SPECTECH

ST150 Nuclear Lab Station

Operating and Service Manual

April 1996

Model ST150 Nuclear Lab Station

The ST150 Nuclear Lab Station provides a self-contained unit that includes a versatile timer/counter, GM tube, sample stand, and an 11 piece absorber set. The unit comes complete with a serial interface to either Macintosh or IBM compatible personal computers.

High voltage is fully variable from 0 to +800 volts. The supply is fully regulated and controlled by the processor for digital accuracy and readout on the display. Extra large LED's are used for the digital display for clear visual readout under widely differing ambient light conditions with leading zero suppression for clarity.

Classroom demonstrations and nuclear experiments may now be run directly from an IBM-PC or Apple Macintosh compatible computers using the on-line serial DATALINK built into the ST150 and the NUCLAB emulation software. Counting functions may be initiated from the ST150 or the computer. The software supplied produces computer screen displays of all functions including analog and digital emulation of a ratemeter. Real-time data is automatically transferred to the computer and stored in spreadsheet compatible files. Data analysis and graphical presentation are now possible using many common spreadsheet programs bringing new techniques to Nuclear Science education.

An AC to DC line converter is supplied for continuous benchtop operation.

Warranty

Spectrum Techniques warrants products of our manufacture against defects in workmanship or material for a period of one year from date of shipment. We will repair or replace at our option, any instrument that is deemed to be defective during this period. This warranty fully covers all replacement parts and labor. The instrument must be returned to our factory prepaid and we in turn will pay the cost of return shipping .

This warranty does not cover damage caused by mishandling or misuse. GM tubes with broken windows are specifically excluded from this warranty. Accessory items not manufactured by Spectrum Techniques but supplied as part of our systems will be subject to the original manufacturers warranty.

Specifications.

Input:	Built in Geiger Mueller tube: 15 mm diameter, 1.5-2 mg/cm.^{2} window, 500V operating, 150V plateau.
High voltage:	0 to +800 volts, digitally selectable in 20 volt increments.
Display:	6-decade LED, 1 in. numerals. Displays counts, time, and high voltage.
Modes:	Count for preset time, set and view preset time, and set and view high voltage 0-800v.
Data Link:	DB-9 male connector accepts RS-232 serial cable to IBM-PC compatible, and DB-9 female accepts DIN cable for Macintosh computers.
Absorbers:	11 piece set, 6-7400 mg/cm^2.
Sample holder:	6 position, 1cm spacing.
Power:	Input 9 volt DC, at 500mA from AC adapter. Specify 110-120, 220-240 VAC at time of order.
Dimensions:	10 in. W, x 7.5 in. H, x 6.2 in. D.
Software supplied:	ST150 Nuclear Lab - PC emulation DOS program runs with or without Windows on most IBM compatible PC's. Requires EGA or better graphics capability. Optional Macintosh software runs under Multi-Finder under System 6.0 and later and also runs under System 7.x. All software provides real-time display of simulated analog or digital ratemeter in CPM or CPS, count, elapsed time, preset time, high voltage setting, acquisition time, and run number. Data is saved to spreadsheet compatible files. Bi-directional control offers computer control of count start/stop and data transfer.

Operation

CAUTION

The detector window is extremely thin and fragile. If broken it cannot be repaired and will not be covered under the warranty. Never allow objects to touch the window.

General.

The ST150 Radiation Counter may only be operated with the AC adapter provided or with one of identical specifications. The sample holder provides six positions with 1 cm. separation between each for placement of radioactive sources and absorbers. 11 absorbers are provided for use in radiation absorption experiments. Absorbers may be placed in empty sample holder slots between the source and the detector.

Detectors.

