Technical Handbook

ITC601

Intelligent Temperature Controller

Revision 5

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OXFORD INSTRUMENTS

Contents

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1 Warnings

1. ***Before you attempt to install or operate this equipment for the first time, please make sure that you are aware of the precautions that you must take to ensure your own safety.***

2. ***High Voltage Hazard. Isolate this equipment by switching off the external AC electrical supply, disconnecting and removing the external supply cable.***

3. ***Maintenance: Only qualified and authorised persons should carry out servicing and repair work on this equipment.***

4. ***High Voltage Hazard: High voltages are present inside this equipment. Isolate this equipment by switching off the external AC electrical supply, disconnecting and removing the external supply cable before any covers are removed.***

5. ***If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.***

6. ***The equipment is not suitable for use with explosive or flammable gases. The equipment is not suitable for use in explosive, flammable or hazardous environments.***

7. ***The equipment does not provide protection against the ingress of water. The equipment should be positioned so that it will not be exposed to water ingress.***

2 Cautions

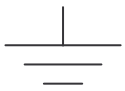
1 If you change set-up data and want it to be retained after power down, the data must be deliberately STORED as described in section 7.6

2 ELECTROSTATIC HAZARD: This equipment contains Electrostatic Sensitive Devices (ESSD). ESSD protective procedures in accordance with BS CECC00015 Part 1 and American National Standard EIA-541-1988 must be applied when installing or maintaining this product. Refer to guidelines in the preliminary pages.

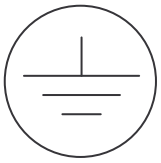
3 COOLING HAZARD. Internal components are air-cooled. Ensure the front lower ventilation space is not obstructed.

Explanation of symbols used in the Instrument

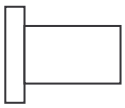
Attention; please refer to the manual



Functional earth



Protective earth



OFF

ON

3 Introduction

This manual is intended as a guide to the technical details of the ITC601 temperature controller. It includes the following information:

a) Full details of the test mode which allows the user to test the ITC601, set limiting values, choose the parameter to be shown on the display and set up tabular data for sweeps and PID values.

b) The means of communicating between the temperature controller and a computer including the full command syntax recognised by the ITC and the responses that it will return. Note that Oxford Instruments ObjectBench is supplied with the ITC601 and that this acts as a high-level interface to communicate with and control the instrument. If you intend to use ObjectBench it will not be necessary to know about the protocols for communication.

c) Specification and circuit diagrams.

Note that an Operator's Handbook is also supplied with the ITC601 which explains in detail the installation and general operation of the instrument.

3.1 Disposal and recycling

Before disposing of this equipment, it is important to check with the appropriate local organisations to obtain advice on local rules and regulations about disposal and recycling.

You **must** contact Oxford Instruments NanoScience Customer Support (giving full product details) before any disposal begins.

3.2 Safety

The following general safety precautions must be observed during the operation, service and repair of this instrument.

3.2.1 Protective Ground

To minimise shock hazard the instrument must be connected to an electrical ground. The ground wire (green/yellow) in the instrument power cable must be connected to the installation electrical ground system. Do not use extension cords without a protective earth conductor. Do not disconnect the protective ground inside or outside the instrument. Do not have external circuits connected to the instrument when its protective ground is disconnected.

3.2.2 Repair and Adjustment

Under no circumstances is the user permitted to adjust or repair this unit while mains is connected.

Ensure that the instrument is disconnected from the AC power supply (switching off the rear panel switch is not sufficient) before the covers are removed or the fuse is replaced, otherwise dangerous voltages are accessible. Capacitors inside the instrument and power connector filter, if fitted, may remain charged after removal of AC power. These should be discharged before starting work.

For fault finding and calibration, the AC Power supply may require reconnection. This work may only be carried out by skilled personnel who are aware of the hazard involved.

4 Installation

4.1 Supply Connections

Before applying power to the instrument, ensure that the voltage selector on the rear panel is correctly set for the intended supply voltage.

If necessary, open the voltage selector panel using the slot provided, withdraw the voltage selector and replace it in the correct orientation for the intended voltage. Check that the correct fuses are fitted, then close the voltage selector panel.

Fuse ratings are:

~100/115 V T1.0AH 250 V

~200/230 V T500mAH 250 V

Note : Please note that there is voltage selector switch at the back of the equipment which needs to be set at 115 V for the mains voltages 100-120 VAC and should be set at 230 V for the mains input voltages 200-230 VAC.

4.2 Classification

The ITC is Class1 Equipment.

The equipment is not suitable for use in the presence of a flammable anaesthetic mixture with air or with oxygen or with nitrous oxide.

4.3 Environment

The following operating environment conditions must be observed;

The instrument is designed for indoor use only.

Maximum Altitude	2000 m
Atmospheric pressure	700 to 1060 mbar (10 to 15 psi)
Ambient temperature	18 to 30 Celsius
Maximum Relative humidity	80% non-condensing
Maximum magnetic field	50 GAUSS
Rated Pollution Degree	Degree 2

5G intermittent 0.5G continuous, 5 to 200 Hz broadband, with a sweep rate of octave/min

4.4 Handling and Storage Including Transport

The module may be stored for up to 15 weeks in a storage environment as follows;

Ambient temperature	-20 to 45 Celsius
Relative humidity	30% to 75% (non-condensing)
Atmospheric pressure	700 to 1060 mbar

If storage is less than 3 days then the following environmental restrictions apply;

Ambient temperature	-40 to 45 Celsius
Relative humidity	30% to 75% (non-condensing)
Atmospheric pressure	700 to 1060 mbar

Marking for packaging and handling complies with international standards ISO 780/BS2770

4.5 Maintenance

Preventive maintenance

Warning

Access within the equipment and removal of connecting cables is restricted to suitably skilled and competent persons. See WARNINGS and CAUTIONS.

Maintenance interval

Six months or as for cleaning if more frequent.

4.6 Cleaning

External cleaning

Interval between cleaning is as required by appearance.

Warning

Ensure that the AC supply to the equipment is isolated at the external disconnect device before cleaning. See WARNINGS and CAUTIONS.

To remove surface dust and light markings, the equipment may be wiped down using lint free cloth, barely moistened with clean water. For removal of heavy marks, the use of a proprietary aerosol foaming cleaner is permissible. Test carefully on a small inconspicuous area to ensure that the product does not damage the surface finish.

4.7 Connections

Warning

High voltage hazard. Ensure that the AC supply to the equipment is isolated at the external disconnect switch before accessing any connection.

Check all cables and connections to the equipment for mechanical security and ensure all covers are securely fixed in place.

Mains cord selection

In the EU, the mains supply cord shall be rated for the maximum current for the equipment. The cable used shall meet the requirements of IEC227 or IEC245, mains cords certified or approved by any recognised national test house are regarded as meeting this requirement.

In the USA the mains cord selected must be a listed mains cord set approved to the standard UL817 for Cord Sets and Power Supply Cords, the mains plug must be a separable plug (without a locking device). If the mains plug is to be a disconnecting device for the equipment, the mains cord must be less than 3 m in length. In Canada the cord set must be certified by CSA. The cord set must be suitable for use and of current rating at least 125% that of the equipment rating.

Green/Yellow covered conductors shall be used only for connection to protective conductor terminals.

4.8 Mounting Instruction

The controller must not be positioned such that it is difficult to remove mains from the rear of the unit.

5 Test mode

The **test mode** provides facilities to assist in testing the ITC601, to set limiting values and to set tabular data for sweeps and PID values.

A second use of the test mode is for storing PID values. If these are set in normal use and the values are to be remembered after switching the unit off, then they must be stored. This is done simply by entering and exiting test mode, see section 5.3.

5.1 Entry to Test Mode

Test mode is entered from the front panel by pressing the SET UP button. On entering test mode the message **tESt** is displayed, which will shortly be followed by the test menu, consisting of a letter "t" and an integer; initially, **t 00** will be displayed.

5.2 Test Menu

Rotate the knob to step through the menu options, but do not press any buttons. When the required option is displayed, press SET UP to select it.

The Test Options are:

- t 00 Exit test mode
- t 01 Test front panel display and lamps
- t 02 Test front panel buttons
- t 03 (Not used)
- t 04 Select "F" menu (front panel display)
- t 05 Set Auto-PID values
- t 06 Set sweep program parameters
- t 07 Select sensor type
- t 08 Calibrate sensor
- t 09 Set limiting values

5.3 Test 00 Exit Test Mode

This option should be used to exit from test mode. On exit, the display will briefly show **Stor** indicating that the all data has been correctly stored.

