TM 11-6625-368-24

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ORGANIZATIONAL AND FIELD
MAINTENANCE MANUAL

PULSE GENERATOR SETS AN/UPM-15 AND AN/UPM-15A

This copy is a reprint which includes current pages from Changes 1 and 2

HEADQUARTERS, DEPARTMENT OF THE ARMY
SEPTEMBER 1960

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.; 27 *September 1960*

TM 11-6625-368-24 (a reprint of Air Force TO 33 A1-8-6-12, 1 November 1959), is published for the use of Army personnel.

By Order of *Wilber M. Brucker,* Secretary of the Army:

L. L. LEMNITZER,
General, United States Army,
Chief of Staff.

Official:

R. V. LEE,
Major General, United States Army,
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-7 requirements for TM 11 series (Uncl) plus the following additional formula:

Active Army:

ASA (2)	Units organized under following	11-98
CNGB (1)	TOE's (2 copies each) :	11-117
Tech Stf, DA (1) except CSigO (18)	7	11-155
	9-25	11-500 (AA-AE)
Def Atomic Spt Agcy (5)	11-5	11-557
US ARADCOM (2)	11-6	11-587
US ARADCOM (2)	11-7	11-592
MDW (1)	11-16	11-597
Seventh US Army (2)	11-55	17
Eighth US Army (2)	11-56	39-51
	11-57	39-52

NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

TECHNICAL MANUAL

Organizational and Field Maintenance Manual

PULSE GENERATOR SETS AN/UPM–15 AND AN/UPM–15A

TM 11–6625–368–24
CHANGES No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *8 March 1962*

TM 11–6625–368–24, 27 September 1960, is changed as follows:

Page 26. Add the following:

APPENDIX I

MAINTENANCE ALLOCATION

(Added)

Section I. MAINTENANCE ALLOCATION

1. General

a. This section assigns maintenance functions to be performed on Components, assemblies, and subassemblies by the lowest appropriate maintenance echelon.

b. Columns in the maintenance allocation chart are as follows:

(1) *Component.* This column shows only the nomenclature or standard item name. Additional descriptive data is included only where clarification is necessary to identify the component. Components, assemblies, and subassemblies are listed in top-down order. That is, the assemblies which are part of a component are listed immediately below that component, and the subassemblies which are part of an assembly are listed immediately below that assembly. Each generation break-down (components, assemblies, or subassemblies) are listed in disassembly order or alphabetical order.

(2) *Maintenance function.* This column indicates the various maintenance functions allocated to the echelons.

(*a*) *Service.* To clean, to preserve, and to replenish lubricants.

(*b*) *Adjust.* To regulate periodically to prevent malfunction.

(*c*) *Inspect.* To verify serviceability and to detect incipient electrical or mechanical failure by scrutiny.

(*d*) *Test.* To verify serviceability and to detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, etc.

(*e*) *Replace.* To substitute serviceable components, assemblies, or subassemblies, for unserviceable components, assemblies, or subassemblies.

(*f*) *Repair.* To restore an item to serviceable condition through correction of a specific failure or unserviceable condition. This function includes but is not limited to welding, grinding, riveting, straightening, and replacement of parts other than the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.

(*g*) *Align.* To adjust two or more components of an electrical system so that their functions are properly synchronized.

(*h*) *Calibrate.* To determine, check, or rectify the graduation of an instrument, weapon, or weapons system, or components of a weapons system.

(*i*) *Overhaul.* To restore an item to *completely serviceable* condition as prescribed by serviceability standards developed and published by heads of technical services. This is accomplished through the employment of the technique of "Inspect and Repair Only as Necessary" (IROAN). Maximum utilization of diagnostic and test equipment is combined with minimum disassembly of the item during the overhaul process.

(*j*) *Rebuild.* To restore an item to a standard as near as possible to original or new condition in appearance, performance, and life expectancy. This is accomplished through the maintenance technique of complete disassembly of the item, inspection of all parts or components, repair or replacement of worn or unserviceable elements using original manufacturing tolerances and/or specifications and subsequent reassembly of the item.

(3) *1st, 2d, 3d, 4th, 5th echelon.* The symbol X placed in Columns 3 through 7 indicates the echelon responsible for performing that particular maintenance operation, but does not necessarily indicate that repair parts will be stocked at that level. Echelons higher than the echelon marked by X are authorized to perform the indicated operation.

(4) *Tools required.* This column indicates codes assigned to each individual tool equipment, test equipment, and maintenance equipment referenced. The grouping of codes in this column of the maintenance allocation chart indicates the tool, test, and maintenance equipment required to perform the maintenance function.

(5) *Remarks.* Entries in this column will be utilized when necessary to clarify any of the data cited in the preceding columns.

c. Columns in the allocation of tools for maintenance functions are as follows:

(1) *Tools required for maintenance functions.* This column lists tools, test, and maintenance equipment required to perform the maintenance functions.

(2) *1st, 2d, 3d, 4th, 5th echelon.* The dagger (†) symbol in these columns indicates the echelons normally allocated the facility.

(3) *Tool code.* This column lists the tool code assigned.

2. Maintenance by Using Organizations

When this equipment is used by signal services organizations organic to theater headquarters or communication zones to provide theater communications, those maintenance functions allocated up to and including fourth echelon are authorized to the organization operating this equipment.

3. Comments or Suggestions

Any comments concerning omissions and discrepancies in Appendix I will be prepared on DA Form 2028 and forwarded direct to Commanding Officer, U.S. Army Signal Materiel Support Agency, ATTN: SIGMS-ML, Fort Monmouth, N.J.

Section II. MAINTENANCE ALLOCATION CHART

Part or component	Maintenance function	1st ech	2d ech	3d ech	4th ech	5th ech	Tools required	Remarks
PULSE GENERATOR SET AN/UPM-15; AN/UPM-15A	service				X		2, 7	
	adjust				X		1, 2, 3, 6, 7	
	inspect				X		2	
	test				X		1, 2, 3, 6, 7	
	repair		X				2, 3, 5, 6, 7	
	align				X		1, 2, 3, 4, 6, 7	
	calibrate				X		1, 2, 3, 4, 6, 7	
	rebuild					X	1, 2, 3, 4, 6, 7	
	overhaul					X	1, 2, 3, 4, 6, 7	
PULSE GENERATOR	repair		X				2, 3, 5, 6, 7	
	rebuild					X	1, 2, 3, 4, 6, 7	
ADAPTER	replace		X					
CABLE ASSEMBLIES	replace		X					
	trpsit				C		6, 7	
CASE	repair				X			

Section III. ALLOCATION OF TOOLS FOR MAINTENANCE FUNCTIONS

Tools required for maintenance functions	1st ech	2d ech	3d ech	4th ech	5th ech	Tool code	Remarks
AN/UPM-15; AN/UPM-15A (continued)							
FREQUENCY METER AN/TSM-16				†	†	1	
MULTIMETER TS-352/U				†	†	2	
OSCILLOSCOPE AN/USM-50				†	†	3	
TEST SET. ELECTRON TUBE TV-2/U					†	4	
TEST SET. ELECTRON TUBE TV-7/U				†		5	
TOOL EQUIPMENT TK-87/U				†	†	6	
VOLTMETER. METER ME-30/U				†	†	7	
TOOL AND TEST EQUIPMENT AVAILABLE TO THE REPAIRMAN USER BECAUSE OF HIS ASSIGNED DUTIES	†						

BY ORDER OF THE SECRETARY OF THE ARMY:

G. H. DECKER,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

DASA (6)
USASA (2)
CNGB (1)
Tech Stf, DA (1) except
CSigO (14)
Tech Stf Bd (1)
USCONARC (5)
USAARTYBD (1)
USAARMBD (2)
USAIB (1)
USARADBD (2)
USAAVNBD (1)
USAABELCTBD (1)
USAATBD (1)
ARADCOM (2)
ARADCOM, Rgn (2)
OS Maj Comd (3)
OS Base Comd (2)
LOGCOMD (2)
MDW (1)
Armies (2)
Corps (2)
Fort Monmouth (63)
USATC AD (2)
USATC Armor (2)
USATC Engr (2)
USATC Inf (2)
USATC FA (2)
USAOMC (3)
Svc College (1)
Br Svc Sch (1)
GENDEP (2) except
Atlanta GENDEP (none)
Sig Dep (12)
WRAMC (1)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
OSA (1)
USAEPG (2)
AFIP (1)
AMS (1)
Army Pictorial Cen (2)
EMC (1)
Yuma Test Sta (2)
USACA (3)
USASSA (20)
USASSAMRO (1)
USASEA (1)
USA Caribbean Sig Agcy (1)
USA Sig Msl Spt Agcy (13)
Sig Fld Maint Shops (1)
USA Corps (3)
Def Log Svc Cen (1)
JBUSMC (2)
Units org under fol TOE:
(2 copies each except as indicated)
9-47
9-87
9-227
9-377
9-500 (AA-AC)
11-5
11-7
11-16
11-55
11-56
11-57
11-96
11-97
11-98
11-117
11-155
11-157
11-500 (AA-AE, RM-RT) (4)
11-555
11-557
11-587
11-592
11-597
17
39-51
39-52
44-435
44-436
44-437
44-445
44-446
44-447
44-448
44-535
44-536
44-537
55-544
44-545
44-546
44-547
44-548

NG: State AG (3); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

TECHNICAL MANUAL

Organizational and Field Maintenance Manual

PULSE GENERATOR SETS AN/UPM-15 AND AN/UPM-15A

TM 11-6625-368-24
CHANGES No. 2

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *19 June 1963*

TM 11-6625-386-24, 27 September 1960, is changed as follows:

Page 1. Add paragraphs 1-2.1 and 1-2.2 after paragraph 1-2.

1-2.1. Index of Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new additions, changes, or additional publications pertaining to your equipment. DA Pam 310-4 is an index of current technical manuals, technical bulletins, supply bulletins, lubrication orders, and modification work orders that are available through publications supply channels. The index lists the individual parts (-10, -20, (35P, etc.) and the latest changes to an revisions of each equipment publication.

1-2.2. Comments on Publications

Forward all comments on this publication direct to: Commanding Officer, U.S. Army Electronics Materiel Support Agency, ATTN: SELMS-MP, Fort Monmouth, N. J. DA Form 1598 (Record of Comments on Publications), DA Form 2496 (Disposition Form), or letter maybe used.

Note. For applicable forms and records, see paragraph 1-2.2, TM 11-6625-368-10.

Page 14. Add section IV.1 after section IV.

Section IV.1. ORGANIZATIONAL PREVENTIVE MAINTENANCE

4.1-1. Scope of Organizational Maintenance

a. This section contains instructions covering second echelon preventive maintenance of Pulse Generator Sets AN/UPM-15 and AN/UPM-15A. It includes instructions for performing preventive and periodic maintenance checks and services and repair functions to be accomplished by the organizational repairman. Operating instructions are in TM 11-6625-368-10.

b. Second echelon preventive maintenance checks and services of Pulse Generator Sets AN/UPM-15 and AN/UPM-15A includes.—

(1) Preventive maintenance (par. 4.1-3 through 4.1-5).
(2) Cleaning and touchup painting instructions (par. 4.1-6).
(3) Replacement of pilot light (par. 5-8).
(4) Replacement of fuses (par. 5-8).
(5) Replacement of vacuum tubes (par. 5-9).

4.1-2. Test Equipment Required

It is necessary to use an oscilloscope, such as the AN/USM-50, to check the pulse generator. Refer to appendix II for the test equipment allocation.

4.1-3. Preventive Maintenance

a. Preventive maintenance is the systematic care, inspection, and servicing of equipment to maintain it in serviceable condition, prevent breakdowns, and assure maximum operational capability. Preventive maintenance is the responsibility of all echelons concerned with the equipment and includes the inspection, testing, and repair or replacement of parts, subassemblies, or units that inspection and tests indicate would probably fail before the next scheduled periodic service. Preventive maintenance checks and services of Pulse Generator Sets AN/UPM-15 and AN/UPM-15A at the second echelon level are made at monthly intervals unless otherwise directed by the commanding officer. The preventive maintenance checks and services should be scheduled concurrently with the periodic service schedule of the carrying vehicle for all vehicular installations.

b. Maintenance forms and records to be used and maintained on this equipment are specified in TM 38-750.

4.1-4. Monthly Maintenance

a. Perform the maintenance functions given in the monthly maintenance service and inspection chart (par. 4.1-5) once a month. A month is defined as approximately 30 calendar days of 8-hour-per-day operation. If the equipment is operated 16 hours a day, the monthly preventive maintenance checks and services should be performed at 15-day intervals. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have monthly preventive maintenance checks and services performed on it. Equipment in limited storage (requires service before operation) does not require monthly preventive maintenance.

b. Monthly maintenance will be scheduled in accordance with the requirements of TM 38-750. If the equipment is part of a vehicular installation, the monthly maintenance should be scheduled concurrently with the periodic service schedule of the carrying vehicle to reduce out-of-service time to a minimum. All deficiencies or shortcomings will be recorded, and those not corrected during the inspection and service will be immediately reported to higher echelon by use of forms and procedures specified in TM 38-750. Equipment that has a deficiency that cannot be corrected by second echelon should be deadlined in accordance with TM 38-750. Perform all the services listed in the monthly preventive maintenance checks and services chart (par. 4.1-5) in the sequence listed.

4.1-5. Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Completeness	See that the equipment is complete (appx. II, TM 11-6625-368-10).	
2	Installation	See that the equipment is properly installed (par. 2-22 and 2-23, TM 11-6625-368-10).	
3	Cleanliness	See that the equipment is clean (par. 3.1-7, TM 11-6625-368-10).	
4	Preservation	Check all surfaces for evidence of fungus. Remove rust and corrosion and spot-paint bare spots.	Par. 4.1-6.
5	Publications	See that all publications are complete, serviceable and current.	DA Pam 310-4.
6	Modifications	Check DA Pam 310-4 to determine if new applicable MWO's have been published. All URGENT MWO's must be applied immediately. All ROUTINE M must be scheduled.	TM 38-750 and DA Pam 310-4.
7	Pluckout items	Inspect clamps and seating of pluckout items. Check for wrong, bent, or broken parts.	Par. 5-8.
8	Fuses	See that the operating fuses are of the correct value (4 amp). Check spare fuse (4 amp) for proper value.	TM 11-6625-368-20P.
9	Connections	Check to be sure that plugs and sockets are clean, intact, and not loose fitting. Cords and cables are free from strains, cracks, and breaks.	Fig. 1-1 and par. 2-23, TM 11-6625-368-10.
10	Resistors and capacitors	Inspect for cracks, blistering or any other defect. Tighten resistor and capacitor mounting boards.	
11	Grommets and insulators	Check to see that insulators are free from cracks and chipping, and grommets are in place.	
12	Variable capacitors	Inspect for proper mounting and dirt.	
13	Knobs, dials, and switches	While making the operating checks (item 14), observe that the mechanical action of each knob, dial, and switch is smooth and free of external or internal binding.	
14	Operating check	Check the pulse generator for proper operation (par. 5-1 through 5-5).	Pars. 5-7 through 5-9.
15	Spare parts parts	Check all spare parts for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	Appx. II, TM 11-6625-368-10 and TM 11-6625-368-20P.

4.1-6. Cleaning and Touchup Painting Instructions

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats or paint on the bare metal to protect it from further corrosion. Refer to applicable cleaning and refinishing practices in TM 9-213.

Page 26, appendix I (page 1 of C 1). Renumber the existing appendix "I" to appendix II.

Add appendix I before appendix II.

APPENDIX I
REFERENCES

Following is a list of references available to the organizational and field maintenance repairman of Pulse Generator Sets AN/UPM-15 and AN/UPM-15A.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 9-213	Painting Instructions for Field Use.
TM 11-6625-368-10	Operator's Manual, Pulse Generator Sets AN/UPM-15 and AN/UPM-15A.
TM 38-750	The Army Equipment Record System and Procedures.

By Order of the Secretary of the Army:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

DASA (6)
USASA (2)
CNGB (1)
CofEngrs (1)
TSG (1)
CSigO (7)
CofT (1)
C/Spt Svcs (1)
USA CD Agcy (1)
USCONARC (5)
USAMC (5)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (3)
OS Base Comd (2)
LOGCOMD (2)
USAECOM (5)
USAMICOM (3)
USASCC (4)
MDW (1)
Armies (2)
Corps (2)
USATC AD (2)
USATC Engr (2)
USATC Inf (2)
USATC Armor (2)
Instl (2) except
Ft Monmouth (63)
Svc College (2)
Br Svc Sch (2)
GENDEP (OS) (2)
Sig Dep (OS) (12)
Sig Sec, GENDEP (OS) (5)
Army Dep (2) except
Ft Worth (8)
Lexington (12)
Sacramento (28)
Tobyhanna (12)
USA Elct RD Actv White Sands (13)
USA Elct RD Actv, Ft Huachuca (2)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
USAOSA (1)
AMS (1)
WRAMC (1)
AFIP (1)
Army Pic Cen (2)
USA Mbl Spt Cen (1)
USA Elct Mat Agcy (12)
Chicago Proc Dist (1)
USARCARIB Sig Agcy (1)
Sig Fld Maint Shop (3)
USA Corps (3)
Units org under fol TOE:
Two copies each unit:

9-47	11-557
9-87	11-587
9-227	11-592
9-377	11-597
9-500 (AA-AC)	44-435
11-5	44-436
11-7	44-437
11-16	44-445
11-55	44-446
11-57	44-447
11-96	44-448
11-97	44-535
11-98	44-536
11-117	44-537
11-155	44-544
11-157	44-545
11-500 (AA-AC), RM-RU)	44-546
11-555	44-547
	44-548

NG: State AG (3); units—same as active Army except allowance is one copy each unit.
USAR: None.
For explanation of abbreviations used, see AR 320-50.

