TM 11-6625-524-14

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR,

ORGANIZATIONAL AND

FIELD MAINTENANCE MANUAL

ELECTRONIC VOLTMETER AN/URM-145

This copy is a reprint which includes current pages from Changes 1 through 3.

HEADQUARTERS, DEPARTMENT OF THE ARMY

FEBRUARY 1963

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)
CSigO (7)
CofT (1)
CofEngrs (1)
TSG (1)
AMC (5)
USCONARC (5)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (3)
OS Base Comd (2)
LOGCOMD (2)
MDW (1)
USA CD Agcy (1)
Armies (2)
Corps (2)
USA Tng Cen (2)
USA Elct Comd (5)
USA Msl Comd (4)
USA Strat Comm Comd (4)
Svc Colleges (2)
Br Svc Sch (2)
Army Dep (2) except
Lexington, Tobyhanna (12)
Ft Worth (8) Sacramento (17)
Sig Dep (OS) (12)
GEN DEP (OS) (2)
Sig Sec, Gen Dep (OS) (5)
WRAMC (1)
USA Trans Tml Comd (1)
USA Tml (1)
POE (1)
OSA (1)
AFIP (1)
AMS (1)
USA Pictorial Cen (2)
USA Mobility Spt Cen (1)
Yuma Test Station (2)
USARCARIB Sig Agcy (1)
USA Sig Fld Maint Shops (3)
USA Corps (3)
JBUSMC (2)
Instl (2) except
Ft Monmouth (63)
USA Elct Mat Agcy (25)
Chicago Proc Dist (1)
USA Elct R&D Activity,
Ft Huachuca (2)
USA Elct R&D Activity (WSMR) (13)
Def Log Svc Cen (1)
Units org under fol TOE:
(2 copies UNOINDC)
11-7
11-16
11-57
11-97
11-98
11-117
11-155
11-157
11-500 (AA-AE) (4)
11-557
11-587
11-592
11-597

.NG: State AG (3).

USAR: None.

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

TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL, AND FIELD MAINTENANCE MANUAL

VOLTMETER, ELECTRONIC AN/URM-145

TM 11-6625-524-14
CHANGES No. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *17 June 1963*

TM 11–6625-524-14, 20 February 1963, is changed as follows:

Page 24. Add appendix I and II

APPENDIX I

MAINTENANCE ALLOCATION

SECTION I. INTRODUCTION

1. General

a. This appendix 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) *Part or component.* This column shows only the nomenclature or standard item name. Additional descriptive data are 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 breakdown (components, assemblies, or subassemblies) is 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 component of a weapons system.

(i) Overhaul. To restore an item to *completely serviceable* condition as prescribed by serviceability standards. This is accomplished through 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 echelons.* The symbol X placed in columns 3 through 7 indicate 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) *lst, 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 of communication zones to provide theater communications, those maintenance functions allocated up to and including fourth echelon are authorized to the organization operating this equipment.

SECTION II MAINTENANCE ALLOCATION CHART

PART OR COMPONENT	MAINTENANCE FUNCTION	ECHELON 1	2	3	4	5	TOOLS REQUIRED	REMARKS
VOLTMETER, ELECTRONIC AN/URM-145	service		X				11	
	adjust				X		8	
						X	8	
	inspect							
	test				X		1,10	
						X	1,10	
					X		7	
						X	6	
	replace				X			
	repair				X		8,9	
	align				X		1,3,4,5,8,10	
	calibrate				X		1,2,10	
	rebuild					X	1 thru 10	
	overhaul					X	1 thru 10	
PROBE SUBASSEMBLY MX-4528/U	replace				X		8,9	
PROBE SUBASSEMBLY MX-4529/U	replace				X		8,9	
TEST LEAD MX-4527/U	replace				X			
VOLTMETER, ELECTRONIC ME-247/U AND ME-247A/U	replace				X		8,9	

SECTION III ALLOCATION OF TOOLS FOR MAINTENANCE FUNCTIONS

TOOLS REQUIRED FOR MAINTENANCE FUNCTIONS	ECHELON 1 2 3 4 5	TOOL CODE	REMARKS
AN/USM-145 (continued)			
GENERATOR, SIGNAL SG-479( )/USM-50	† †	1	Visual
METER TEST SET TS-682/USM-1	†	2	Tube tests. Tube tests.
MULTIMETER TS-352/U	†	3	
OSCILLOSCOPE AN/USM-50	†	4	
RESISTOR, DECADE ZM-16/U	†	5	
TEST SET, ELECTRON TUBE TV-2/U	†	6	
TEST SET, ELECTRON TUBE TV-7/U	†	7	NOTE: This item returned to contractor on exchange basis. Repaired and calibrated by contractor only. Depot returns to contractor.
TOOL KIT, RADAR AND RADIO REPAIRMAN TK-87/U	† †	8	
TOOL KIT, SUPPLEMENTARY, RADAR AND RADIO REPAIR TK-88/U	† †	9	
VOLTMETER, METER ME-30/U	† †	10	
TOOL AND TEST EQUIPMENT NORMALLY SUPPLIED TO THE REPAIRMAN USER BECAUSE OF HIS ASSIGNED MISSION	†	11	

APPENDIX II
BASIC ISSUE ITEMS LIST
(Added)
Section I. INTRODUCTION

1. Scope

This appendix lists items supplied for initial operation and for running spares. The list includes tools, parts, and material issued as part of the major end item. The list includes all items authorized for basic operator maintenance of the equipment. End items of equipment are issued on the basis of allowances prescribed in equipment authorization tables and other documents that are a basis for requisitioning. The columns are as follows:

a. Federal stock number. This column lists the 1l-digit Federal stock number.

b. Designation by model. Not used.

c. *Description.* Nomenclature or the standard item name and brief identifying data for each item are listed in this column. When requisitioning, enter the nomenclature and description.

d. Unit of issue. The unit of issue is each unless otherwise indicated and is the supply term by which the individual item is counted for procurement, storage, requisitioning, allowances, and issue purposes.

e. Expendability. Nonexpendable items are indicated by NX. Expendable items are not annotated.

f. Quantity authorized. Under "Items comprising an Operable Equipment," the column lists the quantity of items supplied for the initial operation of the equipment. Under "Running Spare Items" the quantities listed are those issued initially with the equipment as spare parts. The quantities are authorized to be kept on hand by the operator for maintenance of the equipment.

g. Illustration. The "Item No." column lists the reference symbols used for identification of the items in the illustration or text of the manual.

