by placing across its output (i.e. effectively in parallel with the 600 ohms internal source impedance) a 120 ohm resistor. This is the corrected (CORR) situation.

The LDO can also allow for operation into the reference impedance alone from the 600 ohm source impedance by using the UNCoRrected condition.

To convert the output impedance of the LDO for CORR operations use the following resistors:-

For 50 ohms use 54.5 ohms in parallel with the output.

For 75 ohms use 85.7 ohms in parallel with the output.

For 93 ohms use 110 ohms in parallel with the output.

For 100 ohms use 120 ohms in parallel with the output.

For 150 ohms use 200 ohms in parallel with the output.

For 200 ohms use 300 ohms in parallel with the output.

For 600 ohms - no additional resistor is required.

For 1K2 ohms use 600 ohms in series with the output.

4.8 PAGE 4 - Frequency Calibration

As soon as you go to this PAGE the LDO will commence calibrating all of its frequency ranges. It does so by using the microprocessor system clock as a reference. The first thing that happens is that the display shows all its digits and annunciators for a brief period followed by the display:-

SELF
-CAL

This remains until calibration is complete, a period of around a minute.

So when are you going to use calibration ? Normally not often, its there as insurance against the normal ageing effects of components. It allows you to maintain the instruments calibration during normal use.

4.9 Using the Outputs

The three outputs MAIN, AUXILIARY, and Quadrature, come from the same printed circuit board, but they do not share the same grounding points. When the highest signal purity is required from the MAIN Output, care should be taken to ensure that the only ground point used is that at the MAIN Output.

The AUXiliary Output is driven from an emitter follower, with an active pull down, with a series resistance of 51 ohms. In TTL and AUX mode, loading the output will cause the voltage drop across the emitter follower to be seen as a reduction in AUXiliary output. To drive TTL levels into a 50 ohm load will require using the VARIable mode. If it is known that the AUX output will always be loaded with 50 ohms, then the TTL level can be reset to allow for this by selecting a new resistor value for R496.

When the AUX output is set to DC, negative feedback is taken after the drive devices and the effect of the diode drops seen in pulse output modes is eliminated.

4.10 Indication of Stabilised Amplitude

The microprocessor monitors a digital output from the analog board that indicates that the oscillator amplitude has not stabilised. While the condition of this output is "true", the decimal point, just in front of the "mV" annunciator, is displayed. This decimal point is not used by any other function. The speed of stabilisation is linked with the oscillator frequency. Above 1 kHz, it is fast enough to cause the stability indicator to show only very briefly.

NOTES

5.0 APPENDICES

5.1 APPENDIX 1

The following three pages show the layout of the PAGE dependent keys for PAGEs 1, 2, and 3.

5.2 APPENDIX 2

Example programs, IEEE488 Control from BASIC.

5.3 APPENDIX 3

Programming techniques

PAGE 1 - STORE TO MEMORY

(1) MEM 1	(2) MEM 2	(3) MEM 3
(4) MEM 4	(5) MEM 5	(6) MEM 6
(7) MEM 7	(8) MEM 8	(9) MEM 9
(.) COARSE	(0) MEM 10	(*) FINE

PAGE 2 - RECALL FROM MEMORY

(1) MEM 1	(2) MEM 2	(3) MEM 3
(4) MEM 4	(5) MEM 5	(6) MEM 6
(7) MEM 7	(8) MEM 8	(9) MEM 9
(.) UNUSED	(0) MEM 10	(*) UNUSED

PAGE 3 - SELECT REFERENCE IMPEDANCE AND LOAD CONDITIONS

(1)	(2)	(3)
50	75	93
(4)	(5)	(6)
100	150	200
(7)	(8)	(9)
600	1K2	----
(.)	(0)	(*)
10-4	uncr	corr

5.2 Appendix 2. Example Programs, IEEE488 Control from BASIC

The following example is of a BASIC program suitable for interactive control using the VIC20 with an INTERPOD. The user is prompted for a command which is sent to the IEEE interface using an arbitrary file (5), and address (7) as set up on the interface dip switches and an arbitrary secondary address (12). Note that the secondary address is not optional! The program loops round waiting for a reply and if one is received within an arbitrary number (10) of attempts it is printed, otherwise the message "NO REPLY" is output.

```
10  PRINT "(CLR)"
20  INPUT "COMMAND";A$
30  OPEN5,7,12
40  PRINT#5,A$
50  B$="NO REPLY"
60  FOR L=0 TO 10
70  INPUT#5,B$
80  IF B$<>"NO REPLY" THEN 100
90  NEXT
100 CLOSE5
110 PRINT
120 GOTO 20
```

The format of the dialogue is as follows:

```
    prompt from program
    !       user response (CR repeats previous input)
    !       !
COMMAND?    X
XXXXXXX
    !
    response from program
```

An interactive dialogue might be e.g. (with added comments):

```
COMMAND? F              - read frequency
F99.0HZ                 - reply
COMMAND? 0.1HZ          - set frequency
E10                     - no command character
COMMAND? F0.1HZ         - set frequency
E17                     - out of range
COMMAND? F10HZ          - set frequency
NO REPLY                - no errors so expect to be OK
COMMAND? F              - read new frequency
F10.0 HZ                - there it is
```

An alternative program, which is shorter and rather more sophisticated, it handles multiple replies, is as follows:

```
20  DIM A$[80],B$[80]
30  INPUT A$
40  IF A$<>"" THEN 70
50  A$=B$
60  DISP A$
70  B$=A$
80  OUTPUT 707 ; A$
90  ENTER 707 ; A$
100 IF A$<>"" THEN DISP A$
110 IF A$="" THEN 10
120 GOTO 90
```

This was developed for integration on an HP85 and makes use of the fact the interface will send a null string if the GPIB goes into the TACS state and the LDO is not busy. (This feature was added during integration to prevent the bus being hung by a read when no data was being generated). The user can enter a series of commands (using ";" as separator) and will receive however many replies are generated.

NOTES

5.3 Appendix 3 Programming Techniques

Remote and Local Operation

These commands select one of two sources for controlling the instrument. These are the instruments' own (local) front panel or an external (remote) controller. Remote/Local selection can be made in software. The reason for these commands is to facilitate Remote/Local control from the RS232 port. When using the RS232 interface, the LDO should always be sent the remote command "L" before sending control instructions. The IEEE488 bus has its own special implementation of Remote/Local that is part of the IEEE488 specification. The method of invoking them is dependent upon the programming techniques used by the controller. However, because all oscillator commands are accessible from either remote input port, the IEEE488 controller can make use of the software commands for Remote and Local and this can be useful with controllers that implement a subset of the IEEE488 specification excluding remote and local commands.

Avoiding apparent Bus "hang-up"

There are certain circumstances where the LDO may appear to hang-up a controller. In fact the controller holds up itself waiting for a reply. For example, when the 'C' command is sent to set the LDO into self calibrate any request for information during the self calibration period will hang-up the controller. A solution to this problem is to have a time-out on such bus transactions. If a reply is not received within a predetermined time interval, the controller returns without data, enabling the programme to continue execution. Some controllers have commands in their control language that specifically deal with the setting of time out periods. Other controllers have a time out facility always operative.

Serial Poll

The LDO does not use the service request (SRQ) facility. If the instrument is serial polled it will respond by putting a status byte on the bus in the normal way. Bit 3 of this byte will be 1 if the LDO is Remote and zero if Local.

Parallel Polling

The LDO does not make use of Parallel Polling and will ignore any Parallel Polling or configuring commands sent to it.

Device Clear

Sending the IEEE488 bus command DEVICE CLEAR will cause the LDO to perform a "cold" reset. That is, it will clear PAGE 3 conditions to 600 ohms and open circuit, turn ON the whole display for one second, revert to operation in the lowest frequency and amplitude ranges showing frequency and main amplitude output voltage and go LOCAL.

```
    DIM A$[80]
    ASSIGN @Ldo TO 711
    ASSIGN @Hpib TO 7
    ON TIMEOUT 7,6 GOTO Timeout
    !
    !
Loop: INPUT A$
    !
    IF A$="Z" THEN Local
    IF A$="Q" THEN Remote
    IF A$="LL" THEN Local_lockout
    IF A$="UL" THEN Unlock
    IF A$="SP" THEN Serial_poll
    IF A$="DC" THEN Reset
    IF A$="C" THEN Calibrate
    !
    PRINT A$
    OUTPUT @Ldo;A$
    !
Enter: WAIT .2
    ENTER @Ldo;A$
    PRINT A$
    IF A$="" THEN Loop
    GOTO Enter
    !
    !
Local: LOCAL @Ldo
    PRINT "Local"
    GOTO Loop
    !
Remote: REMOTE @Ldo
        PRINT "Remote"
        GOTO Loop
    !
Local_lockout: LOCAL LOCKOUT @Hpib
               PRINT "Local Lockout"
               GOTO Loop
    !
Unlock: LOCAL @Hpib
        WAIT 2
        REMOTE @Ldo
        PRINT "Unlock"
        GOTO Loop
    !
Serial_poll: Spoll_stat=SPOLL(@Ldo)
             PRINT "Serial poll status byte = ";Spoll_stat
             WAIT .5
             GOTO Loop
    !
Timeout: PRINT "Bus timeout"
         GOTO Loop
    !
Reset: CLEAR @Ldo
   WAIT 5
   GOTO Remote
    !
Calibrate: OUTPUT @Ldo;"L"
           WAIT 1
           OUTPUT @Ldo;"C"
           WAIT 100
           OUTPUT @Ldo;"L"
           WAIT 1
           GOTO Loop
    !
END
```

Programme Explanation

Opposite is a programme for the Hewlett Packard 9816 which demonstrates the use of Remote/Local bus commands, serial polling, device clear and auto-calibrate.

LDO bus address in this case is 11, the 9816 interface address is 7. Line 4 indicates that if a reply is not received from the bus within 6 seconds, the programme should proceed to the Timeout routine. This feature can be used within programmes to trap error conditions.

Loop — Input a command from the keyboard, look for command codes, go to the relevant sub routine or immediately output to LDO.

Enter — Wait 0.2 seconds for the transactions to complete and then read a byte of data from the LDO. If data from LDO is a null byte, go back to loop for another keyboard command. If not, print the data received and go back to Enter for more.

Local — IEEE488 bus command LOCAL

Remote — IEEE488 bus command REMOTE

Local Lockout — IEEE488 bus command LOCAL LOCKOUT

Unlock — This takes LDO out of Local Lockout but returns the instrument to remote operation. Local Lockout and Local both operate on the controller. Local should always be followed by the Remote LDO command, to avoid the instrument operating in an undefined state.

Serial Poll — Performs a serial poll and prints the status byte received. Value will be 8 or 0 for Remote or Local operation.

Timeout — This sub routine prints the message "Bus timeout" if for any reason the controller does not receive a reply from the oscillator.