Geiger-Mueller tubes produce electrical pulses when ionizing radiation events occur within their sensitive volume. For proper operation, these detectors should be run at a predetermined operating voltage specified by the manufacturer or derived empirically. To improve sensitivity to alpha and beta particle radiation, many GM tubes have extremely thin entrance windows which require considerable care in handling. Do not allow any object to come in contact with the GM tube mounted in the top of the sample holder. The ST150 includes a fully adjustable high voltage power supply to cover a wide range of applications. The high voltage level may be displayed on the digital readout by pressing the H.V. button once. Adjustments to the high voltage may then be made in 20 volt increments using the UP/DOWN buttons. To return to count display mode press H.V. again.

Operating Modes and Controls.

COUNT. This is the normal operating mode where the display registers the number of radiation events detected by the GM tube. Before starting a count, a preset time may be entered using the TIME and UP/DOWN buttons. To begin the count interval press the COUNT button. Any existing count and elapsed time will be automatically cleared. If a preset time has been entered, the unit will count until the preset time is reached.

STOP. This button will stop the current count.

TIME. If the operator wishes to count radiation events for a predetermined time, a preset time may be entered by pressing TIME and entering the required counting time in seconds using the UP/DOWN buttons. To return to count display mode press TIME again.

HIGH VOLTAGE. The high voltage setting on the GM tube may be set by pressing the H.V. button. The current setting will be displayed. The high voltage may be adjusted in 20 volt increments using the UP/DOWN buttons between 0 and 800 volts. To return to count display mode press H.V. again.

Operation.

Basic operation of the model ST150 Radiation Counter is straightforward and intuitive.

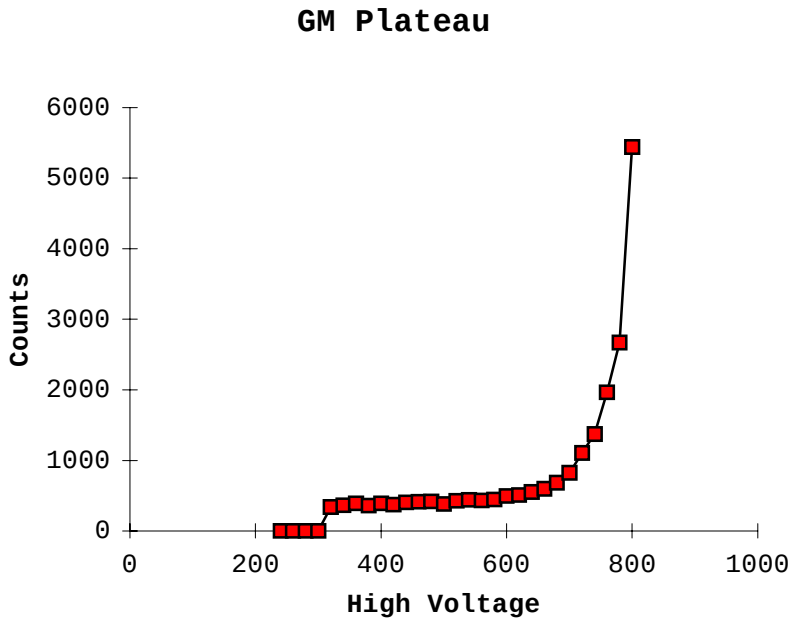
First set the high voltage to the recommended value for the GM tube using the H.V. and UP/DOWN buttons.

If no other presets are required, press H.V. again to return to the count display mode. Operation may now be controlled with the START and STOP buttons. Pressing TIME will display the acquisition time in seconds.

To count for a preset time, press the TIME button and enter the required counting time in seconds using the UP/DOWN buttons. Once set the preset time will remain unchanged unless the UP/DOWN buttons are pressed again. Start the count with the COUNT button. The count may be stopped before the preset time is reached by pressing the STOP button. Once the preset time is reached the counter will stop accumulating data. At this point it is only necessary to press COUNT to restart the next cycle as the preset will automatically be restored and the count register reset to zero. If the ST150 is linked to a computer running the NUCLAB software, data will be automatically transferred to the computer whenever a count stops either by reaching the preset time or pressing the STOP button. If however, the count is stopped by remote control from the computer the data is NOT automatically transferred. This allows a single run in a multiple run experiment to be repeated before it is stored.

