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## LIST OF EFFECTIVE PAGES

Title Page	Change 2		
ii thru xvi	Change 2		
A and B	Change 2		
	Section 1		Section 9
1-1 and 1-2	Original		9-A-1 thru 9-A-9
			Original
			9-A-10 thru 9-A-21
			Change 1
			9-B-1 and 9-B-2
			Original
			9-B-3 thru 9-B-7
			Change 1
			Section 10
	Section 2		10-A-1 and 10-A-2
2-1 thru 2-13	Original		Original
			10-A-3 thru 10-A-11
			Change 1
			10-B-1 thru 10-B-4
			Original
	Section 3		10-B-5 thru 10-B-7
3-1 thru 3-37	Original		Change 1
			Section 11
	Section 4		11-A-1 and 11-A-2
4-A-1 thru 4-A-43	Original		Original
4-B-1 thru 4-B-35	Original		11-A-3 and 11-A-4
			Original/Change 1
4-C-1 thru 4-C-22	Original		11-A-5 and 11-A-6
			Change 1/Change 2
4-D-1 thru 4-D-19	Original		11-A-7 thru 11-A-37
			Change 2
			11-B-1 and 11-B-2
			Original/Change 2
			11-B-3 thru 11-B-12
			Change 2
	Section 5		Section 12
5-A-1 thru 5-A-8	Original		12-A-1 thru 12-A-13
5-A-9 thru 5-A-34	Change 1		Original
5-B-1 thru 5-B-4	Original		
5-C-1 thru 5-C-4	Original		Section 13
			13-A-1 and 13-A-2
			Original
	Section 6		13-A-3 and 13-A-4
6-A-1 thru 6-A-5	Original		Original/Change 2
6-A-6 thru 6-A-6CC	Change 1		13-A-5 thru 13-A-15
6-A-7 thru 6-A-21	Original		Change 2
6-A-22 thru 6-A-22FFF	Change 1		13-B-1 thru 13-B-4
6-A-23 and 6-A-24	Original		Original
6-A-25 and 6-A-26	Original/Change 2		13-B-5 thru 13-B-9
6-A-27 thru 6-A-38	Original		Change 2
6-A-39 thru 6-A-43	Change 1		Section 14
6-B-1 thru 6-B-8	Original		14-A-1 thru 14-A-38
6-B-9 and 6-B-10	Change 1/Change 2		Original
6-B-11 thru 6-B-18	Change 1		14-A-39 and 14-A-40
6-B-19 and 6-B-20	Change 1/Change 2		Original/Change 2
6-B-21 thru 6-B-44	Change 1		14-A-41 thru 14-A-46
6-B-45 and 6-B-46	Change 2/Change 1		Change 2
6-B-47 thru 6-B-57	Change 1		14-A-46A and Blank
			Change 2
			14-A-47 thru 14-A-70
			Change 2
			14-B-1 thru 14-B-4
			Original
			14-B-5 thru 14-B-16
			Change 2
			Section 15
	Section 7		15-A-1 thru 15-A-22
7-A-1 and 7-A-2	Original/Change 2		Original
7-A-3 thru 7-A-76	Original		15-A-23 thru 15-A-28
			Change 2
			15-B-1 and 15-B-2
			Original
			15-B-3 thru 15-B-11
			Change 2
			Section 16
	Section 8		16-A-1 thru 16-A-4
8-A-1 thru 8-A-5	Original		Original
8-A-6 thru 8-A-27	Change 1		16-A-5 and 16-A-6
			Original/Change 2
8-B-1 and 8-B-2	Original		16-A-7 thru 16-A-13
			Change 2
8-B-3 and 8-B-4	Original/Change 1		16-B-1 and 16-B-2
			Original
8-B-5 and 8-B-6	Change 1/Change 2		16-B-3 thru 16-B-9
			Change 2
8-B-7 thru 8-B-23	Change 1		

	Section 17		Section 21
17-1 and 17-2	Original	21-A-1 thru 21-A-6	Original
17-3 thru 17-11	Change 2	21-A-7 and 21-A-8	Original/Change 2
		21-A-9 thru 21-A-31	Change 2
	Section 18	21-B-1 and 21-B-2	Original
18-A-1 and 18-A-2	Original/Change 2	21-B-3 and 21-B-4	Original/Change 2
18-A-3 thru 18-A-5	Change 2	21-B-5 thru 21-B-7	Change 2
18-B-1 and 18-B-2	Original		
18-B-3 thru 18-B-6	Change 2		Section 22
		22-1 thru 22-6	Original
	Section 19	22-7 thru 22-39	Change 2
19-A-1 and Blank	Original		
19-B-3 thru 19-B-12	Change 1		Section 23
19-B-13 and 19-B-14	Change 2/Change 1	23-1 thru 23-4	Original
19-B-15 thru 19-B-32	Change 1	23-5 thru 23-17	Change 2
19-C-1 and 19-C-2	Original		
19-C-3 thru 19-C-11	Change 1		
	Section 20		
20-A-1 thru 20-A-5	Original		
20-A-6 thru 20-A-8	Change 1		
20-A-9 and 20-A-10	Change 1/Change 2		
20-A-11 and Blank	Change 2		
20-B-1 and Blank	Original		
20-C-1 thru 20-C-7	Original		