Reset — Send Device Clear to LDO, wait for it to perform a cold reset and then put the instrument to Remote operation.

Calibrate — This sequence must be used to avoid bus programming errors. Remote LDO using the software command, initiate auto-calibrate, wait 100 seconds for completion, return instrument to Remote again using software command and exit.

The following programme demonstrates the LDO's IEEE488 control facilities using a Hewlett Packard 9816. The programme is a practical example and hence a considerable amount of it is taken up with screen formatting.

Apart from the repertoire of commands defined in Table 1, there are two in addition:

S - will display the "status" of the instrument by sending a multiple command string in sub routine STATUS.

Z - starts by loading the LDO's 10 memory locations and then goes into a loop that varies the amplitude, frequency and recalls the memory locations in turn. Once started, the only way to exit this loop is to BREAK the programme.

In this programme, multiple commands are handled by counting the number of commands sent using the Count comms routine and then inputting that specific number of commands in the routine starting at "Fetch".

Sub routine Com_proc looks for a few, but not all of the possible replies by looking at the first letter and then dealing with each separately. Sub routine Imp, demonstrates how to convert the received impedance reference voltage into a value in ohms. If the first letter is an E, then the Err sub routine is entered, that prints the appropriate error message from the array defined in Def-error-array.

The programme from Auto-prog down to Loop2 sets the LDO to a defined state and loads the non-volatile memories. Note the technique of using a dummy Enter command to ensure that the LDO is ready to accept the next data message. Failure to do this can result in the LDO interface computer overwriting data in its circular input buffer. This causes loss of commands.

The programme between Loop2 and END uses a series of loops to step automatically and continuously through a series of amplitude frequency changes and memory locations using both the Main and Auxilliary Outputs.

```
ON TIMEOUT 7,2 GOTO Timeout ! if osc doesn't reply after 2 secs - quit
GOSUB Def_error_array
GOSUB Clear_screen
GOSUB Line
ASSIGN @Oscl TO 711
DIM A$[30]
PRINTER IS 1
REMOTE @Oscl
Loop: INPUT Data$
IF Data$ [1,1] ="Z" THEN GOTO Auto_prog
IF Data$ [1,1] ="S" THEN GOSUB Status ! this is a request to display all
!
IF Data$="U" THEN GOSUB Local
IF Data$<>"U" THEN GOSUB Remote
!
GOSUB Count_comms ! find how many separate commands we have
OUTPUT @Oscl;Data$
Fetch: WAIT .1
       ENTER @Oscl;A$
       GOSUB Line
       GOSUB Show_raw_data
       GOSUB Com_proc
       IF Num_coms=1 THEN Exit
       Num_coms=Num_coms-1
       GOTO Fetch
Exit: GOTO Loop
!
Com_proc:!
          X$=A$ [1,1]
          IF X$="A" THEN Ampl
          IF X$="F" THEN Freq
          IF X$="I" THEN Imp
          IF X$="T" THEN Auxt
          IF X$="V" THEN Auxv
          IF X$="D" THEN Auxd
          IF X$="E" THEN Err
          RETURN
Ampl:!
     PRINT TABXY(29,4),"Amplitude.. ";A$[2,LEN(A$)];"          "
     RETURN
Freq:!
     PRINT TABXY(29,6),"Frequency.. ";A$[2,LEN(A$)];"          "
     RETURN
Imp:!
     O=1000*((VAL(A$[2,6]))^2)
     PRINT TABXY(19,8),"Reference impedance.. ";O;" ohms";"     "
     RETURN
Auxt:! Process auxilliary replies
     GOSUB Print_aux
     PRINT TABXY(42,10),"TTL                 "
     RETURN
```

```
Auxv:! Process auxilliary replies
      GOSUB Print_aux
      PRINT TABXY(42,10),"Variable pulse ..";A$[2;3];" volts          "
      RETURN
Auxd_! Process auxilliary replies
      GOSUB Print_aux
      PRINT TABXY(42,10),"Variable DC ..";A$[2;3];" volts             "
      RETURN
      !
      !
Print_aux: PRINT TABXY(21,10),"Auxilliary Output.. "
           RETURN
Err: ! show error message
      PRINT TABXY(15,15)," Error condition ......";Error$(VAL(A$[3;1])+1);"
-----------"
      RETURN
Status:!
      !  PRINT "Request for LDO status"
      !  PRINT
         Data$="A;F;I;D"
         RETURN
Clear_screen: !
           FOR Line=1 TO 40
           PRINT
           NEXT Line
           RETURN
Count_comms:! count the number of commands in the input line
           Num_coms=1 ! there is always 1 command
           FOR N=1 TO LEN(Data$)
           IF Data$[N;1]=";" THEN Num_coms=Num_coms+1
           NEXT N
           RETURN
Remote:  PRINT TABXY(1,1),"----- REMOTE OPERATION ---"
         RETURN
Local:   PRINT TABXY(1,1),"------ LOCAL OPERATION -------"
         RETURN
Show_raw_data: !
               PRINT TABXY(10,17),"   data to bus ... ";Data$;"   data from
bus ... ";A$;"             "
         RETURN
Line: ! draw a line above raw data
         PRINT TABXY(1,15),"---------------------------------------------
----------------------------"
         RETURN
Def_error_array: ! Load error message array
          DIM Error$(9)[33]
          Error$(1)="Unrecognised command"
          Error$(2)="Missing parameter"
          Error$(3)="Illegal or missing multiplier"
          Error$(4)="Unrecognised units"
          Error$(5)="Syntax error in mantissa"
          Error$(6)="Syntax error in exponent"
          Error$(7)="-ve mantissa illegal"
          Error$(8)="Value out of range"
          Error$(9)="Invalid baud rate"
          RETURN
```

```
Timeout: PRINT TABXY(60,1),"**** BUS TIMEOUT ****"
     WAIT 2.5
     PRINT TABXY(60,1),"                    "
     GOTO Loop
Auto_prog:!
     OUTPUT @Oscl;"L" ! ENSURE LDO is REMOTE
     WAIT .1
     OUTPUT @Oscl;"I.7746VREF;0" ! Set page 3 conditions
     WAIT .1
     OUTPUT @Oscl;"A3V;F20KHZ" ! Set MAIN output level and frequency
     WAIT .1
     OUTPUT @Oscl;"D1V;M1" ! load memory 1
     ENTER @Oscl;A$
     OUTPUT @Oscl;"D2V;M2"
     ENTER @Oscl;A$
     OUTPUT @Oscl;"D3V;M3"
     ENTER @Oscl;A$
     OUTPUT @Oscl;"D4V;M4"
     ENTER @Oscl;A$
     OUTPUT @Oscl;"D5V;M5"
     ENTER @Oscl;A$
     OUTPUT @Oscl;"D6V;M6"
     ENTER @Oscl;A$
     OUTPUT @Oscl;"D7V;M7"
     ENTER @Oscl;A$
     OUTPUT @Oscl;"D8V;M8"
     ENTER @Oscl;A$
     OUTPUT @Oscl;"D9V;M9"
     ENTER @Oscl;A$
     OUTPUT @Oscl;"10V;M10"
     ENTER @Oscl;A$
Loop2:    OUTPUT @Oscl;"A2V;T"
          WAIT 1
          N=1000
          ! Step frequency from 1KHZ to 100 KHZ
          WHILE N<100000
          N=N*1.3
          A$="F"&VAL$(INT(N))&"HZ"
          OUTPUT @Oscl;A$
          GOSUB Com_proc
          WAIT .5
          END WHILE
          !
          OUTPUT @Oscl;"F20KHZ"
          ! step main output from 100mV to 2V
          FOR N=100 TO 2000 STEP 100
          A$="A"&VAL$(INT(N))&"MV"
          OUTPUT @Oscl;A$
          GOSUB Com_proc
          WAIT .5
          NEXT N
          ! output each of the memory locations
          FOR N=1 TO 10
          A$="R"&VAL$(INT(N))
          OUTPUT @Oscl;A$
          GOSUB Com_proc
          WAIT .5
          NEXT N
          !
          GOTO Loop2
END
```

Things To Watch Out For

Commands setting the Main Output level relate to the EMF or open circuit output voltage. Requests for the Main Output level will return the terminal voltage.

If remote programming proceeds with PAGE 0 operative, (i.e. display of amplitude and voltage), changing the reference impedance will put the voltage display into dBm units.

Replies from the LDO giving numerical data have sufficient number of digits for compatibility with the specified instrument accuracy, but no more.

When the LOCAL key is pressed there is a delay for data to be exchanged via the internal serial interface. Pressing the LOCAL key a second time during this period may cause the front panel "Err" message to be displayed.

Under conditions of LOCAL LOCKOUT the LDO front panel will be inoperative, but if the LOCAL key is pressed while data is being received from the interface, the "Err" message may be displayed and some data lost.