This "Store" procedure should be used to save any parameters after the instrument is switched off. Such parameters will usually be entered via test mode and will thus be stored automatically. However PID values will need to be stored by entering and leaving **t 00**. Data may also be stored via the serial interface by sending the "~" command.

5.4 Test 01 Test Front Panel Lamps

Lights each LED or display segment in turn. When the test is complete, the unit returns to the test menu. This function is intended to assist with hardware testing.

5.5 Test 02 Test Front Panel Buttons

Tests the front panel switches. This function is intended to assist with hardware testing.

5.6 Test 04 Front Panel Display Menu

Allows the front panel display to be set to indicate one of the internal parameters rather than the normal measured temperature.

When **t 04** is selected, the display will show **F 00** Rotate the knob to select an option for the front panel display. The options are as given in the list below. When the required option has been selected, pressing SET UP will implement it. The temperature controller will return to normal operation but with the selected parameter on display. To restore a normal display **F 00** should be selected.

- F 00 Set temperature
- F 01 Temperature of sensor
- F 04 Difference between temperature of sensor and set temperature
- F 05 Heater output (as % of limit)
- F 06 Heater output (in Volts, approx.)
- F 08 Proportional band
- F 09 Integral action time
- F 10 Derivative action time

5.7 Test 05 Set Auto-PID Coefficients

The Auto-PID data table is normally set up automatically via the computer interface. In some cases it may be desirable to examine or modify this table, and this can be achieved by selecting **t 05** and proceeding as follows:

a) On entry, the display will briefly show **Pid**, followed by **L 01** which corresponds to the first entry in the table. Each entry in the table consists of a value for SET POINT, PROP, INT and DERIV, and while **L 01** is displayed these values may be adjusted by holding down the relevant button and turning the knob. **L 01** gives the PID values that will apply from 0K up to the set point temperature. This temperature defines the point at which the second entry in the table will take over.

b) When the required values have been set for the first entry, select **L 02** by rotating the knob through one click. The parameters for the second entry may then be set in the same way.

c) The SET POINT parameters for successive entries in the table must be in ascending sequence. Any entry for which the SET POINT parameter is zero will mark the top of the table, indicating that no further entries will be used.

To escape from the set PID coefficient mode, press SET UP.

5.8 Test 06 Set Sweep Coefficients

A Sweep Program may be entered from the front panel, by selecting **t 06**.

A Sweep Program may be built with up to 16 separate program steps. When this option is selected, the display initially shows 'P01' corresponding to the first program step. Each program step consists of a set temperature, a sweep time and a hold time. The first program step is entered as follows:

a) Press and hold SET POINT and rotate the knob until the display shows the required set temperature for the first step.

b) Press and hold SWEEP. The display briefly shows 'SEEP' followed by the sweep time for the first program step. Use the knob to bring the sweep time to the desired value. Note that the time is shown in minutes with a resolution of 6 seconds and may be adjusted between zero and 1439.9 minutes (24 hours).

c) Press and hold SWEEP a second time. The display will briefly show 'HOLd' followed by the hold time (in minutes) for the first program step. Use the knob to bring the hold time to the desired value.

d) If any of these settings require further modification, the above steps can be repeated.

To move to the second program step rotate the knob so that the display reads 'P 02'. The parameters for the second step can then be entered in the same way as above. All 16 steps may be programmed in this way.

The sweep and hold times for any unused steps should be set to zero so that these steps are automatically bypassed. The set temperature of step 'P 16' is the temperature at which the set point will remain when the sweep is completed and should be set accordingly.

To escape from the sweep programming mode, press SET UP.

5.9 Test 07 Select Sensor Type

This test mode is only used for initial calibration at the factory.

5.10 Test 08 Calibrate Sensor

This test mode is used to match the temperature controller to the exact characteristics of a specific sensor. A calibration must be carried out at the two ends of the working range.

On entry the display will briefly show **CAL**, followed by the measured temperature. To calibrate the sensor proceed as follows:

a) Cool the sensor to a known temperature as near to the bottom of the range as possible, or apply an equivalent input from a calibrator. Allow the display reading to stabilise. Press and hold SET POINT. The display will initially show **Lo** followed by the current value of the lower calibration point. Whilst holding the SET POINT button, set the correct temperature reading. While SET POINT is being held, the measured input value will be frozen, to prevent any input noise confusing the adjustment. If the input is changing during the calibration process, the displayed value will change when SET POINT is released. In this case simply repeat the process to calibrate for the latest measured value

b) Change to a temperature or calibrator input near the top of the range and repeat the process. This time the display will show **Hi**, the upper calibration point should now be set

c) It may be necessary to repeat until both temperatures read correctly.

To escape from the calibration mode, press SET UP.

5.11 Test 09 Set Limiting Values

Limits may be placed on a number of the controller parameters, either as a means of improving control performance, or to ensure the safety of the system being controlled.

On entry, the display will show **Lit**. Press the appropriate button to set a limit. To escape from the limit mode, press SET UP.

5.11.1 Limiting Maximum Heater Output

To set the heater power limit press the MAN HEATER button. The display will briefly show **H.toP** (Heater top) then the heater limit in volts (approximate value). Use the knob to adjust this value.

5.11.2 Limiting Sensor Temperatures

A limiting value may be placed on the measured temperature. The sensor is continuously checked against this limit and if it is exceeded the heater is turned off.

To set the limiting sensor temperature press the AUTO HEATER button. The display will briefly show **H.oFF** (heater off) then the limiting temperature. Use the knob to adjust this value. The limits should normally be set a little above the maximum operating temperature for the system.

If the limit is exceeded the display will immediately become **Hot1** indicating that the sensor has detected over-temperature. At the same time the heater output voltage will be set to zero. If this causes the temperature to fall below the limit, the message will clear and normal operation will resume. If the heater is in AUTO, heater voltage will be reapplied as necessary to achieve the SET POINT temperature. (In MAN, the heater voltage will remain at zero until a new value is selected).

If after 10 seconds the temperature is still above the limit, the temperature controller will assume that a fault may have occurred in the heater circuit and will isolate the heater from the controller output. If this occurs the display will remain latched in the **Hot1** state, even after the system has cooled. To restore normal operation, it will be necessary to switch the temperature controller off and on again.

By setting a wrong limit, it is possible to end up in a situation where the **Hot1** message is displayed from switch-on. If this occurs, refer to the trouble-shooting guide in the user's handbook.

5.11.3 Limiting Set Temperature

The Set Point Temperature may be limited, preventing the operator from requesting a SET POINT temperature above this limit.

To set this limit press the SET POINT button. The display will briefly show **SEt.P** then the limiting temperature. Use the knob to adjust this value.

6 Remote Operation

6.1 Introduction

The instrument may be remotely operated by means of its RS232 interface. This allows a computer to interrogate the instrument and if required, to take control of it.

In most cases ObjectBench will be used to control the ITC601 remotely. In some cases however, users may want to write their own control programs and the following is included for that purpose.

6.2 RS232 Serial Data Line Connections

The serial data link from the computer is connected via a 25 way D-socket, at the back of the unit, and is accessible from below. ITC601 is configured as a DCE with the standard pin outs given below. The majority of computer RS232 interfaces are configured as a DTE and are fitted with a 25 way D plug. For this type of connector, a simple lead connecting pin 1 to pin 1, pin 2 to pin 2 and so on is all that is required. For computers fitted with a 9 way D plug for RS232, (AT style COM port), a standard "AT lead" fitted with a 9 way socket and a 25 way plug is required.

Pin connections at the RS232 socket are:

Pin	Name	Notes
1	FG	Linked to Chassis Ground in power supply
2	TD	Received Data (From Computer)
3	RD	Transmitted Data (To Computer)
4	RTS	Linked to 5
5	CTS	Linked to 4
6	DSR	+5 V when unit is powered up
7	GND	Signal Ground
8	DCD	+5 V when unit is powered up

All other pins are open circuit.

The temperature controller does not require signals to be present on any of the "modem control" lines, RTS or DTR (pin 20).