GM Plateau.

The correct operating voltage for the Geiger-Mueller tube may be determined experimentally using a small radioactive source such as Cs-137 or Co-60. A properly functioning tube will exhibit a "plateau" effect, where the counting rate remains nearly constant over a range of applied voltage. Place the radioactive source close to the window of the GM probe and slowly increase the high voltage until radiation events just begin to be detected. Now increase the voltage in 20 volt steps recording the counting rate at each increment. The rate should remain fairly constant over a range of voltage and then increase rapidly as the high voltage is further raised indicating that the tube is entering the breakdown region. Do not continue to operate the tube in this breakdown condition but reduce the high voltage and make a plot of the counting rate versus the applied voltage. The recommended operating voltage may now be determined as the center of the plateau region. In the example below note that the plateau extends from approximately 350V to 600V. A reasonable operating voltage in this case would be 500V.



Resolving Time.

Geiger-Mueller tubes exhibit dead time effects due to the recombination time of the internal gas ions after the occurrence of an ionizing event. The actual dead time depends on several factors including the active volume and shape of the detector and can range from a few microseconds for miniature tubes, to over 1000 microseconds for large volume devices.

When making absolute measurements it is important to compensate for dead time losses at higher counting rates. If the resolving time of the detector is known, the true counting rate may be calculated from the measured rate using the following expression:

$$n = \frac{m}{1 - mt}$$

where ***n*** is the true counting rate, ***m*** the measured rate, and **t** the detector resolving time.

If the detector resolving time is unknown, it may be determined experimentally using two radioactive sources. Maintaining constant counting geometry is important throughout the experiment. A special source split into two halves is available for making the measurement, but good results may be obtained by careful positioning of two standard check sources. With the high voltage correctly set for the GM tube, position the two sources (***a+b***) side by side to obtain a count rate of at least 10,000 CPM. Accurately record the countrate as $R_{(a+b)}$. Remove source (***b***) and record the count rate as $R_{(a)}$. Carefully replace source (***b***) to its original position, remove source (***a***) and record the count rate of source (***b***) as $R_{(b)}$. The resolving time is given by

$$T = \frac{R_{(a)} + R_{(b)} - R_{(a+b)}}{2R_{(a)} \cdot R_{(b)}}$$

The resolving time of the ST150 Nuclear Lab Station is very short and is not a significant factor compared to that of the GM tube.

Applications.

The ST150 may be used for a variety of applications some of which are listed below.

Surface contamination measurement.

Plotting a GM plateau.

Radiation background measurement.

Natural radioactivity.

GM resolving time.

Detector efficiency.

Radiation absorption studies.

Backscattering.

Inverse square law.

Isotope half life.

Radiation properties.

Counting statistics.

Maintenance.

CAUTION

Dangerous voltages can exist inside the ST150 from the high voltage power supply. Before removing the cover ensure the instrument is in the OFF position and the high voltage is set to zero. Only qualified technicians should attempt any repairs.

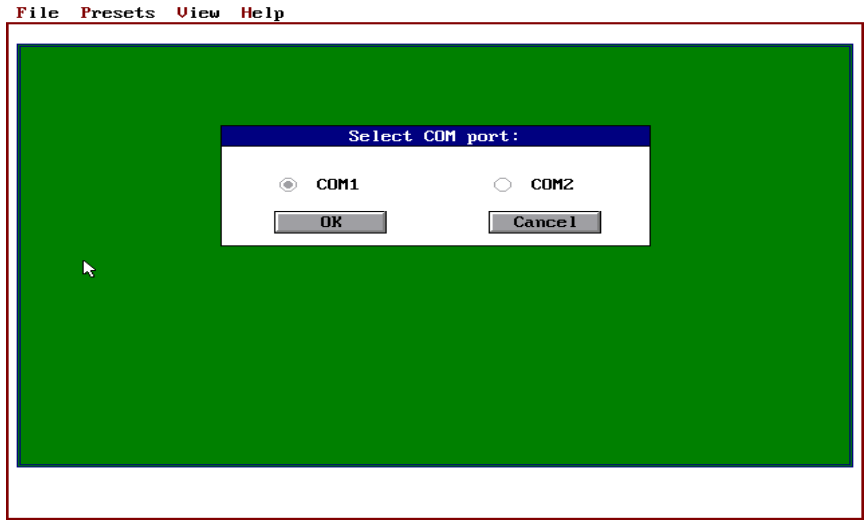
Your ST150 has been built with care using quality parts and should not require any routine service. In the unlikely event of a malfunction, the unit may be returned to the factory for repair. We will gladly supply a cost estimate if the warranty period has expired.