## TABLE OF CONTENTS

Section		Page
1	Introduction	1-1
	Purpose	1-1
	Use	1-1
	Scope	1-1
2	General Information on Electron Tube Circuits	2-1
	Definitions of Letter Symbols Used	2-1
	Construction of Symbols	2-1
	List of Symbols	2-1
	Biasing Methods	2-2
	Cathode Bias	2-2
	Grid-Leak Bias	2-3
	Fixed Bias	2-5
	Classes of Amplifier Operation	2-6
	Class A Operation	2-6
	Class B Operation	2-7
	Class AB Operation	2-7
	Class C Operation	2-8
	Coupling Methods	2-8
	R-C Coupling	2-8
	Impedance Coupling	2-9
	Transformer Coupling	2-10
	Direct Coupling	2-10
	Time Constants	2-11
	R-C Circuits	2-11
	R-L Circuits	2-13
3	General Information on Semiconductor Circuits	3-1
	Definitions of Letter Symbols Used	3-1
	Construction of Symbols	3-1
	Alphabetical List of Semiconductor Letter Symbols	3-1
	Diode Circuits	3-4
	Junction Diode Theory	3-4
	Forward-Biased Diode Stabilization	3-8
	Reverse-Biased Diode Stabilization	3-8
	Double-Diode Stabilization	3-9
	Diode Voltage Stabilization	3-9
	Temperature Compensation	3-10
	Shunt-Limiting Diode	3-10
	Diode AGC Circuit	3-10
	PNPN Switching (Four-Layer Diode)	3-11
	Photodiodes	3-12
	Tunnel Diodes	3-12
	Triode Common-Base Circuits	3-13
	Bias (Common Base)	3-15
	Triode Common-Emitter Circuits	3-16
	Bias Circuits (Common Emitter)	3-17
	Bias Stabilization	3-18
	Triode Common-Collector Circuits	3-21
	Bias (Common Collector)	3-22
	Tetrode, Power, and Special-Purpose Circuits	3-22
	Tetrodes	3-22
	Junction Tetrode (Double-Based Transistor)	3-22
	Spacistor Tetrode	3-23

Section	Page
Crystal-Mixer Tetrode	3-23
Point-Contact Tetrode	3-24
Power Transistors and Considerations	3-24
Special-Purpose Transistors and Circuits	3-25
PNPN Triode (Hook Collector)	3-25
Unipolar (Field-Effect) Transistor	3-26
Unijunction Transistor (Double-Based Diode)	3-26
Surface-Barrier Transistor	3-27
PNIP-NPIN Transistor	3-27
Drift Transistor	3-28
Diffused-Base (MESA) Transistor	3-28
Silicon Controlled Rectifier	3-28
Phototransistor	3-29
Thermistor	3-29
Classes of Amplifier Operation	3-29
Class A	3-29
Class B	3-30
Class AB	3-31
Class C	3-31
Coupling Methods	3-32
R-C Coupling	3-32
Impedance Coupling	3-33
Transformer Coupling	3-34
Direct Coupling	3-34
Time Constants	3-35
Hybrid Parameters	3-36
4     Power Supply Circuits	4-A-1
Part A. Electron-Tube Circuits	4-A-1
Single-Phase, Half-Wave Rectifier	4-A-1
Single-Phase, Full-Wave Rectifier	4-A-3
Single-Phase, Full-Wave Bridge Rectifier	4-A-6
Three-Phase, Half-Wave (Three-Phase Star) Rectifier	4-A-11
Three-Phase, Full-Wave (Single "Y" Secondary) Rectifier	4-A-14
Three-Phase, Full-Wave (Delta Secondary) Rectifier	4-A-19
Three-Phase, Half-Wave (Double "Y" Secondary) Rectifier	4-A-23
Half-Wave Voltage Doubler	4-A-27
Full-Wave Voltage Doubler	4-A-30
Voltage Tripler	4-A-33
Voltage Quadrupler	4-A-36
High-Voltage (CRT) Supply, Audio Oscillator Type	4-A-39
High-Voltage (CRT) Supply, R-F Oscillator Type	4-A-41
Part B. Semiconductor Circuits	4-B-1
Semiconductor Rectifiers	4-B-1
Single-Phase, Half-Wave Rectifier	4-B-2
Single-Phase, Full-Wave Rectifier	4-B-4
Single-Phase, Full-Wave Bridge Rectifier	4-B-7
Three-Phase, Half-Wave (Three-Phase Star) Rectifier	4-B-10
Three-Phase, Full-Wave (Single "Y" Secondary) Rectifier	4-B-12
Three-Phase, Full-Wave (Delta Secondary) Rectifier	4-B-14
Three-Phase, Half-Wave (Double "Y" Secondary) Rectifier	4-B-16
Half-Wave Voltage Doubler	4-B-18
Full-Wave Voltage Doubler	4-B-20
Voltage Tripler	4-B-22
Voltage Quadrupler	4-B-24
High-Voltage (CRT) Supply, Square-Wave Oscillator Type	4-B-25
DC-to-DC Converter	4-B-29
Dosimeter Charger (DC-to-DC Converter)	4-B-32