	FEDERAL STOCK NUMBER	DESIGNATION BY MODEL	DESCRIPTION	UNIT OF ISSUE	SMR	QTY IN UNIT	ILLUSTRATION	
							FIG. NO.	ITEM NO.
			VOLTMETER, ELECTRONIC AN/URM-145					
	6625-973-3986		VOLTMETER, ELECTRONIC AN/URM-145: Is a sensitive instrument for the measurement of voltages of 300 microvolts to 3 volts spanning a wide frequency range of 10 kilocycles to 600 megacycles. Also has application for many associated tests, viz; the frequency response of both active and passive networks, vie, amplifies and filters VSWR and return loss on transmission lines and attendent systems; attenuation and insertion loss of rf attenuators, and high frequency parameters of transistors.		MX			
			ITEMS COMPRISING AN OPERABLE EQUIPMENT					
	ORD THRU AOC		TECHNICAL MANUAL TM 11-6625-524-14			2		
	6625-973-2296		PROBE SUBASSEMBLY MX-4528/U: 2 in lg x 5/8 in dia used as couples for high impedance RF voltage readings (Not mounted)		MX	1		
	6625-973-2295		PROBE SUBASSEMBLY MX-4529/U: 1.5 in lg x 0.59 in dia; used as test prod tip for high impedance RF voltage (Not mounted)		MX	1		
	6625-973-2297		LEAD, TEST MX-4527/U: 2.5 uuf capacitance, 10v ac max, 400v dc max, frequency range 10 kc to 600 mc; 36 in lg o/a; (Not mounted)		MX	1		
	6625-973-2294		VOLTMETER, ELECTRONIC ME-247/U, ME-247A/U: Range; 3000v to 3v ac in 8 steps, 0 to 70 db in 8 steps; 200 ma sensitivity ac 105-125v, 55-65 cps single phase, resistance across terminals of panel meter 475 ohms for ME-247/U; resistance across terminals of panel meter 1400 ohms for ME-247A/U		MX	1		MI

	FEDERAL STOCK NUMBER	DESIGNATION BY MODEL	DESCRIPTION	UNIT OF ISSUE	EXP	QTY IN UNIT	ILLUSTRATION	
							FIG. NO.	ITEM NO.
			AN/URM-145 (continued)					
			RUNNING SPARE ITEMS					
			VOLTMETER, ELECTRONIC AN/URM-145					
			VOLTMETER, ELECTRONIC ME-247/U; Voltmeter, Electronic ME-247A/U					
	5960-503-4880		ELECTRON TUBE: MIL type 0A2WA (Not mounted)			1		
	5960-262-0152		ELECTRON TUBE: MIL type 6AU6WA (Not mounted)			1		
	5960-188-0880		ELECTRON TUBE: MIL type 6X4W (Not mounted)			1		
	5960-262-0167		ELECTRON TUBE: MIL type 12AT7WA (Not mounted)			1		
	5960-166-7664		ELECTRON TUBE: MIL type 12AX7 (Not mounted)			1		
	5920-356-2193		FUSE, CARTRIDGE: Bussman No. AGC 1/2, 1/2 amp, 250v max, ferrule type, glass body. (Not mounted)			5		
	6240-011-5273		LAMP, INCANDESCENT: GE type No. 51, 6v midget screw base, clear, 15/16 in max lg o/a (Not mounted)			2		

By Order of the Secretary of the Army:

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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 (9)
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 UNOINDC:
11-7
11-16
11-57
11-97
11-98
11-117
11-155
11-157
11-500 (AA-AC) (4)
11-557
11-587
11-592
11-597

NG: State AG (3).

USAR: None.

For explanation of abbreviations used, see AR 320-60.

TM 11-6625-524-14
C 2

Operator, Organizational, and Field Maintenance Manual

VOLTMETER, ELECTRONIC AN/URM-145

CHANGE
No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *23 December 1963*

TM 11-6625-524-14, 20 February 1963, is changed as follows:

Page 2. Add section I.1 after section I:

SECTION I.1
GENERAL

1.1.1. Scope

This manual describes Voltmeter, Electronic AN/URM-145 and provides instruction for its operation, and operator, organizational, and field maintenance. It includes instructions for cleaning and inspection of the equipment, troubleshooting, calibration adjustment, and the replacement of parts available to operator, organizational and field repairman.

1.1.2. Index of Publications

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

1.1.3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700–58 (Army), NAVASANDA Publication 378 (Navy), and AFR 71–4 (Air Force).

c. Reporting of Equipment Manual Improvements. The direct reporting, by the individual user, of errors, omissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Technical Manual Parts Lists or. Supply Manual 7,8 or 9) will be used for reporting these improvement. This form will be completed in triplicate using pencil, pen, or typewriter. The original and one copy will be forwarded direct to: Commanding Officer, U.S. Army Electronics Materiel Support Agency, ATTN: SELMS–MP, Fort Monmouth, N. J. 07703. One information copy will be furnished to the individual's immediate supervisor (officer, noncommissioned officer, supervisor, etc).

Page 9. Add section III.1 after section III.

SECTION III.1
PREVENTIVE MAINTENANCE

3.1.1. Scope of Maintenance

The maintenance duties assigned to the operator and organizational repairman of the equipment are listed below together with a reference to the paragraphs covering the specific maintenance functions. The tools and test equipment required are listed in appendix II.

a. Daily preventive maintenance checks and services (para 3.1.4).

b. Weekly preventive maintenance checks and services (para 3.1.5).

c. Monthly preventive maintenance checks and services (para 8.1.6).

d. Quarterly preventive maintenance checks and services (para 3.1.7).

e. Cleaning (para 3.1.8).

j. Touchup painting (para 3.1.9).

g. Troubleshooting (para 5.4).

3.1.2. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 3.1.4 through 3.1.9 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (para 3.1.4–3.1.7) outline functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat-serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and what the normal conditions are; the references column lists the paragraphs or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by performing the corrective actions listed, higher echelon maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

3.1.3. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of the equipment are required daily, weekly, monthly, and quarterly.

a. Paragraph 3.1.4 specifies the checks and services that must be accomplished daily (or at least once each week if the equipment is maintained in standby condition).

b. Paragraphs 3.1.5, 3.1.6, and 3.1.7 specify *additional* checks and services that must be performed on a weekly, monthly, and quarterly basis, respectively.

3.1.4. Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Completeness- - - - - - - - - - - - - -	See that the equipment is complete (appx III).	
2	Exterior surfaces- - - - - - - - - - - -	Clean the exterior surfaces, including the panel and meter glass (para 3.1.8). Check the meter glass for cracks.	
3	Connectors- - - - - - - - - - - - - - - - - -	Check the tightness of all connectors.	
4	Controls and indicator- - - - - - - - -	During operation, observe that the mechanical action of each knob and switch is smooth and free of external or internal binding, and that there is no excessive looseness. Also, check the meter for sticking or bent pointer.	
5	Operation- - - - - - - - - - - - - - - - -	During operation, be alert for any unusual performance or condition.	

3.1.5. Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Cables- - - - - - - - - - - - - - - - -	Inspect cords, cables, and wires for chafed, cracked, or frayed insulation. Replace connectors that are broken, arced, stripped, or worn excessively.	
2	Handle- - - - - - - - - - - - - - - - -	Inspect the handle for looseness. Replace or tighten as necessary.	
3	Metal surfaces- - - - - - - - - - - - -	Inspect exposed metal surfaces for rust and corrosion. Touch up paint as required (para 3.1.8).	

3.1.6. Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Pluckout items- - - - - - - - - - - - - - - -	Inspect seating of pluckout items.	
2	Transformer- - - - - - - - - - - - - - - - - -	Inspect the transformer. All nuts must be tight. There should be no evidence of dirt or corrosion.	
3	Resistors and capacitors- - - - - - - -	Inspect the resistors and capacitors for cracks, blistering, or other detrimental defects.	

