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Westinghouse Astronuclear Laboratory

Operational Manual and Acceptance Test Procedure
for WANL ETS-1 Power Increase Timer Model 937J845G01

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Procedure for WANL ETS-1 Power Increase
Timer Model 937J845G01.

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WANL ETS-1 POWER INCREASE TIMER

OPERATIONAL MANUAL

1.0 INTRODUCTION

This operational manual contains the general description, theories of operation, alignment procedures, maintenance and repair data, and interconnection diagrams for the WANL ETS-1 Power Increase Timer. (See Figures 1 and 2).

1.1 Installation - Operation - Maintenance

The WANL ETS-1 Power Increase Timer is a rack mounted, wholly self-contained (except for the remote readout), transistorized electronic measuring device. It displays via the remote nixie readout the period of the incoming signal. An alternate output in the form of a 1-2-4-8 digital code is available for use in printing out the period information from the unit.

The unit is capable of measuring the period of any incoming signal in the range between 0.1 and 100 seconds. It provides a readout each time the power increase exceeds the preset power increment. This increment is adjustable remotely for incremental Power changes of ϵ , $\epsilon^{t/2}$, or $\epsilon^{t/4}$. This power increment is selected by means of a selector switch on the operators console.

2.0 GENERAL DATA

2.1 Safety Precautions

None other than standard, good-practice safety precautions need to be observed. No high A.C. voltages, other than 115VAC from the external primary power source are present in the unit. The maximal D.C. voltage in the unit is +150 Volt D.C.

FIGURE 1 - POWER INCREASE TIME
DRIVER FRONT PANEL

FIGURE 2 - POWER INCREASE TIME
DRIVER TOP VIEW

If it should become necessary to perform corrective maintenance, component removal, or service, prudence dictates that the unit should be disconnected from the primary power source by disengaging the multipin power connector, J1, on the back of the unit; or by performing such activity during system down-time.

2.2 Weight and Dimensions

The WANL ETS-1 Power Increase Timer has the following gross physical characteristics:

Weight	30 lbs. nominal
Dimensions	19" wide (max.)
	22" deep (max.)
	7" height (max.)

2.3 Power Requirements

Primary power for the WANL ETS-1 Power Increase Timer includes the following: 117VAC RMS at 1 Ampere (max.), plus 15VDC at 1/4 Ampere max., minus 15VDC at 1/4 ampere max. and 28VDC at 1/4 ampere max. This power is obtained from sources external to the unit, along with other circuits, via a Bendix 15 pin connector, J1.

2.4 Heat Dissipation

The Power Increase Timer design is such that the cooling required for the counter assembly is obtained directly through the chassis side panels. All other components and assemblies have been selected to the end that

special subsystem heating or cooling is not necessary. Adequate separation of modules and printed circuit assemblies provides satisfactory up-draft.

3.0 WANL ETS-1 POWER INCREASE TIMER DESCRIPTION

- 3.1 The WANL ETS-1 Power Increase Timer assembly contains two major subassemblies. These are the counter subassembly, which is a Hewlett-Packard H17-5223L electronic counter, and the power interval measuring circuit. This circuit, along with the delay circuits and drivers necessary for proper interfacing between the two major subassemblies and the external circuits are card mounted in the chassis. Westinghouse Drawing 937J847 is a schematic of the entire power increase timer, showing the counter as a block diagram and the remainder of the circuitry in schematic form. Westinghouse Drawing 937J845 shows the locations of all of the assemblies.
- 3.2 The schematic diagrams and location drawings for the electronic counter are shown in the Hewlett-Packard Operating and Service Manual, 5223L, modified per specification H17-5223L.

3.3 Components

3.3.1 Resistors, Capacitors, Transistors, Diodes

All components in the power increase timer have been selected to good commercial practices, all components have been derated sufficiently to provide safe operating margins at the extremes of the operating environments.

All components in the power interval measuring circuit are of military standards or superior.

3.4 Chassis

Aluminum alloy-sheet stock, bolt and rivet construction. Card slots are plastic.

4.0 INSTALLATION INSTRUCTIONS

4.1 WANL ETS-1 Power Increase Timer

The following procedure should be followed for the proper installation of the power increase timer. Mount the removable part of the chassis guides at the desired selected level in a standard 19 inch rack. WANL Drawing 937J845GO1 shows the relative location for the chassis guides with respect to the top and bottom of the instrument. Once the rack portion of the chassis guides are properly located and mounted, the instrument can be slipped into place on the guides.

5.0 PRINCIPLE OF OPERATION

5.1 The WANL ETS-1 Power Increase Timer computes, and displays on a remote nixie tube readout the period of reactor power, as measured from the output voltage of a linear picoammeter.

The linear picoammeter instrument is a 10 decade, multiple scale instrument. It covers the 10 decades of power change in ten one-decade ranges, each range being proportional to power. The picoammeter also has range indication outputs to establish which decade of power is being read. This range output is available either in the form of a staircase voltage 1 V/

decade or a BCD output, 0 to 9. Refer to E G & G operation and maintenance manual for Model ME-8W Automatic Ranging Picoammeter.