Section	Page
	4-C-1
Part C. Electromechanical Circuits	
Rotating Electromechanical Systems	4 C 1
Dynamotor	4-C-1
Inverter	4-C-1
Vibrator-Type Power Supplies	4-C-10
Nonsynchronous Vibrator Supply	4-C-11
Synchronous Vibrator Supply	4-C-17
Part D. Filter Circuits	4-D-1
Power-Supply Filters	4-D-1
Shunt-Capacitor Filter	4-D-6
R-C Capacitor-Input Filter	4-D-9
L-C Capacitor-Input Filter	4-D-11
L-C Choke-Input Filter	4-D-11
Resonant Filter	4-D-17
5 Voltage-Regulator Circuits	5-A-1
Part A. Electron-Tube Circuits	5-A-1
Gas-Tube Regulator	5-A-1
Electronic Regulator	5-A-4
D-C Regulator using Pentode Amplifier	5-A-5
D-C Regulator using Cascode Twin-Triode Amplifier	5-A-9
D-C Regulator using Cascode Twin-Triode Amplifier	5-A-13
D-C Regulator using Twin-Triode and Pentode (Balanced Input)	5-A-18
D-C Regulator using Pentode and Twin-Triode (Balanced Output)	5-A-23
Electromagnetic Regulators	5-A-29
Part B. Semiconductor Circuits	5-B-1
Semiconductor Regulators	5-B-1
Breakdown Diode Shunt-Type Regulator	5-B-2
Part C. Electromechanical Circuits	5-C-1
Electromechanical Regulators	5-C-1
6 Amplifier Circuits	6-A-1
Part A. Electron-Tube Circuits	6-A-1
Audio Amplifiers	6-A-1
R-C Coupled Triode Audio Voltage Amplifier	6-A-3
R-C Coupled Pentode Audio Voltage Amplifier	6-A-4
Impedance-Coupled Triode Audio Voltage Amplifier	6-A-6
Transformer-Coupled Triode Audio Voltage Amplifier	6-A-6C
Single-Ended, R-C Coupled Triode Audio Power Amplifier	6-A-6F
Single-Ended, R-C Coupled Pentode Audio Power Amplifier	6-A-6J
Push-Pull (Class A, AB, and B) Audio Power Amplifier	6-A-6M
Phase Inverters	6-A-6S
Transformer Type Inverter	6-A-6T
Single-Tube Paraphase Inverter	6-A-6U
Two-Tube Paraphase Inverter	6-A-6W
Paraphase, Cathode-Coupled inverter	6-A-6Y
Differential Paraphase Inverter	6-A-6AA
Cathode Follower	6-A-6CC
Low-Level Video Cathode Follower	6-A-11
Pulse Cathode Follower	6-A-12
Video Amplifiers	6-A-14
Triode Video Amplifier	6-A-14
Pentode Video Amplifier	6-A-19
Triode Driver Video Amplifier	6-A-22
Beam-Power Video Driven Amplifier	6-A-22B
Chain (Mixer, Amplifier, and Driver) Video Amplifier	6-A-22E
Cathode-Coupled (In-Phase) Video Amplifier	6-A-22G
Squelch Circuits	6-A-22H
AGC-Controlled Audio Amplifier	6-A-22I