3.1.7. Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Publications- - - - - - - - - - - - - - - - - -	See that all publications are complete, serviceable, and current.	DA Pam 310–4.
2	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 NORMAL MWO'S must be scheduled.	TM 38–750 and DA Pam 310–4.
3	Spare parts - - - - - - - - - - - - - - - - -	Check all spare parts (operator and organizational) for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	Appx III.

3.1.8. Cleaning

Inspect the exterior of the equipment. The exterior surfaces should be clean, and free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean soft cloth.

Warning: **Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation.** ***Do not*** **use near a flame.**

b. Remove grease, fungus, and ground-in dirt from the case; use a cloth dampened (not wet) with Cleaning Compound (Federal stock No. 7930-395-9542).

c. Remove dust or dirt from plugs and jacks with a brush.

Caution: Do **not press on the meter face (glass) when cleaning; the meter may become damaged.**

d. Clean the front panel, meter, and control knobs; use a soft clean cloth. If necessary, dampen the cloth with water; mild soap may be used for more effective cleaning.

3.1.9. Touchup Painting Instructions

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

Page 24 (page 1 of C 1). Change "appendix I" to: appendix II.

Change "appendix II" to: appendix III.

Add appendix I before appendix II.

APPENDIX I

REFERENCES

DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 4,6,7,8, and 9) Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 9–213	Painting Instructions for Field use.
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.

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Major General United States Army,
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Distribution:

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CofT (1)
CofEngrs (1)
OCofSptS (1)
TSG (1)
USACECDA (1)
USACECDA, Monmouth Ofc (1)
USCONARC (5)
USAMC (5)
USAECOM (2)
USAMICOM (4)
USASMCOM (2)
USASCC (4)
ARADCOM (2)
ARADCOM Rgn (6)
OS Maj Comd (5)
OS Base Comd (5)
LOGCOMD (5)
MDW (1)
28th Arty GP (AD) (2)
45th Arty Bde (AD) (2)
18th Arty GP (AD) (2)
WSMR (13)
Ft Hancock (2)
Ft Meade (2)
Ft Lawton (2)
Ft Heath (2)
Ft MacArthur (2)
GENDEP (OS) (2)
Sig Sec, GENDEP (5)
Sig Dep (OS) (5)
Army Dep (2) except
Charleston (1)
Lexington (5)
Sacramento (5)
Tobyhanna (5)
USA Elct Mat Spt Agcy (20)
USA Elct Mat Agcy (14)
USASCS (5)
USAADS (3)
USA Elct Rd Lab (5)
USA Mbl Spt Cen (1)
MAAG (France) (15)
USA Corps (3)
USA AD Engr Agcy (11)

NC: None.
USAR: None.
For explanation of abbreviations used, see AR 320–60.

CHANGE
No. 3

TM 11-6625-524-14
C 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *21 December 1973*

Changes in force: C 1, C 2 and C 3

Operator, Organizational, and Field Maintenance Manual VOLTMETER, ELECTRONIC AN/URM-145

TM 11-6625-524-14, 20 February 1963, is changed as follows:

Page 2, paragraph 1.1.2. Delete paragraph 1.1.2 and substitute:

1.1.2. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO'S) pertaining to the equipment.

Paragraph 1.1.3. Delete paragraph 1.1.3 and substitute:

1.1.3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiency. Fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies) as prescribed in AR 700-56 (Army)/NAVSUP PUB 378 (Navy)/AFR 71-4 (Air Force)/and MCO P4030.29 (Marine Corps).

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 700-58 (Army)/NAVSUP PUB 459 (Navy)/AFM 75-34 (Air Force)/and MCO P4610.19 (Marine Corps).

Paragraph 1.1.4 and 1.1.5 added as follows:

1.1A Reporting of Errors

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on/ DA Form 2028, Recommended Changes to Publications and forwarded direct to Commander, US Army Electronics Command ATTN: AMSEL-MA-C Fort Monmoutg NJ 07703.

1.1.5 Items Comprising An Operable Voltmeter Electronic AN/URM-145

FSN	*Qty*	*Nomenclature*
6625-973-3986		Voltmeter, Electronic AN/URM .145 consisting of:
6625-973-2296	1	Probe Subassembly MX-4258/U: 2 in. 1g x 5/8 in. dia used as coupler for high impedance RF voltage readings (Not Mounted).
6625-973-2295	1	Probe Subassembly MX-4529/U: 1.5 in. lg x 0.59 in. dia. used as test prod tip for high impedance RF voltage (Not Mounted).
6625-973-2297	1	Lead, Test MX-4527/U: 2.5 uuf capacitance, 10V ac max., 400V dc max., frequency range 10 kHz 600 mHz.
6625-973-2294	1	Voltmeter, Electronic ME-247/U, ME-247A/U: range 3000V to 3V ac in 8 steps, 0 to 70 db in 8 steps, 200 ma. sensitivity ac, l05-125V, 55-65 Hz single phase, resistance across terminals of panel meter 475 ohms for ME-247/U; resistance l cross terminals of panel meter 1400 ohms for ME-247A/U.

Page 24, appendix II. Delete appendix II.

By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

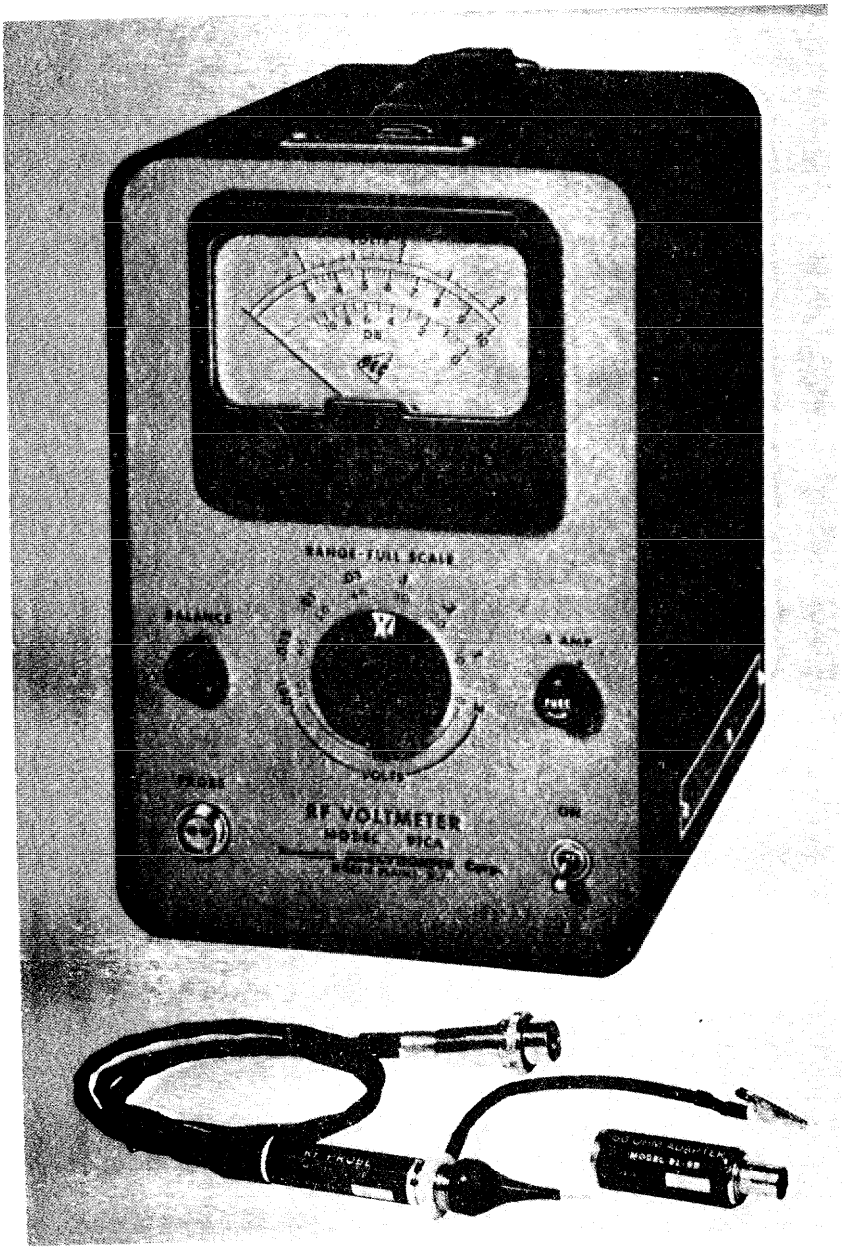
Official:

VERNE L BOWERS
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-36, Direct and General Support maintenance requirements for

M O D E L 91CA
R F V O L T M E T E R
Do not use on Ser. Nos. below 2661



TECHNICAL MANUAL

NO. 11-6625-524-14

HEADQUARTERS,
DEPARTMENT OF THE ARMY
Washington 25, D. C., 20 February 1963

OPERATOR, ORGANIZATIONAL AND FIELD MAINTENANCE MANUAL
ELECTRONIC VOLTMETER AN/URM-l45

SECTION I

MODEL 91 CA

SPECIFICATIONS

1.1	Measurement Range:		300 microvolt to 3 volts
1.2	Full Scale Ranges:		.001, .003, .01, .03, .1, .3, 1, 3 volts.
1.3	Frequency Range:		10 KC to 600 MC
1.4	Accuracy:	.003 range and above	5% of full scale to 200 MC 10% of full scale above 200 MC
		.001 range only	10% of full scale to 200 MC 15% of full scale above 200 MC
1.5	Input Impedance:		91-3B RF Probe See curve for shunt resistance data on high impedance probe. Shunt capacitance varies inversely with input voltage from 2 to 5 μμf. 91-8B 50 Ω BNC Adapter Max. VSWR 1.2 up to 600 MC. 91-13A Probe Tip For direct measurements up to 250 MC.
1.6	Tube Complement:		1 each: BEC 525001, 12AT7, 6AU6, OA2, and 6X4.
1.7	Power Requirements:		105-125 volts, 55-65 ∿ 30 watts.
1.8	Dimensions		7-1/9 W, x 9-1/2 D, x 11 H excluding handle
1.9	Weight		12 pounds

SECTION II

GENERAL DESCRIPTION

The 91CA RF Voltmeter is a sensitive instrument for the measurement of voltages of 300 microvolt to 3 volts spanning a wide frequency range of 10 kilocycles to 600 megacycles. In addition to conveniently measuring voltage levels in a diversity of rf circuits, the instrument has application for many associated tests. Such measurements include: the frequency response of both active and passive networks, i.e., amplifiers and filters; VSWR and return loss on transmission lines and attendant systems; attenuation and insertion loss of rf attenuators; and high frequency parameters of transistors. With true rms response below 0.03 volt (up to 3 volts with the 91-7B, 100:1 divider), wide band noise can be measured, and using suitable null networks measurement of the harmonic distortion of RF waveforms can be performed without the attendant errors of average type meters.

The instrument is also useful as an rf null detector for bridge measurements and analogous techniques when a sensitivity in the order of 200 microvolt will suffice.

Supplied with each instrument is a general purpose probe, 50 ohm adapter, and probe tip. The adapter is fitted with a BNC coaxial connector and provides a 50 ohm termination with a low VSWR up to at least 600 megacycles. The probe tip and companion ground clip are useful for direct measurement to approximately 100 megacycles. Above 100 megacycles, the probe may be used directly without the tip or" ground clip, but the connecting leads must be extremely short to avoid resonant effects. In the special case where it is possible to connect the probe directly to the voltage source, the specified tolerance is maintained to at least 600 megacycles. The impracticability of such a connection, however, precludes our assuring the accuracy of the 91CA RF Voltmeter above 250 megacycles without the use of the 91-8B BNC 50 ohm adapter.

The 91-3B probe with its full-wave crystal detecting circuit produces a true rms response without turnover, or harmonic errors for all voltage levels below 0.03 volt, gradually changing to peak-to-peak reading (calibrated in rms) at approximately 1.0 volt. The probe has a shunt capacitance of approximately 2.5 µµf at levels of 0.3 volt or higher, increasing slightly at levels of 0.1 volt or less. The shunt resistance component shown in Figure 1 is a variable factor, depending on the voltage and frequency.

Figure 1 also shows the input resistance of the 91-7B, 100:1 voltage divider. When the frequency and the voltage to be measured permit, consideration should be given to the use of the 91-7B. In addition to extending the voltage range of the instrument to 300 volts, the benefit is threefold: the input resistance is increased above that available with vacuum tube diode probes, and the diode overload protection as well as the range of true rms response is increased by a factor of 100. The 100:1 divider may be used at frequencies up to 250 megacycles with negligible loading for most rf circuitry.

Boonton *ELECTRONICS* Corp.

MORRIS PLAINS, N.J.