The period of the reactor power is defined as the time required for the power to increase by a factor of e , (2.718). The mathematical equation defining reactor power as a function of time, with constant excess reactivity, that is on a constant period is as follows:

$$N = N_0 e^{\frac{K_{ex} t}{e}} = N_0 e^{t/T} \quad (1)$$

where

N_0 = initial neutron density

N = final neutron density

K_{ex} = excess reactivity

e = neutron relocation distance

$T = \frac{e}{\overline{K_{ex}}} = \text{period in seconds}$

Equation (1) rearranged to get period in terms of the variables is:

$$T = \frac{e}{\overline{K_{ex}}} = \frac{t}{\ln \frac{n}{n_0}} \quad (2)$$

A more familiar form of the equation is:

$$\frac{1}{T} = \frac{\ln \frac{n}{n_0}}{t} = \frac{d}{dt} \ln \left(\frac{n}{n_0} \right) \quad (3)$$

where

$$\frac{1}{T} = \text{inverse period (sec}^{-1}\text{)}$$

This is the form of the measurement when a direct analog differentiation

of Equation 1 is performed. Thus, inverse period is the actual rate of change of the input variable with respect to time as indicated in (3).

In addition to the fact that the analog differentiation yields an inverse quantity in terms of time (sec^{-1}) such a measurement also suffers the greater disadvantage that by nature a pure differentiator is a noise amplifier; that is, it is effectively a high pass filter. Reducing the bandpass helps; that is, inserting poles in series with the zero, however, this reduces the accuracy of the measurement.

The power increase timer implements the measurement by utilizing differentials and operating on the form of equation (2) rather than (3) as follows:

$$T = \frac{\Delta t}{\Delta \ln \left(\frac{n}{n_0} \right)} \quad (4)$$

By taking the differential form the results become approximations; however, by restricting the operation to relatively small differential values of n the accuracy of the measurement is retained while high noise rejection is obtained.

It should be noted that Equation (4) does not restrict the measurement to $\left(\frac{n}{n_0} \right)$ values of $\frac{1}{2}$. If a magnitude of $\frac{1}{2}$ is used, then the measurement is E fold time. If any other power ratio is used; for example, if a power ratio of $\frac{1}{2}$ is used, then the measurement is a power increase time. From (4), if both the power ratio and

measurement times are divided by two, then the measurement of period is valid; however, no longer is the measurement the fold time. More exactly, it is $\frac{1}{2}$ fold time if the ratio of change of $\ln \left(\frac{n}{n_0} \right)$ remains constant.

The implementation of Equation (4) in the power increase timer is accomplished as follows. Refer to Dwg. 937J847, the schematic diagram of the power increase timer. Amplifier A3AR1 is an inverting unity gain operational amplifier, when the field effect switch, A3Q1, on the input of this amplifier is closed. When the field effect switch opens the Capacitor C_1 around the amplifier causes it to retain the value it had when the switch was opened. Amplifier A4AR1 along with its input resistors R_3 through R_6 forms a comparator, the output of which drives a gate which either passes clock pulses to the scaler or not, depending on the state of the gate. Amplifier A3AR1, together with the field effect analog switch on its input and its associated feedback and input resistors and Capacitor C_1 form a hold circuit. The field effect switch is closed at the beginning of a measurement and the output voltage assumes a value equal in magnitude but opposite in polarity to the input voltage. While the analog switch is closed, the circuit is that of an inverting unity gain operational amplifier. Once the field effect switch opens, the output holds the value it had due to capacitor C_1 around the amplifier.

This held value is compared in the comparator circuit made up of Amplifier A4AR1 and its input resistors R_3 through R_6 . The input current to the comparator is zero when the input voltage is greater than the hold voltage by the ratio of the input resistor, R_1 , R_2 , or R_3 to the hold resistor R_4 .

The ratio of these resistors determines the change in the input voltage to cause the comparator to switch. If this ratio is 2.718, the power interval is a factor of e ; if it is 1.648, the power interval is a factor of $e^{1/2}$, and so on. The time between the opening of the field effect switch; that is, the time that the hold signal is established, to the time the comparator indicates a comparison, is indicated by means of a conventional time interval measurement (TIM). A clock generating a known frequency is fed through a gate to a scaler. The gate is closed when the hold circuit is set (the field effect opens) and opens when the comparator switches. The clock frequency is selected so that the scaler reads out reactor period in seconds, to a tenth of a second. The indication on the scaler is always in seconds, regardless of the power interval being measured. This is accomplished by changing the clock frequency when the power increment is changed. The equation being implemented is Equation (4) as follows:

$$T = \frac{\Delta t}{\Delta \ln \left(\frac{n}{n_0} \right)}$$

From this, if $\Delta \ln \left(\frac{n}{n_0} \right)$ is divided by two, Δt will also be divided by two. By doubling the clock frequency the indication is retained as period in seconds.

The timing sequence of the power increase timer over a cycle of operation is as follows. The linear power input at J2-H starts at about 1.000 volt and exponentially increases. Assume the period of the input being measured is 5 seconds, and the power increase timer is measuring the $\left(\frac{R_4}{R_3} = 2.718 \right)$ folding time.

At time zero the field effect switch opens. The input signal increases with time to a value of 2.718 times its initial value. At this time, t , the comparator input is at zero volts and the comparator switches from its plus to negative output. This switches the counter gate, A9J13, off and triggers the one shot multivibrator which drives the field effect switch A3Q1. The field effect goes on, short circuit, and causes the hold amplifier to reset to the new value of input signal. As soon as the hold amplifier output changes to the new value, the comparator input returns to -0.460 volts and the output to its positive state. The one shot multivibrator remains in its triggered state until it reaches the end of its delay period. It resets itself and a new measurement cycle is initiated. While the scaler gate is open, the scaler accumulates the clock output pulses and the display at t is 50 or 5.0 seconds.