Section	Page
R-F Amplifiers	6-A-22L
Pentode R-F Voltage Amplifier	6-A-22L
Triode Grounded-Grid R-F Amplifier	6-A-22O
Cascade R-F-Amplifier	6-A-22Q
Cascode R-F-Amplifier	6-A-22T
Travelling-Wave Tube Amplifier	6-A-22X
Tuned Interstage (I-F) Amplifier	6-A-22AA
Triode R-F Buffer Amplifier	6-A-22EE
Pentode R-F Buffer Amplifier	6-A-22HH
Frequency Multiplier (R-F)	6-A-22KK
Push-Push Frequency Multiplier (R-F)	6-A-22NN
Single-Ended (Class B or C) R-F Amplifier	6-A-22QQ
Push-Pull (Class B or C) R-F Amplifier	6-A-22XX
Multicavity Klystron R-F Amplifier	6-A-22BBB
Direct-Coupled (D-C) Amplifier	6-A-22FFF
Push-Pull Direct-Coupled (D-C) Amplifier	6-A-25
Deflection Amplifiers	6-A-28
Voltage Deflection Amplifier (for Electrostatic CRT)	6-A-31
Current Deflection Amplifier (for Electromagnetic CRT)	6-A-35
Feedback Amplifiers	6-A-39
Positive Feedback (Direct, Regenerative) Amplifier	6-A-39
Negative Feedback (Inverse, Degenerative) Amplifier	6-A-41
<b>Part B. Semiconductor Circuits</b>	6-B-1
Audio Amplifiers	6-B-1
Direct-Coupled Audio Amplifier	6-B-3
Transistor Chopper (D-C) Amplifier	6-B-9
R-C Coupled Audio Amplifier	6-B-11
Impedance-Coupled Audio Amplifier	6-B-14
Transformer-Coupled Audio Amplifier	6-B-17
Audio Power (Class A, AB, and B) Amplifier, Push-Pull, Transformer-Coupled	6-B-20
Audio Power Amplifier, Push-Pull, Single-Ended Complementary Circuit	6-B-25
Audio Power Amplifier, Push-Pull, Single-Ended Series-Connected Circuit	6-B-28
Audio Power Amplifier, Push-Pull, Capacitance-Diode Coupling	6-B-29
Audio Power Amplifier, Compound-Connected	6-B-32
Audio Power Amplifier, Bridge-Connected	6-B-34
Phase Inverters	6-B-37
One-Stage Phase Inverter	6-B-37
Two-Stage Phase Inverter	6-B-39
Video Amplifiers	6-B-41
Wide-Band Video Amplifier	6-B-42
R-F Amplifiers	6-B-45
Tuned Interstage (I-F) Amplifier	6-B-48
Tuned Common-Base R-F Amplifier	6-B-51
Tuned Common-Emitter R-F Amplifier	6-B-54
7 Oscillator Circuits	7-A-1
<b>Part A. Electron-Tube Circuits</b>	7-A-1
L-C Oscillators	7-A-1
Tickler-Coil Oscillator	7-A-2
Hartley Oscillator	7-A-6
Colpitts Oscillator	7-A-9
Clapp Oscillator	7-A-12
Tuned-Plate Tuned-Grid Oscillator	7-A-14
Electron-Coupled Oscillator	7-A-16
Ultraudion Oscillator	7-A-20
R-C Oscillators	7-A-21
R-C Phase-Shift Oscillator	7-A-22
Wien-Bridge Oscillator	7-A-23