6.3 Communication Protocols

This section describes the general procedure for communicating between a computer and the ITC601.

a) All commands consist of a string of printing ASCII characters, terminated by a Carriage Return character. A Line Feed character may optionally be sent after the Carriage Return but is ignored by the instrument.

b) Unless the command starts with a "$" (dollar) character, all commands will evoke a response from the instrument. The response will consist of a string of one or more printing ASCII characters and will be terminated by a Carriage Return Character. This may optionally be followed by a Line Feed character.

c) A response will normally be sent immediately following the command. If a front panel button is pressed when the command is received, the response may be delayed until the button is released.

d) If the first character of a command is a "$", the command will be obeyed but no response will be sent; see section 6.4.

e) The instrument will accept a command string at all times. If a computer linked by the serial (RS232) port, is unable to accept data from the instrument at the full rate of the 9600 baud interface, the "W" command may be used to instruct the instrument to send more slowly

f) Commands to the instrument consist of a single letter, optionally followed by a numeric parameter, the whole being terminated by a Carriage Return. The response sent by the instrument varies depending on the command. Usually it consists of the command letter received, followed by the value of any data requested. Where a command instructs the instrument to carry out an action rather than to send data, the command letter alone will be returned.

g) If a command is not recognised, has an illegal parameter or cannot be obeyed for any reason, an error response will be sent. This consists of a "?" followed by all or part of the command string in question. To simplify error handling in the computer, the "?" will always be the first character returned. The most common reason for a command error is attempting to execute a control command whilst the instrument is in local control. If in doubt, the "X" command may be used to determine the current status.

h) All numeric parameters are treated as signed decimal numbers and are sent as a string of decimal digits with an appropriately placed decimal point. Essentially the format of all numbers matches that displayed on the front panel.

6.4 Use with Oxford Instruments ISOBUS

A feature of this temperature controller and other Oxford Instruments products, is the ability to connect a number of instruments simultaneously, to a single RS232 port on a computer and to control each one independently. This is done by means of an ISOBUS cable which carries a single MASTER connector (25-way D socket) and up to eight, daisy-chained SLAVE connectors (25-way D plugs). Each slave connector incorporates full optical isolation so that the slaves are all isolated from the master and from each other.

When operating on ISOBUS an instrument must be able to recognise and respond to commands addressed to it, whilst ignoring commands addressed to other instruments. This is achieved by starting all commands with a special ISOBUS control character.

When more than one powered-up instrument is connected on ISOBUS, no command should be issued which does not have an ISOBUS control character as its first character. Issuing such a command would result in an unintelligible response, as all instruments would reply together (note that this will only result in lost data, no hardware damage will be caused).

Following the control character and its parameter (where required), the rest of the command follows the form described above. The response of the instrument depends on the initial control character in the following manner:

@n (At) addresses the command to instrument number n, where n is a digit in the range 0 to 9. This instrument obeys the command and returns its usual response. All other instruments ignore the command and send no reply.

**$** (Dollar) instructs all instruments to send no reply. This is normally used to precede a command being sent to all instruments simultaneously, and prevents a conflict as they all echo the command together. It may also be used in non-ISOBUS applications if the computer does not wish to receive a response. It should be used with caution however, since all responses are suppressed, including the "?" error response. Thus the computer has no way of knowing if a command has been received or even if the instrument is connected. If a command is to be addressed to a specific instrument, but no reply is required, it is permissible to use "$" and "@n" together. The "$" should always come first.

& (Ampersand) instructs an instrument to ignore any following ISOBUS control characters. It is included in the ISOBUS protocol to allow instruments whose command repertoire includes "@", "$", "&" or "!" to be used on ISOBUS. ITC601 does not require the use of this command.

!n (Exclamation) instructs the instrument that from now on its address is to be n. This command is included here since it is relevant to ISOBUS operation. However for obvious reasons, it should not be sent when more than one instrument is powered up and connected to ISOBUS. (It would result in all instruments having the same address!). The command is intended for initial setting up of instruments, one at a time. To avoid inadvertently changing addresses, the "!" command will only be obeyed following a "U" command with a non-zero password; see page 21.

7 Command Syntax

Commands fall into 4 categories:

- **Monitor Commands**
  which are always recognised
- **Control Commands**
  which are only recognised when in REMOTE control
- **System Commands**
  which are only recognised after receipt of the correct Unn command or "unlock key"
- **Specialist Commands**
  Which are all lower case letters. They are primarily for use with Oxford Instruments supplied high level system software or as an aid to control algorithm development.

In the Lists which follow "n" and "m" represent decimal digits 0-9. A number represented by “nn” is not constrained to be a single digit.

7.1 Monitor Commands

To monitor the state of the instrument.

Cn Set Control

The control command sets the instrument to Local or Remote and determines whether the REMOTE button is Locked or Active. At power up the instrument defaults to the C0 state. Allowed values are:

C0	Local & Locked	(default state)
C1	Remote & Locked	(front panel disabled)
C2	Local & Unlocked	
C3	Remote & Unlocked	(front panel active)

In the C3 state buttons such as SET POINT, PROP etc., can be used to examine values on the display, but the knob cannot be used to change these values. If any buttons are pressed while in the C3 state, the instrument will not respond to any remote commands. Instead these are held pending and acted upon when the button is released. Computer programs should either be written to tolerate this delay or should put the instrument into the C1 state to completely disable the front panel controls.

Qn Set Communications Protocol

Defines the communication protocol. Currently only 2 values of n are significant:

Q0	“Normal" (Default Value)
Q2	Sends <LF> after each <CR>

Note that unlike all other commands, the Q command does not produce an echoed response to the computer. Having changed the communication protocol, it automatically clears the communications buffer.

Rnn Read Parameter

The READ command allows the computer to interrogate any of a number of variables. The returned value is always an integer as defined in section 6.3. Allowed values for n are listed below.

R0	Set temperature
R1	Sensor 1 temperature
R4	Temperature error (+ve when Set > Measured)
R5	Heater O/P (as % of current limit)
R6	Heater O/P (as Volts, approx.)
R7	Unused
R8	Proportional band
R9	Integral action time
R10	Derivative action time
R11	Channel 1 freq./4

Unn Unlock System Commands

The UNLOCK command allows access to the System Commands. This set of commands are intended for diagnostic and configuration purposes and have the power to erase or modify the contents of the memory. The U command must be sent with the correct KEY parameter before these commands may be used. The KEY value for these commands is 9999.

A lower level of key protection is provided for the "!" command, to avoid accidental errors. Any non-zero value will unlock this command.

Thus the allowed values of U are:-

U0	Locked (power-up default)
U1	"!" command unlocked
U9999	"Y" and "~" commands are unlocked

V Read Version

The VERSION command requires no parameters. It returns a message indicating the instrument type and firmware version number.

For example: "ITC601 Version 1.01 © OXFORD 1996"

Wnn Set Wait Interval

The WAIT command sets a delay interval before each character is sent from the instrument via the serial interface. This allows the instrument to communicate with a slow computer with no input buffering. The parameter nn specifies the delay in milliseconds. It defaults to zero at power-up and the maximum delay is 32767 milliseconds.

X Examine Status

The EXAMINE command allows the computer to read the current ITC601 status. It requires no parameters and will return a message string of the form:

XnAnCnSnnHnLnNn

where the digits "n" have the following meaning:

Xn	System Status	(Always 0)
An	AUTO HEATER Status	(n as for A command but see below)
Cn	REMOTE	(n as for C command)
Snn	SWEEP Status	(nn = 0-32 as follows)
	nn = 0	Sweep not running
	nn = 2P-1	Sweeping to step P
	nn = 2P	Holding at step P
Hn	Control Sensor	(Always 1)
Ln	AUTO-PID Status	(n as for L command)
Nn	TUNE Status	(n as for N command)

7.2 Control Commands

To change the state of the instrument.

An Set heater to Auto or Manual

Allowed values are:

A0 Manual heater
A1 Auto heater

Note that "Manual" in the context of remote control means that the heater may be set directly by an "O" command from the computer.

Fnn Set Front Panel Display

This command sets the display to show one of the internal parameters rather than the normal measured temperature. Normal display operation may be restored by sending "F1". The command is intended chiefly for use during test and fault diagnosis. n may take the same values as for the "R" command above and with the same significance.

Pnn Set Proportional Band

nn is the desired proportional band in kelvin which should be sent as a number in accordance with section 6.3.

Inn Set Integral Action Time

nn is the desired integral action time in minutes which may range from 0 to 140 minutes in steps of 0.1 minute and should be sent as a number in accordance with section 6.3.