The clock, gate circuit, and scaler in the power increase timer consists of a Hewlett-Packard H17-5223L electronic counter. This counter has provision built into it to store an accumulated count while accumulating a second. This mode permits the time indication to be displayed during the next succeeding entire measurement cycle.

In addition to the scaler readout, which is remote (the readout nixie display is located on the LRE Console) the scaler provides a 1-2-4-8 BCD output of the accumulated count together with a print command to be used to print the power increase time on a digital printer. The printer outputs are compatible with a Hewlett-Packard 562 electronic printer.

6.0 OPERATING INSTRUCTIONS

Once the power increase timer has been installed, a series of adjustments and operational checkouts must be made. After these adjustments have been completed, no further manipulation is necessary except for routine calibration checks and preventative maintenance (see maintenance instructions). Controls, adjustments, and operational test procedures follow here.

7.0 CONTROLS - OPERATIONAL AND SEMI-PERMANENT

To limit the access to operational and alignment controls, all operating controls, except for the local manual start and equipment fuses, have been placed inside the power increase timer.

8.0 FRONT PANEL (SEE FIGURE 1)

8.1 Fuses

Four fuses and associated indicating lamps are accessible at the front bottom center of the panel face. These fuses are for the service and of the values listed below, from left to right on the panel face.

<u>Service</u>	<u>Fuse Rating</u>
+15VDC	1/2 ampere
-15VDC	1/2 ampere
+28VDC	1/2 ampere
117VAC	2 ampere

8.2 Switch

The local manual start switch is located in the center of the panel front.

9.0 COMPONENT PANEL (SEE FIGURE 2)

Sixteen test points are located on the component panel on the top and at the front of the instrument. These are clearly marked and are for the following service:

<u>TEST POINT NO.</u>	<u>TEST POINT NAME</u>	<u>TEST POINT FUNCTION</u>
TP1	Range	Measures 1 Volt Pulse when Range Change Occurs (TP1 to TP12)
TP2	Linear Power	Measures Input Signal from Selected Amp. (TP2 to TP12)
TP3	Hold	Measures Hold Amplifier Output (TP3 to TP12)
TP4	Comparator Output	Measures Comparator Output (TP4 to TP12)
TP5	Reset	Measures Reset Pulse (TP5 to TP12)
TP6	Hold Time	Measures Hold One Shot Output (TP6 to TP12)
TP7	Recycle	Measures Recycle Pulse (TP7 to TP12)
TP8	Power Increase Time Print	Measures Print Command Signal (TP8 to TP12)
TP9	Print Red	Measures Print Red Signal (TP9 to TP12)
TP10	117VAC	Measures 117 Volts AC to ACGRD (TP10)
TP11	ACGRD	Measures 117 Volts AC to 117AC (TP9)
TP12	COM	Plus and Minus Common (I & C COM)
TP13	+15V	Measure +15 Volts DC to COM (TP12)
TP14	-15V	Measure -15 Volts DC to COM (TP12)
TP15	+28V	Measure +28 Volts DC to 28V RET (TP16)
TP16	28V RET	

10.0 ELECTRONIC COUNTER CONTROL PANEL

All of the operating controls for the electronic counter, with the exception of the storage and Frequency standard switches, are located on the operating panel

of the electronic counter. This panel is available at the rear of the power increase timer. Location of controls on the operating panel are shown in the H-P Operating and Service Manual for the 5223L Counter.

The controls are grouped; the input polarity and sensitivity switches are located on the left-hand side of the unit, while the operational mode switches are on the right-hand side. The switches and their functions are as follows.

10.1 Function

The function selector is a seven-position switch used to select the mode of measurement. It is set in its Time interval A-B position.

10.2 Time Base Multiplier

The time base multiplier selector is a seven-position switch used to select the time base for measurements in the frequency, period, and time interval functions, and the multiplier for measurements in the manual, period average, and ratio functions. It is set in the $.1S-10^4$ position to produce a last significant digit of 0.1 seconds on the readout. The last significant digit may be changed to 0.01 seconds by setting the switch to its 10^3-10 ms position, or to 1.0 seconds by setting it to $1S-10^5$ position. The last significant digit may be varied from 10 usec through 10 sec. via the seven-positions on this switch in the above manner. The normal, setup, position for this switch is in the $0.1S-10^4$ position.

10.3 Sample Rate Control

The sample rate controls three functions. At the counterclockwise extreme of its rotation it operates the AC power switch. Over the remainder

of its rotation, it varies the sample display rate (when the storage switch is in its off position) from 0.2 seconds to over 5 seconds. In the Hold (extreme clockwise) position the count will be displayed indefinitely, or until the counting cycle in the counter itself is started again by depressing the reset button on the counter. The sample rate control is set for a minimum display time, full counterclockwise of display time but not in the AC off position.

10.4 DC Volts/AC Volts

The DC volts/AC volts selectors are used to select DC or AC coupling of the input start (level A) and stop (level B) signals and the attenuation of these signals by factors of 1, 10, or 100. The selectors on both start and stop channels are set to AC volts X1.0.

10.5 Level A - Level B

The level A and level B controls are used to adjust the triggering levels on the input signals from -1 to +1 volts times the multiplier setting. The level A and level B controls are both set to their full clockwise positions.

10.6 Slope

The slope switches are used to select either the positive or negative slopes of the input signals for triggering. The slope switches are both set to + slope.

10.7 COM/SEP/CHECK

The COM/SEP/CHECK switch is used to select input modes. In the

COM position the A and B channel inputs are connected together at the input. In the SEP position the A and B channel inputs are independent, each connected to its own amplifier. In the CHECK position the inputs are disconnected from the amplifiers in the counter, and circuits are set up for a Self-Check function. The COM/SEP/CHECK switch is set to SEP in the Power Increase Timer.