A complete list of parts is included for your convenience. Please contact our customer service department for pricing and availability. In many instances substitute parts may be used providing they meet or exceed the original specifications.

NucLab Nuclear Lab Station Software for IBM PC Compatibles

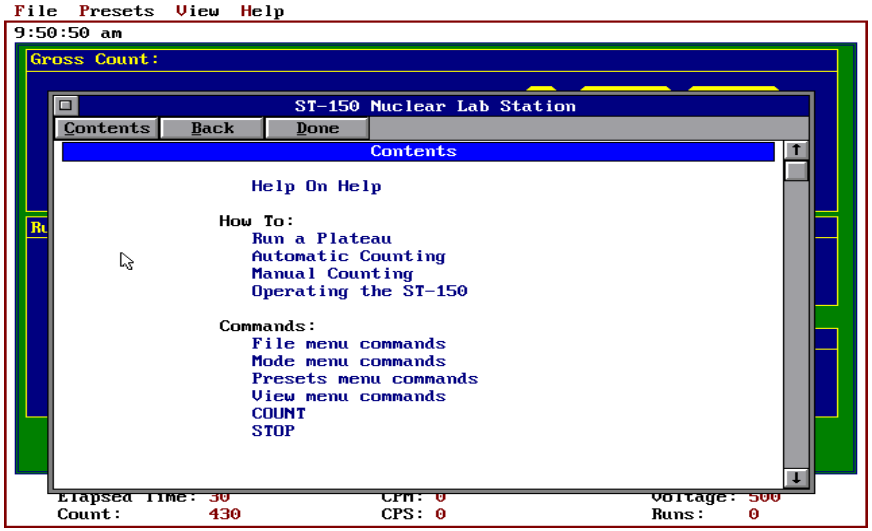
Your ST150 Radiation Counter is supplied with a computer communication and control software package named NUCLAB. Command and data are transferred via the standard RS 232C serial port, and require connection to the computer's COM 1 or COM 2 port. NUCLAB allows counting control of the ST150 from either the front panel buttons or the computer system.

To run NucLab insert the program disk supplied into drive A, type A: NUCLAB and the following screen will appear:



Select the appropriate COM port and continue. The COUNT and STOP controls on the ST150 front panel are repeated on the main NucLab screen and will remotely control those operations on the unit. Other features of the software are invoked from their selection within the menu system. Features and menu selections are made by clicking on the selection with a mouse or by pressing the key corresponding to the underlined character in the selection.