6.0 DIAGRAMS AND PARTS LIST

BLOCK DIAGRAM OF THE OSCILLATOR

FIGURE 1

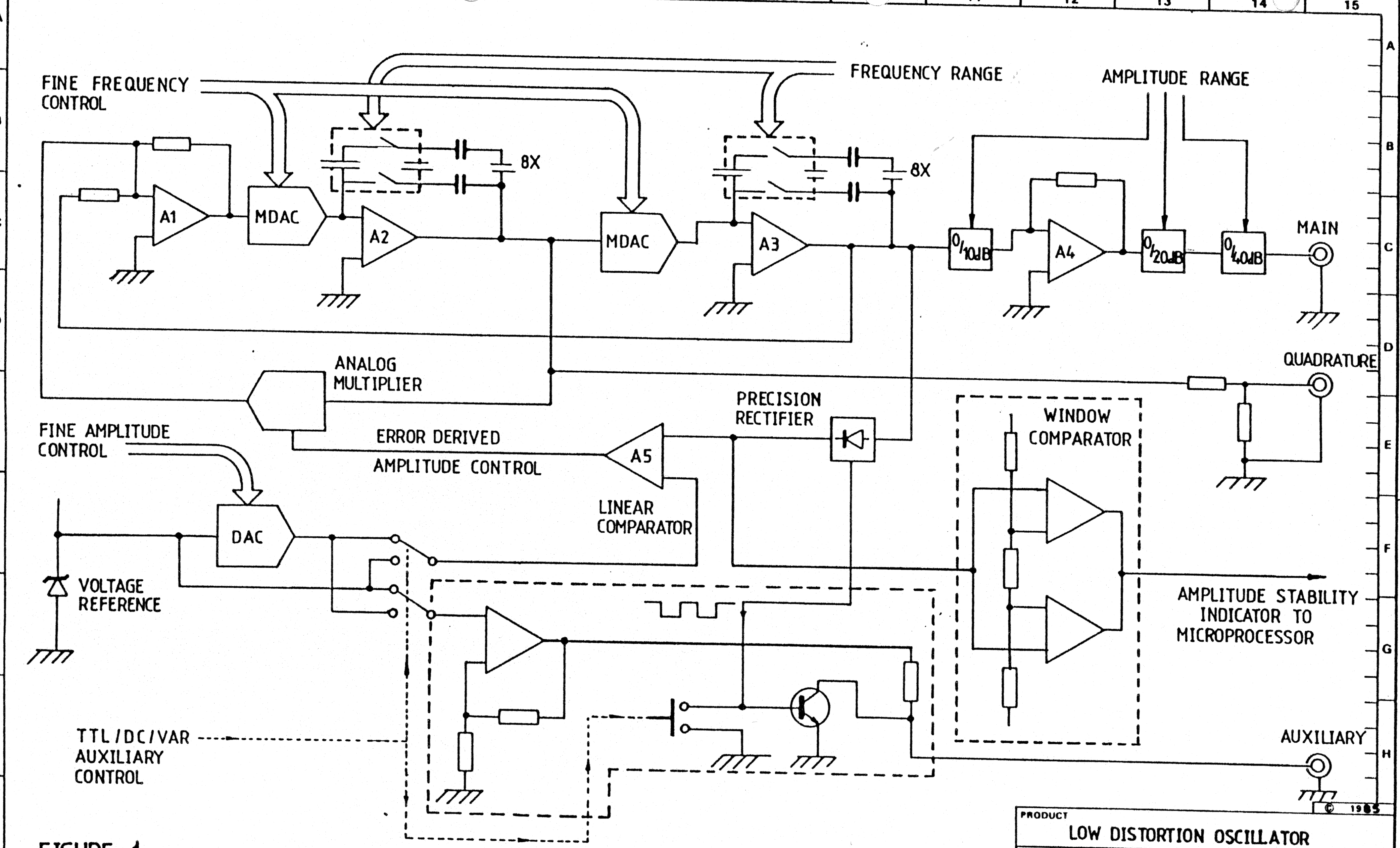
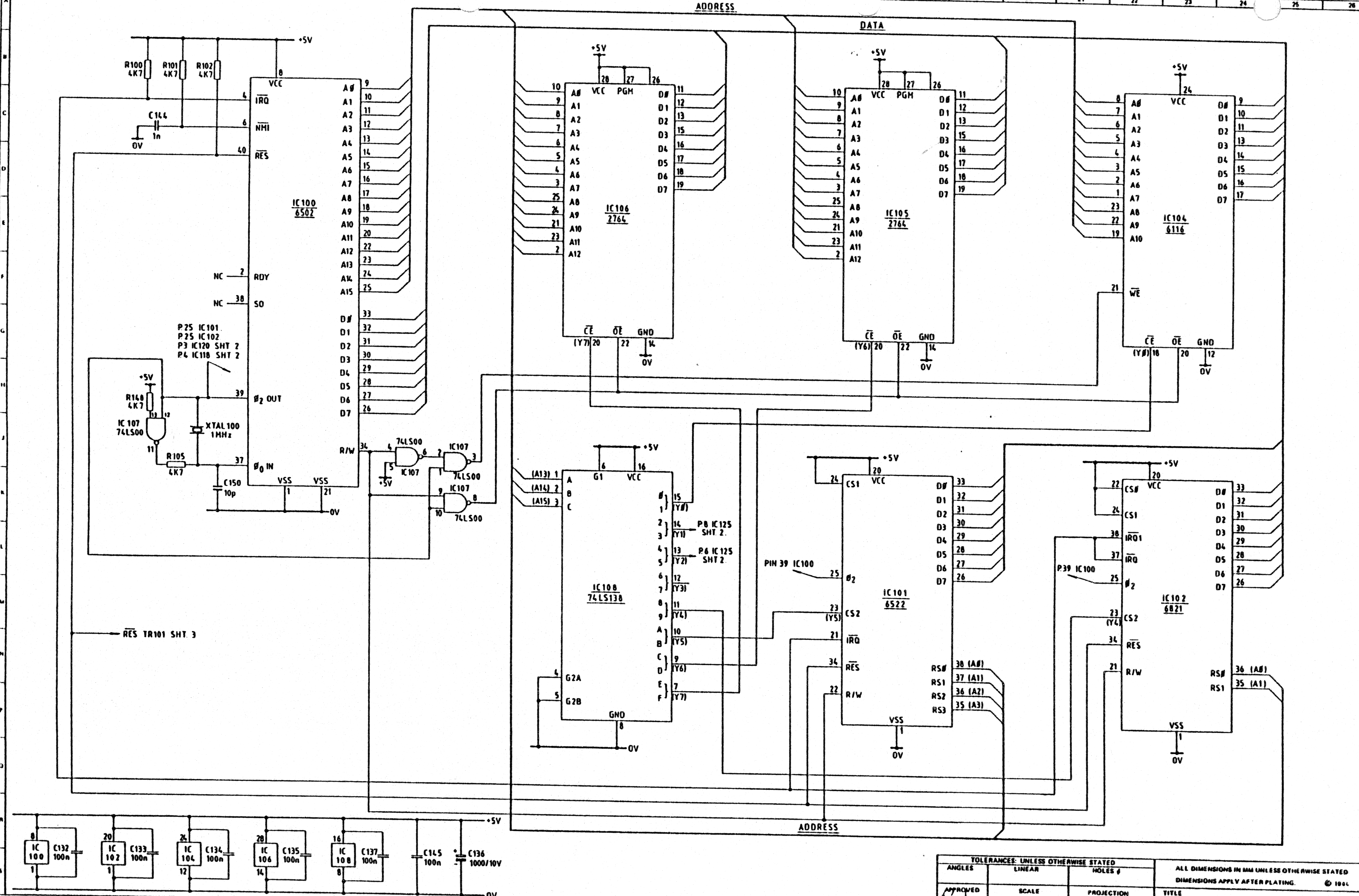


FIGURE 1

PRODUCT	LOW DISTORTION OSCILLATOR
TITLE	BLOCK DIAGRAM
DRAWING No	10/111
SHT	1
OF	1
ISSUE	1
DATE	9-1-85
CHANGE NOTE	
APPROVED	
DRAWN	B.C.S
DATE	9-1-85
CHECKED / DATE	
APPROVED / DATE	

CIRCUIT DIAGRAMS



ISSUE	1	2	3	
DATE	24.5.84		3585	
CHANGE NOTE				
CERTIFIED				

TOLERANCES: UNLESS OTHERWISE STATED

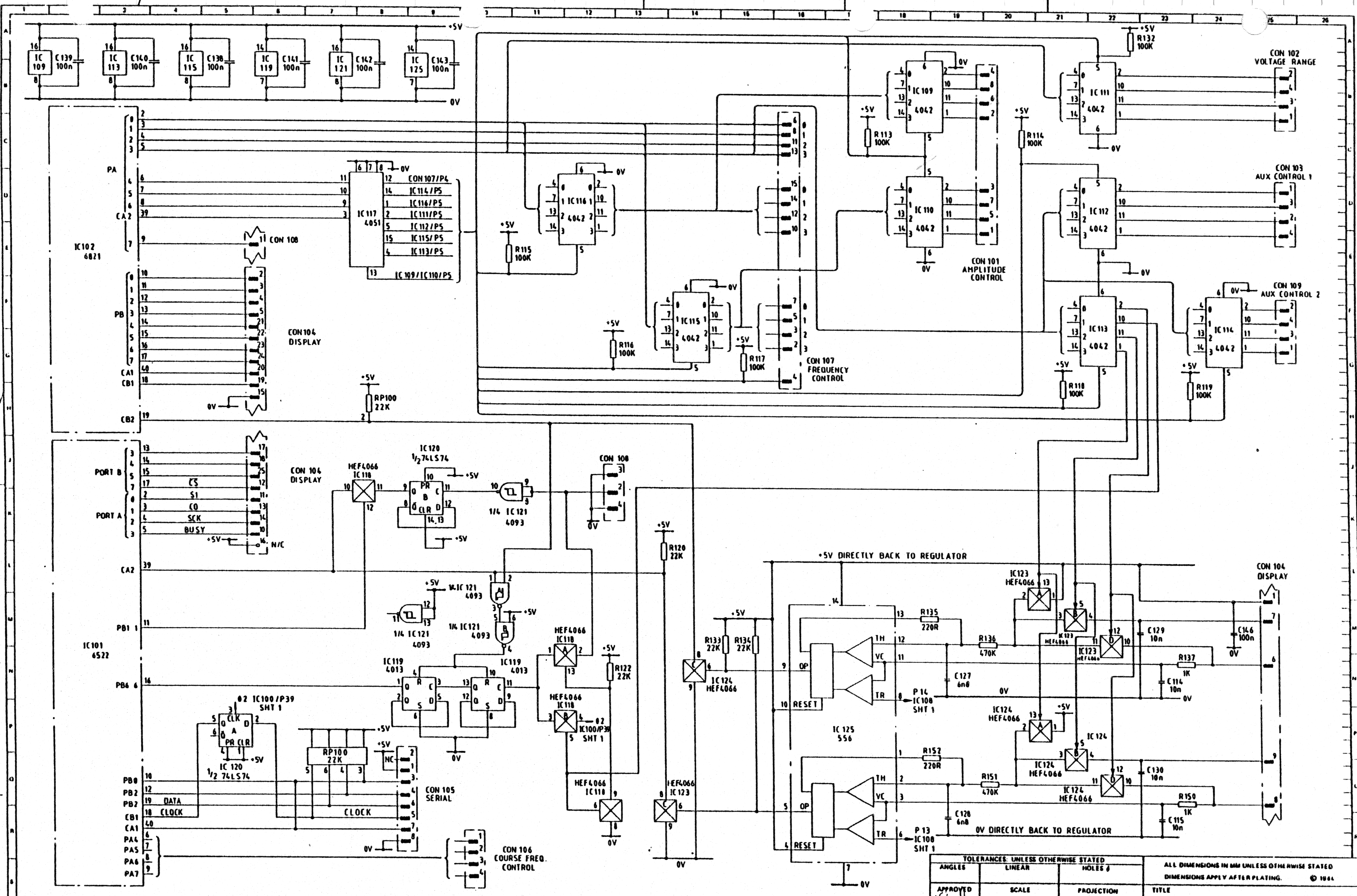
ANGLES	LINEAR	HOLES ø
APPROVED	SCALE	PROJECTION
CHECKED GSP	FINISH	
DRAWN AIM	MATERIAL	

ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED
DIMENSIONS APPLY AFTER PLATING. © 1984

TITLE
DIGITAL CCT. LDO 501

DRAWING No. A410-087 SHEET 1 OF 3

AIM



TOLERANCES UNLESS OTHERWISE STATED			
ANGLES	LINEAR	HOLES ∅	
APPROVED	SCALE	PROJECTION	
CHECKED GSP	FINISH		
DRAWN AIM	MATERIAL		