TECHNICAL MANUAL)
)
NO. 11-6625-368-24)

HEADQUARTERS,
DEPARTMENT OF THE ARMY
Washington 25, D. C., 27 September 1960

ORGANIZATIONAL AND FIELD MAINTENANCE MANUAIL

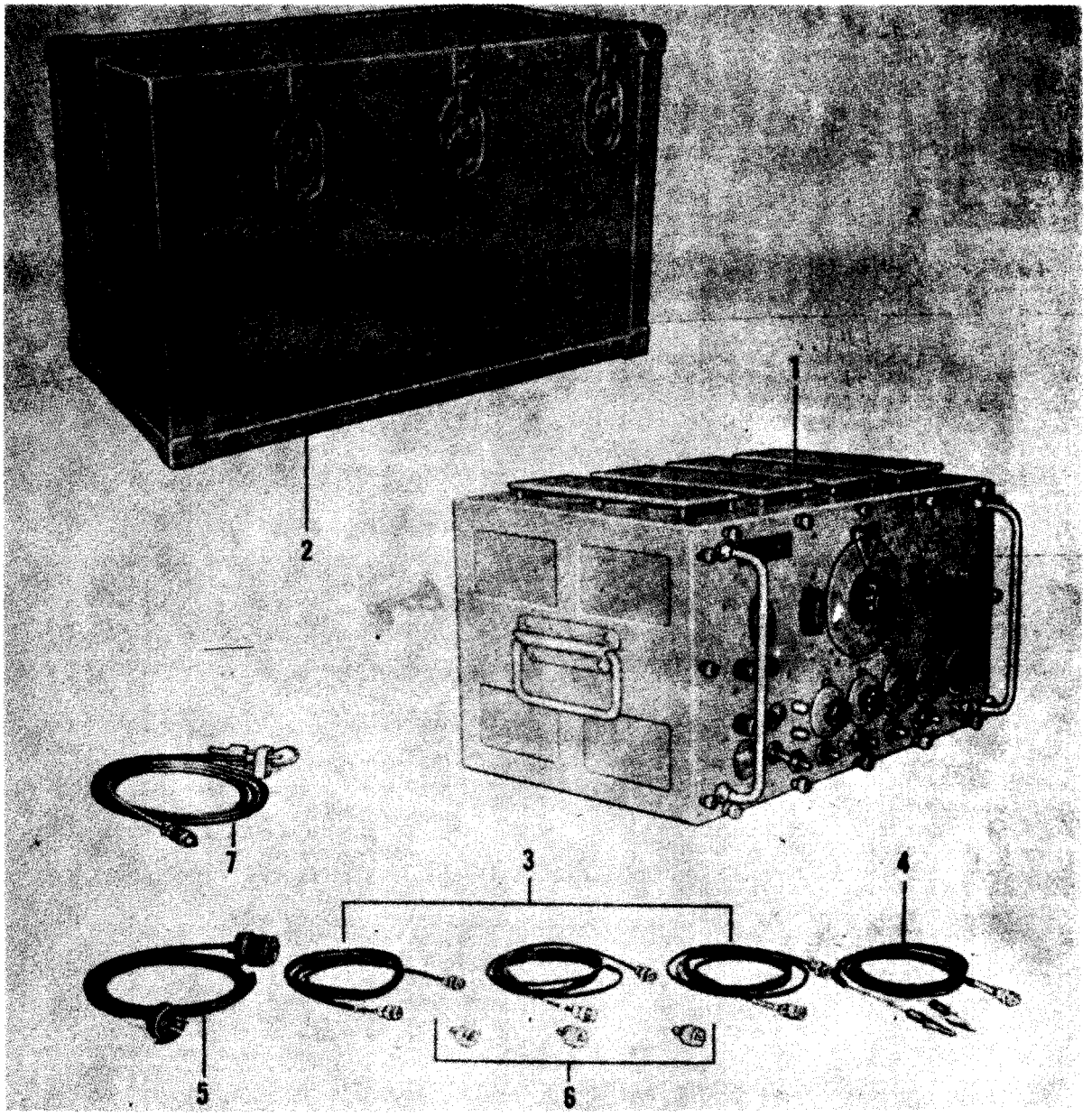
PULSE GENERATOR SETS AN/UPM-15 AND AN/UPM-15A

***This manual, together with TM 11-6625-368-10, 27 September 1960, and TM 11-6625-368-50, 27 September 1960, supersedes TM 11-1177, 1 February 1957.**

INTRODUCTION

The purpose of the Handbook of Service Instructions is to provide adequate information which will aid the technician in servicing and repairing this equipment.

All symbols, reference designations, and abbreviations used in this manual are in accordance with JAN-STD-15 and MIL-STD-16.



1. Pulse Generator TS-592A/UPM-15, TS-592B/UPM-15 or SG-343/UPM-15A
2. Transit Case CY-672/U
3. Cord CX-409E/U
4. RF Cable Assembly CG-521/U
5. Cord CX-337/U (supplied with AN/UPM-15)
6. Adapter UG-273/U
7. Cable Assembly, Power Electrical CX-3135/U (supplied with AN/UPM-15A)

Figure 1-1. Pulse Generator Set AN/UPM-15 and AN/UPM-15A

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. GENERAL.

1-2. This handbook of Service Instructions covers instructions for repair, replacement, adjustment and recalibration of Pulse Generator Set AN/UPM-15 and AN/UPM-15A, manufactured by A. R. F. Products Inc., River Forest, Illinois.

1-3. PURPOSE OF EQUIPMENT.

1-4. Pulse Generator Set AN/UPM-15 or AN/UPM-15A (figure 1-1) is a general purpose video electronic generator for use in the calibration of radar equipment, in field, depot maintenance, and in laboratory work. It produces output wave shapes that are essentially rectangular. By means of manual controls, it is possible to produce a wide range of pulse amplitudes, widths, repetition rates and delays. It is possible to synchronize the equipment either with an external oscillator, or with external sources producing wide varieties of waveforms, frequencies and amplitudes.

1-5. CAPABILITIES.

1-6. OUTPUTS. This pulse generator supplies steeply rising and falling pulses at any positive or negative potential within a range of ±200 volts. A choice of one or two output pulses is provided. Width of pulses is continuously variable from 0.5 to 100 usec. Amplitude of the pulses is variable from 0.0 to 200 volts. The pulse generator also supplies a sync pulse of approximately 1.3 usec width and a positive 25 to 75 volts amplitude. The sync pulse is delayable with respect to the output pulse or pulses and is available at a separate front panel connector.

1-7. EXTERNAL SIGNALS. Externally-supplied synchronizing signals may have an amplitude of from 5 to 100 volts. External signal frequency may vary from 50 to 10,000 cps. However, if the signal is a sawtooth shape, the minimum acceptable frequency is 250 cps.

1-8. AMBIENT TEMPERATURE RANGE. The pulse generator is designed to operate within a temperature range of -20° C (-4°F) to +55° C (+131 °F).

1-9. LIMITATIONS.

1-10. INTERNAL OSCILLATOR CALIBRATION. Calibration of the repetition rate ("PULSE RATE" dial) is accurate within ±5 percent at a temperature of +20° C (+70°F). Accuracy is within ±10 percent at the high and low ends of the temperature range stated in paragraph 1-8.

1-11. PULSE OUTPUTS. Accuracy of all controllable characteristics of pulse output is within ±10 percent.

1-12. BIAS CONTROL. With an externally applied synchronizing signal of up to 100 volts, the pulse output may be synchronized by the bias control with any positive value of the external signal up to 95 volts.

1-13. TUBE COMPLEMENT. The pulse generator contains 27 electron tubes which are listed in Table 1-1.

TABLE 1-1. ELECTRON TUBE COMPLEMENT

Qty	JAN - Type Number	Reference Symbol No.	Function
4	JAN6AU6WA	V1	oscillator
		V3, V4, V24	amplifier
5	JAN5814A	V2, V6, V13	amplifier
		V14, V15	multivibrator
1	JAN6D4	V5	pulse generator
4	JAN12AT7 WA	V7, V9, V11 V12	amplifier
2	JAN5725/ 6AS6W	V8, V10	phantastron
2	JAN6AH6	V16, V17	amplifier
1	JAN6AN5	V18	amplifier
1	JAN829B	V19	amplifier
1	JAN6005/ 6AQ5W	V20	amplifier
1	JAN5R4WGA	V21	rectifier
2	JAN6AS7G	V22, V23	amplifier
1	USN6626/ 0A2WA	V25	voltage regulator
1	JAN6X4W	V26	rectifier
1	USN6627/ 0B2WA	V27	rectifier

1-14. FUSE COMPLEMENT. Two type 3AG, 4 ampere fuses are in the power line circuit. Two spare fuses, mounted on the front panel, are marked "SPARES".

1-15. PULSE FREQUENCY RANGES. There are three pulse rate frequency ranges marked "A", "B" and "C". Range "A" covers from 50 to 280 cps, "B" 280 to 1600 cps, "C" 1600 to 10,000 cps.

1-16. OUTPUT CHARACTERISTICS. Table 1-2 displays the characteristics of the sync pulse and the output pulses. There is a choice of one or two output pulses. Their width and amplitude are produced by a single set of controls so the waveforms of output pulses are the same. The first output pulse may lead or lag

the sync pulse by 2 to 220 usec. A separation of 2 to 30 usec may be established between the first and second output pulse. The second output pulse can be turned off leaving the sync and one output pulse.

1-17. OPERATION CONTROLS.

1-18. Control dials in this equipment are associated with switches of a similar name. These switches give the dials extra range of control. The nomenclature for each control and connector is stated in the Panel Designation column of Table 1-3. All controls and connectors are illustrated in figure 1-2.

TABLE 1-2. PULSE CHARACTERISTICS

	Sync Pulse	Output Pulse
Polarity	Positive	Positive or Negative
Amplitude	50 volts	0.0 to 200 volts
Width	1.5 usec	0.5 to 100 usec
Rise Time	0.1 usec	0.05 to 0.25 usec
Delay	2 to 220 usec	2 to 220 usec

TABLE 1-3. PULSE GENERATOR OPERATING CONTROLS

ndex No.	Panel Designation	Function	ndex No.	Panel Designation	Function
1 or 21	'115V 50-1000"	Connector for 115V 50 to 1000 cycle power source.	10	"FINE ATTN"	Dial for close control of voltage of output pulses. Black engraved numerals on this dial are multiplied by the blue engraved multiplier numeral selected with the "COARSE ATTN" knob (9). Red engraved numerals on the dial are used when the red numerals are selected with the "COARSE ATTN" knob.
2	'POWER"	Power switch to turn equipment on or off.			
3	"SYNC IN"	Input connector for external sync signals.			
4	"SYNC OUT"	Connector for sync pulse.			
5	"OUTPUT"	Connector for output pulses.			
6	"SYNC"	Selector knob for "INT" "A, B, C" ranges of internally-generated pulse rate and "EXT", "GOING +", "GOING -" conditions of external synchronization through "SYNC IN" connector.	11	"SYNC"	Switch has "LEAD" and "LAG" positions to make the sync pulse either lead or lag the output pulses.
			12	"DELAY"	Switch is used in conjunction with "DELAY" dial (13). Switch has "LONG" and "SHORT" positions corresponding to ranges on the "DELAY" dial.
7	"PULSE RATE"	Dial for setting pulse repetition rate. Bands "A", "B", "C" are selected by "SYNC"selector knob. Band "A" covers 50 to 280, band "B" 280 to 1600 and band "C" 1600 to 10,000 pulse repetitions per second.	13	"DELAY"	Dial is the continuous control for setting the delay between the sync and the first output pulse. The dial has the "SHORT" scale of 2 to 20 usec. These scales are selected by the "DELAY" switch. Red marking on the "LONG" scale are 20 to 220 usec.
8	'BIAS"	Knob for determining triggering point when a waveform is fed through the "SYNC IN" connector.			
9	"COARSE ATTN"	Knob for selecting voltage ranges and internal resistance for output panel markings must be combined with "FINE ATTN" dial readings to calculate output voltages.	14	"PULSE NO. 2"	Switch turns on, or eliminates the pulse that occurs late in time. Positions of the switch are "IN" and "OUT".

TABLE 1-3. PULSE GENERATOR OPERATING CONTROLS (CONT)

ndex No.	Panel Designation	Function	Index No.	Panel Designation	Function
15	"SEPARATION"	Dial permits adjusting the time between the output pulses. "PULSE NO. 2" switch must be in "IN" position.	18	"POLARITY"	Switch has "NEG" (negative) and "POS" (positive) positions. This switch determines the polarity of the output pulses.
16	"WIDTH"	Switch is associated with the "WIDTH" dial (17). The switch has "NAR" (narrow) and "WIDE" positions.	19	"RISE TIME"	Dial provides adjustment of the rise time of the output pulses. The dial has two scales. Each scale is calibrated from 0.05 to 0.25 usec. One scale is for positive pulses and the other scale for negative pulses.
17	"WIDTH"	Dial is the continuous control for setting the width of output pulses. The dial has the narrow scale of 0.5 to 10 usec, and wide scale of 10 to 100 usec. These scales are selected by the "WIDTH" switch. Red markings are the "WIDE" scale.	20	"GND"	Connector is an extra ground point, often helpful when hooking up several instruments.

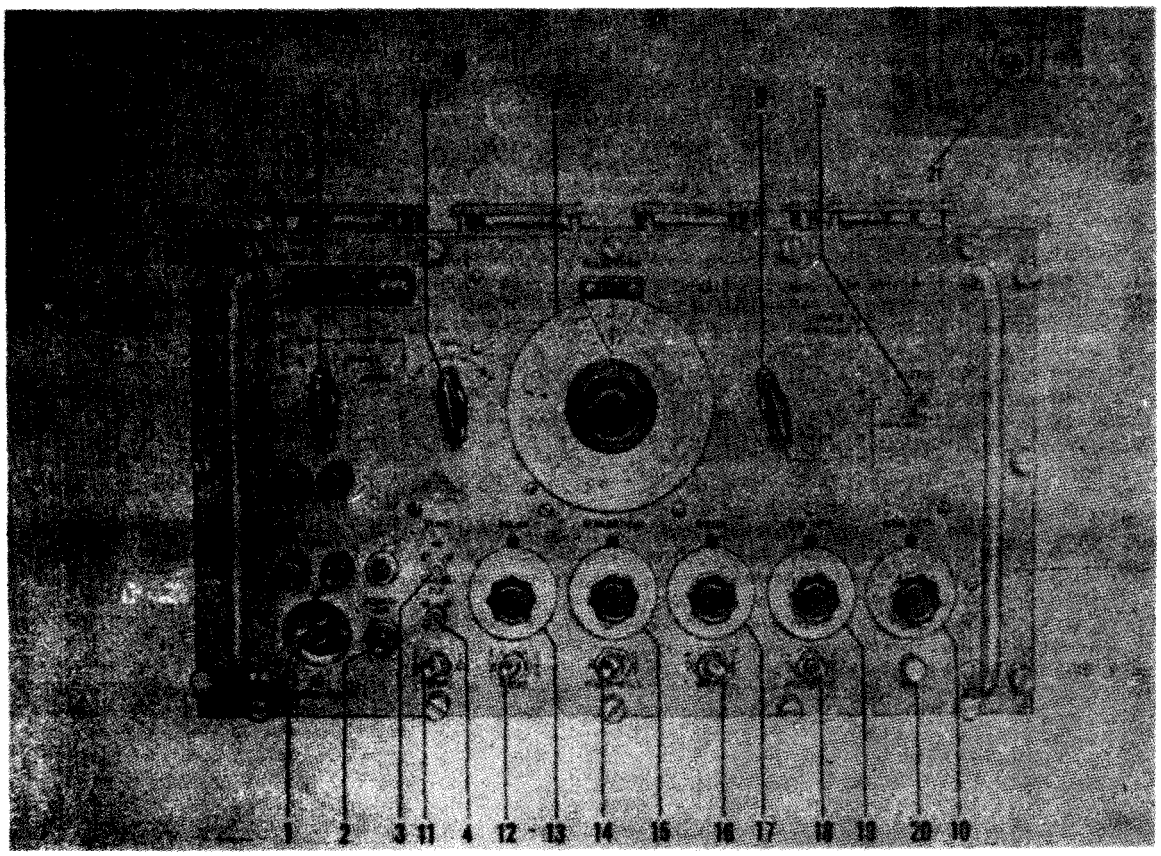


Figure 1-2. Pulse Generator Operating Controls

SECTION II

TEST EQUIPMENT AND SPECIAL TOOLS

2-1. No special test equipment, special tools or cables are required for servicing this equipment. A 10 mc band width synchroscope is required to display waveforms accurately. A vacuum tube voltmeter is required for voltage measurements. For "PULSE RATE" calibration, any audio oscillator with a range between 50 and 10,000 cycles and calibrated within 1/2 percent can be used.

SECTION III

PREPARATION FOR USE AND RESHIPMENT

3-1. **GENERAL.** This pulse generator set is portable electronic test equipment. It includes a transit case and all cords necessary for operation.

3-2. **PREPARING FOR USE.** Open the cover of the transit case and lift out the pulse generator. Loosen the captive screws on the edge of the front panel and slide the dust cover off. Check all the electron tubes for firm seating in their sockets. Replace the dust cover and tighten the captive screws. Plug cord CX-337/U or CX-3135/U into the "POWER" connector and to a source of 115 volts ±10 percent, single phase, 50 to 1000 cps. Connect cords CG-409E/U to the "SYNC OUT" and "OUTPUT" connectors. If an external source is to trigger the pulse generator, use the third CG-409E/U cord and connect it to the "SYNC IN" connector. Turn "POWER" switch to "ON" position and allow 15 minutes for the pulse generator to warm up. Use adapters UG-273/U when the cord connectors do not match the connectors on the equipment to which connection is to be made.

Note

For shortest rise time in the 2 to 200 volt ranges, use the shortest possible leads of unshielded wire rather than the r-f cords.

3-3. **PREPARING FOR RESHIPMENT.** Turn power "OFF", disconnect cords and put them in the transit case. Put the pulse generator in the transit case and put the cover on the case.

SECTION IV

THEORY OF OPERATION

4-1. **GENERAL.** This pulse generator is a single unit of equipment. It provides a sync pulse and one or two output pulses.

4-2. **FUNCTIONAL OPERATION OF ELECTRONIC COMPONENTS.**

4-3. By means of the stages shown in the block diagram, figure 4-1, the pulse generator forms a wide variety of pulse outputs when the proper controls are operated.