Section	Page
Electromechanical Oscillators	7-A-26
Grid-Cathode (Miller) Crystal Oscillator	7-A-27
Grid-Plate (Pierce) Crystal Oscillator	7-A-33
Electron-Coupled Crystal Oscillator	7-A-38
Overtone Cathode-Coupled (Butler) Crystal Oscillator	7-A-40
Magnetostriction Oscillators	7-A-43
Negative-Resistance Oscillators	7-A-45
Dynatron Oscillator	7-A-46
Transitron (Negative GM) Oscillator	7-A-49
Kallitron (Push-Pull) Oscillator	7-A-51
Tuned-Line Oscillators	7-A-53
Lighthouse-Tube Oscillator	7-A-54
Lecher-Wire Oscillator	7-A-56
Magnetron Oscillator	7-A-60
Reflex Klystron Oscillator	7-A-71
Part B. Semiconductor Circuits	7-B-1
L-C Oscillators	7-B-1
Tickler-Coil (Armstrong) Oscillator	7-B-2
Hartley Oscillator	7-B-5
Colpitts Oscillator	7-B-8
Clapp Oscillator	7-B-10
R-C Oscillators	7-B-12
R-C Phase-Shift Oscillator	7-B-12
Wien-Bridge Oscillator	7-B-14
Electromechanical Oscillators	7-B-15
Tickler-Coil Feedback Crystal Oscillator	7-B-16
Colpitts Crystal Oscillator	7-B-19
Overtone Crystal Oscillator	7-B-24
8 Multivibrator Circuits	8-A-1
Part A. Electron-Tube Circuits	8-A-1
Astable (Free-running) Multivibrators	8-A-1
Triode Plate-to-Grid Coupled Astable Multivibrator	8-A-1
Pentode Electron-Coupled Astable Multivibrator	8-A-4
Triode Cathode-Coupled Astable Multivibrator	8-A-6
Bistable (Start-Stop) Multivibrators	8-A-11
Triode Eccles-Jordan (Flip-Flop) Multivibrator	8-A-12
Pentode Eccles-Jordan (Flip-Flop) Multivibrator	8-A-14
Monostable (One-Shot) Multivibrators	8-A-17
Triode Plate-to-Grid Coupled Monostable Multivibrator	8-A-17
Triode Common-Cathode-Resistor Monostable Multivibrator	8-A-20
Phantastron Multivibrator	8-A-23
Part B. Semiconductor Circuits	8-B-1
Astable Multivibrators	8-B-1
Basic Free-Running Astable Multivibrator	8-B-1
Bistable Multivibrators	8-B-4
Basic Flip-Flop Multivibrator	8-B-5
Direct-Coupled (or Binary) Multivibrator	8-B-8
Squaring Multivibrator Circuit	8-B-11
Saturating Multivibrator	8-B-13
Nonsaturating Multivibrator	8-B-15
Relay Control Multivibrator	8-B-18
Monostable Multivibrators	8-B-20
Basic One-Shot Multivibrator	8-B-21
9 Blocking and Shock Excited Oscillator Circuits	9-A-1
Part A. Electron-Tube Circuits	9-A-1
Free-Running PRF Generator	9-A-1

Section		Page
	Triggered Blocking Oscillators	9-A-3
	Parallel-Triggered Blocking Oscillator	9-A-5
	Series-Triggered Blocking Oscillator	9-A-8
	Fast-Recovery Blocking Oscillator	9-A-10
	Pulse-Frequency Divider	9-A-12
	Distance-Mark Divider	9-A-15
	Shock-Excited Ringing Oscillator	9-A-17
	Shock-Excited Peaking Oscillator	9-A-19
	Part B. Semiconductor Circuits	9-B-1
	Free-Running PRF Generator	9-B-1
	Triggered Blocking Oscillators	9-B-3
	Basic Blocking Oscillator	9-B-4
	Nonstaurating, Diode-Clamped Blocking Oscillator	9-B-5
10	Sweep-Generator Circuits	10-A-1
	Part A. Electron-Tube Circuits	10-A-1
	Sawtooth-Wave, Gas-Tube Sweep-Generator Circuits	10-A-1
	Neon Gas-Tube Sweep Generator	10-A-1
	Thyratron Sweep Generator	10-A-3
	Triode Sawtooth-Wave Sweep Generator Circuits	10-A-5
	Basic Triode Sawtooth Sweep Generator	10-A-6
	Bootstrap Sweep Generator	10-A-8
	Triode Trapezoidal-Wave Sweep Generator	10-A-10
	Part B. Semiconductor Circuits	10-B-1
	Sawtooth-Wave Circuits	10-B-1
	Unijunction (Double-Base Diode)	10-B-1
	Four-Layer Diode	10-B-5
11	Detector (Demodulation) Circuits	11-A-1
	Part A. Electron-Tube Circuits	11-A-1
	AM Detectors	11-A-1
	Diode Detectors	11-A-1
	Diode Detector with AVC	11-A-4
	Diode Detector (with Noise Limiter)	11-A-6
	Grid-Leak Detector	11-A-8
	Plate Detector	11-A-11
	Infinite-Impedance Detector	11-A-13
	Regenerative Detector	11-A-15
	Superregenerative Detector	11-A-18
	Product Detector	11-A-21
	Coherent (Synchronous) Detector	**
	FM (or PM) Detectors	11-A-23
	Foster-Seeley Discriminator	11-A-24
	Travis Discriminator	11-A-27
	Ratio Detector	11-A-29
	Gated-Beam Detector	11-A-33
	Video Detectors	11-A-36
	Basic Video Detector	11-A-36
	Part B. Semiconductor Circuits	11-B-1
	AM Detectors	11-B-1
	Voltage Output Diode Detector	11-B-1
	Current Output Diode Detector	11-B-2
	Common-Emitter Detector	11-B-3
	Common-Base Detector	11-B-5
	FM Detectors	11-B-6
	Foster-Seeley Discriminator	11-B-6
	Ratio Detector	11-B-8
	Video Detectors	11-B-11
	Basic Video Detector	11-B-11