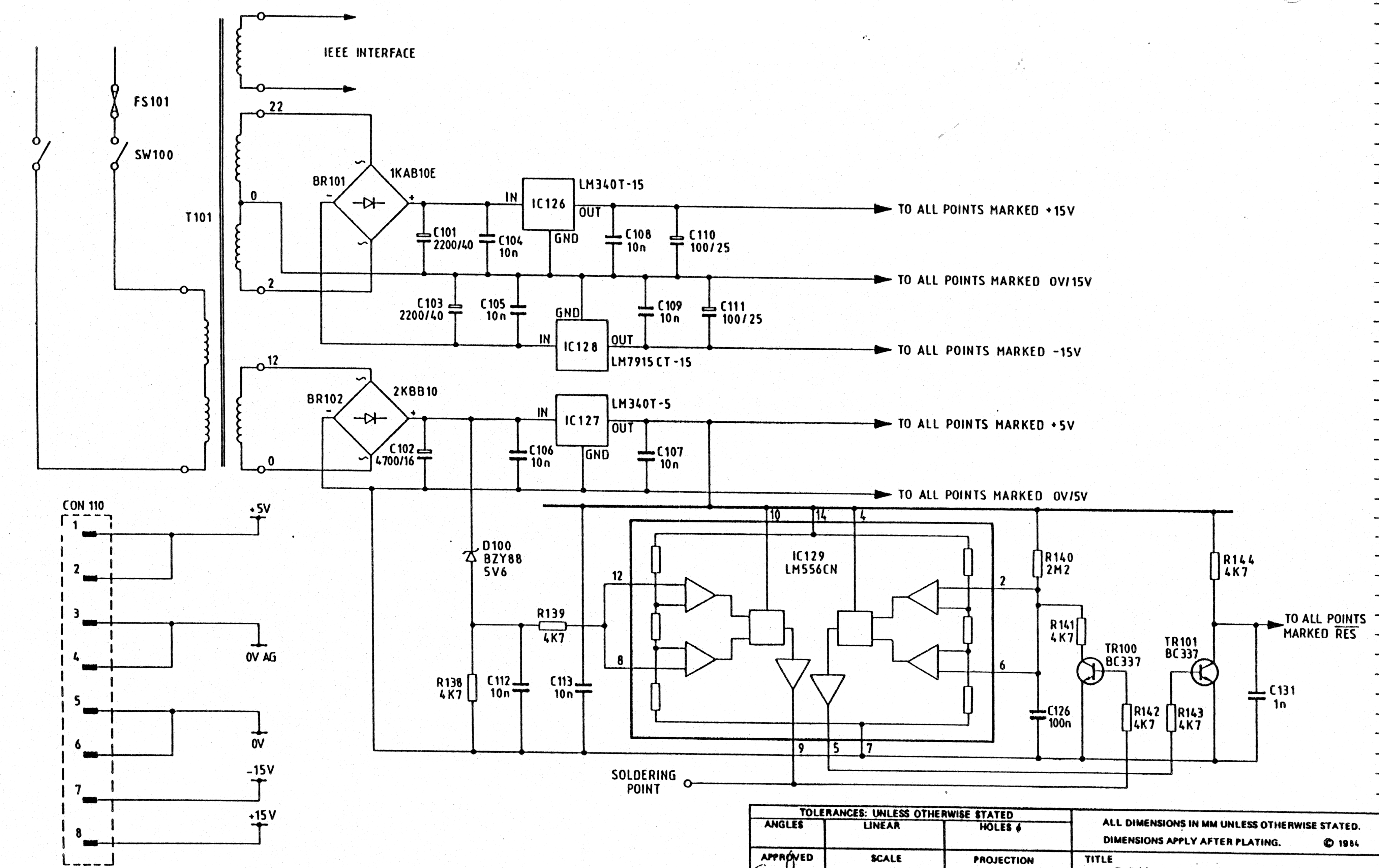
ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED
DIMENSIONS APPLY AFTER PLATING. © 1984

TITLE DIGITAL CCT-L D O 501

DRAWING No. A410-087 SHEET 2 OF 3

AIM

ISSUE	1	2	3	4
DATE	25.5.84	20.6.84	—	3.5.85
CHANGE NOTE				
CERTIFIED				



TOLERANCES: UNLESS OTHERWISE STATED		
ANGLES	LINEAR	HOLES ϕ
APPROVED Scal	SCALE	PROJECTION
CHECKED GSP	FINISH	
DRAWN AIM	MATERIAL	

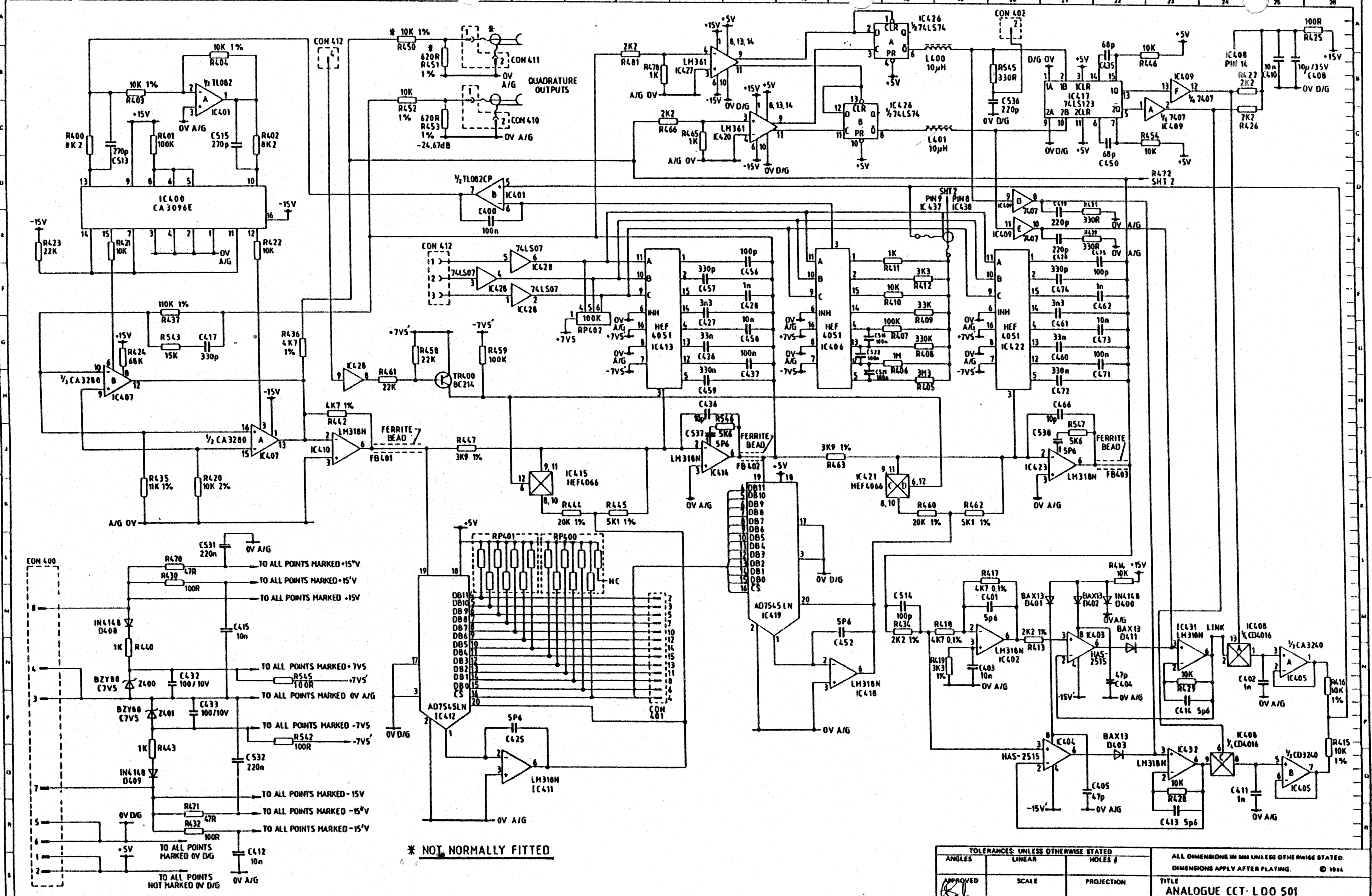
ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED.
DIMENSIONS APPLY AFTER PLATING. © 1984