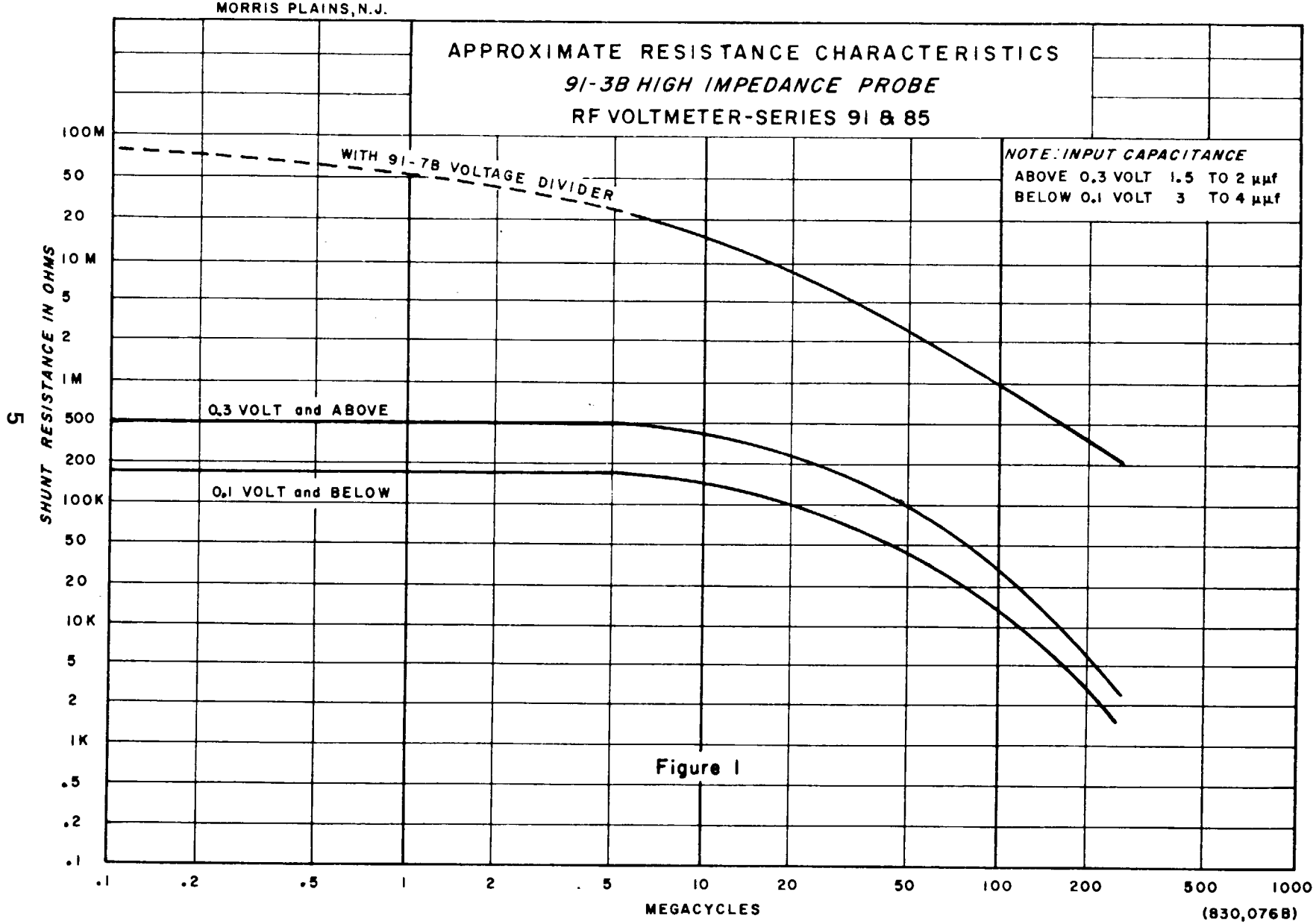


Figure 1

(830,076B)

SECTION III
OPERATING PROCEDURE

3.1 General

3.2 This section describes in detail the operating procedure for the 91CA RF Voltmeter. All information required for safe and proper operation of the instrument is included. Be sure to read this section before placing the instrument into operation.

3.3 Initial Turn-On Procedure and Tests

3.4 Tests To perform the initial tests proceed as follows:

a. After unpacking the unit, and before plugging it into an ac outlet for the first time, turn the instrument back and forth several times to make sure the tubes have not fallen from their sockets due to rough handling.

b. Observe the meter pointer to see that it moves freely and rests at zero when the instrument is steady.

c. If the pointer rests to the right or left of zero, set it at zero with the zero set screw.

CAUTION

Before plugging the instrument into the convenience outlet, make sure the power supply is 105-125 volts ac, 55-65 ∿, unless otherwise specified on nameplate.

3.5 Turn-On Procedure. To perform the initial turn-on procedure proceed as follows:

a. Plug the instrument into the power source.

b. Set the toggle switch to ON (up), and allow a warm-up period of approximately one minute.

c. Connect probe cable assembly to the instrument at jack marked PROBE. Check serial number of probe and see that it is the same as that of the voltmeter.

d. Set RANGE-FULL SCALE control to .001 and carefully adjust "BAL" control for minimum meter deflection. Normal meter deflection for zero input signal shall then be as follows:

RANGE	DEFLECTION
.001	less than 3/4 inch
.003, .01, .03, .1, .3, 1	less than 1/16 inch
3	Suppressed

3.6 Measurement Procedure

a. Set RANGE-FULL SCALE control to appropriate setting (or higher) for voltage to be measured.

b. Connect probe ground clip to ground point of voltage source under test. This connection must be as short and direct as possible to minimize errors arising from circulating RF currents in the ground return impedance.

c. Connect probe tip to high point of voltage source under test. This connection must also be as short as possible to minimize resonance rise effects at frequencies above 100 megacycles.

d. Read RF voltage on appropriate meter scale corresponding to setting of RANGE-FULL SCALE CONTROL.

e. To obtain relative level readings in decibels add the DB (red scale) meter reading to the DB (red) setting of the RANGE-FULL SCALE control. Although individual DB readings have no significance as measured on the 91 type RF Voltmeter the difference between two DB readings represents the actual change in level on a decibel basis. When used with a good signal generator the DB scale greatly facilitates the measurement of relative attenuation and bandpass characteristics of networks.

f. As it is frequently desired to measure RF voltages in coaxial systems the Model 91 is provided with a 50 Ω coaxial adapter having a low VSWR up to 600 MC.

3.7 Operating Precautions

3.8 Maximum Input Voltages

RF voltages exceeding 10 volts must not be applied to the probe or permanent damage to the crystal diodes may result. The 50Ω adapter should not be subjected to continuous overloads exceeding 10 volts to avoid excessive heating of terminating resistor.

Maximum DC voltage for HI-Z probe is 300 volts.
Maximum DC voltage for 50 Ω adapter is 10 volts.

Note: Do not apply maximum DC voltage simultaneously with maximum RF voltage when using 50Ω adapter

3.9 Temperature Effects

The normal ambient temperature range for specified accuracy is 65° to 90° F. Appreciable inaccuracies can be expected while the probe is exposed to temperatures above or below this range. No permanent change in probe characteristics will result from the high or low temperature exposure.

Inaccuracies due to temperature effects may occur after soldering to the probe tip or from heat sources such as resistors or tubes.

When making low level measurements in the order of 2 millivolts or less, it is important to make sure that the probe has attained a uniform temperature throughout. A temperature difference between the inside and outside of the probe can generate a small thermal voltage that may add to or subtract from the DC voltage generated by the diodes.

3.10 Hum, Noise and Spurious Pick-up

When measuring low level RF voltages, precautions should always be taken to avoid the possibility of erroneous readings resulting from hum, noise, or stray RF pick-up. Although all low frequency hum and noise is attenuated at the input by 60 db, it is still possible for high level unwanted signals to get through and-cause errors. The best test for this condition is to reduce the test signal to zero level and note whether the voltmeter continues to read some spurious signal level. In some cases it may be necessary to provide extra shielding around the probe connections to reduce stray field pick-up. Typical sources of spurious radiation are induction or dielectric heating units, diathermy machines, local radio transmitters, grid dip meters and amplifiers with parasitic oscillations.

SECTION IV

THEORY OF OPERATION

An understanding of the operating features of the Model 91 Sensitive RF Voltmeter may be obtained by a study of the block diagram (Fig. 2) in conjunction with the following description.

The radio frequency voltage to be measured is rectified in the RF Probe by means of a full wave germanium diode rectifier circuit. The resulting DC potential is then attenuated as required before conversion to 60∿ AC by the chopper. This AC signal is then amplified in a narrow band feed-back stabilized amplifier prior to its re-conversion to DC for use in actuating the meter.