4-4. The oscillator stage, electron tubes V1 and V2A, delivers a sine wave of 50 to 10,000 cycles per second to establish the "PULSE RATE" when internal syncing is desired.

4-5. Next, in the voltage discriminator stage, the sine wave produces a negative pulse output.

4-6. The pulse amplifier consists of an amplifier, electron tube V4 and a cathode follower V6A. The pulse amplifier converts the negative pulse to a positive pulse. This positive pulse is used at four different points in the circuit depending on the mode of operation selected.

4-7. By its direct connection to the delay stage, the positive pulse always triggers the delay circuit. This is a phantastron circuit. The output of the delay stage is a positive pulse. It is delayable 2 to 220 usec in relation to the "SYNC OUT" pulse when the "SYNC" switch is in the "LEAD" position. Then also, No. 1 pulse width and separation stage receive the pulse from the delay stage. This makes the output pulse later than the sync pulse.

4-6. With the "SYNC" switch in "LAG" position, the positive pulse from the pulse amplifier stage goes directly to the No. 1 pulse width stage. The positive pulse for the sync stage comes from the delay stage. Thus the sync pulse may be delayed 2 to 220 usec after the No. 1 output pulse.

4-9. The sync stage is a thyratron tube V5. It yields a pulse 1.3 usec in width

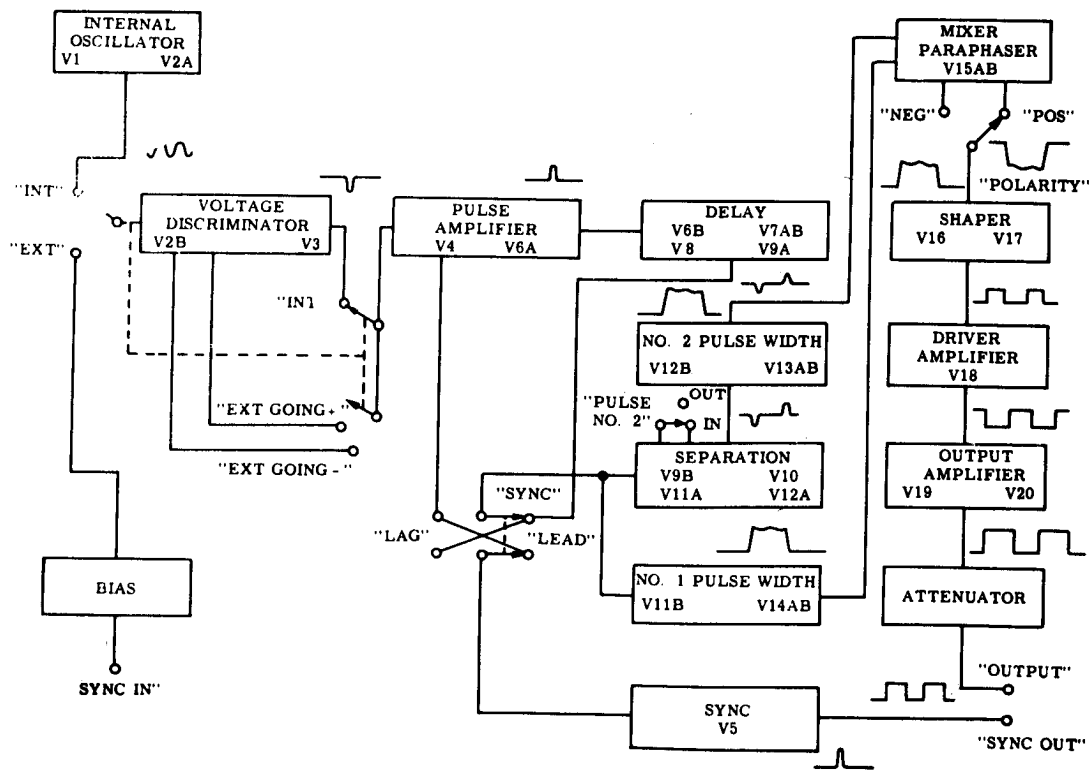


Figure 4-1. Pulse Generator Block Diagram

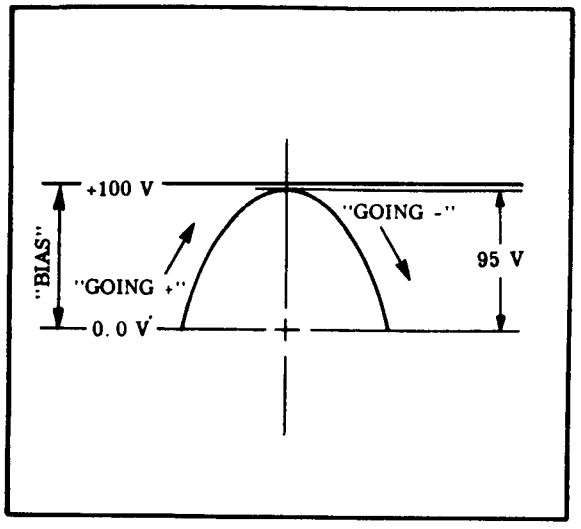


Figure 4-2. External Triggering Range

4-10. The No. 1 pulse width stage is a multivibrator that enables the output wave to be controllable from 0.5 to 100 usec in width. The No. 1 pulse width stage feeds directly to one half of the mixer paraphaser stage.

4-11. When a second output pulse is desired, the "PULSE NO. 2" switch is put in "IN" position. When in "LEAD" position of the "SYNC" switch, the delay stage triggers the separation stage. In "LAG" position of the "SYNC" switch the pulse amplifier stage triggers the separation stage. The separation stage is a phantastron circuit identical in function with the delay stage. It allows triggering to be controlled 2 to 30 usec after the No. 1 pulse, and thus separates the No. 2 pulse from the No. 1 pulse.

4-12. The No. 2 pulse is controlled in width by the No. 2 pulse width stage. This is a multivibrator the same as the No. 1 pulse stage. The pulse width controls of the unit are common to both output pulses. Thus output pulse widths are always the same.

4-13. The mixer paraphaser stage is a twin triode tube with a grid connected to each pulse width stage. By means of the "POLARITY" switch the polarity of the output pulses is made negative or positive. When the switch is in "NEG" position the output is taken from the mixer paraphaser cathode.

4-14. Waveforms at this point are non-rectangular. Therefore, the shaper stage acts to make the waveforms essentially rectangular.

4-15. The amplification stages are straight-forward. The attenuator gives six ranges of voltage with output impedances of 2500, 250, 50 and 75 ohms. The 50 and 75 ohm outputs are matched.

4-16. Returning to the beginning of the block diagram, figure 4-1, when the unit is externally synced, "BIAS" and "GOING +" and "GOING -" functions are activated. The unit may be biased to trigger at any point between 0 and +95 volts. (See figure 4-2).

4-17. DETAILED OPERATION.

4-18. OSCILLATOR CIRCUIT. The pulse rate is determined by the sine wave oscillator section. (See figure 4-3.) Switch S2A connects capacitors C1, C2 and C3 with capacitors C4, C5, and C6 respectively, depending on the pulse repetition rate required. Switch position "1" represents 50 to 280 pulses per second. Switch position "2" represents 280 to 1600 pulses per second. Switch position "3" represents 1600 to10, 000 pulses per second. Variable resistor R1A-B gives continuous control of the pulse rate across the three bands. Electron tube V1 is the oscillator. Electron tube V2 is an amplifier. Phone tip jack J3 is a test point on the chassis. When an oscilloscope is connected between J3 and ground, a distorted sine wave is indicated by a pulse generator that is operating properly.

4-19. In this pulse generator the chassis ground is

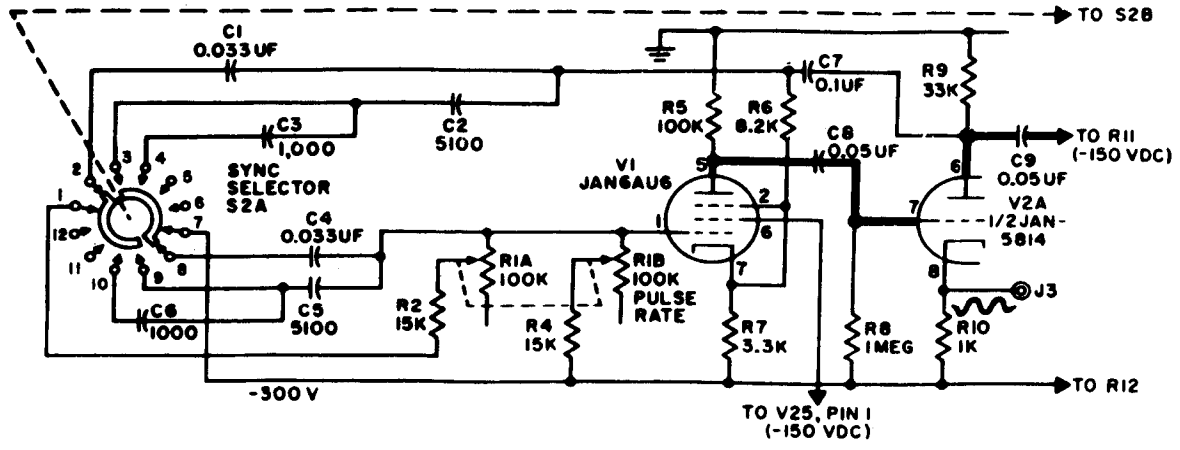


Figure 4-3. Internal Oscillator Circuit, Schematic Diagram

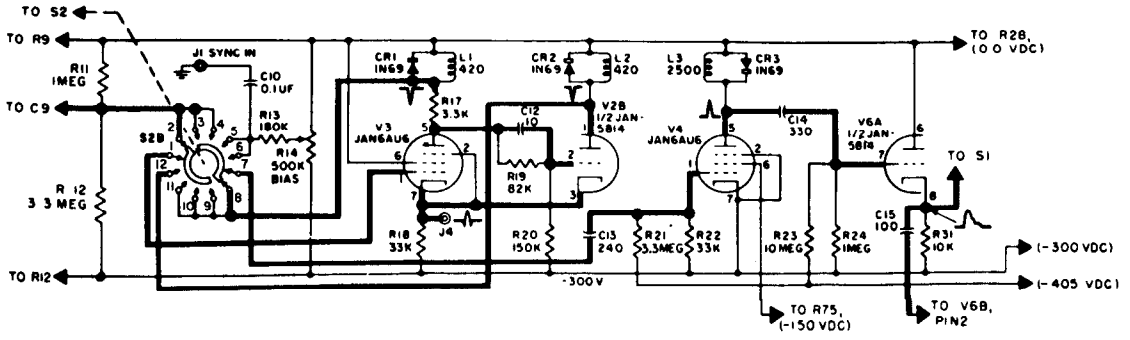


Figure 4-4. Voltage Discriminator and Pulse Amplifier Schematic Diagram

connected to the B+ side of the power supply section. Most plate supply voltages are therefore shown as 0.0. However, the screen grid and cathode potentials run from -150 to -450 V dc.

4-20. **VOLTAGE DISCRIMINATOR AND PULSE AMPLIFIER.** The voltage discriminator converts synchronizing signals of any shape, including the sine wave which is internally supplied, into standard triggering pulses. The internally supplied sine wave looks into fixed bias caused by resistor R11 and triggers the pulse generator at 0.0 volts.

4-21. Electron tubes V3 and V2B, figure 4-4, are coupled between plate and grid and there is regenerat ive feedback through common cathode resistor R18. The circuit triggers in one direction when the input on the grid, pin 1 or electron tube V3, is raised above its normal cut-off state. The circuit triggers in the opposite direction when the input signal is reduced. Electron tube V2B normally draws current which flows through resistor R18 making the cathode of electron tube V3 have a higher potential than the grid. Capacitor C12 speeds up the trigger action and allows the circuit to function on input signals consisting of a brief pulse. In the "EXT SYNC" positions of switch S2B the critical point of triggering is determined by the setting of variable resistor R13 which is the "BIAS" control. To obtain short trigger pulses, the two coils L1 and L2 are used as differentiators. Oscillations are damped by the crystal diodes CR1 and CR2. The trigger is a narrow negative pulse taken from the plate circuit of electron tube V3 for "GOING +" operat ion, and from the plate of electron tube V2B for "GOING-" operation.

4-22. Phone tip jack J4, figure 4-4, is a test point. An oscilloscope connected between J4 and ground should indicate a waveform that is a sine wave with sharp negative tips when the unit is triggered internally. Electron tube V4 is the pulse amplifier which inverts the negative pulse into a positive pulse. The coil L3 preserves the rise time of the input signal and crystal CR3 damps out any oscillations. Electron tube V6A is a cathode follower providing a low impedance source for the next stages.

4-23. **SYNC OUT CIRCUIT.** Electron tube V5, figure 4-5, is a thyratron used as a switch to discharge the pulse-forming network L4. The output signal is taken across the cathode resistor R29. Amplitude of the sync pulse is 25 to 75 volts positive. The width is about 1.4 usec.

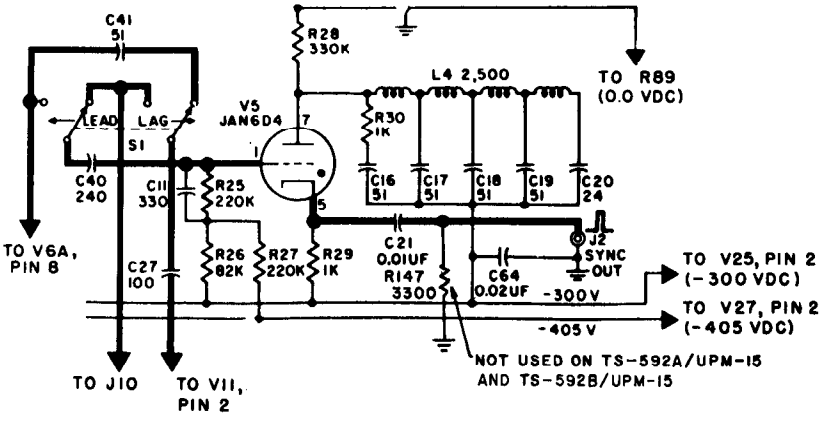


Figure 4-5. Sync Out Circuit Schematic Diagram

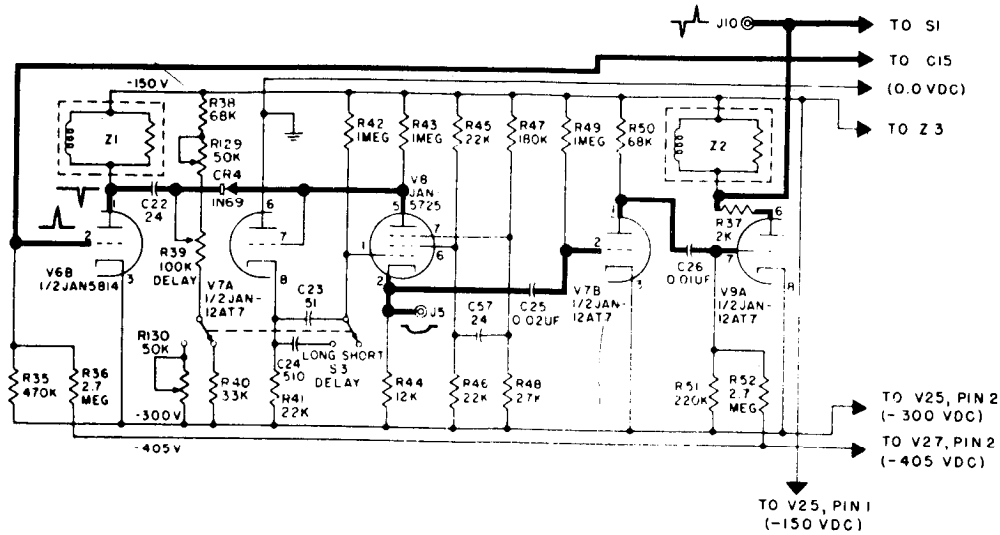


Figure 4-6. Delay Circuit TS-592A/UPM-15, Schematic Diagram

4-24. **DELAY CIRCUIT TS-592A/UPM-15.** The positive pulse coming from the pulse amplifier forms a negative pulse at the plates of electron tubes V6B and V8, figure 4-6. Crystal CR4 prevents any positive swing reaching the plate, pin 5 of electron tube V8. This electron tube is part of a phantastron delay circuit which provides waveforms that can be controlled accurately in duration. The negative pulse reaching the plate of this electron tube results in a negative square wave at the cathode, pin 2, and can be seen by connecting an oscilloscope at test jack J5. Resistors R38 and R42, the "DELAY" control, R39, trimmer control R129 and capacitors C23 and C24 function to control the duration of the waveform. The negative waveform is amplified and inverted to a positive waveform in electron tube V7B. Electron tube V9A then differentiates the waveform into negative and positive triggers which are separated by the delay time established by variable resistor R39. These triggers can be seen by connecting an oscilloscope at test jack J10. The negative trigger can be regarded as the same as the original pulse that triggered electron tube V8. The positive trigger is the delay stage output. Switch S3 gives the delay control two ranges "SHORT" and "LONG", by switching either capacitor C23 alone, or both C23 and C24 into the cir-