TITLE P.S.U. CCT - L D O 501

DRAWING No. A410-087 SHEET 3 OF 3

AIM

ISSUE	1	2	3	4
DATE	24:5:84	11.7.84	—	3-5-85
CHANGE NOTE				
CERTIFIED		Scal		



* NOT NORMALLY FITTED

ISSUE	1	2	3	4	5
DATE	22.5.84	26.6.84	5.7.84	28.8.84	3-5-85
CHANGE NOTE				119/120	
CERTIFIED					

TOLERANCES: UNLESS OTHERWISE STATED

ANGLES	LINEAR	HOLES ⌀

APPROVED — SCALE — PROJECTION

CHECKED SGP — FINISH

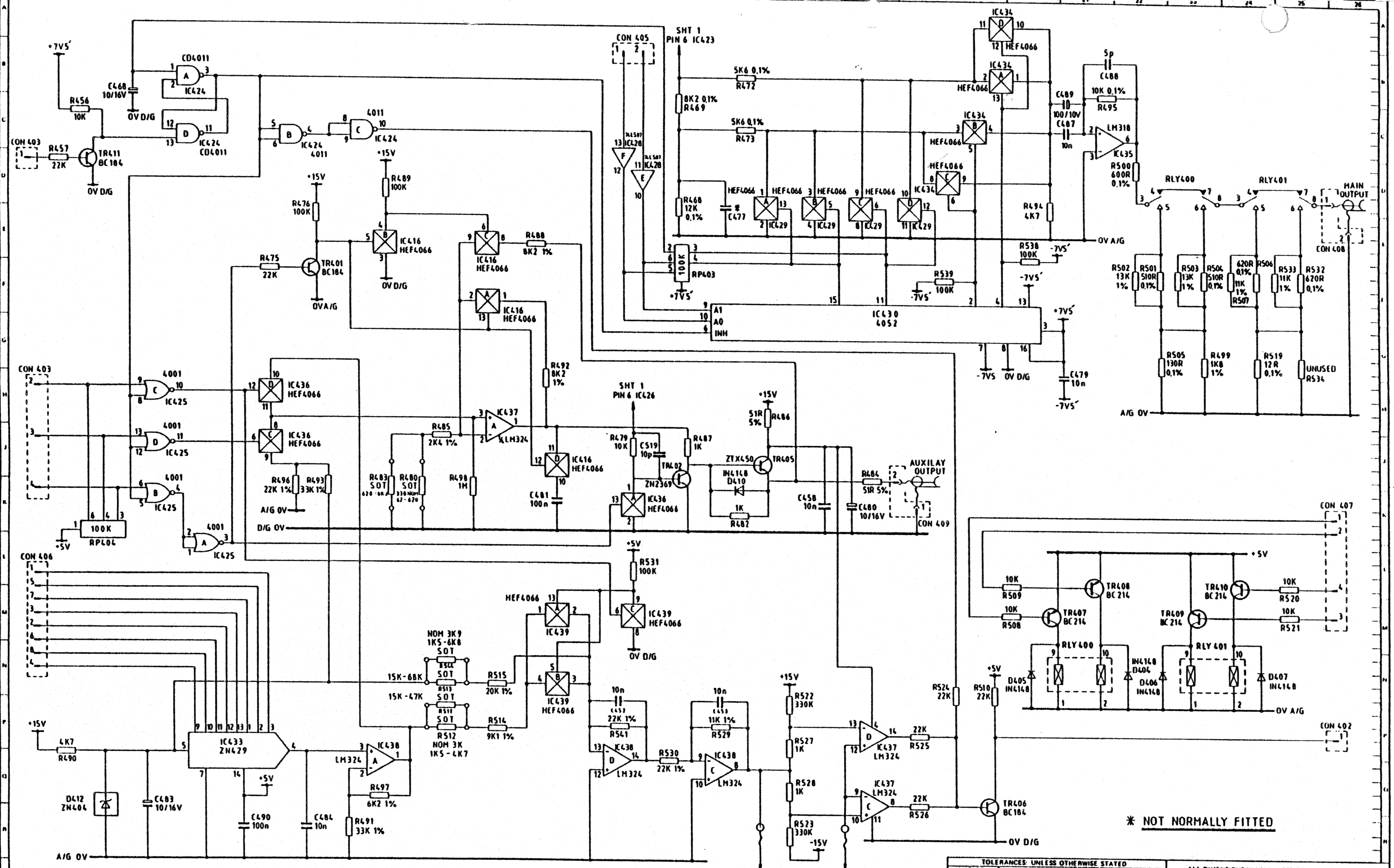
DRAWN AIM — MATERIAL

ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED.
DIMENSIONS APPLY AFTER PLATING. © 1984

TITLE
ANALOGUE CCT- LDO 501

DRAWING No.
A410-088 SHEET 1 OF 3

AIM



ISSUE	1	2	3	4
DATE	23.5.84	11.7.84	221184	3-685
CHANGE NOTE				
CERTIFIED				

TOLERANCES: UNLESS OTHERWISE STATED

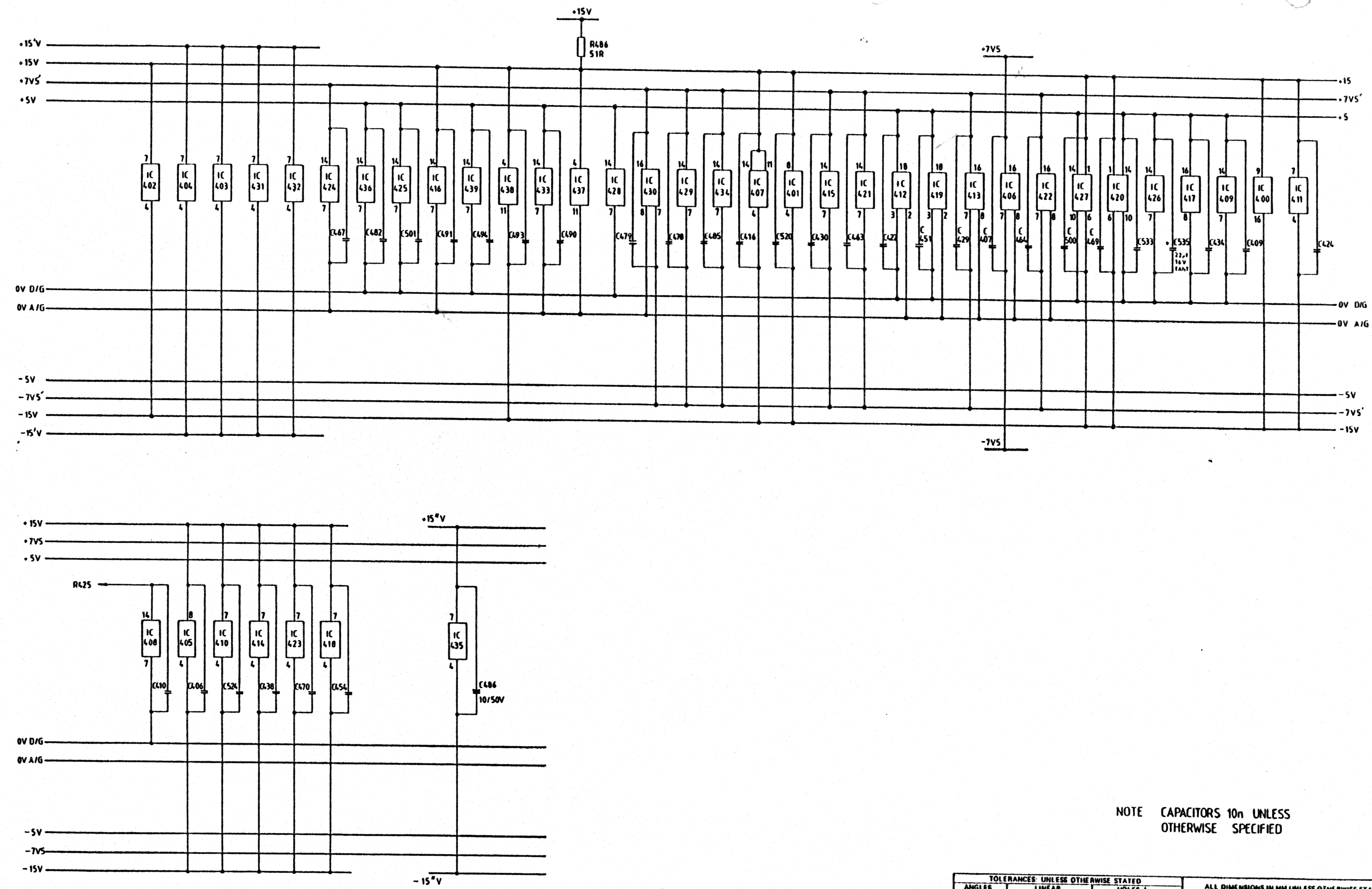
ANGLES	LINEAR	HOLES ⌀
APPROVED	SCALE	PROJECTION
CHECKED	FINISH	
DRAWN AIM	MATERIAL	

ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED
DIMENSIONS APPLY AFTER PLATING. © 1984

TITLE
ANALOGUE CCT-LDO 501

DRAWING No.
A410-088 SHEET 2 OF 3

AIM



NOTE CAPACITORS 10n UNLESS OTHERWISE SPECIFIED

ISSUE	1	2	3
DATE	6.7.84.		3.5.85
CHANGE NOTE			
CERTIFIED			

TOLERANCES: UNLESS OTHERWISE STATED

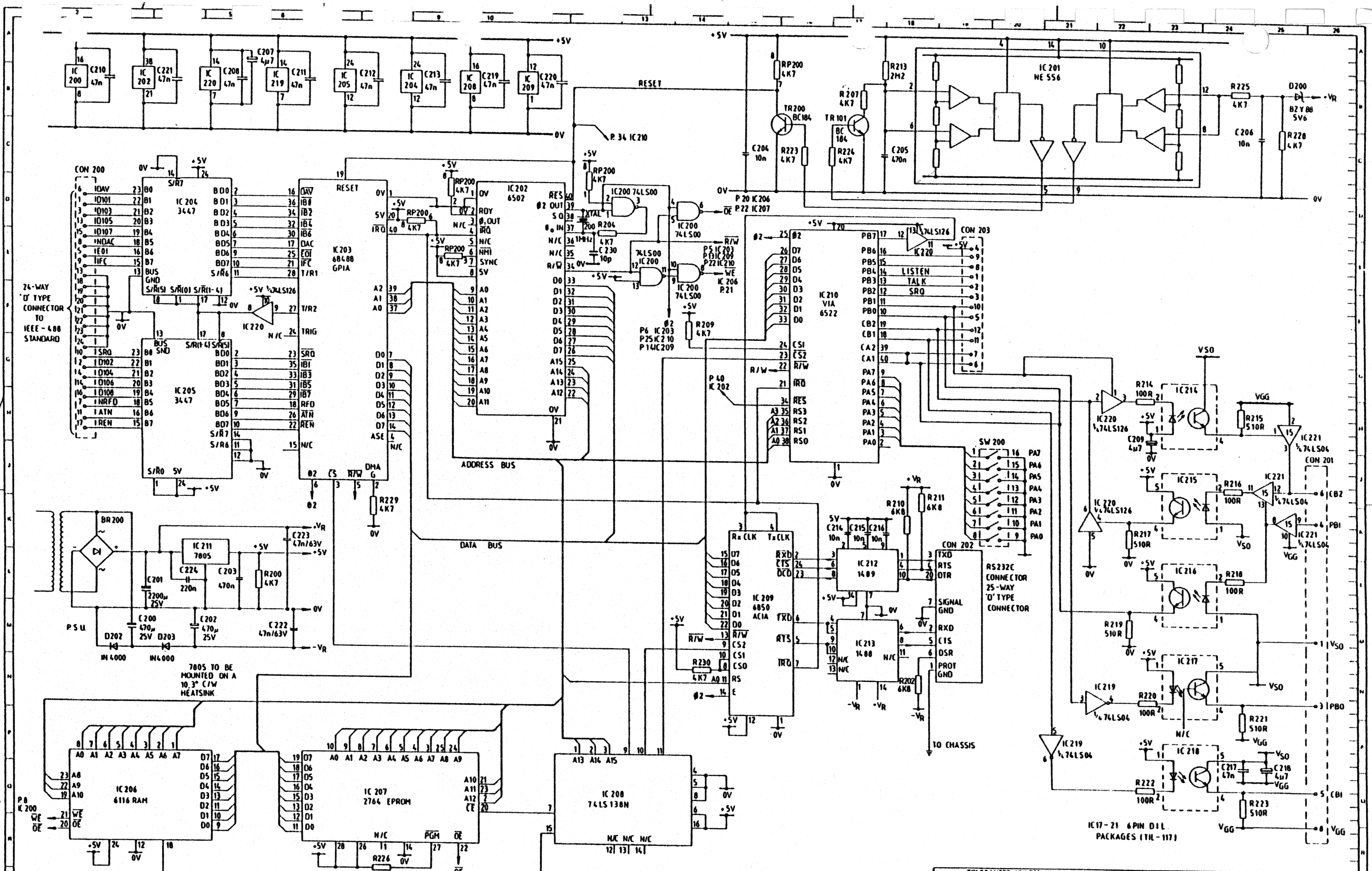
ANGLES	LINEAR	HOLES ∅
APPROVED	SCALE	PROJECTION
CHECKED GSP	FINISH	
DRAWN AIM	MATERIAL	

ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED.
DIMENSIONS APPLY AFTER PLATING.