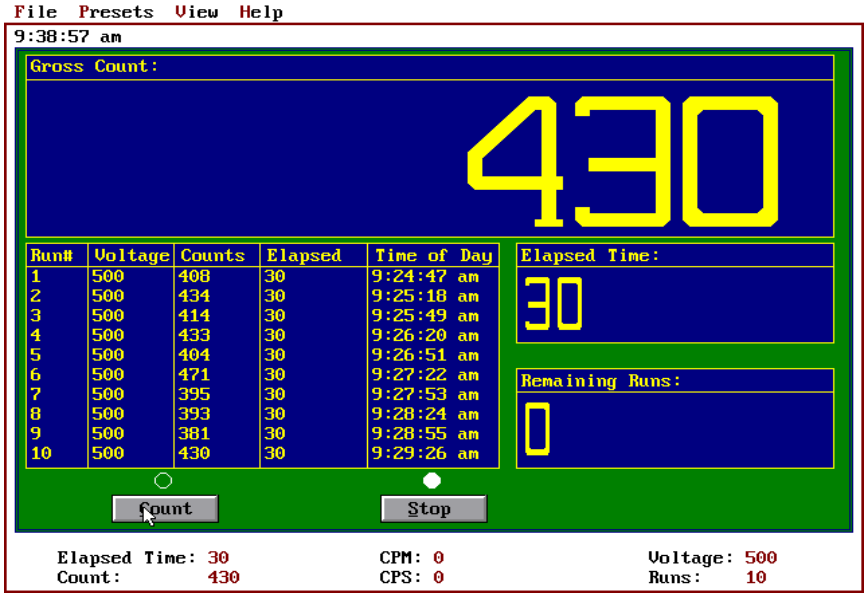
NucLab contains an on-screen help menu for guidance through the basic operations. The Help system provides hypertext allowing topics to be quickly accessed. To invoke the Help system choose Help Contents from the Help menu bar selection. Click on any highlighted text to see an explanation of the feature. Highlighted text may also be selected by pressing TAB until the desired selection is indicated.



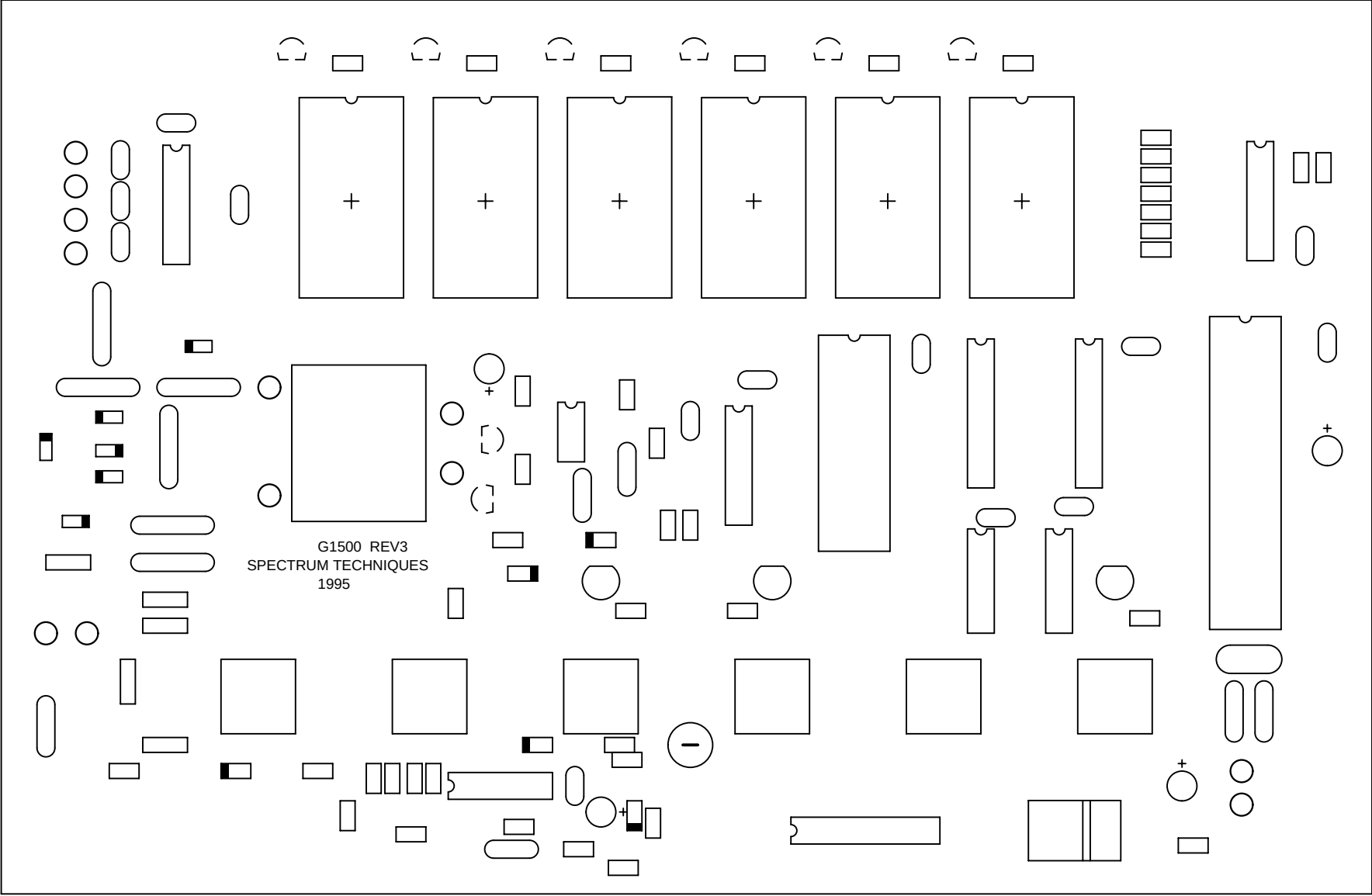
Several different VIEW modes are possible including analog ratemeter and digital counter/timer with CPM or CPS selection. When counting is stopped on the ST150 either by pressing STOP or by reaching a preset time, the latest count data will be transferred to the computer. If a count is interrupted by clicking the STOP icon on the NucLab screen the data will be not transferred. This allows a count to be interrupted and restarted without being saved on the computer. To force a count to be saved as a legitimate data run press the Insert (Ins) key.