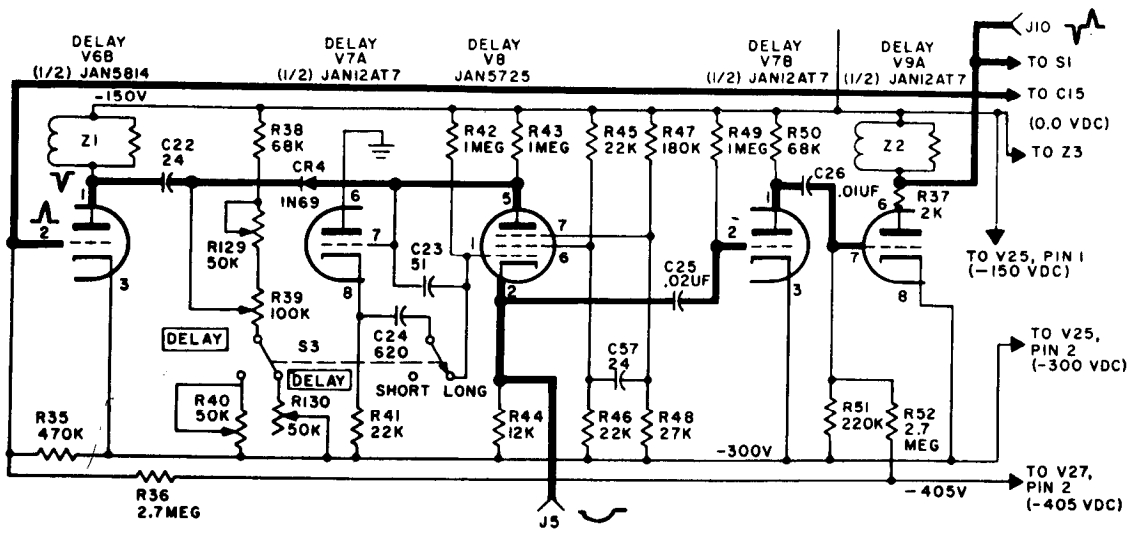


Figure 4-7. Delay Circuit TS-592B/UPM-15 and SG-343/UPM-15A, Schematic Diagram

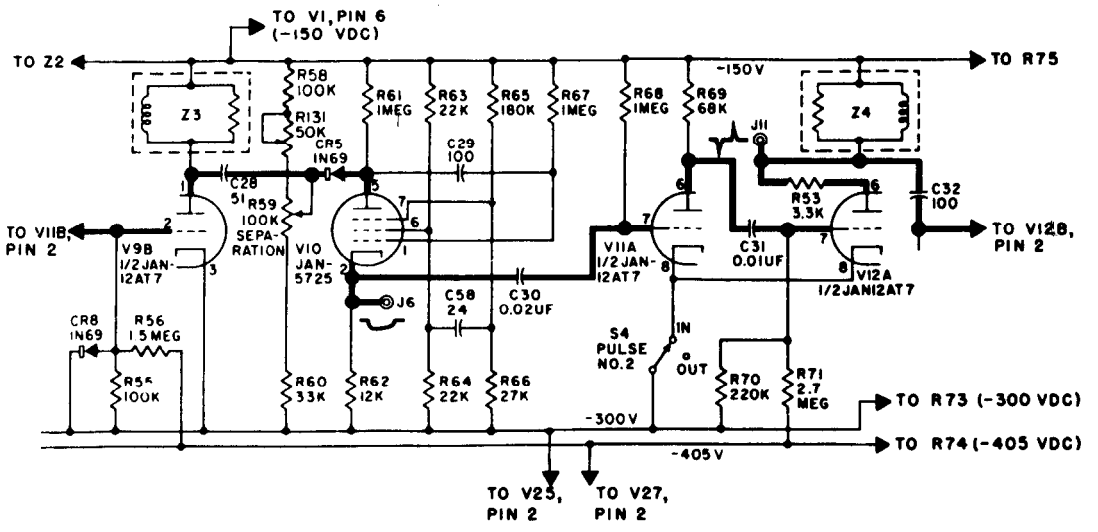


Figure 4-8. Separation Circuit TS-592A/UPM-15, Schematic Diagram

cuit. Electron tube V7A is a cathode follower which recharges capacitors C23 and C24 between pulses. Variable resistors R129 and R130, set the maximum delay of the short range and the minimum delay of the long range respectively. See paragraph 6-5 for adjustment procedure of trimmer controls.

4-25. The delay signal output goes to switch S1, figure 4-5. In "LEAD" position the delay makes the output pulse occur after the sync pulse. In "LAG" position the delay is applied to the sync pulse generator and the output pulse or pulses occur before the sync pulse.

4-26. DELAY CIRCUIT TS-592B/UPM-15 AND SG-343/UPM-15A. (See figure 4-7). This circuit is essentially the same as that used in TS592A/UPM-15 except R40 has been changed to a potentiometer, in order to allow setting of minimum delay of the short range, and C23 was repositioned in order to increase accuracy of the short delay range. See paragraph 6-6 for adjustment procedure of trimmer controls.

4-27. SEPARATION CIRCUIT TS-592A/UPM-15. (See figure 4-8.) The word "separation" relates to the time between output pulses and occurs when switch S4 is in the "IN" position and the generator is producing two output pulses. The circuit is essentially the same as the delay circuit. The range is 2 to 30 usec. Capacitor C29, resistor R67, and trimmer control R131 determine the maximum range of the delay period, while continuous control is provided by variable resistor R59. For adjustment of trimmer control R131 see paragraph 6-7.

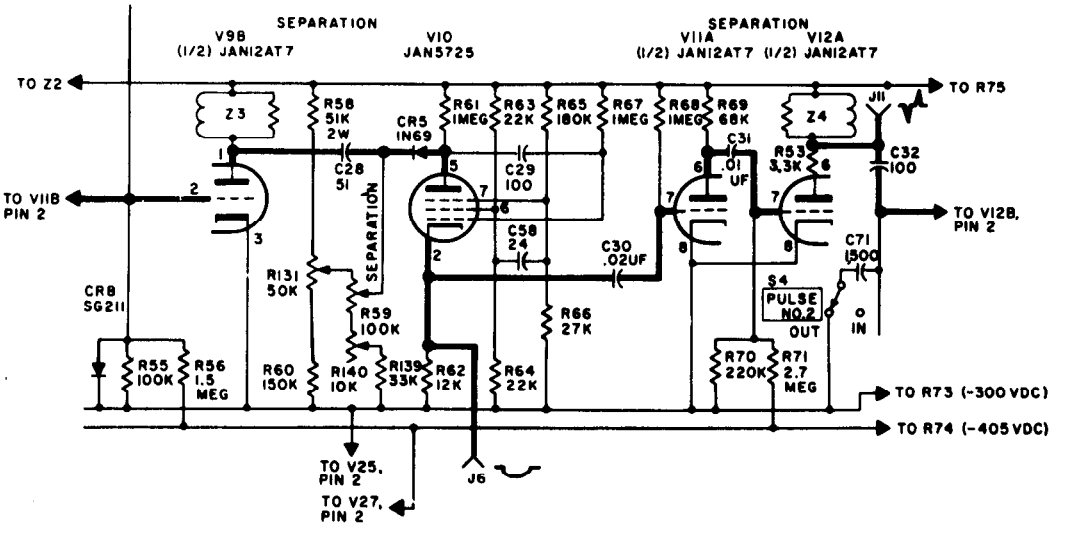


Figure 4-9. Separation Circuit TS-592B/UPM-15 and SG-343/UPM-15A, Schematic Diagram

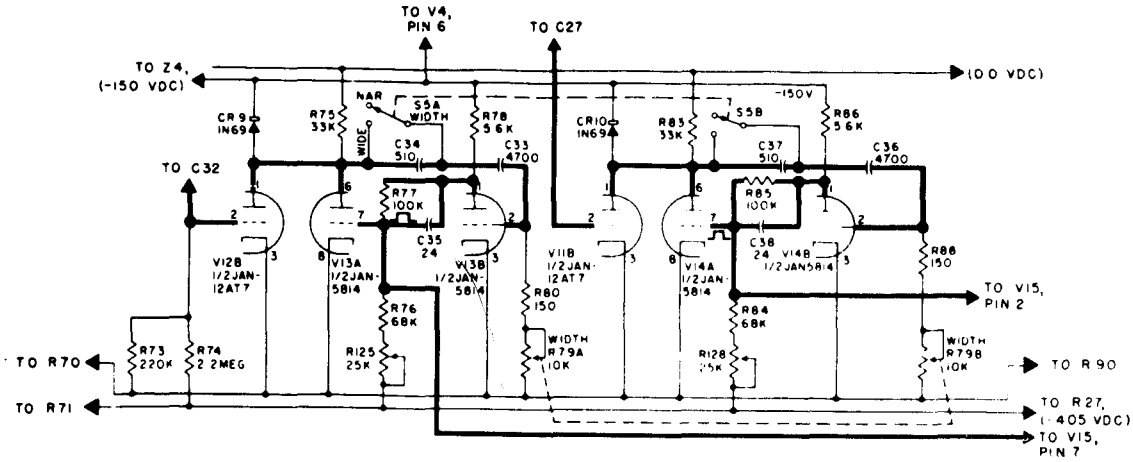


Figure 4-10. Width Multivibrator TS-592A/UPM-15, Schematic Diagram

4-28. **SEPARATION CIRCUIT TS-592B/UPM-15 AND SG-343/UPM-15A.** (See figure 4-9.) The separation circuit is the same as that in TS-592A/UPM-15 with the following exceptions. Variable resistor R140 has been added to allow setting of minimum separation range. The method of eliminating pulse No. 2 was changed. Previously the cathode of V11A was opened when switch S4 was placed in the "OUT" position. This caused a slight increase in pulse width. In order to maintain pulse width accuracy in all switch positions the cathode was grounded and pulse No. 2 is shorted out through capacitor C71 when S4 is in the "OUT" position.

4-29. **WIDTH MULTIVIBRATOR TS-592A/UPM-15.** (See figure 4-10.) The word "width" refers to the time in usec that an output pulse is maintained. The one-shot, plate coupled type multivibrator is used in this unit. Electron tube V13B is normally drawing current. The positive input pulse, which comes either from the pulse amplif ier or the delay stage, causes a drop in the plate voltages of electron tubes V12B and V13A. Either capacitor C34 and C33 in series, or C33 alone, depending on the position of switch S5A, apply this negative voltage to the grid, pin 2 of V13B. This negative voltage is amplified and inverted by this tube and coupled back to electron tube V13A at the grid. This signal is amplified and appears at the plate with the same polarity as the original pulse. This action causes this circuit to be regenerative and the switching action occurs, so that V13A conducts and V13B is held at cut-off. This condition holds until capacitors C33 and C34 are able to discharge through resistor R79, after which another switching action occurs and the tubes assume their original condition. The length of time for this cycle, which is equivalent to the pulse width, is controlled by variable resistor R79 and capacitors C33 and C34. Narrow and wide ranges are provided by switch S5A which adds capacitor C34 or removes it from the circuit. The output, which is a square wave, is taken from the grid, pin 7 of electron tube V13A. In this pulse generator there are two width multivibrators,

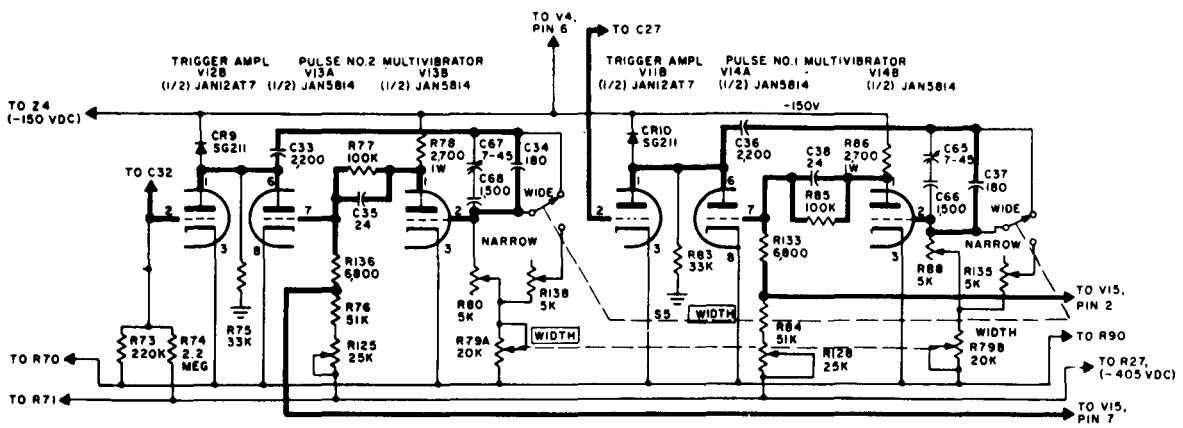


Figure 4-11. Width Multivibrator TS-592B/UPM-15 and SG-343/UPM-15A, Schematic Diagram

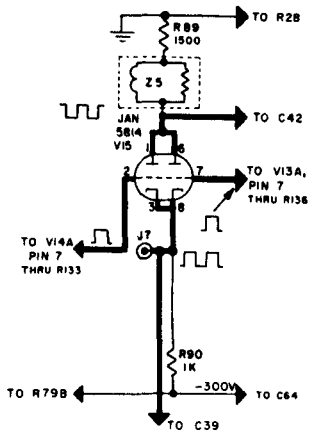


Figure 4-12. Mixer Paraphraser, Schematic Diagram

one for each output pulse. The circuits are the same. The width control switch S5AB and variable resistor R79AB are dual and common to each circuit. This makes the output pulses' width the same whenever two output pulses are used.

4-30. **WIDTH MULTIVIBRATOR TS-592B/UPM-15 AND SG-343/UPM-15A.** (See figure 4-11.) The type of width multivibrator used is the same as that in TS-592A/UPM-15. Timing circuitry has been changed in order to incorporate trimmer controls which will allow setting of minimum and maximum width in both NARROW and WIDE positions of switch S5. In the NARROW position the timing network consists of capacitors C36, C66, and C67 and trimmer controls R135 and C65. When switch S5 is in WIDE position only capacitor C36 and trimmer control R88 are in the circuit. For adjustment of trimmer controls see paragraph 6-10.

4-31. **MIXER PARAPHASER.** (See figure 4-12.) Electron tube V15 is a twin triode which accepts one output pulse at each of its two grids. Through switch S6A, the output signal is taken either from the plate (pins 1 and 6) for final output of positive polarity, or from the cathode (pins 3 and 8) for final output of negative polarity. At test point J7, an oscilloscope should indicate a positive square shape wave in a unit operating in a normal manner.

4-32. **SHAPER.** (See figure 4-13.) Electron tubes V 16 and V17 are connected in parallel to provide larger output. They function as a clipper. Resistor R92, crystal CR6, and resistors R93 and R94 form a network which biases the circuit sufficiently when the signal to electron tubes V16 and V17 is positive. The network consisting of resistor R82 and crystal CR7 biases the c ircuit properly for positive input signals to electron tube V18. Switch S6AB with its two positions "NEG" and "POS" controls the polarity of the output pulses.

4-33. **DRIVER AMPLIFIER.** (See figure 4-13.) Electron tube V 18 is the driver amplifier. It is directly coupled to the grid, pin 2 of electron tube V19 without a d-c blocking capacitor in order that the pulse shape will not be distorted. Resistor R110 is the plate load for electron tube V18.

4-34. **OUTPUT AMPLIFIER AND ATTENUATOR TS-592 A/UPM-15.** (See figure 4-14.) Electron tube V19 is the main output amplifier. Electron tube V20 regulates this main tube and is controlled itself by vari - able resistor R99 the "FINE ATTN" dial and trimmer

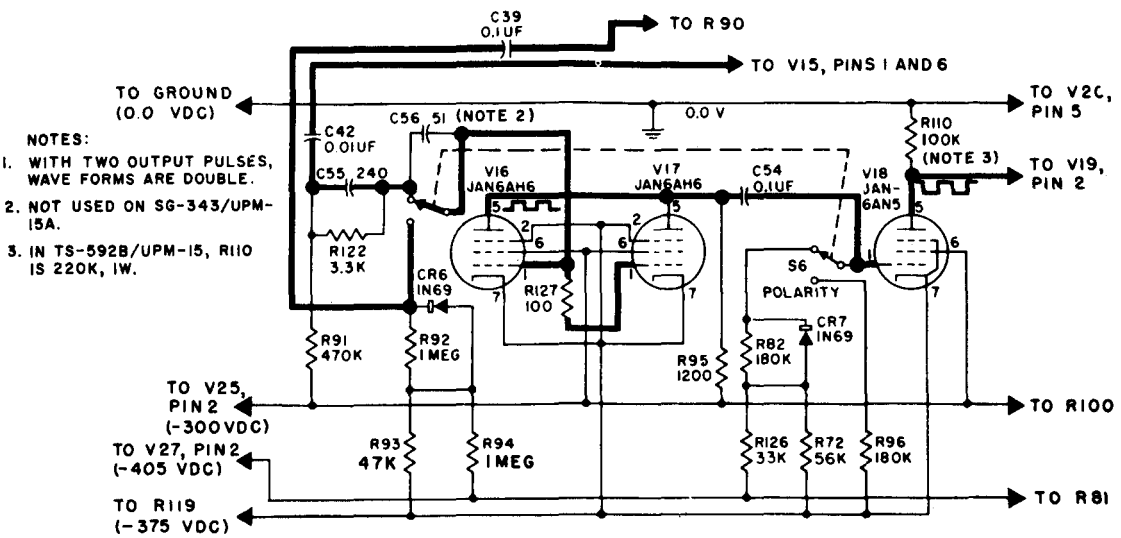


Figure 4-13. Shaper and Driver Amplifier, Schematic Diagram

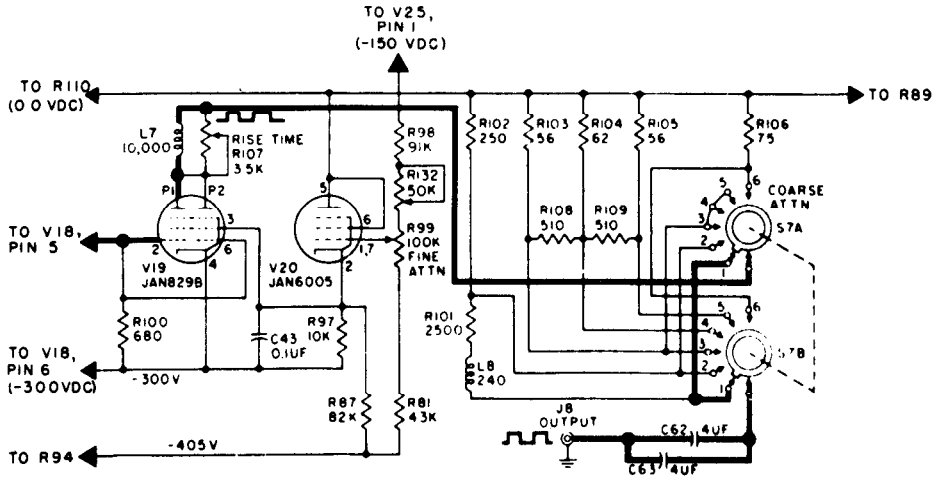


Figure 4-14. Output Amplifier and Attenuator TS-592A/UPM-15, Schematic Diagram

control R132. The six different positions of switch S7AB, the "COARSE ATTN" control, provide stepped variation for the main output amplifier, and thus give the six ranges of output voltage. The pulse rise time is controlled by variable resistor R107. When the resistance is shorted out by the movable arm, the rise time is shortest, approximately 0.05 usec. Capacitors C62 and C63 eliminate d-c voltage from the output pulses. Some drop-off in the top of the waveform is caused by these capacitors, but this can be overcome by short circuiting them when d-c voltage in the output is unimportant and the best waveform is desired.