Dnn Set Derivative Action Time

nn is the desired derivative action time in minutes which may range from 0 to 273 minutes and should be sent as a number in accordance with section 6.3.

Ln Set Auto PID

This command enables or disables the use of the tables of (Learnt) Auto-PID values.

L0 Disables Use of AUTO-PID
L1 Use AUTO-PID

When the "L0" command is issued, the P, I and D values will remain at their existing settings. These will remain in force until they are changed by the issue of individual "P", "I" or "D" commands or until an "L1" command is issued.

If the Auto-PID table is not in use (that is the "SET POINT" parameter for the first entry has been set to zero), the "L1" command will not be available and will produce a "?L1" error response.

Mnn Set (Maximum) Heater Volts Limit

The MAXIMUM HEATER command sets the maximum heater voltage that the temperature controller may deliver, under automatic control or in response to an "O" command.

Nn Start / Stop Tune

The Tune command may be used to start and stop the automatic tuning process

N0 Stops Tune
N1 Starts Tune

When ITC601 is tuning, many of the remote commands are disabled. Those controls which only affect the display will still work, but those which could change the operation of the instrument will not.

Onn Set Output Volts

Sets the required heater output in MANUAL. The parameter nn is expressed as a percentage of the maximum heater voltage and has a range of 0 to 99.9.

Sn Start / Stop Sweep

The Sweep command may be used to start and stop a sweep remotely.

S0 Stops Sweep
S1 Starts Sweep

Values of n from 2 to 32 may also be sent so as to begin the sweep program part way through.

Tnn Set Desired Temperature

This command sends a set point temperature. The parameter is the required temperature, sent as a number in accordance with section 6.3. Note that if a sweep is running, the temperature set by the T command will be over-ridden by the sweep.

7.3 System Commands

These commands need to be "unlocked by the correct "Unn" command.

Yn Load RAM Contents

The Y command allows the contents of the RAM memory to be loaded in binary, via the serial interface. It is not intended as a user command.

Zn Dump RAM Contents

The Z command allows the contents of the RAM memory to be dumped in binary, via the serial interface. It is not intended as a user command.

! Set ISOBUS Address

See section 6.4

~ Store Memory

The ~ command saves new settings, so that they will be remembered after power off. The front panel display will briefly show **Stor**, see test mode section 5.3

7.4 Specialist Commands

In general the commands in this section are not intended for customer use. They have been provided for engineering use during algorithm development and to interface with certain Oxford Instruments application software. The details which follow are provided for interest only.

a Read Auto-Tune Peak Data

This command reads peak data from the ITC601 autotune algorithm. It is not intended as a user command.

b.. Read Auto-Tune Diagnostic Data

This command reads diagnostic data from the ITC601 autotune algorithm. It is not intended as a user command.

n.. Set Auto-Tune Control Switches

This command sets various control options for the ITC601 autotune algorithm. It is not intended as a user command.

p.. Program Auto-PID Table

The pnnn command allows programming of PID settings for use in Auto-PID mode. 32 entries are allowed in the Auto-PID Table. Each entry contains an upper temperature limit, and values for P, I and D. The PID values for a particular entry apply up to the upper temperature limit for that entry and from the upper temperature limit of the previous entry. A value of 0 for the Upper Temperature Limit of any entry is used to mark the end of the active part of the table. Any higher entries will be ignored.

The P, I and D values for the first entry in the table apply down to 0 K. If the Upper Limit Temperature for the first entry is set to zero (p=0 for x=1, y=1), auto-PID operation will be disabled.

The x pointer defines the entry (1 to 32). The y pointer selects the parameter from:

y=1 Upper Temperature Limit
y=2 Proportional Band
y=3 Integral Action Time
y=4 Derivative Action Time

q Read Auto-PID Table

The q command allows the individual entries in the Auto-PID table to be read back, using the x and y pointers as above.

r Read Sweep Table

The r command allows the individual steps of the sweep table to be read back, using the x and y pointers as above.

s.. Program Sweep Table

The s command allows the individual steps of the sweep table to be programmed. The x pointer should be pre-set to the sweep step (1 to 16). The y pointer selects the parameter to program:

y=1 Set Point Temperature
y=2 Sweep Time to Set Point
y=3 Hold Time at Set Point

To program a sweep, the temperature controller must be in REMOTE and a sweep must not be running.

w Wipe Sweep Table

Wipes all the values entered by the s command (or entered manually). This command will not be recognised if the temperature controller is in LOCAL or if a Sweep is running.

x.. Set x Pointer

y.. Set y Pointer

The x and y commands set pointers into tables for loading and/or examining data values in the table. The sequence of operations is to load either or both pointers as appropriate, then issue the command to load or examine the data. The number following 'x' or 'y' is a decimal integer in the range 0 to 128. If a command is issued with incorrect values set for x or y, that command will not be obeyed and an error response will be returned.

At power-up x and y are set to zero. None of the tables hold data at x=0, y=0; so it is good practice to leave x and y set to zero after use. This will ensure that if one of the "table" commands is issued inadvertently, it will always be rejected and produce an error response.

8 Quick reference guide

8.1 Front Panel Controls

REMOTE	Toggle local (front panel) and remote (computer) control.
SWEEP	Start and stop an automatic temperature sweep.
TUNE	Start and stop the Automatic Tune.process
SET UP	Enter Test Mode (see below).
SET POINT	Adjust the set point temperature.
PROP	Adjust the Proportional term.
INT	Adjust the Integral term.
DERIV	Adjust the Derivative term.
MAN HEATER	Switch to manual heater control (and adjust).
AUTO HEATER	Switch to automatic heater control.
AUTO PID	Automatically set PID values from internal look-up table.

8.2 Test Mode

			Display
t 00	Exit and store.		**Stor**
t 01	Test front panel display and lamps.		
t 02	Test front panel buttons.		_ _ _ _
t 03	(not used)		
t 04	Select "**F**" menu to set front panel display, see section 8.4		
t 05	Select "**L**" menu to set PID values		**Pid**
	SET POINT, **PROP**, **INT**, **DERIV** buttons		
t 06	Select "**P**" menu, set sweep program values		**Pro**
	SET POINT button	Set target temperature	
	SWEEP button, 1st. time	Set sweep time	**SEEP**
	SWEEP button, 2nd. time	Set hold time	**HOLd**
t 07	Select sensor, factory set.		**LOAd**
t 08	Calibrate the sensor		**CAL**
	SET POINT button		**Hi** or **Lo**
t 09	Set limits		**Lit**
	SET POINT button	Limit user set point	**SEt.P**
	MAN HEATER button	Limit heater output	**H.toP**
	AUTO HEATER button	Fault, Heater off	**H.oFF**

8.3 Serial Commands

An Set auto/man for heater
Cn Set control
Dnn Set derivative action time
Fn Set front panel to display parameter n
Inn Set integral action time
Ln Set AUTO-PID (Learned PID's)
Mnn Set maximum heater volts limit
Onn Set output volts (in manual only)
Pnn Set proportional band
Qn Define communication protocol
Rn READ PARAMETER N
Sn Start/stop sweep
Tnn Set desired temperature
Unn Unlock for "!" and system commands
V Read version
Wnn Set wait interval between output characters
X Examine status
Y Load entire RAM contents
Z Dump entire RAM contents
! Set ISOBUS address
~ Store Memory

Specialist Commands

a Read Auto-Tune Peak Data
b.. Read Auto-Tune Diagnostic Data
n.. Set Auto-Tune Control Switches
p.. Program auto PID table
q Read auto PID table
r Read sweep table
s.. Program sweep table
w Wipe sweep table
x.. Set x Pointer
y.. Set y Pointer

8.4 Display Parameters

These numbers identify the display variables for the two computer interface commands, **Fnn** and **Rnn**. The test mode ,**t 04**, sets the front panel display using the same numbers.