10.8 Reset

When the reset switch on the counter is depressed, the readout and internal count are returned to zero and a new counting cycle is started.

11.0 MISCELLANEOUS CONTROLS AND TEST POINTS

11.1 Electronic Counter

11.1.1 Storage

The storage switch, located on the counter panel facing away from the panel of Paragraph 10.0, provides a means for disabling the storage feature. This feature provides a continuous visual display while the instrument is totalizing a new count. Only if the new count differs from the previous count will the display change when the storage switch is in its normal "On" position.

11.1.2 Frequency Standard

This switch provides for the use of an external frequency in place of the internal clock. To use this the external frequency is

FIGURE 3 - TRACK AND HOLD
AMPLIFIER NO. 1,
CARD A3

FIGURE 4 - TRACK AND HOLD
AMPLIFIER NO. 2,
CARD A4

connected to the Frequency Standard connector on this same panel and the frequency standard switch placed in External. The switch is always placed in the internal position in the power increase timer.

11.1.3 Controls and Test Points Located on Track and Hold No. 1, Card A3

(See Figure 3.)

11.1.3.1 Test Points

There are two test points located on tracking Amplifier No. 1. Test Point No. 1 is common and Test Point No. 2 the current offset signal test point.

11.1.3.2 Controls

Three potentiometers are located on Tracking Amplifier No. 1. These are for the following services:

R_1 , 50K Ω , amplifier offset voltage

R_2 , 100K Ω , amplifier current offset

R_3 , 5K Ω , amplifier gain adjust

11.1.4 Controls and Test Points Located on Track and Hold No. 2, Card A4.

(See Figure 4)

11.1.4.1 Test Points

There are two test points located on Tracking Amplifier No. 2. Test Point No. 1 is common and Test Point No. 2 the current offset signal test point.

FIGURE 5 - TRIGGER PULSE AMPLIFIER, CARD A5

11.1.4.2 Controls

Two potentiometers are located on Tracking Amplifier Card No. 2. These are for the following services:

R_1 , 50K, amplifier voltage offset adjust

R_2 , 100K, amplifier current offset adjust

11.1.5 Controls and Test Points Located on Trigger Pulse Amplifier, Card A5. (See Figure 5).

11.1.5.1 Test Points

There are four test points located on the trigger pulse amplifier; two for each of the two trigger amplifiers. Test Point No. 1 is the trip point adjust, and Test Point No. 2 is the trigger pulse amplifier output for Trigger Amplifier No. 1 and Test Points 3 and 4 serve the same functions respectively on Trigger Amplifier No. 2.

11.1.5.2 Controls

Four potentiometers are located on the trigger pulse amplifier; two for each trigger. These four are for the following services:

R_1 , 20K, trip point adjust, Amplifier No. 1

R_7 , 50 Ω , loop width adjust, Amplifier No. 1

R_{13} , 20K, trip point adjust, Amplifier No. 2

R_{19} , 50 Ω , loop width adjust, Amplifier No. 2

12.0 OPERATIONAL CHECKOUT (ALIGNMENT PROCEDURES)

After installing the power increase timer according to the procedures detailed under installation instructions, Paragraph 4, certain calibration and alignment checks must be performed.

12.1 Test Equipment Required

Multimeter - Simpson Model 269, or equal

Digital Voltmeter - EAI, or equal

12.2 Mechanical Checkout

Before application of primary power for the electrical checkout, examine the equipment carefully for mechanical rigidity of mounted components, connectors, knobs, and the like. Make sure that all cards are properly seated in their connectors and that the proper size fuses are in place in their fuse holders.

Connect the external circuits required to test the unit as shown in the Acceptance Test Procedure or if installed in the use location, check that the system connectors to the unit are consistent with the input requirements per the ATP.

12.3 Electrical Checkout

Operating voltages and check points are identified by Test Point numbers and connector numbers in the following procedures. Refer to Sections 8 through 11 for specific identification of these test point references.

12.3.1 Power Inputs Check - Simpson Model 269 Voltmeter (or equal)

Measurement.

- 12.3.1.1 Apply the main power to the equipment. 117 Volts AC, 28 Volts DC, and plus and minus 15 Volts DC, Check to insure that these voltages exist and are of the proper magnitude as follows,

<u>TEST POINT TO TEST POINT</u>			<u>VOLTAGE TO BE MEASURED</u>
TP10	-	TP11	115 $\pm$ 5% VOLTS at 60 $\pm$ 5% CPS
TP15	-	TP16	+28VDC $\pm$ 10%
TP13	-	TP12	+15VDC $\pm$ 2.0%
TP14	-	TP12	-15VDC $\pm$ 2.0%

Allow the equipment to warm up for a minimum of 30 minutes prior to proceeding with alignments of the various sections.

12.3.2 Controls Check

- 12.3.2.1 Check to see that the following controls are in the positions as listed. Locations of the controls are called out in Sections 7.0 through 11.0.