\*\*To be issued in later changes

Section		Page
12	Mixer Circuits	12-A-1
	Part A. Electron-Tube Circuits	12-A-1
	Audio Mixers	12-A-1
	Common Plate-Load Audio Mixer	12-A-1
	Separate Plate-Load Audio Mixer	12-A-4
	Video Mixers	12-A-6
	Common-Cathode Video Mixer	12-A-6
	Common-Plate Video Mixer	12-A-10
	Part B. Semiconductor Circuits	**
13	Frequency (Heterodyne) Converter Circuits	13-A-1
	Part A. Electron-Tube Circuits	13-A-1
	Mixers	13-A-1
	Diode Mixer	13-A-3
	Triode Mixer	13-A-4
	Pentode Mixer	13-A-6
	Pentagrid Mixer	13-A-8
	Balanced Mixer	13-A-10
	Pentagrid Converter	13-A-12
	Part B. Semiconductor Circuits	13-B-1
	Mixers	13-B-1
	Diode Mixer	13-B-2
	Triode Mixer	13-B-5
	Microwave Diode Mixer	13-B-6
	Autodyne Converter	13-B-8
14	Modulator Circuits	14-A-1
	Part A. Electron-Tube Circuits	14-A-1
	Amplitude Modulation (AM)	14-A-1
	Choke (Heising) Modulator	14-A-3
	Transformer-Coupled Plate Modulator	14-A-6
	Transformer-Coupled Control-Grid Modulator	14-A-16
	Transformer-Coupled Suppressor-Grid Modulator	14-A-20
	Transformer-Coupled Screen-Grid Modulator	14-A-25
	Transformer-Coupled Plate and Screen Modulator	14-A-30
	Transformer-Coupled Cathode Modulator	14-A-36
	Series Modulator	14-A-40
	Double-Sideband Modulator	14-A-42
	Single-Sideband Modulators (SSB)	14-A-46
	Balanced (Push-Pull Carrier Input) Modulator	14-A-47
	Balanced (Parallel Carrier Input) Modulator	14-A-49
	Balanced Bridge Modulator	14-A-51
	Product Modulator	14-A-53
	Phase Modulators (PM)	14-A-55
	Basic Phase Modulator	14-A-55
	Phasitron Modulator	14-A-58
	Frequency Modulators (FM)	14-A-61
	Basic Reactance-Tube Modulator	14-A-61
	Balanced Reactance-Tube Modulator	14-A-63
	Pulse Modulators	14-A-67
	Spark-Gap Modulator	14-A-67
	Thyratron (Gas-Tube) Modulator	14-A-68
	Hard-Tube Modulator	14-A-69
	Part B. Semiconductor Circuits	14-B-1
	Amplitude Modulation (AM)	14-B-1
	Base-Injection Modulator	14-B-1
	Emitter-Injection Modulator	14-B-5
	Collector-Injection Modulator	14-B-7
	Single Sideband Modulators (SSB)	14-B-10

\*\*to be issued in later changes

Section	Page
	14-B-10
	14-B-12
	14-B-15
	14-B-15
15	15-A-1
Limiter (Clipper) Circuits	15-A-1
Part A. Electron-Tube Circuits	15-A-1
Diode Limiter	15-A-1
Series, Positive-Lobe Diode Limiter	15-A-2
Series, Negative-Lobe Diode Limiter	15-A-3
Parallel, Positive-Lobe Diode Limiter	15-A-4
Parallel, Negative-Lobe Diode Limiter	15-A-6
Two-Diode, Positive and Negative Lobe Diode Limiter	15-A-9
Triode Limiters	15-A-10
Triode Grid Limiter	15-A-12
Triode Saturation Limiter	15-A-15
Triode Cutoff Limiter	15-A-17
Triode Overdriven Amplifier Limiter	15-A-20
Pentode Limiters	15-A-23
Video Pentode Limiter	15-A-24
R-F Pentode Limiter	15-A-26
Part B. Semiconductor Circuits	15-B-1
Diode Limiters	15-B-1
Series Limiter, Positive-Lobe	15-B-1
Series Limiter, Negative-Lobe	15-B-3
Parallel Limiter, Positive-Lobe	15-B-5
Parallel Limiter, Negative-Lobe	15-B-6
Two-Diode, Positive and Negative Lobe Limiter	15-B-8
Triode, Basic Common-Base Limiter	15-B-10
16	16-A-1
Clamper (D-C Restorer) Circuits	16-A-1
Part A. Electron-Tube Circuits	16-A-1
Diode Clampers	16-A-1
Negative Diode Clamper	16-A-2
Positive Diode Clamper	16-A-4
Negative-Biased Diode Clamper	16-A-6
Positive-Biased Diode Clamper	16-A-7
Triode Clampers	16-A-9
Basic Single-Tube Clamper	16-A-9
Synchronized Clamper	16-A-11
Part B. Semiconductor Circuits	16-B-1
Diode Clampers	16-B-1
Negative-Diode Clamper	16-B-1
Positive-Diode Clamper	16-B-3
Negative-Biased Diode Clamper	16-B-5
Positive-Biased Diode Clamper	16-B-7
Triode Basic Common-Base Clamper	16-B-8
17	17-1
Waveshaping Circuits	17-1
R-C Differentiator	17-1
R-L Differentiator	17-3
R-C Integrator	17-4
R-L Integrator	17-6
Saturable-Core Reactor Peaking Circuit	17-8
Semiconductor Pulse Shaper	17-9
18	18-A-1
Counter Circuits	18-A-1
Part A. Electron-Tube Circuits	18-A-1
Positive Diode Counter	18-A-1
Negative Diode Counter	18-A-2
Step-by-Step (Step) Counter	18-A-4