TITLE ANALOGUE CCT LDO 501 DECOUPLING CAPACITORS

DRAWING No. A410-088 SHEET 3 OF 3

AIM



ISSUE	1	2	3	4
DATE	29:5:84	28.8.84		3-5-85
CHANGE NOTE		121/122		
CERTIFIED				

TOLERANCES: UNLESS OTHERWISE STATED

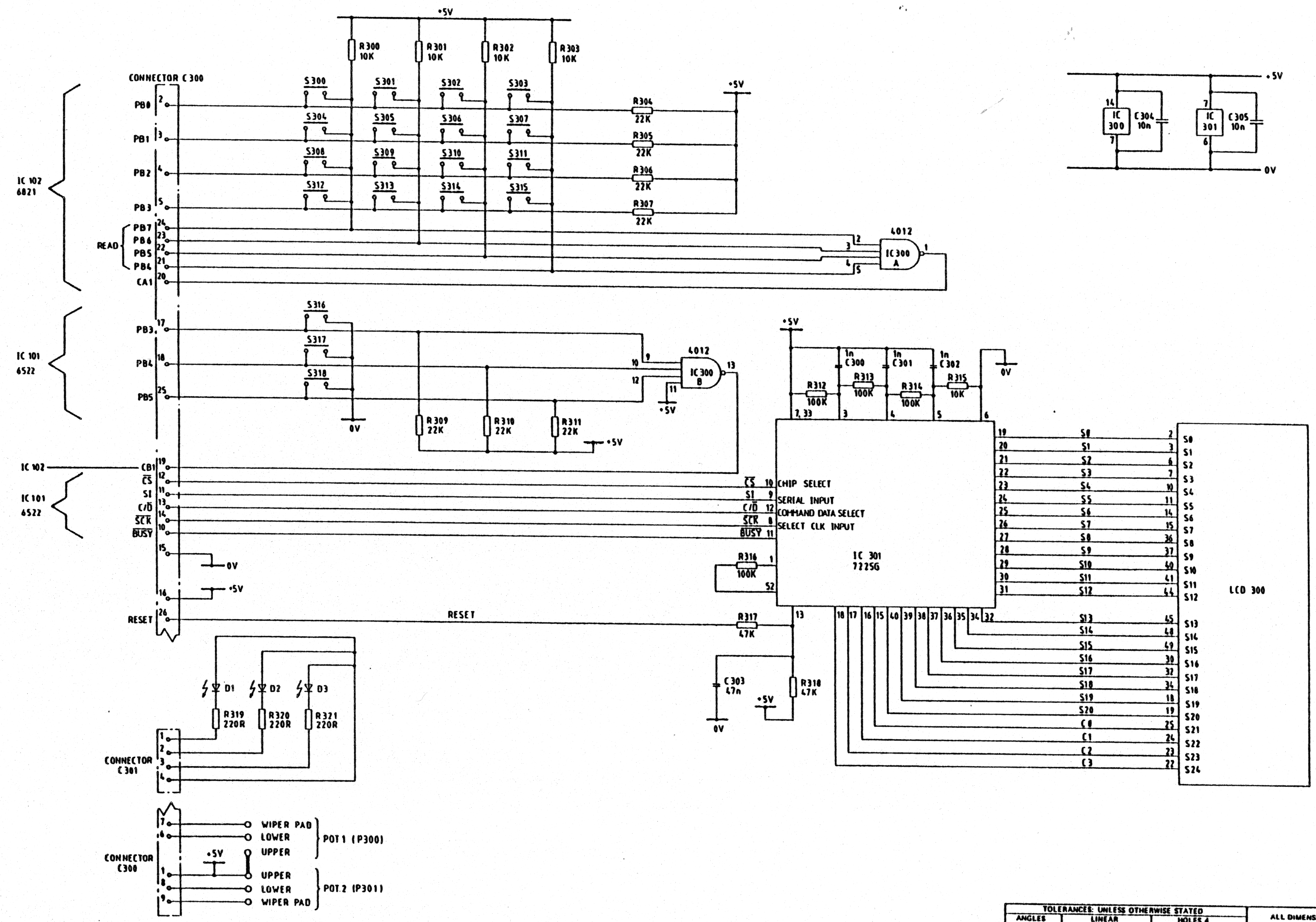
ANGLES	LINEAR	HOLES ∅
APPROVED	SCALE	PROJECTION
CHECKED	FINISH	
DRAWN AIM	MATERIAL	

ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED.
DIMENSIONS APPLY AFTER PLATING. © 1984

TITLE IEEE 488 INTERFACE

DRAWING No. A410 - 089

AIM



TOLERANCES: UNLESS OTHERWISE STATED		
ANGLES	LINEAR	HOLES ⌀
APPROVED	SCALE	PROJECTION
CHECKED SWP	FINISH	
DRAWN AIM	MATERIAL	

ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED.
DIMENSIONS APPLY AFTER PLATING.

TITLE
FRONT PANEL CCT· LDO 501

DRAWING No.
A410-091

AIM

ISSUE	1	2	3
DATE	29:5:84		3-5-85
CHANGE NOTE			
CERTIFIED			

PARTS LIST

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
1		1	INTEGRATED CIRCUIT 74LS00N		IC200		103012295
2		1	" " LM556CN		IC201		103011100
3		1	" " R6502P C.P.U.		IC202		103011101
4		1	" " MC68488P GPIB CONTROLLER		IC203		103011102
5		2	" " MC3447-P GPIB DRIVERS		IC204,IC205		103011103
6		1	" " HM6116P-4 (OR EQUIVALENT) RAM		IC206		103011104
7		1	" " HN482764G-4 EPROM		IC207		103011105
8		1	" " 74LS138N		IC208		103015115
9		1	" " MC6805P ACIA		IC209		103016025
10		1	" " R6522P V.I.A.		IC210		103011106
11		1	" " LM7805CT 5V REGULATOR		IC211		103011117
12		1	" " MC1488N LINE DRIVER		IC213		103016029
13		1	" " MC1489N LINE RECEIVER		IC212		103016030
14		5	" " TIL 117 OPTO ISOLATORS 6 PIN DIL		IC214-IC218		103011107
15		1	" " 74LS04N		IC219		103015109
16		2	" " DM74LS126N		IC220,IC221		103011108
17		2	TRANSISTOR BC337 (NPN GENERAL PURPOSE)		TR200,TR201		103032149
18		1	DIODE, ZENER BZY88 5V6		D200		103022011
19		2	DIODE IN4006		D202,D203		103021001
20		1	BRIDGE RECTIFIER 2KBB10R		BR200		103061100
21		2	CAPACITOR 470uf 25V CEA		C200,C202		102031100
22		1	CAPACITOR 2200uf 25V CEA		C201		102031101
23		2	CAPACITOR 470nf 63V MMP		C203,C205		102081103
24		3	CAPACITOR 4.7uf 35V CEB		C207,C209,C218		102021102
25		11	CAPACITOR 47nf 63V MMP		C208,C210-C213		102081104
					C219-C223,C224		
26		5	CAPACITOR 10nf 63V MMP		C214-C216,C204		102081101
					C206		
27		1	CAPACITOR 220nf 63V MMP		C217		102081105
28		1	RESISTOR PACKAGE 4K7 SIL 8 PIN (1 COMMON)		RP200		101041101
29		13	RESISTORS 4K7 SFR25 5%		R200,R204,R206,		101010706
					R207,R209,R212,		
					R223-R226,		
					R228-R230		
30		3	RESISTOR 6K8 SFR25 5%		R210,R211,R202		101010707
31		1	RESISTOR 2M2 MR25 2%		R213		101021100
32		5	RESISTOR 100R SFR25 5%		R214,R218,R220		101010749
					R222,R216		
33		5	RESISTOR 510R SFR25 5%		R215,R217,R219,		101011100
					R221,R201		

ISSUE	1	2	3	4	5
DATE	18.5.84	2.6.84	18.6.84	22.8.84	20.11.84
CHANGE NOTE					

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TITLE: IEEE-488 BOARD PARTS LIST

PARTS LIST No: A410 /007

Sheet 1 of 2

AIM CAMBRIDGE LTD. ST. IVES, CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
34		1	CONNECTOR 24 WAY GPIB CHAMP 552791-1 AND 552633-4		CON 200		105041103
			HARDWARE KIT				
35		1	CONNECTOR 25 WAY RS232-C (DBPF25V6)		CON202		105041111
36							
37		1	SWITCH DIL 8 WAY LEVER S.P.S.T. RIGHT ANGLED		SW200		105121101
38		1	CRYST[illegible] 1MHZ CASE STYLE HC33/U ±50ppm (30pf load)				105021100
42		1	IC SOCKET 28 WAY 800 SERIES				105031100

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DATE	18.5.84	2.[illegible].84	23.7.84	22.8.84	20.11.[illegible]
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TITLE IEEE-488 BOARD PARTS LIST

PARTS LIST No: A410 /007

Sheet 2 [illegible] 2

[illegible]MBR[illegible] TD, S[illegible], CA[illegible] [illegible]ESH[illegible] GLA[illegible]

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
1		1	INTEGRATED CIRCUIT CD4012BE		IC300		103011109
2		1	" " uD 7225G LCD CONTROLLER		IC301		103011110
3		2	POTENTIOMETERS SERIES 91 10K LINEAR (HORIZ 1, pins(A410/107)		P300,P301		101031100
4		1	LCD DISPLAY WITH CONNECTORS (10mm Pins)		LCD300		103051100
5		19	SWITCHES		S300-S319		104091106
6		3	LED's RED (HIGH EFFICIENCY)		D1,D2,D3		103052217
7		3	RESISTOR 220R SFR25 5%		R319,R320,R321		101010717
8		4	RESISTOR 10K SFR25 5%		R300-R303		101010708
9		4	RESISTOR 100K SFR25 5%		R312-R314, R315		101010722
10		7	RESISTOR 22K SFR25 5%		R304-R307, R309, R310, R311		101010720
11		2	RESISTOR 47K SFR25 5%		R317, R318		101010721
12		3	CAPACITOR 1nf 63V MMP		C300, C301, C302		102081102
13		1	CAPACITOR 47nf 63V MMP		C303		102081104
14		2	CAPACITOR 10nf 63V MMP		C304, C305		102081101
15							
16		5	SOCKET TERMINAL STRIPS 10 WAY AUGAT 510 -AG91D				105041104
17	A410/071	1	DISPLAY PCB				108011101
18		1	RESISTOR 180K SFR25 5%		R316		[illegible]

ISSUE	1	2	3	4	5	6
DATE	22.5.84	2.?.84	23.7.84	22.8.84	4.10.84	20.11.84
CHANGE NOTE			110	125	147	

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TITLE DISPLAY BOARD PARTS LIST LD0501