0 Set temperature
1 Sensor 1 temperature
4 Temperature error (+ve when Set > Measured)
5 Heater O/P (as % of current limit)
6 Heater O/P (as Volts, approx.)
7 Unused
8 Proportional band
9 Integral action time
10 Derivative action time
11 Channel 1 freq./4

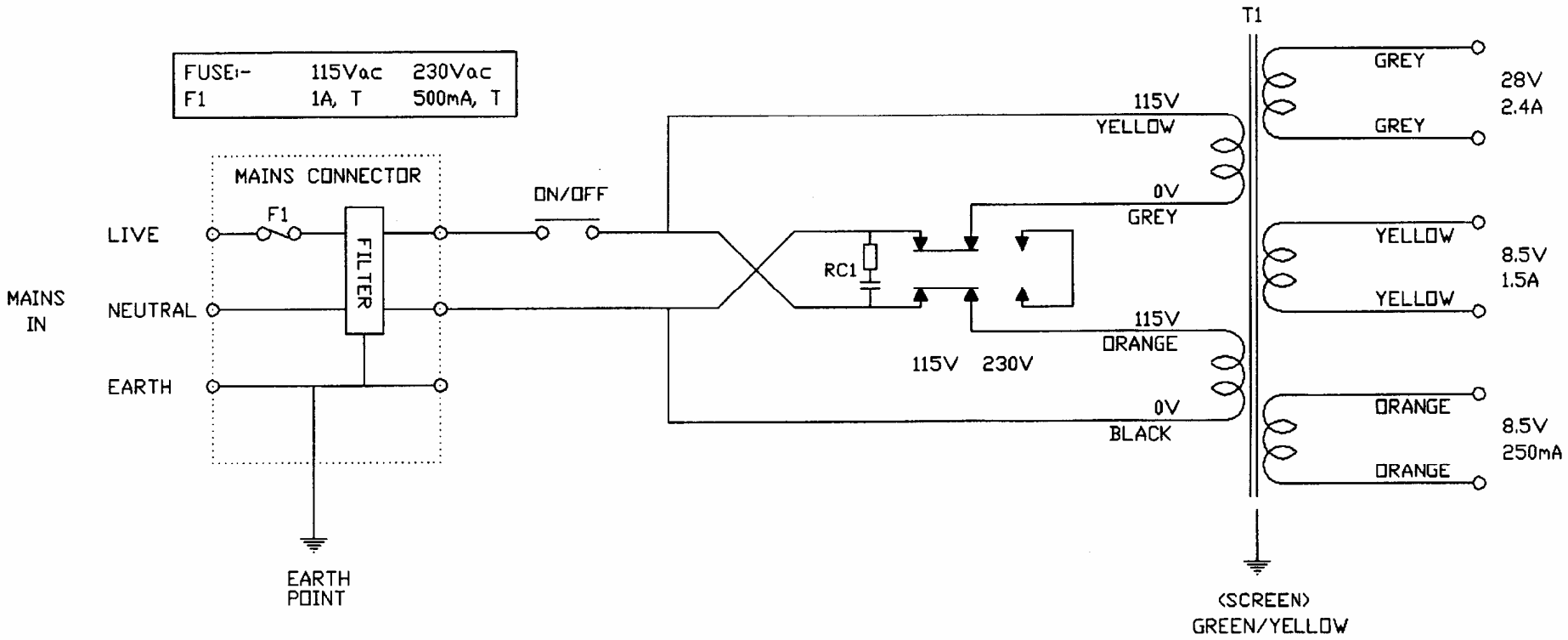
9 Specifications and Circuit Diagrams

Input Channels	1		
Voltage Measurement	2 wire (for thermocouples)		
Resistance Measurement	4 wire (for metal resistors)		
Temperature Sensors Types			
Rhodium Iron	1.5 K to 500.0 K	at 1 mA	(rF.52)
Platinum Resistor	50.0 K to 500.0 K	at 100 μA	(rP.51)
Silicon Diode	2.0 K to 300.0 K	at 10 μA	(dS.32)
Gold /Iron thermocouple	2.0 K to 500.0 K		(tG.57)
Heater Output	0-30 volts DC		
Heater Resistance (minimum)	20 ohms		
Heater Output Power	40 W max. into 20 ohms		
Heater Duty Cycle	45 minutes full power and 45 minutes off		
Display Type	0.56 inch green LED		
Control Method	Digital 3-Term (P,I,D)		
Sample Rate	4 Hz		
RS232 Interface	Configured as DCE		
Handshake	None Required		
Baud Rate	9600 Baud		
Connectors			
Power in	IEC 3 pin		
Sensor Input	9 way D socket		
RS232	15 way D socket		
Power Requirements	100-115 V 50/60 Hz		
	or 200-230 V 50/60 Hz		
Voltage Variation	± 10% of nominal voltage		
Transient Overvoltage Category	Category II of IEC 60364-4-443		
Fuse Rating	100/115 V T1.0AH 250 V		
	200/230 V T500mAH 250 V		
Power Consumption	60 W approx.		
Dimensions			
Depth (front to back)	250 mm		
Width	280 mm		
Height (maximum)	105 mm		
Weight	3.5 kg		

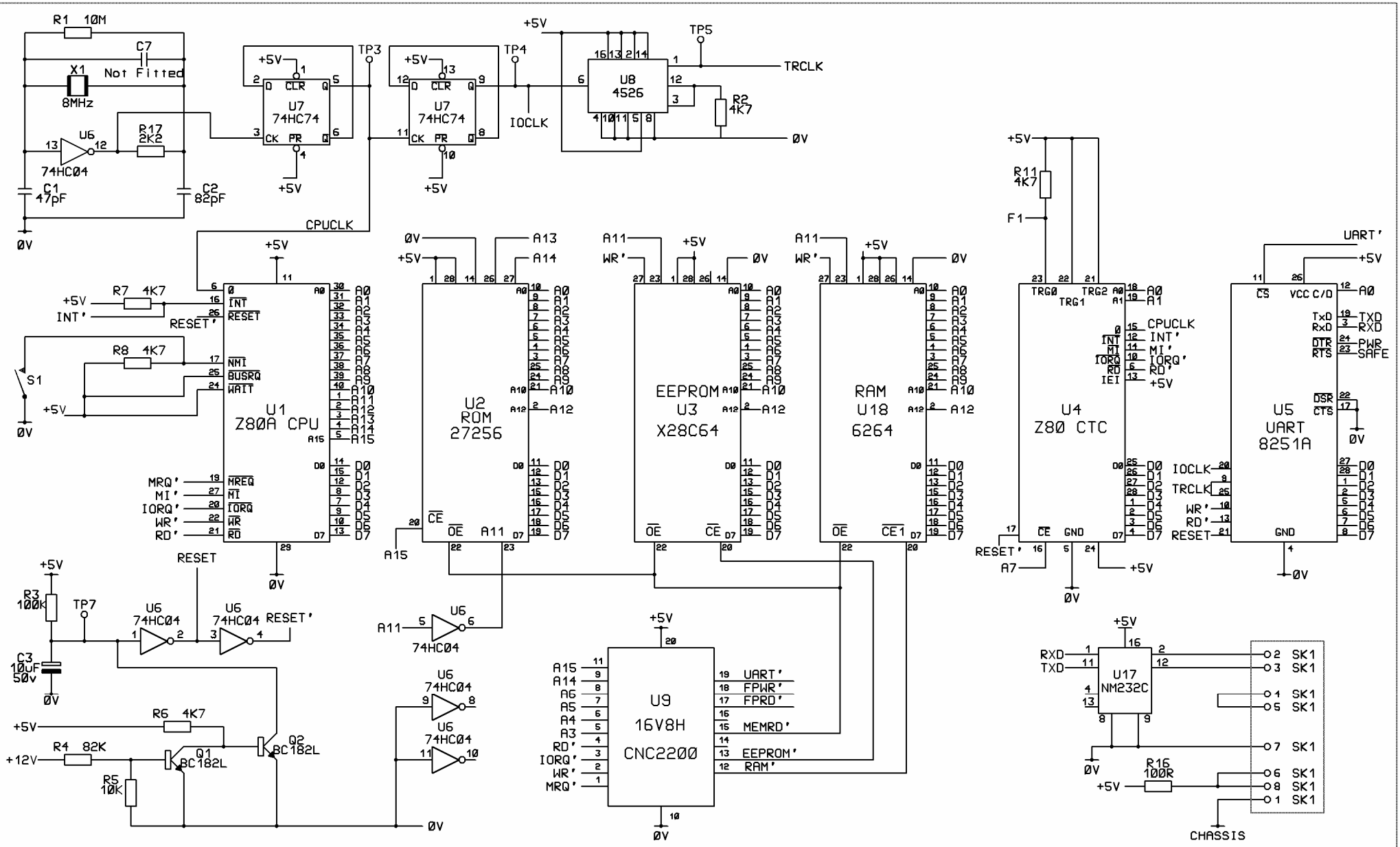
10 Circuit Diagrams

The circuit diagrams that follow are listed below.