Section		Page
	Part B. Semiconductor Circuits	18-B-1
	Positive Diode Counter	18-B-1
	Negative Diode Counter	18-B-3
	Step-by-Step (Step) Counter	18-B-4
19	Logic Circuits	19-A-1
	Part A. Electron-Tube Circuits	19-A-1
	Part B. Semiconductor Circuits	19-B-1
	Logic Polarity	19-B-1
	Positive Logic	19-B-1
	Negative Logic	19-B-2
	Diode Logic	19-B-3
	OR Gate	19-B-3
	AND Gate	19-B-5
	Rectangular Matrices	19-B-7
	Encoding Matrices	19-B-9
	Decoding Matrices	19-B-12
	Two-Level AND-OR Gate	19-B-15
	Half-Adder Circuits	**
	Full-Adder	**
	Transistor Logic	19-B-19
	Transistor "OR" Gate	19-B-19
	Transistor "AND" Gate	19-B-20
	Transistor "NOT" Circuit	19-B-22
	Transistor NOR Gate	19-B-23
	Transistor NAND Gate	19-B-25
	Transistor Flip-Flop Circuits	19-B-26
	Emitter-Follower Circuits	19-B-27
	Lamp Drivers and Relay Pullers	19-B-31
	Part C. Mechanical Circuits	19-C-1
	Switch Logic	19-C-1
	OR Circuits	19-C-3
	AND Circuits	19-C-3
	Flip-Flop Circuits	19-C-6
	Two-Way and Three-Way Circuits	19-C-7
20	Time-Delay Circuits	20-A-1
	Part A. Electron-Tube Circuits	20-A-1
	Phantastron Circuits	20-A-1
	Basic Phantastron Circuits	20-A-1
	Fast-Recovery Phantastron Circuit	20-A-6
	Electromechanical (Acoustic) Delay Lines	20-A-10
	Part B. Semiconductor Circuits	20-B-1
	Part C. Artificial Delay Lines	20-C-1
	Electromagnetic Delay Lines	20-C-1
21	Control Circuits	21-A-1
	Part A. Electron-Tube Circuits	21-A-1
	AGC (AVC) Circuits	21-A-1
	Simple AGC Circuit	21-A-6
	AFC Circuits	21-A-8
	Phantastron AFC Circuit	21-A-9
	Thyatron AFC Circuit	21-A-11
	Reactance Tube AFC Circuit	21-A-13
	D-C Amplifier AFC Circuit	21-A-14
	Servomechanism Circuits	21-A-16
	Synchro Control System	21-A-17
	Servo Motor-Controller Circuit	21-A-24
	Resolver-Driver Circuit	21-A-26
	Phase-Sensitive Null Detector Circuit	21-A-28

\*\*To be issued in later changes

Section		Page
	Part B. Semiconductor Circuits	21-B-1
	AGC (AVC) Circuits	21-B-1
	Transistor "NOT" Gate	21-B-2
	Emitter-Current Control	21-B-2
	Auxiliary-Diode (Shunt)	21-B-4
	Auxiliary-Diode (Collector-Controlled)	21-B-5
22	Cathode-Ray-Tube Circuits	22-1
	Electrostatic	22-1
	Basic Oscilloscope Circuits	22-1
	Synchroscope Circuits	22-7
	CRT Display Circuits	22-13
	A-Scope Presentation	22-14
	J-Scope Presentation	22-14
	B-Scope Presentation	22-14
	C-Scope Presentation	22-15
	Electromagnetic	22-18
	PPI Scan	22-19
	Other Types of Scans	22-26
	Blanking	22-34
	DC Restoration	22-35
	Damper and Flyback	22-37
23	Filter Circuits	23-1
	High-Pass	23-1
	Low-Pass	23-5
	Band-Pass	23-10
	Band-Rejection	23-14

## PREFACE

### POLICY AND PURPOSE

The Electronics Installation and Maintenance Book (EIMB) has been established as the medium for collecting, publishing, and distributing, in one convenient documentation source, those subordinate maintenance and repair policies, installation practices, and overall electronics equipment and material-handling procedures required to implement the major policies set forth in Chapter 9670 of the Naval Ships Technical Manual. All data contained within the EIMB are authoritative, and derive their authority from Chapter 9670 of the Naval Ships Technical Manual, as established in accordance with Article 1201, U. S. Navy Regulations.