PARTS LIST No: A410/097

Sheet 1 of 1

AIM CAMBRIDGE LTD, ST. IVES, CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
1		1	INTEGRATED CIRCUIT R6502P C.P.U.		IC100		103011101
2		1	" " R6522P V.I.A.		IC101		103011106
3		1	" " MC6821P		IC102		103011111
4		1	" " NVR2 NON VOLATILE RAM CHIP		IC104		103011112
5		2	" " HN4827[illegible]G-4 EPROMS		IC105,106		103011105
6		1	" " 74LS00N		IC107		103012295
7		1	" " 74LS138N		IC108		103015115
8		8	" " CD4042BCN		IC109,110,111,		103011113
					IC112,113,114,		
					IC115,116		
9		1	" " HEF4051P		IC117		103011114
10		3	" " HEF40[illegible]P		IC118,123,124,		103011115
11		1	" " CD4013B		IC119		103015116
12		1	" " 74LS74N		IC120		103015107
13		1	" " CD4093B		IC121		103011116
14		2	" " LM556CN		IC125,129		103011100
15		1	" " LM340T-15 REGULATOR		IC126		103011118
16		1	" " LM340T-5 REGULATOR		IC127		103012308
17		1	" " LM7915CT-15 REGULATOR		IC128		103011119
18		1	BRIDGE RECTIFIER 1KAB10E		BR101		103061101
19		1	" " 2KBB10R		BR102		103061100
20		1	CRYSTAL 1MHZ CAN STYLE HC33/U (±50ppm) (30pf load)				105021100
21		2	CAPACITOR 2200uf 40V TYPE 033 SERIES STYLE 17222		C101,103		102031033
22		1	" 4700uf 16V " " " " 15472		C102		102031196
23		6	" 10nf 400V 344-51103 SERIES		C104,105,106,		102121275
					C107,108,109,		
24		2	" 100uf 25V (RADIAL) C.E.B. SERIES		C110,111		102021100
25		1	" 1000uf 10V " " "		C136		102021101
26		14	" 100nf 63V MMP SERIES		C126,132,133,		102081100
					C134,135,137,	145,	
					C138,139,140,	146	
					C141,142,143		
27		2	" 6n8 100V FKS2 SERIES		C127,128		102081106
28		6	" 10nf 63V MMP SERIES		C129,130,112-115		102081101
29		2	" 1nf 63V POLYESTER MMP		C131,C144		102081102
30		1	ZENER DIODE 5V6 BZY88 SERIES		D100		103022011

ISSUE	1	2	3
DATE	24.5.84	2.6.84	20.12.84
CHANGE NOTE			

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TITLE
DIGITAL BOARD LDO 501
PARTS LIST

PARTS LIST No: A410/098

Sheet 1 of 2

AIM CAMBRIDGE LTD, ST. IVES, CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No
31		8	RESISTOR 100K 5% SFR25		R118,117,119,		101010722
					R115,132,114,		
					R116,113		
32		13	" 4K7 " "		R100,101,102,		101010706
					R105,148,106,		
					[illegible],138,		
					[illegible],141,142,		
					R143,144,		
					,139,138		
33		4	" 22K " "		R133,134,122,120		101010720
34		2	" 220R 2% MR25		R135,152		101020206
35		2	" 470K " "		R136,151		101021102
36		2	" 1K " "		R137,150		101020212
37		1	" 2M2 5% SFR25		R140		101010760
38		1	RESISTOR PACK 22K SIL 6 PIN (ONE COMMON)		RP100		101041100
39		3	CONNECTOR 8 WAY SERIES KK TYPE 22-27-2081		CON101,110,105		10504110[illegible]
40		5	" 4 WAY SERIES KK " 22-27-2041		CON102,103,109,		105041101
					CON108,106		
41		2	TRANSISTOR NPN BC184B		TR100,101		103032149
42		1	MAIN SWITCH PART SDS3F00		SW100	)	
43		1	" " BODY SUR210		SW100	)	105121100
[illegible]		1	" " FLEX (84mm) SWR1084)		SW100	)	
46		2	SOCKET 28 WAY IC 500 SERIES				105031100
47		1	" 24 WAY IC 800 SERIES				105032956
50	A410/034	1	DIGITAL AND IEEE P.C.B. *				[illegible]
51		1	CONNECTOR 15 WAY SERIES KK TYPE 22-27-2151		CON 107,		[illegible]
52		1	CONNECTOR 20 WAY (4030)		CON 104		105042962
53		1	CONNECTOR 5 WAY (4030)		CON 107		105041117

* THIS IS A COMPOSITE OF DIGITAL AND IEEE ARTWORKS

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DATE	24.5.84	2.[illegible]	18.[illegible].84	22.[illegible]	20.1[illegible]
CHANGE NOTE				114	10/[illegible]

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TITLE
DIGITAL BOARD LD0501
PARTS LIST

PARTS LIST No: A410/098
Sheet [illegible] 2

AIM CAMBRIDGE LTD. ST. IVES. CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
1	A410/066	1	FRONT PANEL				104051100
2	A410/080	1	COVERLAY				104013100
3	A410/076	1	WINDOW				104011100
4	A410/061	19	BUTTONS				104011101
5	A410/067	19	SINGLE PUSH BUTTON - 5 MOULDINGS OF 4 BUTTONS - TEMPO				104091100
6							
7		2	KNOBS - MATT BLACK (REF. 2615613)				104121101
8		2	KNOB CAPS - MATT GREY (REF 3015001)				104121102
9		2	INSULATED BNC		FRONT PANEL		105044169
10	A410/034	1	LCD				103051100
11	A410/065	1	REAR PANEL				104051101
12		1	GROMMET - STRAIN RELIEF REF R5 SVT 18.3				104091101
13		1	INSULATED BNC		REAR PANEL		105044169
14	A410/084	8	SPACER (DISPLAY PCB)		FRONT PANEL		104111101
15	A410/058	1	TOP COVER				104051102
16	A410/059	1	BOTTOM COVER				104051103
17	A410/085	1	HANDLE WITH GRIP				104051104
18	A410/070	2	HANDLE SPACER				104111102
19		2	HANDLE MOUNTING (REF. 15-9055)				104051107
20		2	BOSS (REF. 15-9056)				104051108
21		2	CAP (REF. 15-9057)				104051109
22	A410/086/1	1	EXTRUSION L.H.				104051106
23	A410/086/2	1	EXTRUSION R.H.				104051113
24		4	RUBBER TELEPHONE FEET				104095306
25	A410/060	1	ESCUTCHEON				104011102
26		10	SCREW M4 x 6 lg PAN HD POZI NICKEL PLATE		COVERS		104041100
27		12	SCREW M4 x 9.5 lg TAPTITE PANHD. POZI NICKEL PLATE		PANELS		104041101
28		4	SCREW M4 x 30 lg POZI PANHD NI PLATE		HANDLE & A/BOARD		
29		4	SCREW 4.40 x ½ CSK POZI TAPTITE		HANDLE		104041103
30		8	NUT M4 NI PLATE		TRANSFORMER		104047063
31		15	WASHER M4 SHAKEPROOF STAR NI PLATE		TRANSFORMER		104046156
32	A410/092	1	HEATSINK BRACKET				104081100
33	A410/093	1	HEATSINK BRACKET				104081101
34		12	SCREW M3 x 6 lg PANHD POSI NI PLATE				104046106
35		18	NUT M3 NI PLATE		H/S BRACKET		104047070
36		24	WASHER SHAKEPROOF M3 STAR NI PLATE				104047069
37		26	WASHER PLAIN M3 NI PLATE				104047068
38		4	WASHER PLAIN M4 NI PLATE				104047062
39							
40		13	WASHER PLAIN M4 NI PLATE		) & EXT		104047062
41							
42		8	3MM NYLON WASHER				

ISSUE	10	2	3	4	5	6	7	8	9
DATE	13.5.85	2.6.84	18.6.84	29.6.84	12.7.84	22.8.84	4.10.84	19.11.84	22.11.84
CHANGE NOTE	10/024 10/015			Knob Ref Added		113	147	CN/10/008	CN10/009

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TITLE
MECHANICAL PARTS LIST

PARTS LIST No:
A410/099

Sheet 1 of 2

AIM CAMBRIDGE LTD, ST. IVES, CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
43		4	RING TERMINAL 4BA				104041105
44		1	SUE 12.5mm RED BUTTON				104121100
		1	SCREW M3 x 5 PO21 PAN HD				104047085
	10/112	1	ACRYLIC SCREEN				
45		1	TRANSFORMER (AS SPECIFIED BY AIM INSTRUMENTS)		T101		105051100
46	A410/101	1	DISPLAY CABLE FORM				105109103
47		1	ANALGUE/DIGITAL CABLE FORM				105109104
48		1	PSU CABLE FORM				105109105
49		1	A/D CONVERTER				105109106
50	A410/102	3	BNC CABLE ASSY				105101100
51		2	NUT COVER (REF 4815103)				104121103
52		1	FUSE HOLDER BODY L2001A		FUSE 1		105171100
53		1	" " RING L2007A				105171101
54		1	" " CAP L2007B				105171102
55		1	20mm FUSE 250mA 'QUICK BLOW' (DIA 5mm)		FUSE 1		105091100
56		1M	MAINS CABLE 3 CORE REF 140-446				
57	A410/108	2	SWITCH SPACER				
58		2	REGULATOR MOUNTING KIT TO220 REF402 507		10 WASHERS PER KIT		
59					REG.MOUNTING KIT		
60							
61							
62	A410/109	2	SPACER (ANALOGUE PCB)				
63		4	M3 x 10 POZI-DRIVE PAN-HEAD SCREW, NICKEL PLATED		SOCKET MOUNTING		104047019
64	10/110	1	IE.E.E./LED CABLEFORM ASSY				105109107
65							
66		0.2	IN SEAL 5259 10mm THK 20mm WIDE				
67							
68		1	INSULATING COVER (FUSE HOLDER)				105171103
69		2	M3 x 8 PANHD PO21 (P.C.B. FIXING)				104046053

ISSUE	10	2	3	4	5	6	7	8	9
DATE	13.5.84	2.6.84	13.6.84	29.6.84	22.8.84	1.10.84	19.11.84	22.11.84	29.1.85
CHANGE	10/[illegible]			[illegible]	114	147	[illegible]10/0[illegible]	[illegible]10/00	1110/011

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TITLE: MECHANICAL PARTS LIST