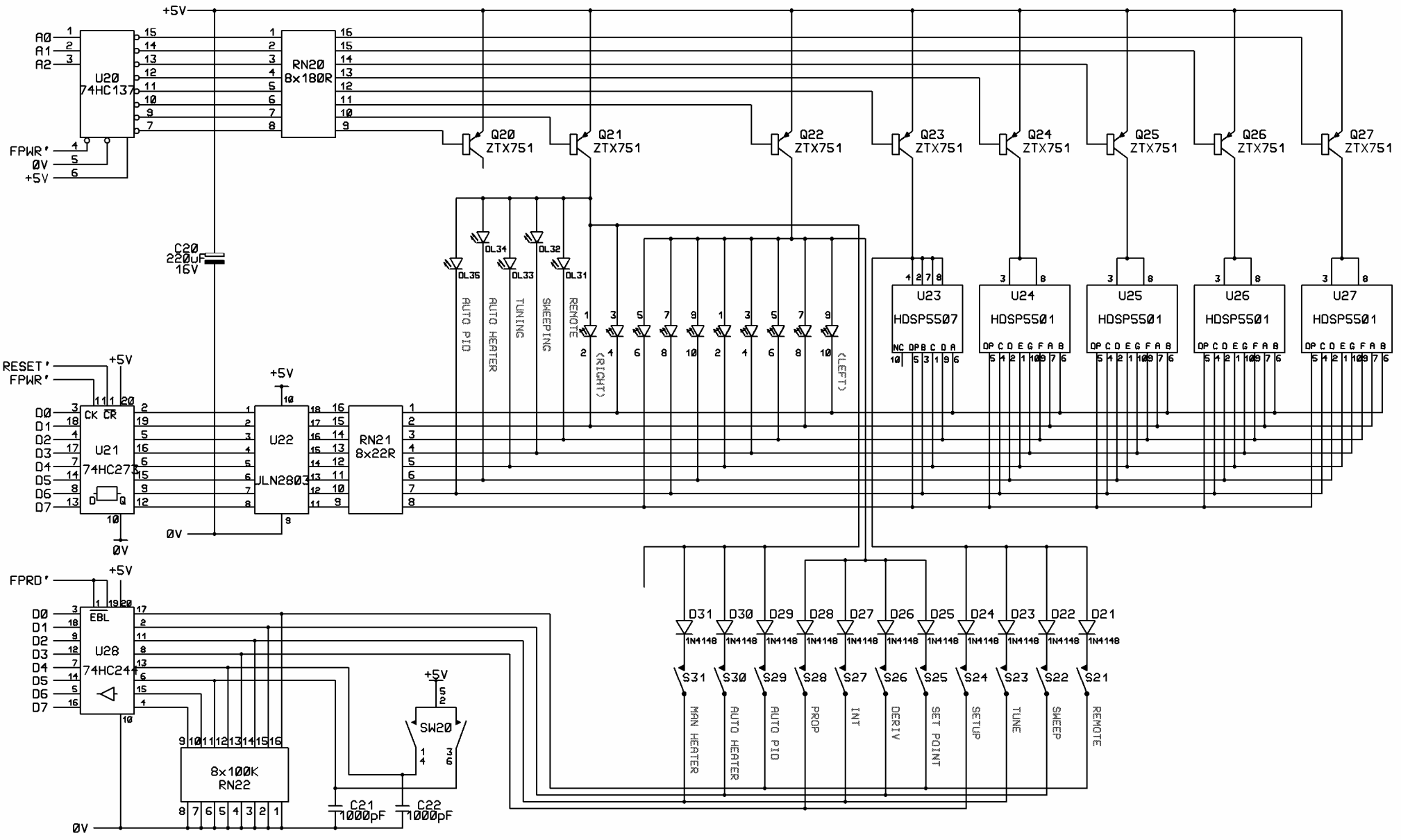
Drawing number	No. of pages	Description
CQL1102	1 of 1	Mains wiring diagram
CQL1200	1 of 6	Main PCB, CPU, Memory and RS232
	2 of 6	Main PCB, Display and Keys
	3 of 6	Main PCB, Input Amplifier
	4 of 6	Main PCB, Output Stage
	5 of 6	Main PCB, Power Supplies
	6 of 6	Main PCB, De Coupling Capacitors
CQL1502	1 of 1	Range Card PCB



			ITC601 MAINS WIRING
			DRAWING NUMBER A4/ CQL1102
MACJ	29/5/96		



06	31/10/07	U8 PINS. VALUE R4 & D41. DELETE C6. PAD UPGRADES.	TITLE	OXFORD
04	18/11/03	ECR6322 C6 WAS 100pF	ITC601 MAIN PCB	
03	12/6/96	REFERENCE VOLTAGE CHANGED	CPU, MEMORY AND RS232	DRAWING NUMBER
02	20/4/96	PROTOTYPE MODS		A4 CQL1200 1 of 6
01	7/2/96			



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04	18/11/03	ECR6322 C6 WAS 100pF
03	12/6/96	REFERENCE VOLTAGE CHANGED
02	20/4/96	PROTOTYPE MODS
01	7/2/96	