4-35. **OUTPUT AMPLIFIER AND ATTENUATOR TS-592B/UPM-15 AND SG-343/UPM-15A. (See figure 4-15.) Essentially the circuit is the same as that used in TS-592A/UPM-15. Trimmer control R143 has been added in order to permit accurate setting of the maximum limit of the fine attenuation range.**

4-36. **POWER SUPPLY TS-592A/UPM-15.** (See figure 4-16.) **The fullwave rectifier circuit associated with electron tube V12 and the electronic voltage regulator circuit formed by electron tubes V22, V23 and V24 provides -150 V and -300 V dc. These voltages are with respect to the chassis ground to which the**

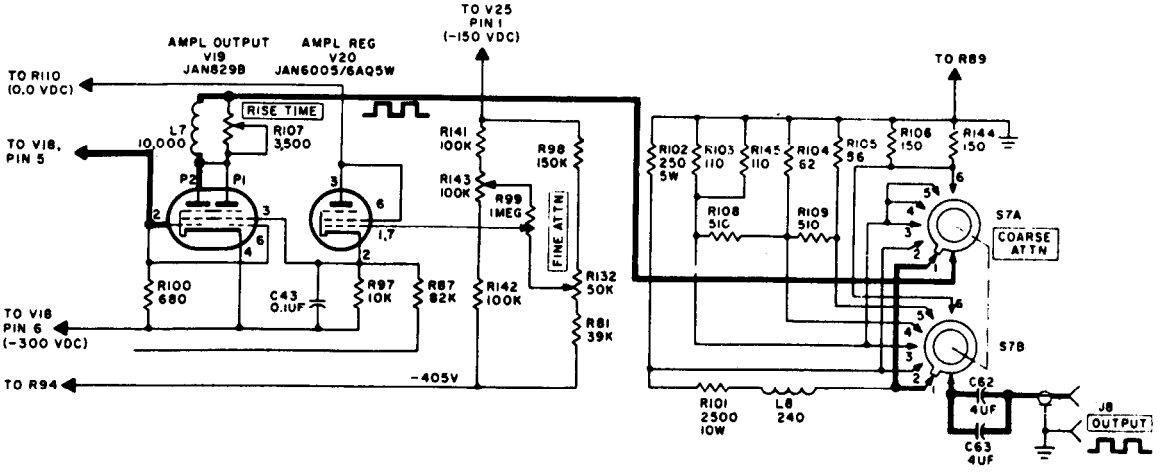


Figure 4-15. Output Amplifier and Attenuator TS-592B/UPM-15 and SG-343/UPM-15A, Schematic Diagram

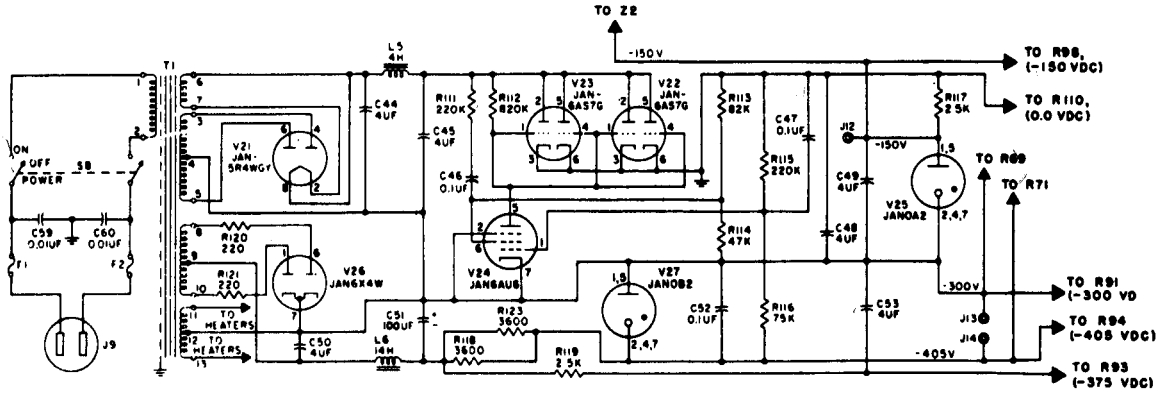


Figure 4-16. Power Supply TS-592A/UPM-15, Schematic Diagram

+ side of the circuit is connected. The regulating action counter-balances variations in both the transformer input and in the internal loading of the pulse generator. Voltage changes are fed back through the grid, pin 1, of electron tube V24. The voltage changes are amplified and inverted. They appear across load resistor R112 which is also the grid bias resistor for the parallel-connected electron tubes V22 and V23. These two electron tubes produce an opposing voltage that is approximately equal to the original fluctuation. The -300 V supply is taken from the cathode, pin 7, of electron tube V24 and can be read at test point jack J13. The -150 V supply is regulated by voltage regulator tube V25 and can be read at test point jack J12.

4-37. Electron tube V26 is the source of the -405 V dc supply. Its cathode is at -300 V and the drop across electron tube V27, is -105 V which totals -405 V with respect to the chassis ground. One part of this output is unregulated and is fed through resistor R119 to the cathode of electron tubes V16, V17 and V18.

4-38. **POWER SUPPLY TS-592B/UPM-15 AND SG-343/UPM-15A.** (See figure 4-17.) The power supply circuit is the same as that used in TS-592A/UPM-15 except trimmer control R146 has been added to provide an accurate means of controlling the B- voltage supplies.

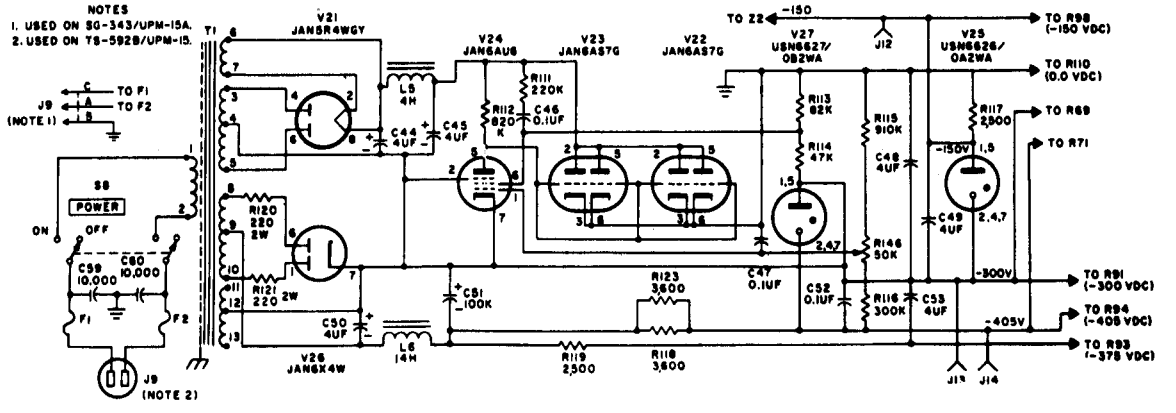


Figure 4-17. Power Supply TS-592B/UPM-15 and SG-343/UPM-15A, Schematic Diagram

SECTION V

ORGANIZATIONAL AND OPERATIONAL MAINTENANCE

5 - 1 . **MINIMUM PERFORMANCE STANDARD.** This pulse generator should provide a sync pulse and one or two output pulses. The output pulses should respond properly to the controls.

5 - 2 . Before checking performance, power must be on as indicated by the glowing of the pilot lamp. The electron tubes must all be operating. This will be indicated by glow of their heaters or feeling warm when touched.

5 - 3 . It is necessary to use an oscilloscope to check the pulse generator. Connect the pulse generator's "OUTPUT" connector to oscilloscope's vertical signal input. Connect the pulse generator's "SYNC OUT" connector to the external sync connector of the oscilloscope. Turn power on in both units and give them 15 minutes to warm up and stabilize.

5 - 4 . Set controls of the pulse generator in the following manner:

a. "SYNC" selector knob - "C" position.
b. "PULSE RATE" dial - "4.0 kilocycles".
c. "SYNC" switch - "LEAD" position.
d. "DELAY" dial - 40 usec.
e. "DELAY" switch - "LONG" position.
f. "SEPARATION" dial - 30 usec.
g. "PULSE NO. 2" switch - "IN" position.
h. "WIDTH" switch - "WIDE" position.
i. "WIDTH" dial - 10 usec.
j. "RISE TIME" knob - 0.05 usec.
k. "POLARITY" switch - "POS" position.
l. "FINE ATTN" knob - "20".
m. "COARSE ATTN" knob - "1 - 250 OHMS".

5-5. Set the oscilloscope controls for 200 usec sweep time, positive polarity and external sync. Use a control position on the oscilloscope which will not overload with a 50 volt sync pulse. The oscilloscope presentation should now appear approximately as shown in figure 5-1. Operate each control and observe the effect. The oscilloscope pattern should respond to "WIDTH", "DELAY" and all other adjustments.

NOTE

If "WIDTH" becomes larger than "SEPARATION", the scope will show a single pulse, but this is not a sign of malfunction.

5-6. TROUBLE ANALYSIS.

5-7. If operating the controls does not cause a matching change in the oscilloscope pattern, it is a sign that the associated circuit may not be functioning. Refer to paragraph 4-2 through 4-38 to find which electron tubes are concerned with the trouble and likely to require replacement.

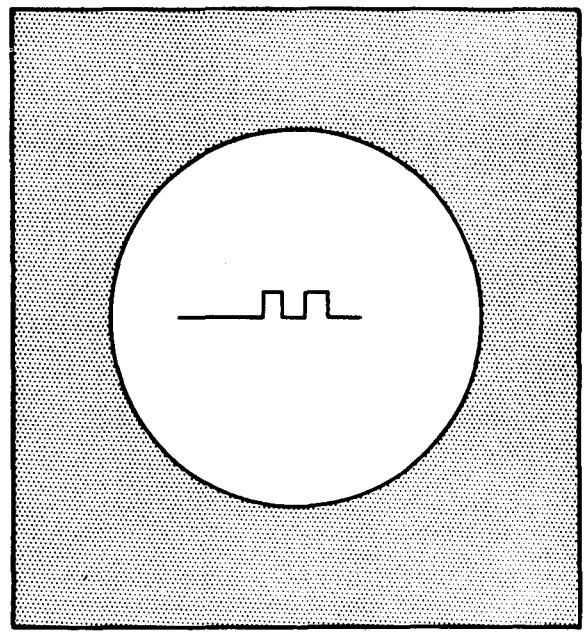


Figure 5-1. Test Pattern

5-8. MINOR REPAIR AND ADJUSTMENT. The pilot light may be replaced when necessary by unscrewing the rim of the indicator light. Then twist the lamp counter-clockwise and pull it out. The fuses are also removable from the front panel by twisting their knobs counter-clockwise. Then the glass cartridge can be lifted out of the spring clamps. When spare fuses are taken from their holders and put in use, always get replacements for the spares and put them in the spare holders. The pulse generator should have two spare fuses available at all times.

5-9. REPLACEMENT OF TUBES. Any electron tube in the pulse generator may be replaced by organizational and operational maintenance personnel. Check the electron tubes carefully on a tube checker. Allow 15 minutes, or more, warm up time after putting in a new electron tube.

5-10. INSPECTION SCHEDULE. The pulse generator has no parts which are subject to continuous mechanical operation. No specific inspection schedule is necessary. After 500 hours operation all switches can be thrown several times to check good toggle action. Also check tightness of all dial and knob setscrews. Check the seating of electron tubes in their sockets and the connection of the plate leads to the top of electron tube V19.

SECTION VI

FIELD MAINTENANCE

6-1. MINIMUM PERFORMANCE STANDARDS.

6-2. DIAL CALIBRATION. Dial calibration tolerances are ±10 percent. Follow instructions in paragraphs 5-1 through 5-6 to prepare the pulse generator and oscilloscope for checking the pulse waveforms against dial readings. Figure 6-1 illustrates a typical bench set up. The unit's dust cover is removed. This gives access to trimmer controls. See detailed operation for an explanation of the trimmer controls.

6-3. Corrections on TS-592A/UPM-15 pulse generators are made by adjusting trimmer controls and by loosening the dial setscrews and turning the dials slightly on their snafts. Before making any corrections carefully take readings to confirm that the indicated output is actually outside the allowed ±10 percent.

6-4. Corrections on TS-592B/UPM-15 and SG-343/UPM-15A pulse generators are made by adjusting the proper trimmer controls for the "DELAY", "SEPARATION", "WIDTH", and "FINE ATTENUATION" dials. The "RISE TIME" dial is adjusted by loosening the dial setscrews and turning it slightly on its shaft. Before making any corrections check the -150 volt supply (J12); adjust R146, figure 6-3, if voltage is incorrect. Check alignment of dial slot and indicator; with dial fully clockwise they should be directly in line. Then carefully take readings to confirm that the indicated output is outside of the allowed ±10 percent.

6-5. "DELAY" DIAL CALIBRATION TS-592A/UPM-15. Set "DELAY" switch to "SHORT" position. "DELAY" dial to 20 usec and adjust the pulse to 20 usec "DELAY" with variable resistor R129, figure 6-2. Turn "DELAY" dial to 2 usec and mechanically relocate it on the shaft so that the oscilloscope indicates 2 usec. Check again at 20 usec and readjust R129 if necessary. Check again at 2 usec and reposition the dial if necessary. Change "DELAY" switch to "LONG" position with the dial at 20 usec. Adjust variable resistor R130 until the oscilloscope indicates 20 usec.

6-6. "DELAY" DIAL CALIBRATION TS-592B/UPM-15 AND SG-343/UPM-15A. Place "DELAY" switch in "LONG" position. Set "DELAY" dial to red 220 usec mark and adjust variable resistor R129, figure 6-2, for a pulse delay of 220 usec. Turn "DELAY" dial to red 20 usec mark and adjust variable resistor R130, figure 6-2, for a pulse delay of 20 usec. Check again at 220 use c, then at 20 usec. Adjust variable resistors R129 and R130 until correct "DELAY" is obtained. Place "DELAY" switch in "SHORT" position. Set "DELAY" dial to black 2 usec mark and adjust R40, figure 6-4, for a pulse delay of 2 usec. Repeat these steps as necessary.

6-7. "SEPARATION" DIAL CALIBRATION TS-592A/UPM-15. Set "SEPARATION" dial to 30 usec and adjust variable resistor R131, figure 6-2, until the oscilloscope indicates 30 usec. Turn dial to 2 usec and mechanically relocate it on the shaft after turning the shaft so that the oscilloscope indicates 2 usec. Repeat these steps as necessary.

6-8. "SEPARATION" DIAL CALIBRATION TS-592B/UPM-15 AND SG-343/UPM-15A. Set "SEPARATION" dial to 2 usec and adjust variable resistor R140, figure

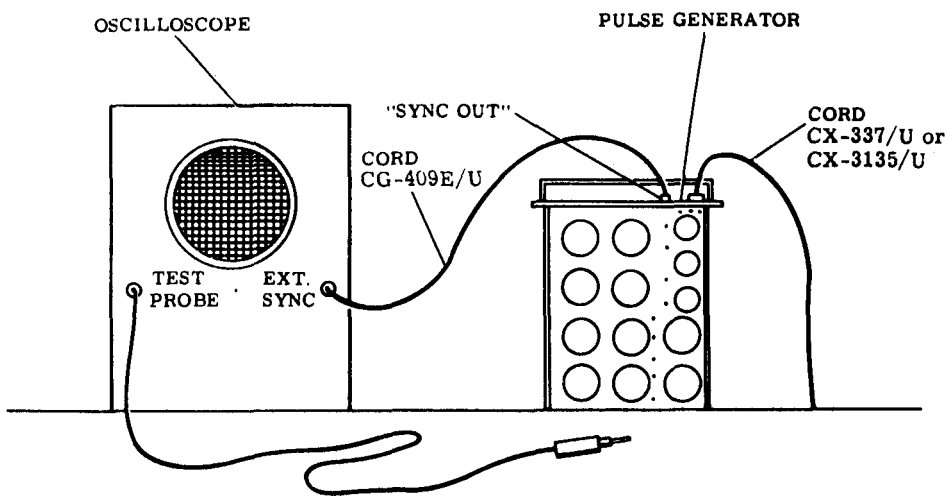


Figure 6-1. Bench Test Set-Up

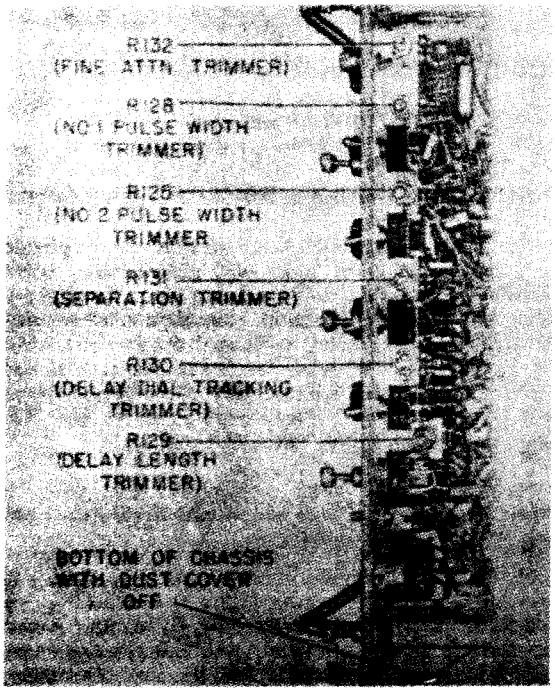


Figure 6-2. Trimmer Controls Under Chassis, Front

6-4, until a pulse separation of 2 usec is indicated on the oscilloscope. Turn dial to 30 usec and adjust variable resistor R131, figure 6-2, until a pulse separation of 30 usec is indicated on the oscilloscope. Repeat these steps as necessary.