<u>CONTROL</u>	<u>LOCATION</u>	<u>POSITION</u>
Function Selector	Electronic Counter Control Panel	Time Interval A-B
Time Base Multipliers	Electronic Counter Control Panel	0.1S-10 ⁴
Sample Rate	"	CCW But Not AC Off
DC Volts/AC Volts Level A	"	X1.0

<u>CONTROL</u>	<u>LOCATION</u>	<u>POSITION</u>
DC Volts/AC Volts Level B	Electronic Counter Control Panel	X1.0
COM/SEP/CHECK	Electronic Counter Control Panel	SEP
Slope A	"	Positive
Slope B	"	Positive
Level A	"	Full Clockwise
Level B	"	Full Clockwise
Storage	Counter Face Away From Electronic Counter Control Panel	ON
Frequency Standard	"	INTERNAL
E Fold Selector	Remote (LRE Console or Test Setup)	E/4
Linear Channel Selector	Remote (LRE Console)	To Channel Being Used for Test

12.3.3 Subassembly Alignments

Each of the following alignments are separate and need not be performed in order, nor do they depend upon each other.

12.3.3.1 Tracking Amplifier No. 1 Alignment

- 12.3.3.1.1 Remove the one shot multivibrator card, A1, from its connector. Connect a jumper from TP1 to TP2 on the Tracking Amplifier No. 1 card.

- 12.3.3.1.2 Remove Connector J2 and place a jumper from TP2 (linear Power) on the component panel to TP12 (COM) on the component panel.
- 12.3.3.1.3 Place a digital voltmeter between TP3 (Hold) and TP12 (COM) on the component panel and adjust the voltage offset adjust, R_1 , on Tracking Amplifier No. 1, A_3 , until the digital voltmeter reads less than 10 millivolt DC.
- 12.3.3.1.4 Remove the jumpers from TP1 and TP2 on Tracking Amplifier No. 1 and from TP2 and TP12 on the component panel. Reconnect connector J2.
- 12.3.3.1.5 Set the input signal (linear power TP2) to read 1.0 ± 0.5 volts DC.
- 12.3.3.1.6 Adjust the current offset adjust, R_2 , on Tracking Amplifier No. 1 until the output as read on the digital voltmeter across TP3 to TP12 does not vary with time by greater than 1.0 millivolt per minute. Adjust the gain potentiometer, R_9 , on Tracking Amplifier

No. 1 until the output as read on the digital voltmeter across TP3 (Hold) to TP12 (COM on the component panel reads within 0.005 volts of a digital voltmeter between TP2 (linear power) and TP 12 (COM).

12.3.3.1.7 Set the input signal to zero, insert the one shot multivibrator card, and remove the digital voltmeter. This completes the alignment of Tracking Amplifier No. 1.

12.3.3.2 Tracking Amplifier No. 2 Alignment

12.3.3.2.1 Place a digital voltmeter between TP2 and TP1 on Tracking Amplifier No. 2.

12.3.3.2.2 Adjust the current offset adjust, R_{2r} on this unit until the digital voltmeter reads less than 5 millivolts DC. Remove the digital voltmeter.

12.3.3.2.3 Remove the power increase timer connector J2. Remove Tracking Amplifier No. 1 card from its connector. Place a jumper between TP3 (Hold) on the component panel and TP12 (COM).

- 12.3.3.2.4 Adjust the voltage offset adjust, R_1 , on Tracking Amplifier No. 2 until the output as read across TP4 (comparator output) and TP12 (COM) on the component panel just switches from its positive state (app +13VDC) to its negative state (-0.3 VDC). (Rotate the potentiometer slowly when making this adjustment so that the potentiometer position is set just at the point where the output switches.)
- 12.3.3.2.5 Remove the jumper, replace the input connector and card A3. This completes the alignment of Tracking Amplifier No. 2.
- 12.3.3.3 Trigger Amplifier, A5, alignment
 - 12.3.3.3.1 Remove the input connector, J2, from the power increase timer.
 - 12.3.3.3.2 Place a multimeter, Simpson Model 269, or equal, between TP2 on the trigger pulse amplifier card and TP12 (COM) on the component panel.

- 12.3.3.3.3 Place a digital voltmeter between TP1 on the trigger amplifier and TP12 (COM) on the component panel.
- 12.3.3.3.4 Adjust the trip set potentiometer until the voltage at TP1 on the trigger pulse amplifier is less than $\pm 0.1\text{VDC}$. The trigger amplifier output as read on the multimeter shall be greater than $+10\text{VDC}$.
- 12.3.3.3.5 Adjust the trip set potentiometer until the voltage at TP1 on the trigger pulse amplifier is $-1.5\text{ Volts DC} \pm 0.1\text{VDC}$. The trigger amplifier output as read on the multimeter shall be less than 0.5 Volts DC .
- 12.3.3.3.6 Remove the meters and reconnect the input connector J2. This completes the alignment of the trigger pulse amplifier.
- 12.3.3.4 Electronic Counter Alignment Check
 - 12.3.3.4.1 Set the COM/SEP/CHECK switch to CHECK.
 - 12.3.3.4.2 Set Levels A and B controls to zero. The remote display should read 1.0 counts .
 - 12.3.3.4.3 Set the Time base multiplier to 10^2-1 ms position. The remote display should read

100.0 counts. (Allow time for count to be accumulated.)

12.3.3.4.4 If either of these conditions do not occur, consult the maintenance section of this procedure, Paragraph 13.0.

12.3.3.4.5 Return the Level A and Level B to zero, the time base multiplier to $0.15 \cdot 10^4$, and the COM/SEP/CHECK switch to SEP.

This completes the alignment check on the electronic counter.

13.0 MAINTENANCE INSTRUCTIONS

13.1 Preventative Maintenance

Under normal conditions, no routine replacement of parts in the power increase timer is required. Good housekeeping practices including periodic dusting, cleaning, inspection, and the like is required and should be performed on a continuing basis.