TITLE

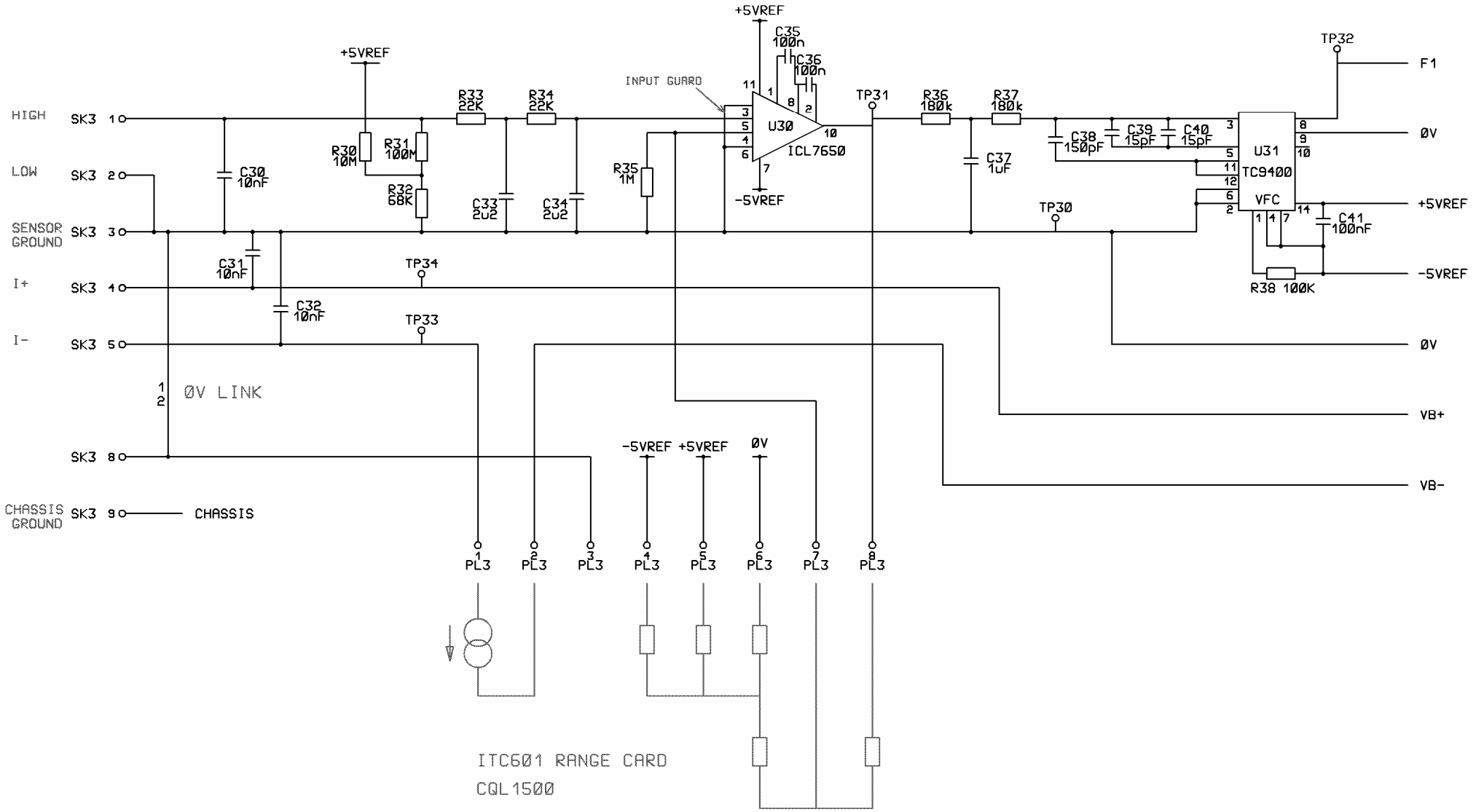
ITC601 MAIN PCB

DISPLAY AND KEYS

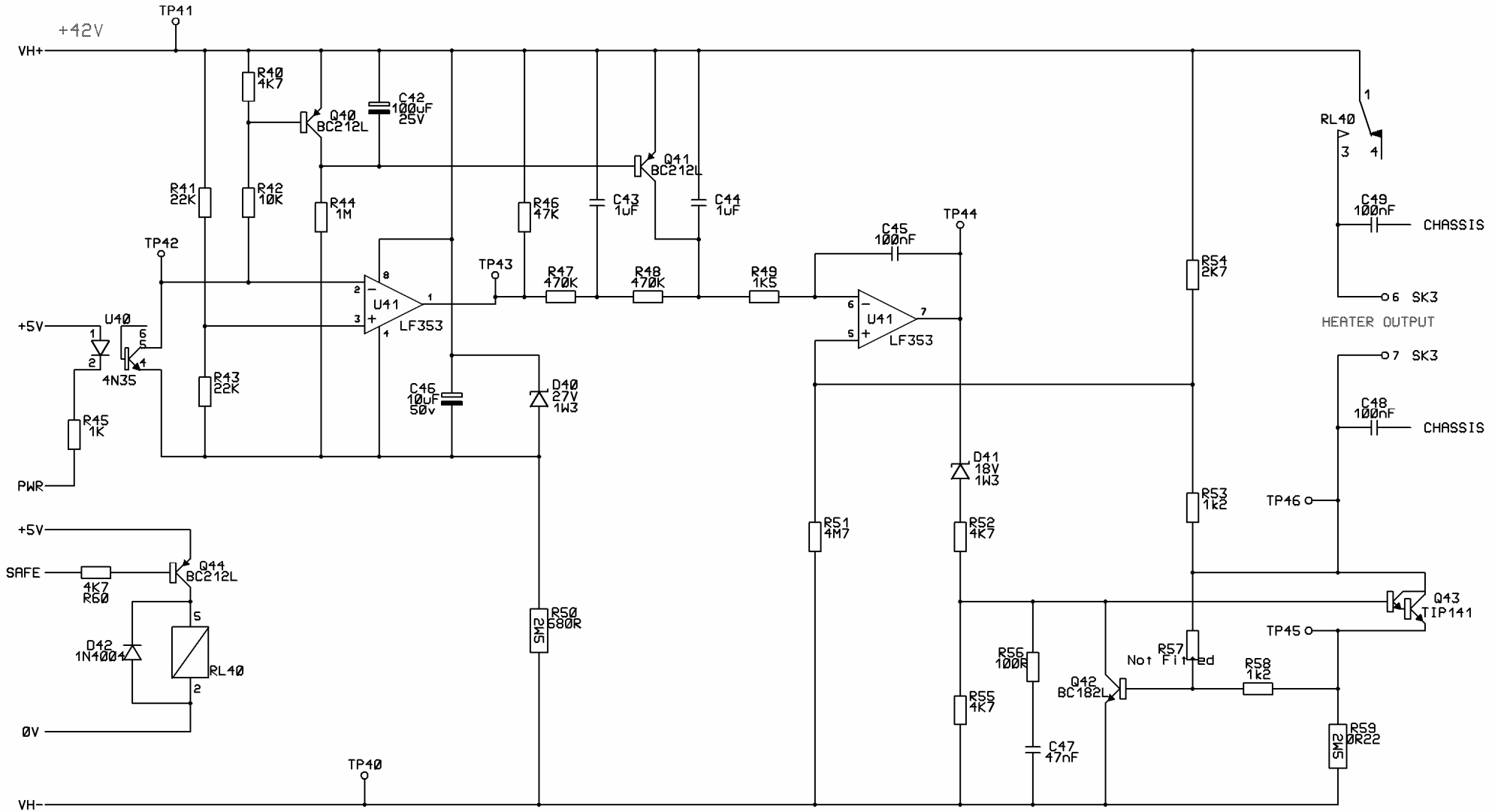
OXFORD

DRAWING NUMBER

A4 CQL1200 2 of 6



06	31/10/07	U8 PINS. VALUE R4 & D41. DELETE C6. PAD UPGRADES.	TITLE
04	18/11/03	ECR6322 C6 WAS 100pF	ITC601 MAIN PCB
03	12/6/96	REFERENCE VOLTAGE CHANGED	INPUT AMPLIFIER
02	20/4/96	PROTOTYPE MODS	OXFORD
01	7/2/96		DRAWING NUMBER A4 CQL1200 3 of 6



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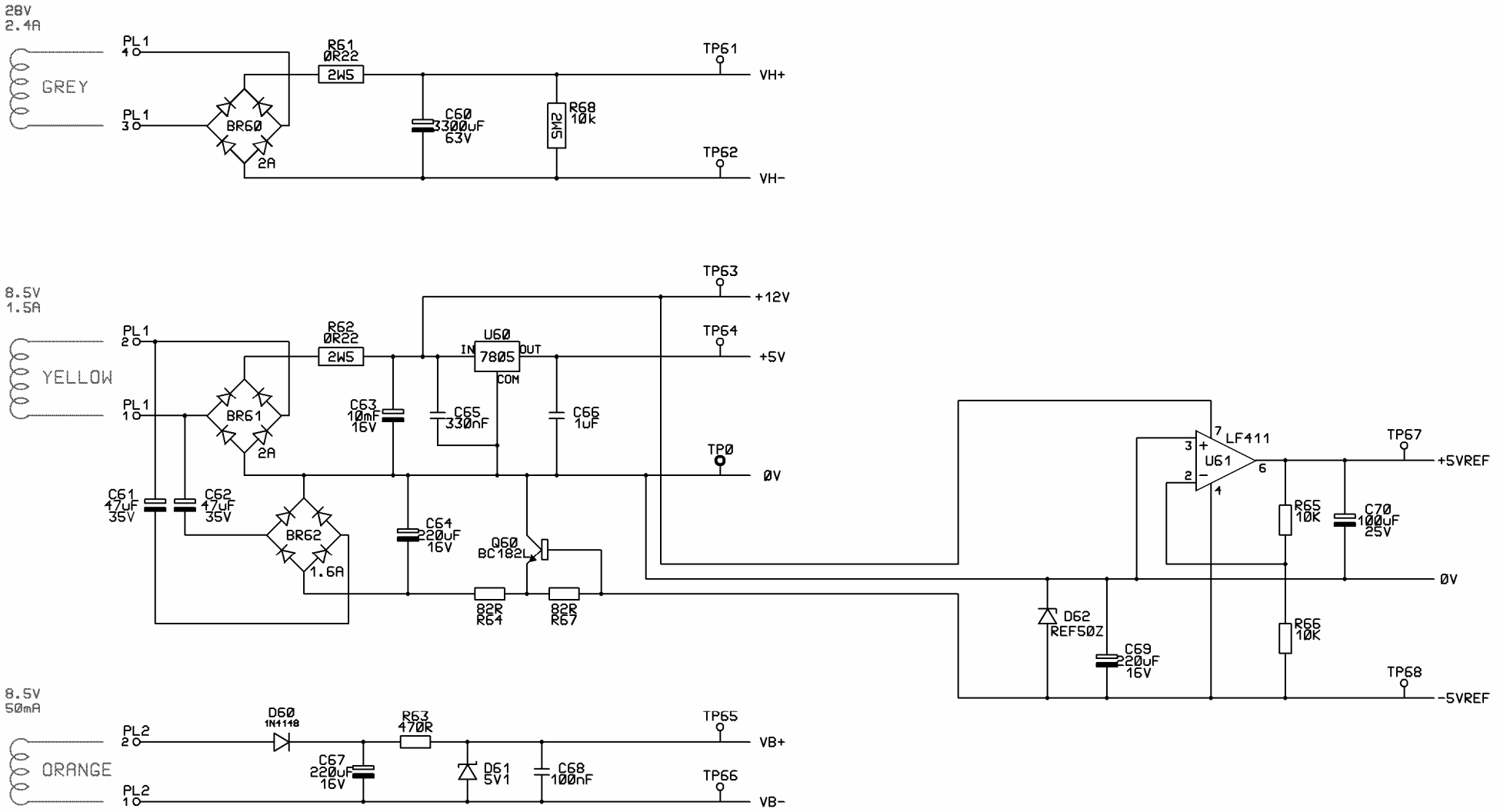
04	18/11/03	ECR6322 C6 WAS 100pF	ITC601 MAIN PCB
03	12/6/96	REFERENCE VOLTAGE CHANGED	OUTPUT STAGE
02	20/4/96	PROTOTYPE MODS	OXFORD
01	7/2/96		DRAWING NUMBER A4 CQL1200 4 of 6