6-9. "WIDTH" DIAL CALIBRATION TS-592A/UPM-15. Turn the "WIDTH" dial full clockwise to the mechanical stop. The 0.5 usec mark on the blue-filled scale should be about 1/4 inch past the white index line on the panel. With the "WIDTH" switch in "WIDE" position adjust variable resistors R1 25 and R128, figure 6-2, until both pulses are 10 usec wide.

6-10. "WIDTH" DIAL CALIBRATION TS-592B/UPM-15 AND SG-343 /UPM-15A. Place "WIDTH" switch in "WIDE" and "PULSE NO. 2" switch in "OUT" position. Set "WIDTH" dial to red 100 usec mark. Turn variable resistor R125, figure 6-2, fully clockwise. Adjust variable resistor R128, figure 6-2 until the oscilloscope indicates a pulse width of 100 usec. Eliminate "PULSE NO. 1" by connecting a 0.01 uf capacitor between pin 2 of V15 and ground. Set "PULSE NO. 2" switch to "IN" and adjust variable resistor R125, figure 6-2, until the oscilloscope indicates a pulse width of 100 usec. Remove the pulse shorting capacitor and set "PULSE NO. 2" switch to "OUT". Check "PULSE NO. 1" for 100 usec width and readjust R128 for 100 usec pulse width if necessary. Set "WIDTH" dial to red 10 usec mark, place "PULSE NO. 2" switch in "ON" position and set "SEPARATION" dial for 30 usec pulse separation. Adjust variable resistors R80 and R88 until both pulses are 10 usec wide. Check 100 usec pulse width. Repeat these steps until the dial tracks correctly. Place "WIDTH" switch in "NARROW" position, set "WIDTH" dial to black 10 usec mark and "SEPARATION" dial for 30 usec pulse separation. Adjust variable capacitor C65 and C67, figure 6-4, until pulses are 10 usec long on the oscilloscope. Turn "WIDTH" dial to black 0.5 usec mark and adjust variable resistors R135 and R138, figure 6-4, until each pulse is 0.5 usec long on the oscilloscope. Check 10 usec pulse width. Repeat these steps as necessary.

6-11. "RISE TIME" DIAL CALIBRATION. Position the dial on the shaft for best tracking between dial and actual readings. When measuring with an oscilloscope, measure from the 10 PCT to the 90 PCT amplitude points. Measure with "FINE ATTN" set to 10 and with "COARSE ATTN" set to .1-50 ohms.

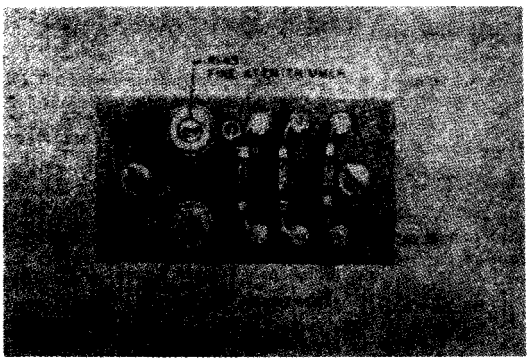


Figure 6-3. Trimmer Controls Under Chassis, Rear

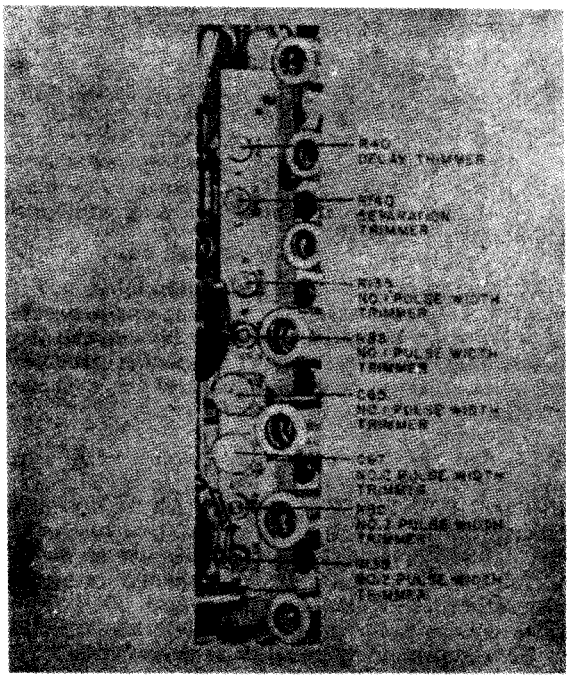


Figure 6-4. Trimmer Controls, Top

NOTE

When calibrating the SG-343/UPM-15A Pulse Generator be sure to use the scale which corresponds to the polarity of the pulse.

6-12. **"FINE ATTN" DIAL CALIBRATION TS-592A/UPM-15.** Set the "COARSE ATTN" knob to the blue "1" mark on the panel. Turn the "FINE ATTN" dial to the black "20" mark. Adjust variable resistor R132 until the oscilloscope indicates 20 volts. Turn the dial back to the black "2" mark. If the oscilloscope does not indicate 2 volts turn the shaft until the output is 2 volts and reposition the dial so the black "2" mark lines up with the white index line on the front panel. Turn the dial back to the "20" mark and check the voltage. Repeat these adjustments of the high and low readings as necessary.

6-13. **"FINE ATTN" DIAL CALIBRATION TS-592B/UPM -15 AND SG-343/UPM-15A.** Connect 50 ohm termination to generator front panel position. Turn "FINE ATTN" dial to black "2" mark and adjust R132, figure 6-2, until the oscilloscope indicates a pulse amplitude of 0.2 volts. Turn dial to black "20" mark and adjust R143, figure 6-3, until the oscilloscope indicates a pulse output of 2.0 volts. Repeat these adjustments as necessary.

WARNING

Voltages exposed in this equipment are high. Do not touch any part while testing except with voltmeter and oscilloscope probes.

6-14. **SYSTEMS TROUBLE ANALYSIS.**

6-15. The purpose of the systems trouble analysis chart (Table 6-1), is to narrow down the location of trouble into a small section of the circuit. It is assumed that all electron tubes will have been checked, and the unit warmed up for at least 15 minutes. Troubles to be corrected can always be seen as deviations of more than ±10 percent between dial readings and the actual pulse shape.

6-16. To check the pulse generator fully, take the steps directed in Table 6-1. The progressive checking of waveforms indicates if a particular circuit is not functioning properly. When a specific trouble is apparent, take a complete check of the associated circuit.

6-17. Use the information in the schematic wiring diagram (figure 7-2 or 7-4) and the practical diagram (figure 7-3, 7-5 or 7-6) to trace out the circuit and identify parts. Check voltages and resistances with the values given in Table 6-2. The Usable on Code in Table 6-2 shows variations for the different pulse-generators as explained below. Where the Usable on Code column has been left blank the values of voltage and resistance apply to all pulse generators. When a reading differs by more than 10 percent from the listed value, carefully check that particular section of the circuit.

Pulse Generator Type Number	Usable on Code
TS-592A/UPM-15	A
TS-592B/UPM-15 and SG-343/UPM-15A	B

6-18. **GENERAL REPAIR HINTS.**

6-19. Make a thorough examination of the physical components and the soldered connections. Do not change the location of wires, but look carefully for loose connections. Examine resistors and capacitors for signs of overloading such as discoloration, swelling and dripping of wax. When such damage is noted check carefully for a basic fault such as a short circuit between wires. Then replace parts with their exact duplicates in tolerance and rating.

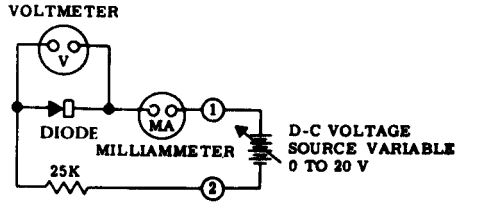
6-20. Coils must show continuity. The coils are wound of fine size wire which may break. Coil function is to peak the waveforms.

6-21. All of the crystal diodes must keep their rated current-carrying characteristics to maintain proper operation of the pulse generator. When the cause of the trouble is hard to detect with voltage and resistance readings, a crystal diode may be the cause of the malfunction.

6-22. All crystal diodes in a circuit section where trouble exists must be capable of conducting at least 5 milliamps per volt in a forward direction, and 0.05 milliamps per volt in a reverse direction. To prove that these rated characteristics are present in these crystal diodes, a direct current voltage source variable from 1 to 20 volts, a d-c voltmeter, a d-c milliammeter, and a 25,000 ohm resistor are required. Connect this equipment to the crystal diode as shown in figure 6-5 and apply test voltages as shown in the figure. Do not use any crystal diode that fails to pass the test.

NOTE

When replacing a crystal be certain that the + side is connected to the proper terminal. Hold the wire lead close to the crystal body with pliers to prevent over heating while soldering.



FORWARD CURRENT	REVERSE CURRENT
Connect "+" side of voltage source to terminal 2 and "-" side to terminal 1. Adjust voltage until voltmeter reads 1 volt. Milliammeter must read 5 ma or higher.	Connect "+" side of voltage source to terminal 1 and "-" side to terminal 1. Adjust voltage until voltmeter reads 10 volts. Milliammeter must read 0.05 ma or less.

Figure 6-5. Crystal Diode Test

6-23. **When wiring is repaired, always put the connections back on the original terminal. Empty terminals on the electron tube sockets must not be used for tie points. The location and length of each wiring enters into the proper performance of the pulse generator. In repair work make the least possible movement of wires and do not alter lengths.**

TABLE 6-1. SYSTEMS TROUBLE ANALYSIS CHART (Sheet 1 of 2)

Step	*Test Points*	*Test Equipment Control Positions*	*Pulse Generator Control Positions*	*Normal Indication*	*Possible Cause of Abnormal Indication*
1	①	Vacuum tube voltmeter using a-c scale across terminals 6 and 7 of transformer T1.	Power "ON". Allow 15 minutes to warm up.	5 volts a-c.	The actual power source, power cord, faulty windings in transformer T1. Fuses F1, F2, capacitors C59, C60.
2	②	Same as step 1, but put prods on terminals 11 and 13 of transformer T1.	Same as step 1.	6.3 volts a-c.	Same as step 1.
3	J12	Vacuum tube voltmeter using d-c scale. Put positive prod on chassis ground. Put negative prod on test point J12.	Same as step 1.	150 volts d-c.	Electron tubes V21, V22, V23, V24, V25 and associated components.
4	J13	Same as step 3, but put negative prod on test point J13.	Same as step 1.	300 volts d-c.	Same as step 3.
5	J14	Same as step 3, but put negative prod on test point J14.	Same as step 1.	405 volts d-c.	Electron tube V26, V27 and associated components.
6	J3	Oscilloscope (synchroscope) having 0.03 usec rise time and high impedance probe. Connect oscilloscope's input to "SYNC OUT" connector of TS-592/UPM-15. Connect probe to vertical input of oscilloscope. (See figure 6-1.) Put probe on test point J3. Adjust oscilloscope for clear pattern.	Power "ON". "SYNC SELECTOR" knob on Band "A". "COARSE ATTN" knob on "1-250" range. "PULSE NO. 2" switch in "IN" position. "SEPARATION" dial set at 30 usec. "DELAY" switch in "LONG" position. "DELAY" dial set to 100 usec. "WIDTH" switch in "NAR" position. "WIDTH" dial set to 10 usec. "POLARITY" switch set to "POSITIVE" position. "FINE ATTN" dial to 10 (black numerals).	 (Test pulse rate by turning "PULSE RATE" dial over full rotation and putting "SYNC SELECTOR" knob in positions "A, B, C".	Capacitors C1, C2, C3, C4, C5, C6, variable resistor R1AB, switch S2A, electron tubes V1, V2A and associated parts.
7	J4	Same as step 6 but put probe on test point J4.	Same as step 6.		Crystal CR1, CR2, Coil L1, L2 electron tube V3, V2B and associated parts.
8	③	Same as step 6 but put probe on socket pin 8 of electron tube V6.	Same as step 6.		Crystal CR3, coil L3 electron tubes V4, V6A and associated parts.
9	J2	Same as step 6 but put probe on "SYNC OUT" connector J2.	Same as step 6 but move switch S1 from "LEAD" to "LAG" positions several times to test continuity.	 (Sync pulse 1.3 usec wide, 50 volt amplitude.	Electron tubes V5, coil L4 and associated parts. Switch S1.
10	J5	Same as step 6 but put probe on test point J5.	Same as step 6 but vary "DELAY" switch and "DELAY" knob to check their control of wave form.	 Width varies with "DELAY" control changes.	Peaking coil Z1, crystal CR4, electron tubes V6B, V7A, V8 and associated components.

TABLE 6-1. SYSTEMS TROUBLE ANALYSIS CHART (Sheet 2 of 2)

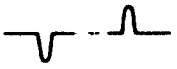
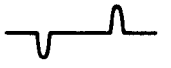
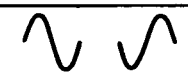
Step	Test Points	Test Equipment Control Positions	Pulse Generator Control Positions	Normal Indication	Possible Cause of Abnormal Indication
11	J10	Same as step 6 but put probe on test point J10.	Same as step 6.		Electron tubes V7B, X9A, peaking coil Z2.
12	J6	Same as step 6 but put probe on test point J6.	Same as step 6 but turn "SEPARATION" dial to check control of waveform.	 Width varies with "SEPARATION" dial rotation.	Electron tubes V9B, V10 and associated components.
13	J11	Same as step 6 but put probe on test point J11.	Same as step 6 but put "PULSE NO. 2" switch in "IN" position.		Peaking coil Z4, electron tubes V11A, V12A and associated components.
14	④	Same as step 6 but put probe on grid, pin 7 of electron tube V13A.	Same as step 13 but vary positions of "WIDTH" switch and "WIDTH" dial.	 Width varies with control changes.	Electron tubes V12B, V13AB and associated components. Variable resistor R79AB.
15	⑤	Same as step 6 but put probe on grid, pin 7 of electron tube V14A.	Same as step 14.	Same as step 14.	Electron tubes V11B, V14AB and associated components. Variable resistor R79AB.
16	J7	Same as step 6 but put probe on test point J7.	Same as step 6.		Electron tube V15 and associated components.
17	⑥	Same as step 6 but put probe on plate pin 5 of electron tube V18.	Same as step 6 but put "PULSE NO. 2" switch in "IN" position. Move "POLARITY" switch back and forth. Turn "WIDTH" dial. Check that each pulse's width is within 10% of the dial reading. Adjust width with variable resistors R125 and R128 and variable capacitor C61.	 Positive position.  Negative position.	Electron tubes V16, V17 and associated components. Variable resistors R125, R128.
18	J8	Same as step 6 but put probe on output connector J8.	Same as step 17. Turn "COARSE ATTN" knob through all six positions. Turn "FINE ATTN" dial. Turn "RISE TIME" dial.	Positive and negative pulses with amplitude varying with "COARSE ATTN" position. "RISE TIME" dial should alter wave leading edge slope from 0.05 to 0.25 usec.	Electron tubes V18, V19, V20 and associated components, variable resistors R99, R107. Switch S7AB and associated components.
19	none	Audio oscillator set for 25 volt rms sine wave, frequency between 50 and 10,000 cycles. Connect to vertical input of the oscilloscope. Also connect to "SYNC IN" connector of TS-992/-UPM-15. During test vary audio oscillator between 8 and 40 volts.	Connect "SYNC OUT" connector to External Sync input of the oscilloscope. Move "BIAS" knob back and forth. Turn "SYNC SELECTOR" knob to "GOING +" and "GOING —".	 "GOING +" "BIAS 0" "GOING —" "BIAS 0" Waveform is to begin along its "GOING +" or "GOING —" slope depending on position of controls. (See figure 4-2.)	Capacitor C10, resistor R13, variable resistor R14, switch S2B.