PARTS LIST No: A410/099
Sheet 2 of

AIM CAMBRIDGE LTD, ST. IVES, CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
1		1	INTEGRATED CIRCUIT CA3280AG		IC407		103011120
2		1	" " TL082CD		IC401		103011131
3		9	" " LM318N		IC402,431,432		103012304
					IC410,411,414		
					IC418,423,435		
4		2	" " HAS2515 OP AMP 8 PIN DIL PLASTICS		IC403,404		103011121
5		1	" " CA3240E 8 PIN DIL		IC405		103011122
6		3	" " HEF4C51BP		IC406,413,422		103011114
7		1	" " CD4016CN		IC408		103015118
8		2	" " AD7545LN		IC412,419		103011124
9		1	" " 74LS123N		IC417		103011125
10		2	" " LM351N		IC420,427		103011126
11		7	" " HEF4066P		IC421,429,439,		103011115
					IC415,416,436,	434	
117		1	" " CA3096E		IC400		103011130
12		1	" " CD4011BE		IC424		103012199
13		1	" " CD4001BE		IC425		103015179
14		1	" " DM74LS74AN		IC426		103011127
15		2	" " DM7407		IC428,409		103011123
16		1	" " HEF4052BP		IC430		103011128
17		2	RELAY DS2E-MIL2-DC5V		RLY400,401		105081100
18		2	INTEGRATED CIRCUIT LM324N		IC437,438		103012244
19		8	DIODES IN4148		D400,408,409		103022043
					D404,405,406,		
					D407,410		
20		1	DIODE ZN404		D412		103021101
21		4	DIODE HIGH SPEED BAX13		D401,D402,D403		103021102
					D411		
22		2	ZENER DIODES BZX79C7V5		Z400,401		103021100
23		2	RESISTOR NETWORKS 4K7 8 PIN SIL (ONE COMMON)		RP400,401		101041101
24		3	" " 100K 6 PIN SIL (ONE COMMON)		RP402,403,404		101041102
25		2	RESISTOR 5K1 MR25 1%		R462,445		101021215
26		7	" 2K2 SFR25 5%		426,		101010718
					R466,425,481,		
					R427		
27		9	" 22K SFR25 5%		R423,458,461,		101010720
					R457,475,524,		
					R525,526,510		
28		8	" 100K SFR25 5%		R407,531,459,		101010722
					R456,489,476,		
					R538,539, 401		
122		1	INTEGRATED CIRCUIT ZN429E-8		IC433		103071100

ISSUE	1	2	3	4	5	6			
DATE	24.5.84	2.?.84	18.?.84	22.8.84	20.11.84	13.5.85			
CHANGE NOTE									

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TITLE ANALOGUE BOARD LD0501 PARTS LIST

PARTS LIST No: A410/100

Sheet 1 of 4

AIM CAMBRIDGE LTD ST. IVES CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
29		15	RESISTOR 10K SFR25 5%		R422,421,446		101010706
					R454,429,459		
					R401,479,521		
					R520,428,509		
					R508,410,414		
30		1	RESISTOR 68K SFR25 5%		R424		101010714
31		8	RESISTOR 1K SFR25 5%		R443,411,465		101010704
					R478,487,482,		
					R526,527		
32		1	RESISTOR 3K3 SFR25 5%		R412		101010705
33		3	RESISTOR 330K SFR25 5%		R522,523,408		101015203
34		2	RESISTOR 1M SFR25 5%		R498,406		101010767
35		2	RESISTOR 4K7 SFR25 5%		R490,494		101010706
36		1	RESISTOR 15K SFR25 5%		R543		101010763
37		1	RESISTOR 68K SFR25 5%		R424		101010714
38		1	S.O.T. RESISTOR NOM 3K BAND 1K5-4K7 5%		R512		
39		1	" " " 15K-47K 5%		R511		
40		1	" " " 15K-68K 5%		R513		
41		1	" " NOM 3K9 " 1K5-6K8 5%		R544		
42		1	" " " 620-1K2 5%		R483		
43		1	" " NOM 330 " 62-620 5%		R480		
44		3	RESISTOR 20K MR25 1%		R515,444,460		101021217
45		1	" 1K8 " "		R499		101021213
46		1	" 3M3 " "		R405		101021219
47		2	" 330R " "		R439,431		101021212
48		3	" 100R " "		R430,432,425		101021211
49		2	" 33K " "		R409,491,496		101021218
50		2	" 51R " "		R484,486		101021210
51		3	" 3K9 MFR4 1% 50PPM		R447,R463		101021220
52		6	" 10K MR25 1%		R404,403,450		101021200
					R416,452,415,		
124		2	" 5K6 SFR25 5%		R546, 547		101010142
53		2	" 4K7 MFR4 1% 50 ppm		R442, 436		101021221
54		1	" 2K2 MR25 1%		R413,434		101021202
55		4	" 11K " "		R435,507,533,		101021203
					R529		
56		1	" 110K " "		R437		
57		2	" 47R SFR 25 5%		R470,471		101021204
58		1	" 8K2 0.1% 50 ppm 63 mw		R469		101015384
59		1	" 12K " " "		R468		101021301
60		2	" 5K6 " " "		R473,472		
123		1	" 330R SFR25 5%		R545.		101021303

ISSUE	1	2	3	4	5	6
DATE	24.5.84	2.6.84	18.6.84	22.8.84	20.11.84	13.5.85
CHANGE				119/		10/02

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TITLE: ANALOGUE BOARD LD0501 PARTS LIST

PARTS LIST No: A410/100

Sheet 2 of

AIR [illegible] BRIDGE [illegible] ST. [illegible] CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
61		1	RESISTOR 10K 0.1% 50ppm 63mW		R495,		101020807
62		2	" 510R " " "		R501,504		101021304
63		2	" 620R " " "		R532,506		101021305
64		1	" 12R " " "		R519		101021311
65		2	" 4K7 " " "		R418,417		101021309
66		1	" 600R " " "		R500		101021310
67		1	" 2K4 MR25 1%		R485		101021207
68		3	" 22K " "		R530,541,496,		101021208
					R493		
69		2	" 8K2 " "		R492,488		101021209
70		2	" 10K " 2%		R403,420		101020227
71		2	" 620R " "		R451,453		101021107
72		1	" 6K2 " "		R497		101021108
73		2	" 13K " "		R502,503		101020229
74		1	" 130R 0.1% 50 ppm 63mW		R505		101020833
		2	8K2 MR25 5%		R400, 402		101010764
118		1	" 9K1 MR25 1%		R514		101021216
76		5	TRANSISTOR BC214		TR400,407,408,		103032150
					TR409,410		
77		3	" BC184		TR401,406,411		103032149
78		1	" 2N2369		TR402		103031102
79		1	" ZTX450		TR405		103031160
125		2	RESISTOR 100R SFR25 5%		R543, 542		101010749
80		3	CAPACITOR 5.6pf PLATE CERAMIC 683 SERIES		C401,413,486		102041105
81		7	" 100nf K63 MMP SERIES		C400,481,490,		102081100
					C516,418,		
					C521,522		
82		39	" 10nf K63 MMP SERIES		C535,403,407,		102081101
					C409,410,412,		
					C415,416,424,		
					C430,431,434,		
					C451,438,469,		
					C467,470,500,		
					C501,464,479,		
					C478,487,485,		
					C484,491,492,		
					C493,494,		
					C520,524,530,		
					C533,C458,453		
33		2	CAPACITOR 1nf POLYESTER FKS2 SERIES		C402,411		102081107
34		1	" 10uf 35V RADIAL CEB SERIES		C408		102021103
85		3	" 10uf 16V RADIAL CEB SERIES		C468,480,483		102021215

ISSUE	1	2	3	4	5	6	7		
DATE	24.5.84	2.6.84	18.6.84	23.7.84	22.8.84	20.11.84	13.5.85		
CHANGE NOTE				110			10/021		

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TITLE: ANALOGUE BOARD LD0501 PARTS LIST

PARTS LIST No: A410/100

Sheet 3 of 4

AIM CAMBRIDGE LTD, ST. IVES, CAMBRIDGESHIRE ENGLAND

PARTS LIST

ITEM NO.	DRAWING NUMBER	QTY.	DESCRIPTION	SUPPLIER	REMARKS	COST	PART No.
86		4	CAPACITOR 100uf 10V RADIAL CED SERIES		C489,C523,432,433		102021317
87		1	" 330pf 63V POLYPROP FKP2 SERIES		C417		102061015
88		2	" 68pf POLYSTYRENE 160V 'HS' SERIES (AXIAL) 2½%		C435,450		102061100
89		4	" 10pf " " " " ±1pf		C43?,4??		102061011
90		2	" 33nf " 63V 424 1%		C42?,4?0		102061102
91		2	" 3n3 " 160V 425 SERIES 1%		C427,4?1		102061104
92		2	" 1nF " " " "		C428,4?2		102061105
93		2	" 10nf " 63V 424 " "		C458,473		102061103
94		2	" 330pf " 630V 427 " "		C457,474		102061106
95		2	" 1000pf " 630V 427 " "		C45?,475		102061107
96		2	" 330nf 100V POLYCARBONATE 344-21334 SERIES		C459,472		102121100
97		2	" 100nf " " 344-21104 SERIES		C437,471		102121274
98							
99		1	" 10uf 50V RADIAL K SERIES SUB MIN		C48?		102021104
100		2	" 47pf PLATE CERAMIC 683 SERIES		C405,404		102041104
101		2	" 220nf 63V MHR SERIES		C531, 532		102081105
		2	" 5p6 POLYSTYRENE ±0.5pf 125V		C537, 538		102061108
102		3	" 220 nf PLATE CERAMIC 683 SERIES		C420,534, 536		102041103
103		1	" 100 pf " " " "		C514		102041102
104		4	" 270pf PLATE CERAMIC " "		C50?,507,513, C515		102041101
105		4	" 10pf PLATE CERAMIC " "		C508,519,452 C425		102041100
107		2	SOCKET 8 WAY TYPE 22-27-2081 SERIES KK		CON 400,40?		105041105
108		21	" 15 WAY TYPE 22-27-2151 " "		CON401		105041106
109		5	" 4 WAY TYPE 22-27-2041 " "		CON402,409,403 CON404,405,407		105041107
110		4	" 2 WAY TYPE 22-27-2021 SERIES KK		CON412 CON410,411,408		105041108
111		3	FERRITE BEADS L5mm D4mm, HOLE DIA. 2mm		FB400,401,402		104021100
112		0.3 M	TWIN OVAL SCREENED CABLE				105109044
119		2	INDUCTOR 10uH (AXIAL) TYPE LAL04 KB		L401,400		109011100
120	A410/044	1	ANALOGUE PCB				108011102

ISSUE	1	2	3	4	5	6	7	8
DATE	24.5.84	2.?.84	18.?.84	23.7.84	22.8.84	23.10.84	20.11.84	1?.5.85
CHANGE				110	..6/1..	..10/00..		10/023

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TITLE ANALOGUE BOARD LD0501 parts list

PARTS LIST No: A410 /100

Sheet 4 of 4

AIM CAMBRIDGE LTD, ST. IVES, CAMBRIDGESHIRE ENGLAND