The germanium diodes used in the RF Probe have been carefully selected for several characteristics. As the selected diodes do not all exhibit the same rectification efficiency characteristics, it becomes necessary to adjust each meter range to match individual probe diodes. The range adjustments consist of individual non-linear circuits shunting the output meter circuitry. As the RANGE switch is set to the required test voltage position the appropriate non-linear adjusting circuit is automatically shunted across the output. It is also important to understand that the non-linear output circuitry is designed to compensate for the non-linear characteristics of the probe diodes when operating at levels below .3 volts.

SECTION V

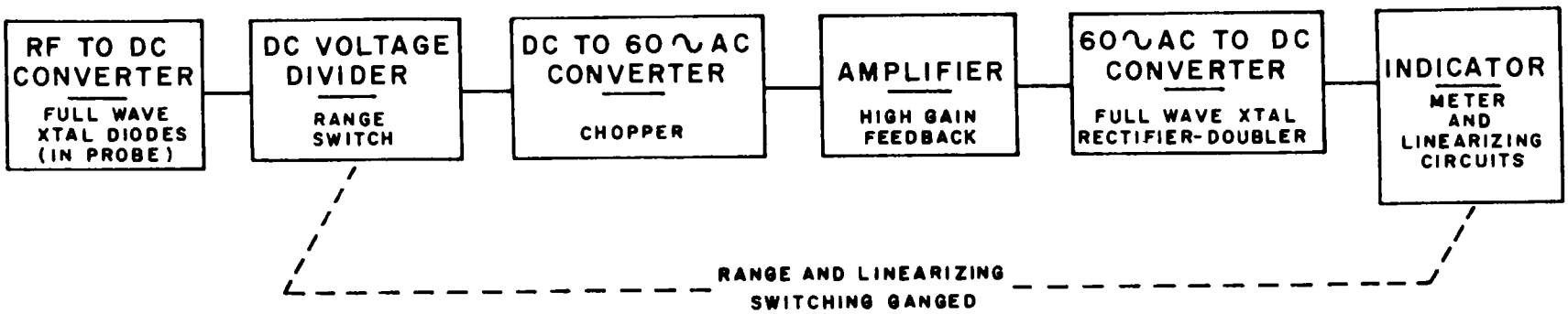
MAINTENANCE

5.1 Periodic Checking

The Model 91CA Voltmeter is designed to give long periods of service without maintenance when operated in accordance with these instructions. It is recommended, however, that the instrument be checked occasionally using reliable standards to insure against errors resulting from deterioration of tubes or chopper. To make these checks, it is necessary to have a signal source in the 200 to 500 KC region with less than 2% distortion at levels up to 3 volts across 50 Ω. A precision electronic voltmeter of the averaging response type, such as the Ballantine Model 310A or 314, Hewlett Packard Model 400D or 400H, may be used to monitor the signal source for this purpose. To insure its accuracy, the monitoring meter should be checked at some low frequency (50-100 ~) of good waveform against a dynamometer type AC meter of at least 1% accuracy.

5.2 Calibration Precautions

When attempting to check the voltage calibration accuracy on an instrument having the sensitivity and bandwidth of the Model 91CA, it is essential to take precautions to avoid errors resulting from stray pick-up voltages. (See paragraph 3.10). A well shielded signal source must be used in conjunction with coaxial connections to both the Model 91CA and the standard reference meter. Even with a well shielded generator and associated connections, it is sometimes possible for the reference meter to pick up stray RF signals and feed them into the probe. Check for this condition by disconnecting standard meter and noting change in level.



BLOCK DIAGRAM

TYPE 91, RF VOLTMETER

Figure 2

(A830,071A)

5.3 Calibration Check Procedure

With suitable calibrating equipment (paragraph 5.1) and taking necessary precautions (paragraph 5.2), we can now check the Model 91CA for calibration accuracy. Each range should be checked at a voltage representing 90% of full scale value. If these check points agree within ± 2% of the standard, it is recommended that no adjustment be made. If the check points deviate by more than ± 5% from the standard, it is recommended that a trouble shooting procedure be followed as outlined in paragraph 5.4. If the check points fall between 2% and 5% of the standard, the calibration adjustment procedure as outlined in paragraph 5.5 should be followed.

5.4 Trouble Shooting Procedure

a. Case Removal

The instrument may be removed from its case after first removing the two screws located at the back of the case (near the bottom) and the four screws located on the sides of the case near the front.

The power supply may be removed from the case after first removing the four screws located on the sides of the case near the rear.

b. Tube Replacement

If the tube V1 should become weak or noisy, it should be replaced with BEC 525001 or a commercial low noise 12AX7 which has low microphonism and meets the requirements of paragraph 3.5[d] above. The Telefunken ECC83/12AX7 has been found to consistently meet these requirements. After replacing defective tubes, re-check calibration as outlined in paragraph 5.3 and adjust if necessary as described in paragraph 5.5.

c. Chopper Replacement

If a satisfactory operation is not obtained by replacing

tubes, a replacement chopper should be tried. If the new chopper does not clear the difficulty, place the original chopper back in socket. If new chopper does clear the difficulty, the calibration accuracy must be re-checked and adjusted, if necessary.

d. Voltage and Resistance Tests

After determining that the trouble cannot be cured by replacement of tubes or chopper, as described previously, it is advisable to make a systematic check of AC voltage, DC voltage and resistance at each socket pin. Table I shows the nominal AC and DC voltages to ground from each socket pin number. Table II shows the nominal resistance values expected for each point. Large or erratic deviations from the listed values of voltage or resistance will serve as a valuable clue in tracking down a faulty component. Once the trouble has been found and corrected, the calibration must be re-checked and re-adjusted as outlined in paragraph 5.3 and paragraph 5.5.

5.5 Calibration Adjustment Procedure

Before making any calibration adjustments, it is essential to provide the necessary reference standards as described in paragraph 5.1 and take all precautions as outlined in paragraph 5.2. The calibration adjustment procedure shall then be made as outlined in Table III.

TABLE I

VOLTAGE MEASUREMENTS

Conditions:

117V 60∿ line input.

VTVM used for all measurements.

All measurements to chassis unless otherwise noted.

Input .01V at any frequency between 100 KC and 1 MC.

Use Ballantine Model 314 VTVM for all AC voltage measurements.

Pin #		1	2	3	4	5	6	7	8	9	10	11
Tube	DC	78	0	.83	53	53	95	0	.9	46		
v1 BEC 525001	AC	2.5mv	1.5mv				.14V	2.5mv				
	DC	.82	2	59	53	30	45	2				
V2 (6AU6)		.076V				.86V						
V3 (12AT7)	AC	135 27V	.76V	2.3	53	53	250	53 25V	74 25V	53	-	-
	DC			53	53			300				
V4 (6X4)	AC	235					235					
	DC	150				150						
V5 (0A2)	AC											
		53	53			53		150	250	0	46	59
11 Pin socket	AC											
	DC											
Chopper Socket	AC			1.5mv								
				DC 12.6V								
Pin 10 to Pin 11 of 11 Pin Socket	AC			.36V								
				DC 6.3V								
Pin 10 to Pin 5 of 11 Pin Socket	AC			.015V								

TABLE II

RESISTANCE MEASUREMENTS

Conditions:

Power turned off.