TABLE 6-2. ELECTRON TUBE SOCKET TERMINAL VOLTAGES AND RESISTANCES

Tube No.	Term. No.	Voltage to Test Point J13	Resistance (Ohms) to Chassis	Usable on Code
V1	1	0	130K	
JAN	2	3.9 (5 V)	16K	
6AU6	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	225 (500 V)	105K	
	6	155 (500 V)	2.8K	
	7	3.9 (5 V)	16K	
V2	1	315 (500 V)	10	
JAN	2	180 (500 V)	60K	
5814	3	210 (500 V)	48K	
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	160 (500 V)	33K	
	7	0	1.1K	
	8	5.4 (15 V)	16K	
	9	3 ac (5 V)	12K	
V3	1	205 (500 V)	800K	
JAN	2	210 (500 V)	45K	
6AU6	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	300 (500 V)	3.3K	
	6	315 (500 V)	0	
	7	210 (500 V)	45K	
V4	1	-1 (5 V)	45K	
JAN	2	0	12K	
6AU6	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	315 (500 V)	40	
	6	155 (500 V)	2.8K	
	7	0	12K	
V5	1	-27 (50 V)	310K	
JAN	2	0	——	
6D4	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	2 (1.5 V)	13K	
	6	315 (500 V)	22K	
	7	225 (500 V)	340K	
V6	1	155 (500 V)	2.8K	
JAN	2	-14.5 (15 V)	440K	
5814	3	0.0	12K	
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	315 (500 V)	0	
	7	-10.2 (15 V)	1M	
	8	9 V (15 V)	23K	
	9	3 ac (5 V)	12K	
V7	1	30 (50 V)	75K	A
JAN		24 (50 V)	75K	B
12AT7	2	-0.3 (1.5 V)	1M	A
		-0.25 (1.5 V)	1M	B
	3	0.0	12K	
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	315 (500 V)	0	
	7	68 (150 V)	60K	A
		54 (150 V)	110K	B
	8	72 (150 V)	35K	A
		58 (150 V)	35K	B
	9	3 ac (5 V)	12K	
V8	1	32 (50 V)	1M	A
JAN		27 (50 V)	1M	B
5725	2	31 (50 V)	24K	A
		26 (50 V)	24K	B
	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	68 (150 V)	60K	A
		54 (150 V)	110K	B
	6	54 (150 V)	16K	
	7	20 (50 V)	35K	
V9	1	155 (500 V)	2.8K	
JAN	2	-15 (15 V)	14K	A
12AT7		-6.5 (15 V)	22K	B
	3	0.0	12K	
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	155 (500 V)	4.8K	
	7	-14.6 (15 V)	220K	
	8	0	12K	
	9	3 ac (5 V)	12K	
V10	1	26 (50 V)	1M	
JAN	2	25 (50 V)	24K	
5725	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	66 (150 V)	70K	A
		66 (150 V)	50K	B
	6	56 (150 V)	16K	A
		48 (150 V)	16K	B
	7	20 (50 V)	35K	
V11	1	150 (150 V)	2.8K	A
JAN		130 (150 V)	7.5K	B
12AT7	2	-15 (15 V)	14K	A
		-6.3 (15 V)	2.2K	B
	3	0	12K	
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	24 (50 V)	75K	
	7	-0.7 (1.5 V)	1M	A
		-1.1 (1.5 V)	1M	B
	8	0	inf	A
		0	12K	B
	9	3 ac (5 V)	12K	

TABLE 6-2. ELECTRON TUBE SOCKET TERMINAL VOLTAGES AND RESISTANCES (CONT)

Tube No.	Term. No.	Voltage to Test Point J13	Resistance (Ohms) to Chassis	Usable on Code
V12	1	150 (150 V)	2.8K	A
JAN		150 (150 V)	7.5K	B
12AT7	2	-10.5 (15 V)	210K	
	3	0	12K	
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	155 (500 V)	6K	
	7	-24 (50 V)	220K	
	8	0	12K	
	9	3 ac (5 V)	12K	
V13	1	96 (150 V)	8.2K	A
JAN		112 (150 V)	5K	B
5814	2	-1 (1.5 V)	22K	A
		-0.11 (1.5 V)	33K	B
	3	0	12K	
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	150 (150 V)	2.8K	A
		150 (150 V)	7.5K	B
	7	-24 (50 V)	60K	A
		-11.5 (50 V)	60K	B
	8	0	12K	
	9	3 ac (5 V)	12K	
V14	1	92 (150 V)	8.2K	A
JAN		115 (150 V)	5K	B
5814	2	-0.8 (1.5 V)	22K	A
		-5.3 (1.5 V)	33K	B
	3	0	12K	
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	150 (150 V)	2.8K	A
		130 (150 V)	7.5K	B
	7	-24 (50 V)	60K	A
		-9.5 (50 V)	60K	B
	8	0	12K	
	9	3 ac (5 V)	12K	
V15	1	315 (500 V)	1K	A
JAN		315 (500 V)	1.5K	B
5814	2	-24 (50 V)	60K	A
		-17 (50 V)	50K	B
	3	0.65 (1.5 V)	13K	A
		2.3 (1.5 V)	13K	B
	4	3 ac (5 V)	12K	
	5	3 ac (5 V)	12K	
	6	315 (500 V)	1K	A
		315 (500 V)	1.5K	B
	7	-24 (50 V)	60K	A
		-19 (50 V)	50K	B
	8	0.65 (1.5 V)	13K	A
		2.3 (1.5 V)	13K	B
	9	3 ac (5 V)	12K	

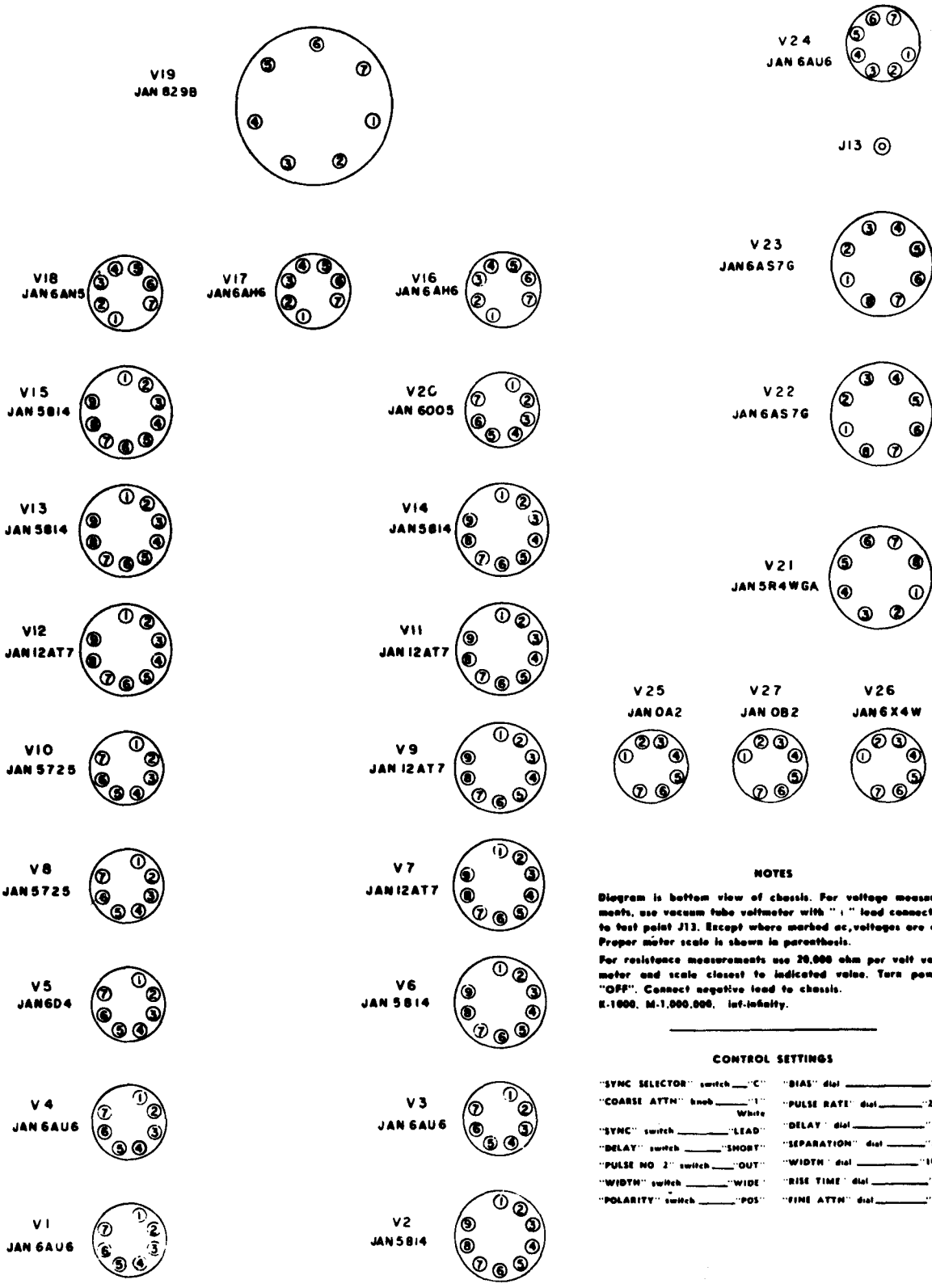
Tube No.	Term. No.	Voltage to Test Point J13	Resistance (Ohms) to Chassis	Usable on Code
V16	1	-80 (150 V)	500K	A
JAN		-64 (150 V)	500K	B
6AH6	2	-80 (150 V)	35K	A
		-64 (150 V)	35K	B
	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	-20 (50 V)	13K	
	6	0	12K	
	7	-80 (150 V)	35K	A
		-64 (150 V)	35K	B
V17	1	-80 (150 V)	500K	A
JAN		-64 (150 V)	500K	B
6AH6	2	-80 (150 V)	35K	A
		-64 (150 V)	35K	B
	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	-20 (50 V)	13K	
	6	0	12K	
	7	-80 (150 V)	35K	A
		-64 (150 V)	35K	B
V18	1	-110 (150 V)	220K*	A
JAN		-84 (150 V)	220K*	B
6AN5	2	-82 (150 V)	35K	A
		-64 (150 V)	35K	B
	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	-1.4 (5 V)	13K	A
		-5.2 (50 V)	13K	B
	6	0	12K	
	7	-82 (150 V)	35K	A
		-64 (150 V)	35K	B
		*Put "POLARITY" switch in "NEG" position for this reading only.		
V19	1	3 ac (5 V)	12K	
JAN	2	-1.4 (1.5 V)	13K	A
829B		-5.2 (1.5 V)	13K	B
	3	24 (50 V)	22K	A
		31 (50 V)	22K	B
	4	0	12K	
	5	3 ac (5 V)	12K	
	6	-1.4 (5 V)	12K	A
		-5.2 (5 V)	12K	B
	7	3 ac (5 V)	12K	
V20	1	-11 (15 V)	80K	A
JAN		-3 (15 V)	280K	B
6005	2	24 (50 V)	22K	A
		31 (50 V)	22K	B
	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	315 (500 V)	0	
	6	315 (500 V)	0	
	7	-11 (15 V)	80K	A
		-3 (15 V)	280K	B

TABLE 6-2. ELECTRON TUBE SOCKET TERMINAL VOLTAGES AND RESISTANCES (CONT)

Tube No.	Term. No.	Voltage to Test Point J13	Resistance (Ohms) to Chassis	Usable on Code
V21	1	165 ac(500 V)	——	
JAN	2	500 (500 V)	inf	
5R4WGA	3	165 ac(500 V)	——	
	4	430 ac(500 V)	12K	
	5	——	——	
	6	430 ac(500 V)	12K	
	7	——	——	
	8	500 (500 V)	inf	
V22	1	200 (500 V)	inf	
JAN	2	500 (500 V)	inf	
6AS7G	3	315 (500 V)	——	
	4	200 (500 V)	inf	
	5	500 (500 V)	inf	
	6	315 (500 V)	0	
	7	3 ac (5 V)	12K	
	8	3 ac (5 V)	12K	
V23	1	200 (500 V)	inf	
JAN	2	500 (500 V)	inf	
6AS7G	3	315 (500 V)	——	
	4	200 (500 V)	inf	
	5	500 (500 V)	inf	
	6	315 (500 V)	0	
	7	3 ac (5 V)	12K	
	8	3 ac (5 V)	12K	
V24	1	-3.3 (5 V)	77.5K	A
JAN		-3.3 (5 V)	260K	B
6AU6	2	0	12K	
	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	200 (500 V)	inf	
	6	116 (150 V)	35K	
	7	0	12K	

Tube No.	Term. No.	Voltage to Test Point J13	Resistance (Ohms) to Chassis	Usable on Code
V25	1	155 ac(500 V)	2.8K	
USN	2	0	12K	
6626/	3	——	——	
OA2WA	4	0	12K	
	5	155 (500 V)	2.8K	
	6	——	——	
	7	0	12K	
V26	1	155 ac(500 V)	35K	
JAN	2	——	35K	
6X4W	3	3 ac (5 V)	12K	
	4	3 ac (5 V)	12K	
	5	——	35K	
	6	155 ac(500 V)	35K	
	7	0	12K	
V27	1	0	12K	
USN	2	-108 (150 V)	35K	
6627/	3	——	——	
OB2WA	4	-108 (150 V)	35K	
	5	0	12K	
	6	——	——	
	7	-108 (150 V)	35K	

TABLE 6-2. ELECTRON TUBE SOCKET TERMINAL VOLTAGES AND RESISTANCES (CONT)



NOTES

Diagram is bottom view of chassis. For voltage measurements, use vacuum tube voltmeter with " ⊥ " lead connected to test point J13. Except where marked ac, voltages are dc. Proper meter scale is shown in parenthesis.

For resistance measurements use 20,000 ohm per volt voltmeter and scale closest to indicated value. Turn power "OFF". Connect negative lead to chassis.
K-1000, M-1,000,000, Inf-infinity.

CONTROL SETTINGS

"SYNC SELECTOR" switch "C"	"BIAS" dial "0"
"COARSE ATTN" knob "1" White	"PULSE RATE" dial "2.0"
"SYNC" switch "LEAD"	"DELAY" dial "10"
"DELAY" switch "SHORT"	"SEPARATION" dial "30"
"PULSE NO 2" switch "OUT"	"WIDTH" dial "100"
"WIDTH" switch "WIDE"	"RISE TIME" dial "1"
"POLARITY" switch "POS"	"FINE ATTN" dial "10"

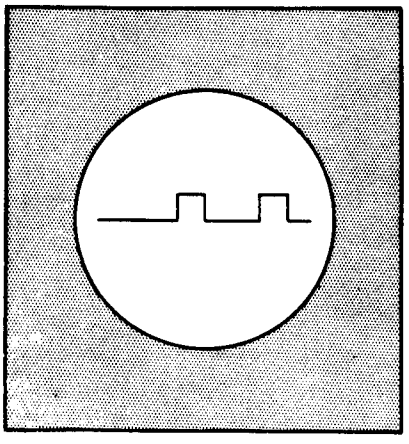
SECTION VII

DIAGRAMS

7-1. Figure 7-1 shows the appearance of output pulse patterns formed by a pulse generator that is in normal operating condition.

7-2. Waveforms on figures 7-2 and 7-4 indicate the appearance of the signal at test points in a unit that is operating normally. The test points consist of the standard symbols. A star-encircled number is a major test point. No secondary test points are required.

7-3. Figures 7-3, 7-5 and 7-6 are the practical wiring diagram. Each electrical part is identified by the reference symbol used in the schematic wiring diagrams. The electrical parts are illustrated in the same position that they occupy in the unit. Reference symbol numbers are stamped on the parts or on the chassis to aid accurate identification. Practical wiring diagrams show color coding and location of wiring. Where the full length of a wire is not shown the connection point for the open end is given. For example a connection to variable resistor R132 on the front panel, is given as R98, V, B. On terminal board B, resistor R98 is labeled R132, V showing that it connects to resistor R132 with a violet color wire.

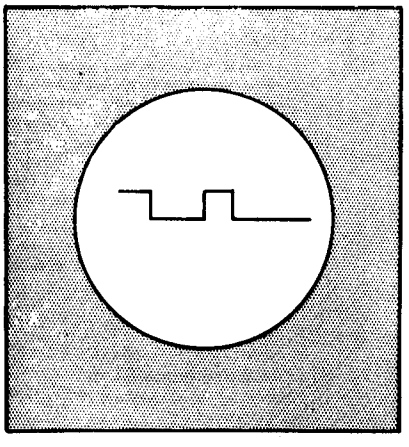


SYNC LEAD CONDITION

CONTROL POSITIONS

CONTROL	SETTING
"SYNC SELECTOR" knob	"A"
"PULSE RATE" dial	0.150 KC
"SYNC" switch	"LEAD"
"DELAY" switch	"LONG"
"PULSE NO. 2" switch	"IN"
"SEPARATION" dial	30 usec
"DELAY" dial	100 usec
"WIDTH" switch	"NAR"
"WIDTH" dial	10 usec
"COARSE ATTN" knob	"1—250 OHM"
"FINE ATTN" dial	15
"POLARITY" switch	"POS"
"RISE TIME" dial	0.05 usec

Use oscilloscope having 0.03 usec rise time. Synchronize oscilloscope from test oscillator set.



SYNC LAG CONDITION

Use same control positions as above except, put "SYNC" switch in "LAG" position.