13.2 Corrective Maintenance

Corrective maintenance, in depth, is performed at the factory, or by a Westinghouse field representative. Local corrective measures, however, may, if necessary, be performed at the skilled technician level. The alignment and test equipment specified earlier in this manual suffices to determine a faulty component or circuit.

<u>SYMPTOM</u>	<u>ACTION</u>
Blown Fuses	Replace
Blown Lamps	Replace
Loose Controls	Tighten
Off Voltages at Test Point	Check Mains
Faulty Instrument Indications	Realign
Overheating, Smoke, and Odors	Examine for Shorts in Load or Output Cables
Intermittents	Search for and correct High Resistance Joints or Loose Connectors

If any of the above symptoms persist, it is an indication of deepseated malfunction and should be attended to at the using facility or rectified by the factory field representative.

Minor items (non-critical capacitors, and the like) may be replaced by local parts of identical value and tolerance.

The modular (card) mounted construction used in the power increase timer permits the replacement of entire subassemblies, and stocking these subassembly cards (spares) will enhance the continuous operation of the unit with a minimum of down time.

13.3 Trouble Shooting Procedure, Electronic Counter A9

If malfunction occurs in the counter assembly A9, refer to the Hewlett-Packard Operating and Service Manual for the 5223L Electronic Counter for trouble-shooting procedures.

14.0 DRAWING LIST

937J845	Assembly - Power Increase Timer
937J847	Schematic Diagram - Power Increase Timer
938J074	Wiring Diagram - Power Increase Timer
978D864	Assembly - Relay Module
978D916	Assembly - Tracking Amplifier No. 2 Module
978D914	Assembly - Tracking Amplifier No. 1 Module
978D764	Assembly - Relay Driver Module
978D704	Assembly - Trigger Pulse Amplifier Module
978D196	Assembly - Grounding Module
978D918	Assembly - Component Module
978D917	Assembly - Component Module

15.0 TEST SPECIFICATION AND PROCEDURE

Each unit has been tested in accordance with the procedures and must comply with the limits of WANL Acceptance Test Spec. T-711850, which is included with this manual.

TEST SPECIFICATION NUMBER T-711850

TITLE

Acceptance Test Specification and Procedure

POWER INCREASE TIMER

Date: January 17, 1966

PREPARED BY:

Charles E. Hardus
Control Equipment Design and Fabrication
Control Systems Engineering

APPROVED BY:

R. A. Elmer
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Quality Engineering

INFORMATION CATEGORY

Unclassified
F. S. Malik 1/18/66
Authorized Classifier Date

ACCEPTANCE TEST SPECIFICATION AND PROCEDURE, POWER INCREASE TIMER

1.0 SCOPE

This document contains the requirements for acceptance testing the power increase timer (WANL Drawing 937J845), part of the ETS-1 TestStand Control System.

2.0 REQUIREMENTS

2.1 The acceptance tests shall consist of the following:

2.1.1 Visual Examination - To be performed by Quality Control.

2.1.2 Weights and Dimensions - To be performed by Quality Control.

2.1.3 Insulation Resistance - To be performed by Quality Control.

2.1.4 Operational Test (Functional Test) - To be performed by Instrumentation and Control and witnessed by Quality Control.

2.2 The acceptance test shall be performed in the order of and as specified in this procedure. Discrepancies found during the visual examination shall be corrected and re-inspected before performing the functional test. Failure or inability to obtain a required measurement during formal functional testing shall result in establishing a "hold" on the test. The failure or inadequacy shall be recorded by Quality Control and shall be reviewed by the WANL Engineering review board (ERB). Visual examination shall be performed on the reworked or repaired areas before resuming testing.

3.0 APPLICABLE DOCUMENTS

- 3.1 Drawing 937J845 - Power Increase Time Driver, XE Control System (TSCS)
- 3.2 Drawing 937J847 - Schematic Diagram Driver, Power Increase Time, XE Control System (TSCS)
- 3.3 Drawing 938J074 - Wiring Diagram Driver, Power Increase Time, XE Control System (TSCS)
- 3.4 NDC-118A NERVA Design Criteria ETS-I TSCS (AGC)
- 3.5 Power Increase Timer Operational Manual

4.0 EQUIPMENT REQUIRED

- 4.1 Multimeter (Simpson 269 or equal)
- 4.2 Digital Voltmeter (0.1% accuracy)
- 4.3 Function Generator (Figure 2) or equal
- 4.4 ± 15 VDC Power Supply, Technipower, (2)P-14.5-.100A or equal
- 4.5 +28VDC Power Supply, Technipower, P-28.0-.100A or equal
- 4.6 Oscilloscope, Tektronix 502 or equal
- 4.7 Megohmmeter - General Radio Megger Type 1862-B or equal
- 4.8 1VDC Power Supply ($\pm 50\%$)
- 4.9 Philbrick USA-3 Operational Amplifier Manifold with Amplifiers

5.0 ACCEPTANCE TEST PROCEDURE, POWER INCREASE TIMER

5.1 Visual Examination

The equipment under test shall be presented in its final form together with the applicable schematic, wiring diagram, and assembly drawing. The visual examination shall consist of the following parts.

5.1.1 Workmanship, Assembly, and Fit

The inspector shall inspect the equipment for workmanship to WANL requirements, and to assure that the overall chassis is of the

proper dimensions per the assembly drawing, Westinghouse Drawing Number 937J845.

Workmanship OK _____

5.1.2 Materials, Parts, and Finishes

The equipment shall be inspected to assure that the materials, parts, and finishes are in accordance with the applicable assembly drawings. Incoming inspection records on materials, parts, and finishes shall be utilized to determine conformance to the assembly drawings where possible.