From the Presets pull down menu a number of automated data runs may be invoked by choosing Set Preset Runs. After the number of desired runs is entered pressing the COUNT button on the ST150 or clicking the Count icon from the software will initiate the first count. When the preset time is reached, the data will be transferred to the computer, the elapsed time and counter will be cleared and the next count interval will begin. This process continues until

the number of entered runs have completed. When all of the desired data has been collected, the data may be saved to a spreadsheet compatible text file by choosing the Save selection from the File menu. The extension defaults to . TSV to indicate a Tab Separated Value file format. This format allows the collected data to be directly imported into most speadsheets with the run number, voltage, count, elapsed time, and time of day information correctly separated into columns.



In the event of a breakdown in the communication between the ST150 and the computer the link may be reestablished if possible by choosing Serial Relink from the Presets menu. If this fails to reestablish communications, try powering down both the ST150 and the computer to fully reset the serial port.


G1500 REV3
SPECTRUM TECHNIQUES
1995

VAL
SW1
WP1
R1
U1
LM7805CTB
C1
10uF
C2
C3
C4
C5
C6
C7
C8
C9
J1
WP2
GND
+5V
I1
I2
I3
I4
I5
I6
LR1720R
Q1
Q2
Q3
Q4
Q5
Q6
2N3906
R2
R3
R4
R5
R6
R7
51
DS6
DS5
DS4
DS3
DS2
DS1
CN1
DB9M
WP3
WP4
WP5
WP6
U3
C10
C11
C12
C13
.1
T1OUT
T2OUT
R1IN
R2IN
T1IN
T2IN
R1OUT
MAX232
TXD
CTS
RXD
P-80C32
U5
12MHz
47
C15
C16
C14
1UF
S1
S2
S3
S4
S5
S6
START
STOP
HV
TIME
U6
2764-17
U7
74HC374
U8
74LS373
U9
7447
U13
SN74LS32N
U4:A
U4:B
U4:C
U2:A
U2:B
U2:C
U2:D
U2:E
74LS04
COUNT
H.V.
TIME
LED1
LED2
LED3
R8
R9
R10
2K
R11
R12
R13
R14
R15
R16
R17
R18
R19
10
5.1K
SEGA
SEGB
SEGC
SEGD
SEGE
SEGF
SEGG
U11
LM555CHC
R24
1.8K
R29
4.7K
C26
C27
.01
R28
100
Q7
R32
100K
R39
10K
Q8
MPSA64
R37
1K
10uF
C31
WP7
WP8
WP9
WP10
T1
VAL
C19
C20
C17
.01/1KV
D1
D2
D3
D4
D5
D6
1N4004
C22
C23
C24
.01/1KV
R22
3.3M
R26
22M
R33
22M
R35
22M
R36
22M
R22A
5.1M
C21
47pF/1KV
R23
47K
WP11
WP12
TB1
GM-15
R46
1.00K
D7
1N914
R31
1M
R30
3K
R20
1M
R21
5.1K
C18
.1
U10:A
MC3405P
R25
100
R27
5.1K
R45
51K
CNT
U10:D
U10:C
R40
62K
R40A
C29
.001
C30
10uF
R41
100K
R42
1.00K
R43
10K
CW
CCW
R47
1.00K
D10
D11
R34
4.22K
R38
1.00K
C28
.1
U12
TLC7524CN
TLED
HVLED
CLED
WR*
A2
A1
A0
GND
+5V
Changed R22 22M>>3.3M 5-2-02
Added R22A <5.1M> 5-2-02
Title
ST 150 COUNTER
Size
A1
Number
G1500
Rev
3
Date
3/22/96
Drawn by
R.S.S
Filename
ST150.S01
Sheet
1
of
1