Tubes in sockets, chassis interconnected (11 Pin), all measurements to chassis.

Pin #	1	2	3	4	5	6	7	8	9
Tube									
V1 BEC 525001	1M	6.8M	11K	16K	16K	500K	2.2M	6.8K	16K
V2 (6AU6	2.5M	3.8K	16K	16K	500K	1M	3.8K	_	
V3 (12AT7)	135K	1M	2.2K	18K	18K	55K	500K	18.5K	18K
V4 (6X4)	300	-	19K	19K	-	300	50K		
V5 (OA2)	50K	0	-	0	50K	-	0	-	-
11 Pin Corm.	19K	19K	-		17K	-	45K	60K	0

TABLE III

CALIBRATION ADJUSTMENT PROCEDURE

Step	Reference Std. Voltage	Voltage Range Setting Model 91CA	Adjust to read	Adjusting Screw No.	Notes
1	.300	1	.30	1	Adjusting screws numbered from front to rear on right side of cabinet No. 1 is gain adjustment.
2	2.50	3	2.50	2	Meter bias adjustment affects up scale readings most.
3	.900	1	.90	3	Slope adjustment, affects full scale readings *more* than down scale readings.
4	.280	.3	.280	4	Slope adjustment, affects full scale readings more than down scale readings.
5	.0300	.1	.0300	5	Gain adjustment, affects all ranges from 1 volt to .003 volts.
6	.0900	.1	.0900	6	Slope adjustment affects upper readings most.
7	.0280	.03	.0280	7*	Slope adjustment affects upper readings most.
8	.00900	.01	.00900	8*	Slope adjustment affects upper readings most.
9	.00280	.003	.00280	9*	Slope adjustment, affects upper readings most.
10	.00090	.001	.00090	10*	Gain adjustment

*These adjusting screws are numbered from back to front on left side of cabinet.

PARTS LIST

FOR 91C AND 91CA

Reference		Description			BEC Part No.
C1	Capacitor, Mylar	0.1	µf	200V	230,116
C2	" Mylar	0.1	µf	200V	230,116
C3	" Mylar	0.1	µf	200V	230,116
C4	" Mylar	0.1	µf	200V	230,116
C5	" Mylar	0.0033	µf	200V	230,119
C6	" Mylar	0.022	µf	200V	230,101
C7a	" Elect.	20	µf	475V	283,109
C7b	" Elect.	50	µf	50V	
C7c	" Elect.	20	µf	25V	
C8	" Mylar	0.005	µf	200V	230,121
C9	" Elect.	50	µf	6V	283,112
C10	" Elect.	50	µf	6V	283,112
C11	" Mylar	0.1	µf	200V	230,116
C12	" Mica	1000	µµf	500V	201,143
C13	" Mica	1000	µµf	500V	201,143
C14	" Mica	1000	µµf	500V	201,143
C15	" Mylar	0.005	µf	200V	230,121
C16	" Mylar	0.1	µf	200V	230,116
C17	" Mylar	0.01	µf	300V	230,120
C18	" Elect.	50	µf	6V	283,112
C19	" Met. Paper	1.0	µf	200V	230,104
C20	" Met. Paper	1.0	µf	200V	230,104
C21	" Elect.	50	µf	6V	283,112-91CA only
C27a,b,c	" Elect.	20-20-20	µf	475V	283,113
C28a,b	" Elect.	1000-1000	µf	15V	283,114
C29	" Ceramic	.001	µf	500V	224,115
C30	" Ceramic	.001	µf	500V	224,115
C31	" Ceramic	.001	µf	500V	224,115

Reference		Description	BEC Part No.
CH-1	Chopper, 91CA only	BBM-Special	540,108
CH-1	Chopper, 91C only	Stevens Arnold	540,103
CR-1	Rectifier, Sel.	Sarkes-Tarzian #304B	432,001
D1	Diode	1N600	530,008
D2	Diode	1N600	530,008
D3	Diode	SG22	530,009
D4	Diode	SG22	530,009
D5	Diode	Special	530,000
D6	Diode	Special	530,000
F1	Fuse	AGC 0.5 Amp	545,502
I1	Lamp	#51	545,103
I2	Lamp	#51	545,103
I3	Lamp, 91C only	#47	545,101
J1	Receptacle	Amphenol 80-PC-2FT	479,119
J2	Socket	Amphenol 77-MIP-11	472,101
J3	Receptacle	Amphenol UG-290/U	479,107
L1	Choke	Stancor #C1707 7HY	440,001
Ml	Meter	Special 0-200μa	554,135
P1	Plug (Input Cable)	Amphenol 80-MC-2M	479,101
P2	Plug (Amplifier)	Amphenol 86-PM1l-11	477,105
P3	Plug & Adapter	P/O AC Line cord	568,101
R1	Resistor, Comp.	330K l/2W 5%	301,147
R2	"	330K l/2W 5%	301,147
R3	" Dep.Car.	5Meg. l/2W 1%	306,693
R4	" " "	5Meg. l/2W 1%	306,693
R5	" " "	576K l/2W 1%	306,570

Reference		Description			BEC Part No.	
R6	Resistor, Dep.Car.	576K	l/2w	1%	306,570	
R7	" " "	47.5K	l/2w	1%	306,440	
R8	" " "	47.5K	l/2w	1%	306,440	
R9	" " "	6.81K	1/2W	1%	306,339	
R1O	" " "	6.81K	1/2W	1%	306,339	
Rll	" " "	1.39K	1/2W	1%	306,694	
R12	" " "	1.39K	l/2W	1%	306,694	
R13	" " "	675	l/2W	1%	306,695	
R14	" " "	675	l/2W	1%	306,695	
R15	" " "	2K	l/2W	1%	306,276	
R16	" Comp.	6.8 Meg.	l/2W	5%	301,179	
R17	" "	47K	l/2W	5%	301,127	
R18	" "	1 Meg.	l/2W	5%	301,159	
R19	" Dep.Car.	845	l/2W	1%	306,231	
R20	" " "	10K	l/2W	1%	306,359	
R21	" " "	820K	l/2W	5%	306,598	
R22	" Comp.	470K	l/2W	10%	301,029	
R23	" "	6.8K	l/2W	5%	301,107	
R24	" "	2.2 Meg.	l/2W	5%	301,167	
R25	" "	470K	l/2W	5%	301,029	
R26	" "	470K	l/2W	5%	301,029	
R27	" "	470K	l/2W	5%	301,029	
R28	" "	470K	l/2W	5%	301,029	
R29	" Variable	2K	2W	20%	ADJ 311,114	91CA only
R30	" "	2K	2W	20%	ADJ 311,114	
R31	" "	2K	2W	20%	ADJ 311,114	
R32	" Dep.Car	845	l/2W	1%	306,231	
R33	" Comp.	1 Meg.	l/2W	5%	301,159	
R34	" "	1 Meg.	l/2W	5%	301,159	
R35	" Dep.Car.	1 Meg	l/2W	1%	306,598	
R36	" Comp.	100K	l/2W	5%	301,135	