Materials OK _____

5.1.3 Treatment for Prevention of Corrosion

The equipment shall be inspected to assure that the coatings for prevention of corrosion have not been impaired during the manufacturing cycle.

Treatment OK _____

5.1.4 Safety Requirements

The equipment shall be inspected to insure that no safety hazard, such as sharp edges, etc., exist on the equipment which are potential hazards to personnel operating or maintaining the equipment.

Safety OK _____

5.1.5 Marking

The markings on the equipment shall be inspected to ensure conformance to the applicable drawings and to assure that they are acceptable as to permanence and readability.

Marking OK _____

5.1.6 Visual Examination Review

After the visual examination of the equipment has been completed, all deficiencies shall be reviewed by WANL Engineering and Quality Control and corrected by one of the following methods:

- a. Drawing changes where drawing deficiencies are noted.
- b. Design changes if necessitated.
- c. Rework of the parts affected.

5.2 Weights and Dimensions

5.2.1 The unit shall be weighed and the weight shall be recorded.

Weight _____ lbs.

5.2.2 The unit shall be measured and the overall dimensions of width, height, and depth recorded.

Width _____ in.

Height _____ in.

Depth _____ in.

5.3 Insulation Resistance

5.3.1 Apply a test voltage of 500 V DC between chassis and circuit common with all external leads tied to circuit common, except the chassis ground, Pin E of Connector J1 using a Megger, General Radio 1862-B or equal. The insulation resistance shall be greater than 10 megohms.

Insulation Resistance _____ megohms

5.4 Functional Tests

5.4.1 Alignment and Alignment Stability.

5.4.1.1 Connect the Power Increase Timer in the test set-up of Figure 1. Apply power, 115 V AC, ± 15 V DC, and + 28 V DC, and allow the equipment to warm up for a minimum of 30 minutes.

5.4.1.2 Align the equipment per the alignment procedure in the Power Increase Timer operational manual.

5.4.1.3 Set S_2 to Positive 1 (E) and insert an exponentially increasing voltage into the input from the Function Generator. This exponential shall have a period of 10 sec. The nixie readout shall indicate 10 sec. ± 0.5 sec.

Input period _____ Nixie readout _____

5.4.1.4 Set S_2 to Positive 2 (E/2). With the same period input, the nixie readout shall read 10 sec. ± 0.5 sec.

Input Period _____ sec.

Nixie Readout _____ sec.

5.4.1.5 Set S_2 to Positive 3 (E/4). With the same period input as 5.4.1.3 the nixie readout shall be 10 ± 0.5 sec.

Input Period _____

Nixie Readout _____

5.4.1.6 Depress the Range Sim switch, S_4 . The voltage across J2P to J2R shall be less than 5 ohms for a time period of 200 millisecc. ± 50 milliseconds. The resistance after the 200 millisecond pulse shall be greater than 10 megohms.

J2P to J2R shorted _____ ohms

Time J2P to J2R shorted _____ ohms

J2P to J2R open _____ ohms

5.4.1.7 Repeat steps 5.4.1.3 through 5.4.1.6 after one hour.

The readings shall not deviate from the initial run by greater than 1.0%.

5.4.2 Set S_2 to Positive 1 (E) and insert an exponentially increasing voltage into the input from the Function Generator. This exponential shall have a period of 1.0 sec. The nixie readout shall indicate 1.0 sec. ± 0.05 sec.

Input Period _____ Nixie Readout _____

5.4.2.1 Set S_2 to Positive 2 (E/2). With the same period input, the nixie readout shall read 1.0 ± 0.05 sec.

Input Period _____ sec.

Nixie Readout _____ sec.

5.4.2.2 Set S_2 to Positive 3 (E/4). With the same period input as 5.4.2, the nixie readout shall be 1.0 ± 0.05 sec.

Input Period _____ sec.

Nixie Readout _____ sec.

5.4.3 Set S_2 to Positive 1 (E) and insert an exponentially increasing voltage into the input from the Function Generator. This exponential shall have a period of 25 sec. The nixie readout shall indicate 25 sec. ± 1.25 sec.

Input Period _____ Nixie Readout _____

5.4.3.1 Set S_2 to Positive 2 ($E/2$). With the same period input, the nixie readout shall read 25 ± 1.25 sec.

Input Period _____ sec.

Nixie Readout _____ sec.

5.4.3.2 Set S_2 to Positive 3 ($E/4$). With the same period input as 5.4.3, the nixie readout shall be 25 ± 1.25 sec.

Input Period _____

Nixie Readout _____

5.4.4 Set S_2 to Positive 1 (E) and insert an exponentially increasing voltage into the input from the Function Generator. This exponential shall have a period of 50 sec. The nixie readout shall indicate 50 sec. ± 2.5 sec.

5.4.4.1 Set S_2 to Positive 2 ($E/2$). With the same period input, the nixie readout shall read 50 ± 2.5 sec.

Input Period _____ sec.

Nixie Readout _____ sec.

5.4.4.2 Set S_2 to Positive 3 ($E/4$). With the same period input as 5.4.4, the nixie readout shall be 50 ± 2.5 sec.

Input Period _____

Nixie Readout _____

5.4.5 Set S_2 to Positive 1 (E) and insert an exponentially increasing voltage into the input from the Function Generator. This exponential shall have a period of 75 sec. The nixie readout shall indicate 75 sec. ± 3.75 sec.