Figure 7-1. Normal Output Waveforms

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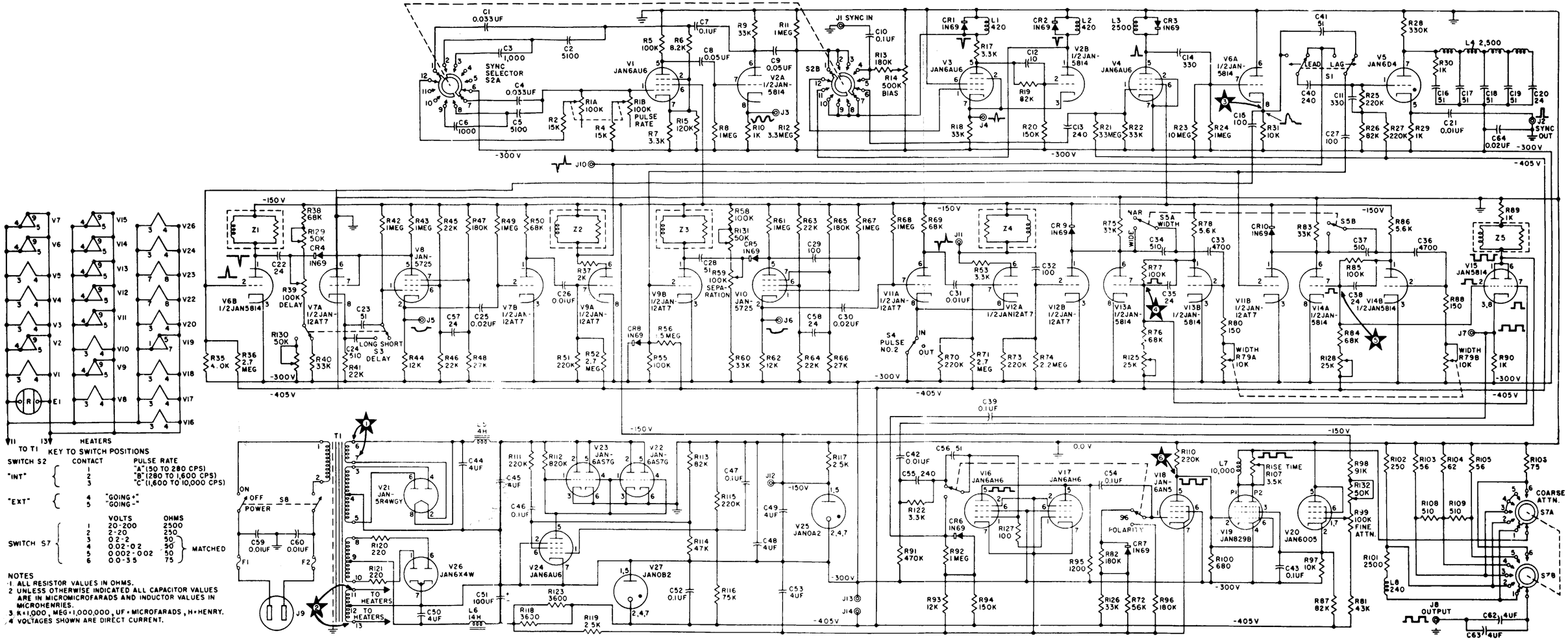


Figure 7-2. Pulse Generator TS-592A UPM-15, Overall Schematic Wiring Diagram

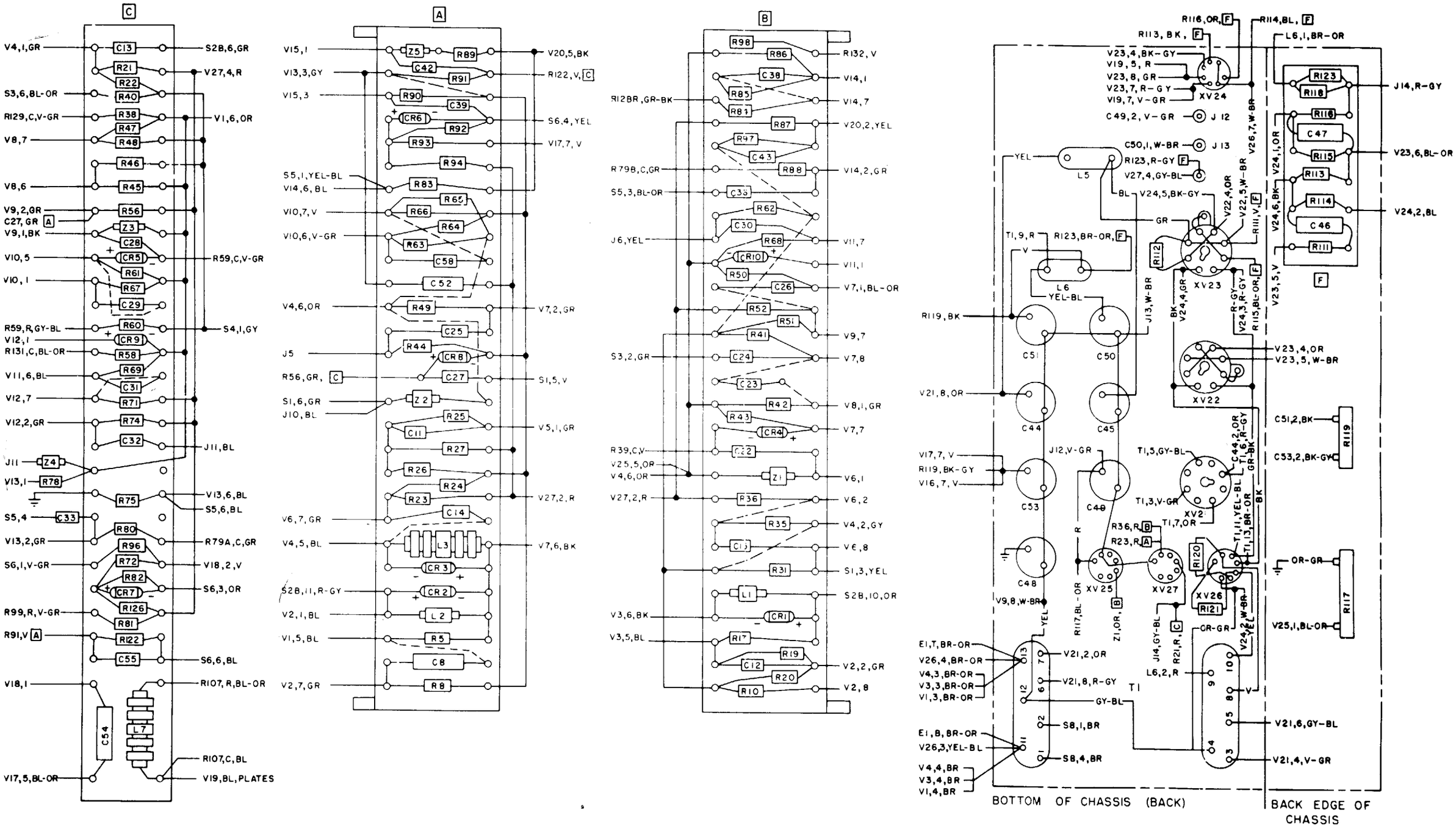


Figure 7-3. Pulse Generator TS-592A/UPM-15, Practical Wiring Diagram

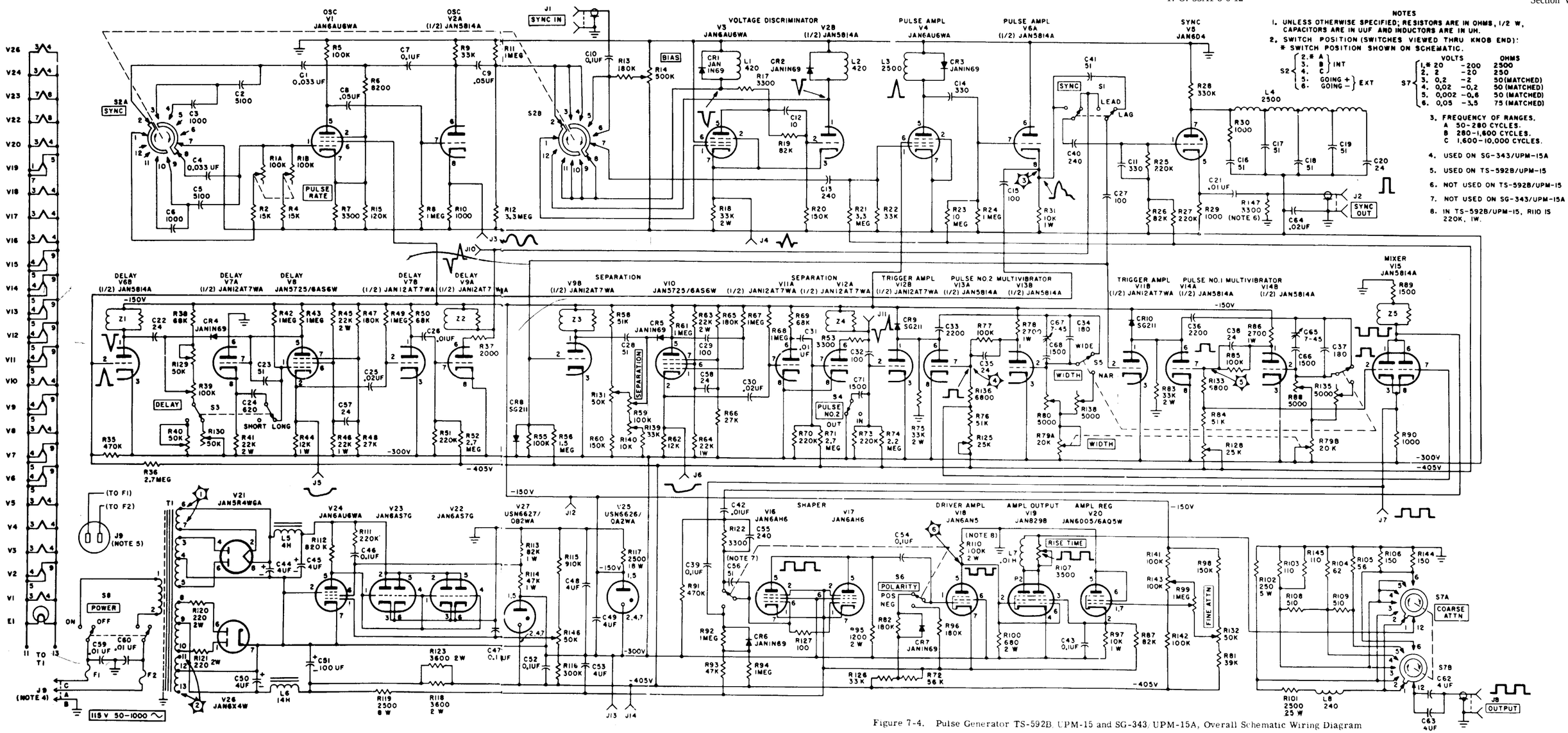
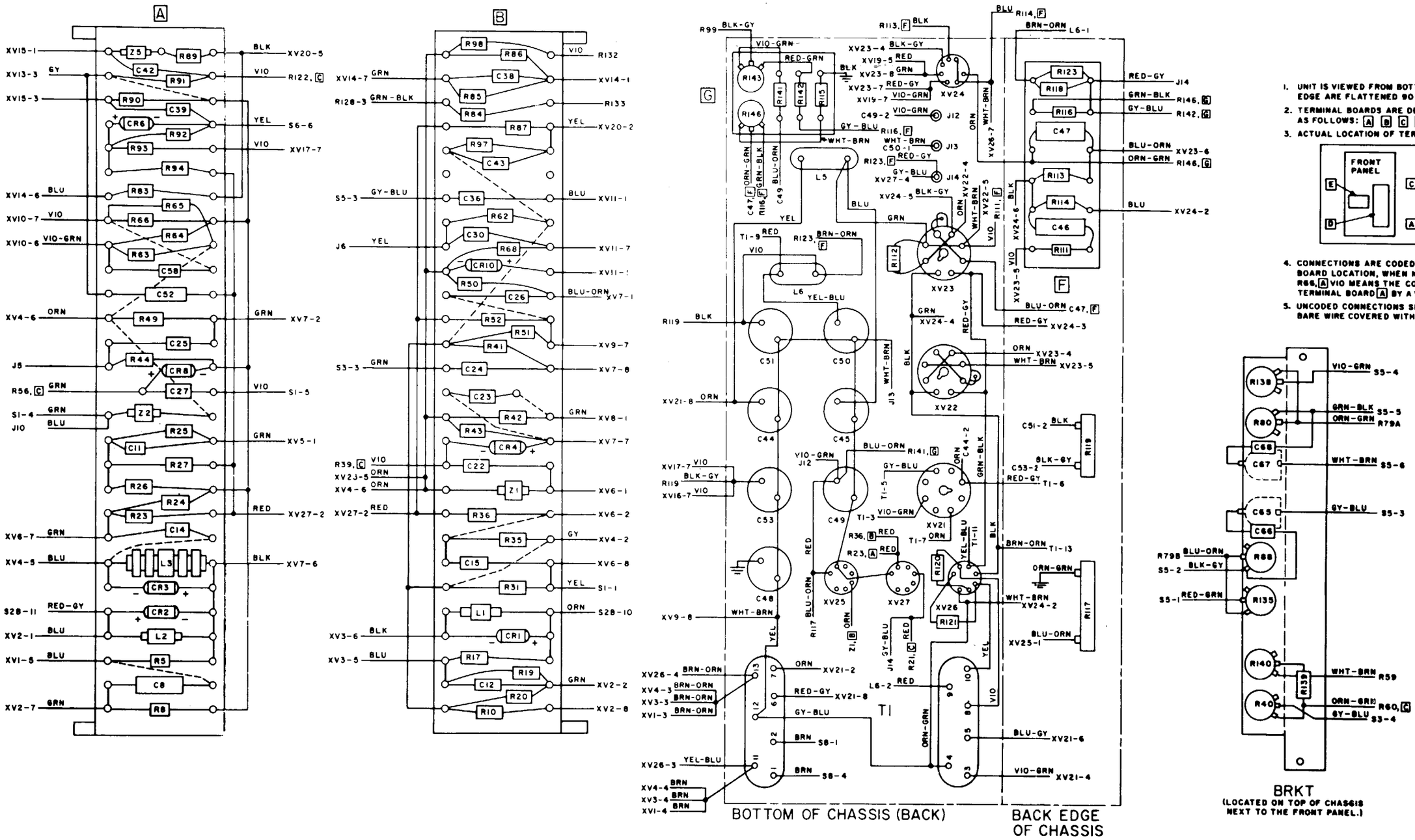
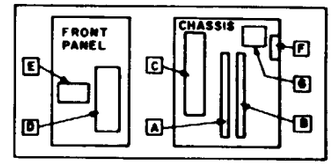


Figure 7-4. Pulse Generator TS-592B, UPM-15 and SG-343, UPM-15A, Overall Schematic Wiring Diagram



NOTES:

1. UNIT IS VIEWED FROM BOTTOM OF CHASSIS. FRONT PANEL AND REAR EDGE ARE FLATTENED 90 DEGREES TO SHOW ALL PARTS.
2. TERMINAL BOARDS ARE DESIGNATED BY LETTERS INSIDE SQUARES AS FOLLOWS: A B C D E F AND G
3. ACTUAL LOCATION OF TERMINAL BOARDS.



4. CONNECTIONS ARE CODED FIRST BY THE PART THEN THE TERMINAL BOARD LOCATION, WHEN NECESSARY, AND THE WIRE COLOR. THUS, R66, A VIO MEANS THE CONNECTION IS MADE TO RESISTOR 66 ON TERMINAL BOARD A BY A VIOLET WIRE.
5. UNCODED CONNECTIONS SHOWN BY SOLID OR DOTTED LINES ARE BARE WIRE COVERED WITH FLEXIBLE SLEEVE INSULATION.
6. IN THE DUAL PARTS S2A AND S2B S7A AND S7B, R1A AND R1B, R79A AND R79B, THE SECTIONS S2B, S7A, R1B AND R79A ARE NEXT TO THE PANEL.
7. ON R129, R130, R131, R125, R128 AND R132, TERMINALS ARE NUMBERED SHOWING 2 AS THE ROTOR, 1 AS THE CCW CONTACT, AND 3 AS THE CW CONTACT.

BRKT
(LOCATED ON TOP OF CHASSIS NEXT TO THE FRONT PANEL.)

Figure 7-5. Pulse Generator TS-592B/UPM-15, Practical Wiring Diagram

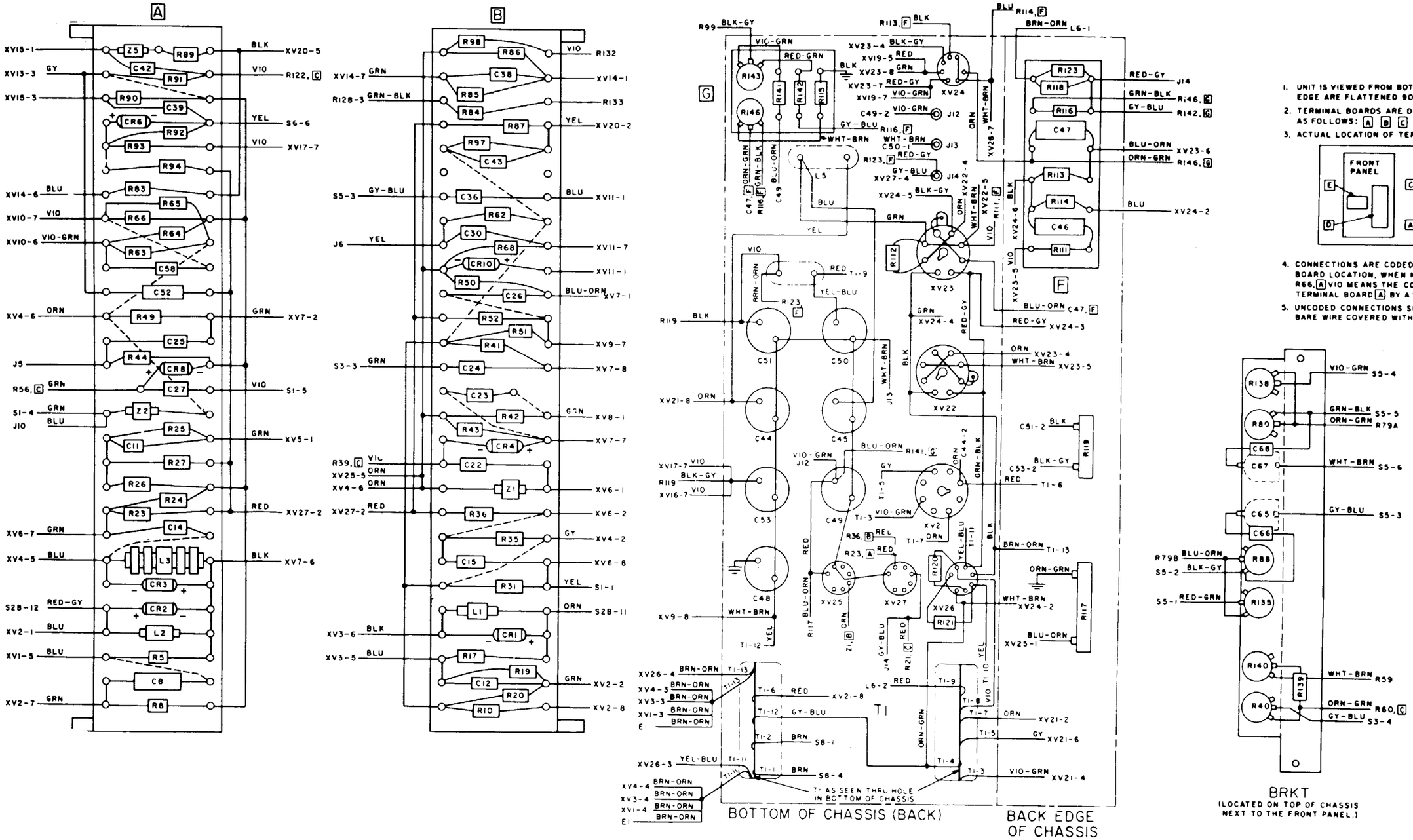


Figure 7-6. Pulse Generator SG-343/LPM-15A, Practical Wiring Diagram

PIN : 017189-000