Reference		Description				BEC Part No.		
R37	Resistor, Comp.	2.2K	l/2W	5%		301,095		
R38	" "	470	l/2W	5%		301,079		
R39	" "	18K	l/2W	5%		301,117		
R40	" "	470K	l/2W	5%		301,029		
R41	" Dep.Car.	39.2K	l/2W	1%		306,430		
R42	" " "	12.lK	l/2W	1%		306,369		
R47	" Comp.	22 Meg.	l/2W	5%		301,230	91CA	only
R48	" " 2	22 Meg.	l/2W	5%		301,230	"	"
R49	" Variable	50K	2W	20%	BAL	311,125	"	"
R50	" Comp.	8.2K	l/2W	5%		301,209	"	"
R51	" "	8.2K	l/2W	5%		301,209	"	"
R52	" "	220K	l/2W	5%		301,027	"	"
R53	" "	24 Ω	l/2W	5%		301,048	"	"
R54	" Variable	25K	2W	20%	⑨ ADJ	311,115		
R55	" "	25K	2W	20%	⑧ ADJ	311,115		
R56	" "	25K	2W	20%	⑦ ADJ	311,101		
R57	" "	25K	2W	20%	⑥ ADJ	311,101		
R58	" "	50K	2W	20%	④ ADJ	311,163		
R59	" "	250K	2W	20%	③ ADJ	311,103		
R60	" "	250K	2W	20%	② ADJ	311,157		
R61	" Comp.	220 Ω	l/2W	5%		301,071		
R62	" "	1.5K	l/2W	5%		301,091		
R63	" "	1.5K	l/2W	5%		301,091		
R64	" "	5.6K	1/2W	5%		301,105		
R65	" "	8.2K	l/2W	5%		301,109		
R66	" "	18K	l/2W	5%		301,117		
R67	" "	33K	l/2W	5%		301,022		
R68	" "	3K	l/2W	5%		301,098		
R69	" "	3.9K	l/2W	5%		301,101		
R70	" "	12K	l/2W	5%		301,113		
R76	" "	1 Meg.	1W	20%		302,128		

Reference	Description			BEC Part No.
R77	Resistor, W.W.	7.5K	10W 10%	312,100
R78	" Comp.	5.6K	2W 5%	304,105
R81	These resistors determined by diode characteristics			
R82	" " " " " "			
R83	" " " " " "			
R84	" " " " " "			
R85	Resistor, D. P.	52 Ω	l/4W 1%	305,600
S1	Switch 7 pole 8 pos.	spec. (91CA)		466,145
S1	" 6 pole 7 pos.	spec. (91C)		466,144
S2	" SPST. Carling #110-63			465,105
T1	Transformer	Power, special		446,007
V1	Elect. Tube	12AX7, special		525,001
V2	Elect. Tube	6AU6		526,6AU6
V3	Elect. Tube	12AT7		526,12AT7
V4	Elect. Tube	6X4		526,6X4
V5	Elect. Tube	OA2		526,0A2
W1	Ground Lead			571,010

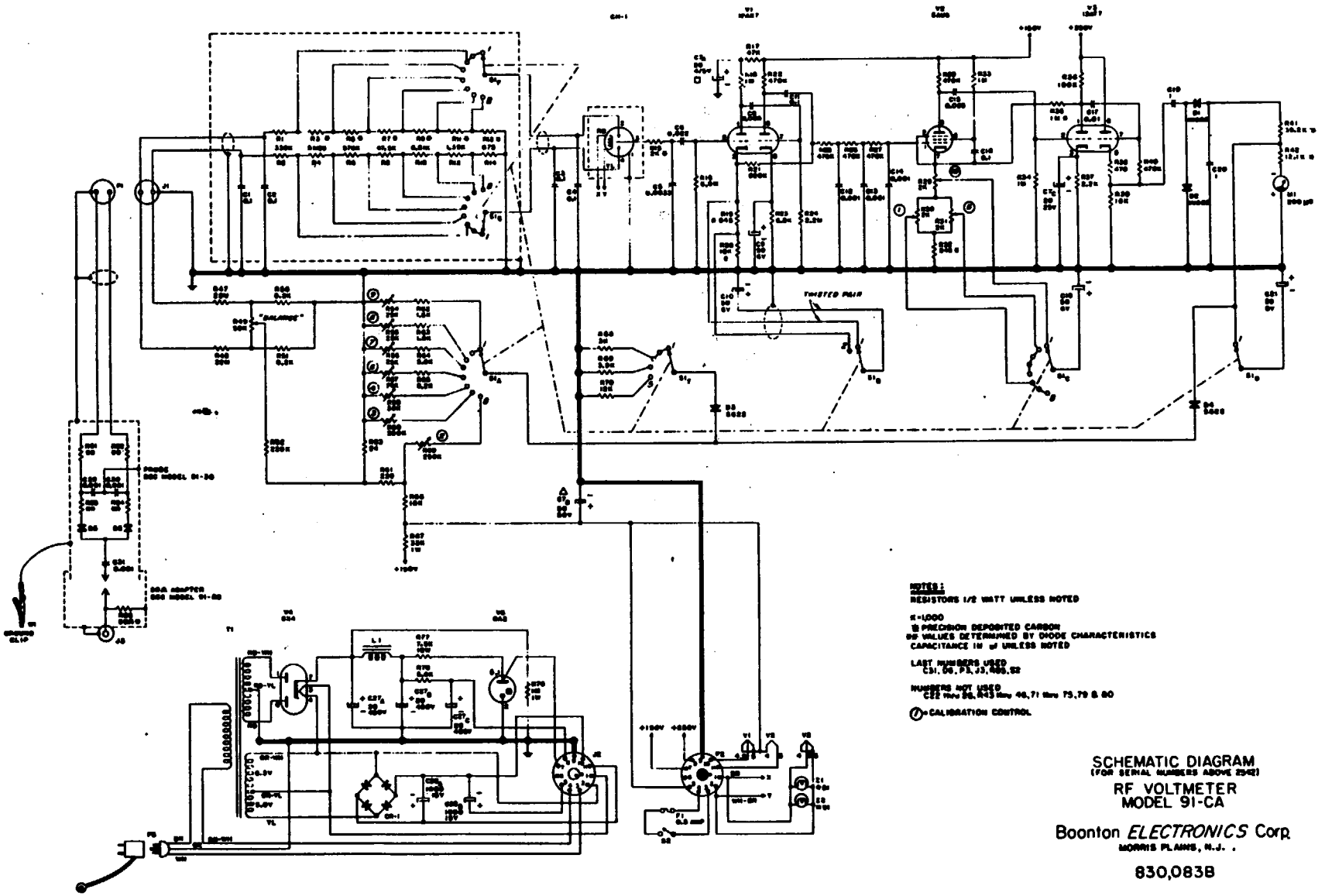
SECTION VI

SHIPPING INSTRUCTIONS

6.1 If it becomes necessary to ship the instrument for any reason the following steps should be followed.

a. Wrap the instrument with heavy wrapping paper and seal the seams with gummed tape. Place in fibre-board carton large enough to permit three inches of soft packing material between instrument and sides of box.

b. Separately wrap with heavy paper and pad the proper serial number probe and serialized resistance termination or other probe parts being shipped.



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