Input Period _____ Nixie Readout _____

- 5.4.5.1 Set S_2 to Positive 2 ($E/2$). With the same period input, the nixie readout shall read 75 ± 3.75 sec.

Input Period _____ sec.

Nixie Readout _____ sec.

- 5.4.5.2 Set S_2 to Positive 3 ($E/4$). With the same period input as 5.4.5, the nixie readout shall be 75 ± 3.75 sec.

Input Period _____

Nixie Readout _____

- 5.4.6 Set S_2 to Positive 1 (E) and insert an exponentially increasing voltage into the input from the Function Generator. This exponential shall have a period of 100 sec. The nixie readout shall indicate 100 sec. ± 5 sec.

Input Period _____ Nixie Readout _____

- 5.4.6.1 Set S_2 to Positive 2 ($E/2$). With the same period input, the nixie readout shall read 100 ± 5.0 sec.

Input Period _____ sec.

Nixie Readout _____ sec.

- 5.4.6.2 Set S_2 to Positive 3 ($E/4$). With the same period input as 5.4.6, the nixie readout shall be 100 ± 5.0 sec.

Input Period _____

Nixie Readout _____

- 5.4.7 Set S_2 to Positive 1 (E) and insert an exponentially increasing voltage into the input from the Function Generator. This exponential shall have a period of 500 sec. The nixie readout shall indicate 500 sec. ± 25 sec.

5.4.7.1 Set S_2 to Positive 2 (E/2). With the same period input, the nixie readout shall read 500 ± 25 sec.

Input Period _____ sec.

Nixie Readout _____ sec.

5.4.7.2 Set S_2 to Positive 3 (E/4). With the same period input as 5.4.7, the nixie readout shall be 500 ± 25 sec.

Input Period _____

Nixie Readout _____

5.5 QUALITY CONTROL REQUESTED TESTS

5.5.1 Perform the following tests using the test set-up of Figure 1.

5.5.1.1 Check the operation of each fuse indicator light by removing and replacing fuses F1 through F4. Each fuse indicator shall light when fuse is removed and the applicable power supplies are on.

Fuse Indicators _____

5.5.1.2 Measure 117 ± 10 VAC between TPI0 and TPI1.

A.C. Volts _____

5.5.1.3 Measure 117 ± 10 VAC between P7-1 and P7-2 when test power switch

SI is on.

A. C. Volts _____

Measure 0 volts with SI off.

A. C. Volts _____

5.5.1.4 Measure 15 ± 1 VDC between TPI3(+) and TPI2(-).

D. C. Volts _____

5.5.1.5 Measure 15 ± 1 VDC between J5-1(+) and TPI2(-) when test power switch

SI is on.

D. C. Volts _____

Measure 0 volts with SI off.

D. C. Volts _____

5.5.1.6 Measure 15 ± 1 VDC between TPI4(-) and TPI2(+).

D. C. Volts _____

- 5.5.1.7 Measure 15 ± 1 VDC between J5-2 (-) and TPI2(+). when test power switch SI is on. D. C. Volts _____
- Measure 0 volts with SI off. D. C. Volts _____
- 5.5.1.8 Measure 28 ± 2 VDC between TPI5(+) and TPI6(-). D. C. Volts _____
- 5.5.1.9 Twenty-Eight volt remote power on-off test.
- The 28 volt test light (power off) shall be lit when the test power switch SI is off. The (power on) test light shall not be lit.
 - The 28 volt test light (power on) shall be lit when the test power switch SI is on. The (power off) test light shall not be lit.
- 28 Volt Remote Test _____
- 5.5.1.10 Depress the Manual Start Switch SI. The circuit shall reset and start. Manual Start Test _____
- 5.5.1.11 Depress the REMOTE RESET. The circuit shall reset and restart. Remote Reset Test _____
- 5.5.1.12 Measure the continuity of the wires between connector P-1, mates with J12, and connector J2. The wires should show continuity only as shown on the following table:
P1	Wire No.	J2
1	204	i
2	209	j
26	214	T
27	219	U
3	224	V
4	229	W
28	234	X
29	239	Y
5	244	Z

<u>PI</u>	<u>Wire No.</u>	<u>J2</u>
6	249	<u>a</u>
30	254	<u>b</u>
31	259	<u>c</u>
7	264	<u>d</u>
8	269	<u>e</u>
32	274	<u>f</u>
33	279	<u>g</u>
50	1776	N
23	1748	<u>h</u>

5.5.1.13 Additional Continuity Checks

Remove all power and perform the following continuity checks using the multimeter of Section 4.1. Acceptance shall be indicated by a short (less than 1 ohm).

<u>From</u>	<u>To</u>	<u>Accept</u>	<u>Reject</u>
TP1 (range)	J2-D	_____	_____
TP2 (Linear Power)	J2-H	_____	_____
TP3 (Hold)	J6-4	_____	_____
TP4 (Comparator Output)	J6-11	_____	_____
TP5 (Reset)	J11-9	_____	_____
TP6 (Hold Time)	J11-16	_____	_____
TP7 (Recycle)	J11-13	_____	_____
TP8 (Power Incr. Time Print)	J2-h	_____	_____
TP9 (Print Red)	J9-5	_____	_____
A3-TP1	TP12 (Com)	_____	_____
A4-TP1	TP12 (Com)	_____	_____
A5-TP2	J8-8	_____	_____

FIGURE 1
Test Setup
Power Increase Timer

WANL-TME-1394

WANL-TME-1394

FIGURE 2

Function Generator Test Setup
Power Increase Timer

1/15/66 CEH