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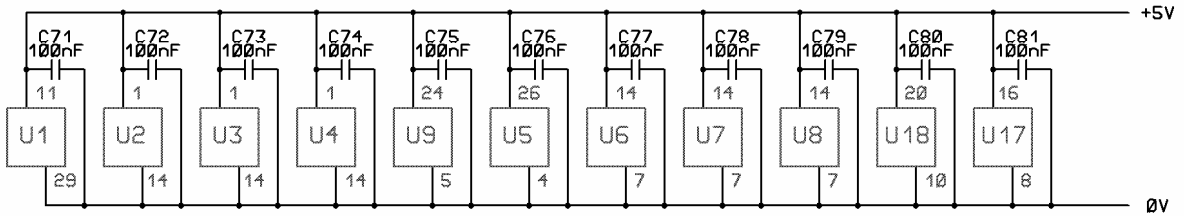
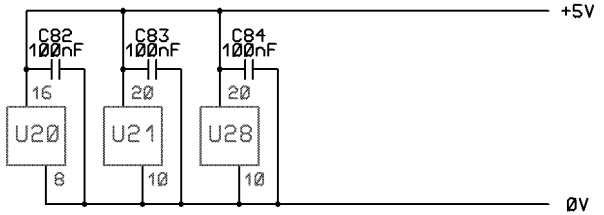
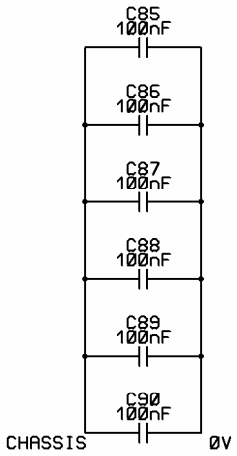
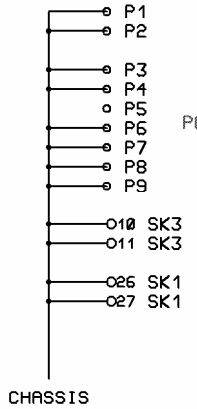
04	18/11/03	ECR6322 C6 WAS 100pF	ITC601 MAIN PCB	
03	12/6/96	REFERENCE VOLTAGE CHANGED	POWER SUPPLIES	DRAWING NUMBER
02	20/4/96	PROTOTYPE MODS		A4 CQL1200 5 of 6
01	7/2/96			









PCB MOUNTING HOLES

DECOUPLING CAPACITORS TO BE CLOSE TO THE RELEVANT COMPONENT.

Ø6	31/10/07	U8 PINS. VALUE R4 & D41. DELETE C6. PAD UPGRADES.
Ø4	18/11/03	ECR6322 C6 WAS 100pF
Ø3	12/6/96	REFERENCE VOLTAGE CHANGED
Ø2	20/4/96	PROTOTYPE MODS
Ø1	7/2/96	

TITLE

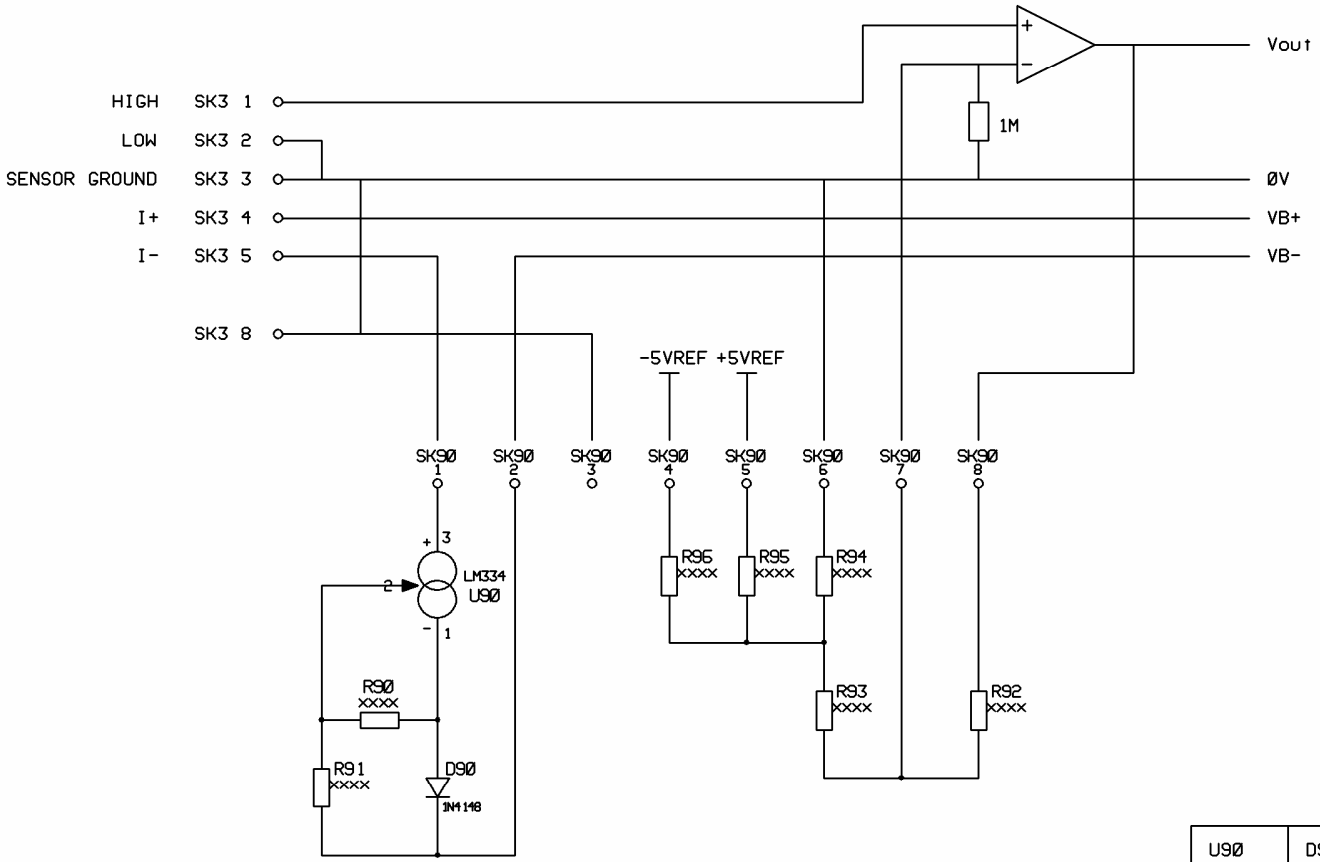
ITC6Ø1 MAIN PCB

DE-COUPLING CAPACITORS etc.

OXFORD

DRAWING NUMBER

A4 CQL1200 6 of 6



		U9Ø	D9Ø	R9Ø	R91	R92	R93	R94	R95	R96
RF 52	CQL1510	LM334	1N4148	150R	1K5	1M	10K	680R	N.F.	1M
RP 51	CQL1511	LM334	1N4148	1K5	15K	1M	3K6	68R	1M	N.F.
TG 57	CQL1512	N.F.	N.F.	N.F.	N.F.	1M	2K2	510R	N.F.	1M
DS 32	CQL1514	LM334	1N4148	15K	150K	1M	680K	33K	N.F.	3K3

N.F. = Not Fitted

			TITLE
			ITC601 RANGE CARD PCB
01	05/12/96		

OXFORD

DRAWING NUMBER
A4 CQL1502 1 of 1