Reference Designator	Part #	Comp. Description	Qnty
R38,R42	A1001	Res 1.00K 1%	2
R34	A4221	RES 4.22K 1%	1
R11,R14,R15,R16,R17,R18,R19	AA100	Res 10	7
R25,R28	AA101	RES 100	2
R37	AA102	RES 1K	1
R29,R39	AA103	RES 10K	2
R32,R41	AA104	RES 100K	2
R20,R22,R31	AA105	RES 1M	3
R4	AA563	RES 56K	1
R24	AA182	RES 1.8K	1
R1	AA1R0	Res 1	1
R8,R9,R10	AA202	RES 2K	3
R26,R33,R35,R36	AA226	RES 22M	4
R30	AA302	RES 3K	1
R23	AA473	RES 47K	1
R2,R3,R4,R5,R6,R7	AA510	RES 51	6
R2A,R3A,R4A,R5A,R6A,R7A,	AA512	RES 5.1K	10
R12,R13,R21,R27			
R45	AA513	RES 51K	1
C29	CB102	CAP .001UF	1
C27	CB103	CAP .01UF	1
C15,C16	CB470	CAP 47PF	2
C2,C3,C4,C5,C6,C7,C8,C9,C10,	CC104	CAP .1UF Mono	15
C11,C12,C13C18,C26,C28			
C17,C19,C20,C22,C23,C24	CD103	CAP .01UF	6
C21	CD470	CAP 47PF	1
C1,C30,C31	CN100	CAP 10UF 35V	3
C14	CN10R	CAP 1UF 25	1
D1,D2,D3,D4,D5,D6	DA004	Diode 1N4004	6
D7,D8,D9	DA008	Diode 1N4148	3
LED1,LED2,LED3	DL001	LED HLMP4700	3
I1,I2,I3,I4,I5,I6	DL002	LED LR1720R P	6
CN1	EC001	Conn DE9P m	1
J1	EC007	Power Jack ST350	1
CN2	EC018	Conn DE9P f	1
SW1	ES005	Switch SPST	1
T1	LX001	XFormer HV	1
	Man 150	Operation Manual	1
	MC002	Charger 9 v, 115v	1
R43	PA103	POT 10K Trimmer	1
	RAB 11	ST150 Absorber holder	1
Q8	TA001	Trans MPSA64	1
Q1,Q2,Q3,Q4,Q5,Q6,Q7	TA003	Trans 2N3906	7

Spectrum Techniques, Inc.

106 Union Valley Road
Oak Ridge, TN 37830
USA.
Tel: (865) 482-9937
Fax: (865) 483-0473
support@spectrumtechniques.com
www.spectrumtechniques.com