Since its inception, however, the EIMB has been expanded to include selected information of general interest to electronic installation and maintenance personnel. These items are such as would generally be contained in textbooks, periodicals, or technical papers, and form (along with the information cited above) a comprehensive, single-source reference document. In application, the EIMB is to be used for information and guidance by all military and civilian personnel involved in the installation, maintenance, and repair of electronic equipment under cognizance, or technical control, of the Naval Ship Systems Command (NAVSHIPS). All information, instructions, and procedures in the EIMB supplement such instructions and data supplied in equipment technical manuals and other approved maintenance publications.

### ORGANIZATION

The EIMB is organized into a series of handbooks to afford maximum flexibility and ease in handling. The handbooks are stocked and issued as separate items so that activities requiring extra copies of any handbook may obtain them with relative ease.

The handbooks fall within two categories: general information handbooks and equipment-oriented handbooks. The general information handbooks contain data which are of interest to all personnel involved in installation and maintenance, regardless of their equipment specialty. The titles of the various general information handbooks give only an overall idea of their data content; a more complete description of each handbook is provided in the General Handbook.

The equipment handbooks are devoted to information on a particular equipment class; they provide general test procedures, adjustments, general servicing information, and field change identification data.

The following table lists all handbooks of the series, together with their old and new NAVSHIPS numbers. (The old NAVSHIPS numbers are shown in parentheses.) The new NAVSHIPS numbers, although not presently imprinted on all handbooks of the EIMB series, serve also as the stock numbers which are to be used on any requisitions submitted.

HANDBOOK TITLE	NAVSHIPS NUMBER
(General Information Handbooks)	
General	0967-000-0100 (900,000.100)
Installation Standards	0967-000-0110 (900,000.101)
Electronic Circuits	0967-000-0120 (900,000.102)
Test Methods and Practices	0967-000-0130 (900,000.103)
Reference Data	0967-000-0140 (900,000.104)
RFI Reduction	0967-000-0150 (900,000.105)
General Maintenance	0967-000-0160
(Equipment-Oriented Handbooks)	
Communications	0967-000-0010 (900,000.1)
Radar	0967-000-0020 (900,000.2)
Sonar	0967-000-0030 (900,000.3)
Test Equipment	0967-000-0040 (900,000.4)
Radiac	0967-000-0050 (900,000.5)
Countermeasures	0967-000-0070 (900,000.7)

## PREFACE

### INFORMATION SOURCES

Periodic revisions are made to provide the best current data in the EIMB and keep abreast of new developments. In doing this, many source documents are researched to obtain pertinent information. Some of these sources include the Electronics Information Bulletin (EIB), the Naval Ship Systems Command Technical News, electronics and other textbooks, industry magazines and periodicals, and various military installation and maintenance-related publications. In certain cases, NAVSHIPS publications have been incorporated into the EIMB in their entirety and, as a result, have been cancelled. A list of the documents which have been superseded by the EIMB and are no longer available is given in Section 1 of the General Handbook.

### SUGGESTIONS

NAVSHIPS recognizes that users of the EIMB will have occasion to offer comments or suggestions. To encourage more active participation, a self-addressed comment sheet is frequently provided in the back of each handbook change. Complete information should be given when preparing suggestions. It is most desirable that the suggestor include his name and mailing address on the form to facilitate direct correspondence in the event clarification is required and an immediate reply can be supplied regarding the suggestion. Any communication will be made through a personal letter to the individual concerned.

If a comment sheet is not available or correspondence is lengthy, suggestions should be directed to the following:

Commander, Naval Ship Engineering Center  
Department of the Navy  
Washington, D. C. 20360  
Attn: Technical Data and Publications Section  
(SEC 6181C)

### CORRECTIONS

Report all inaccuracies and deficiencies noted in all NAVSHIPS technical publications (including this manual, ship information books, equipment manuals, drawings, and such) by a "Planned Maintenance System (PMS) Feedback Report, OPNAV 4700.7 (REV. 5-65)" or superseding form. If PMS is not yet installed in this ship, report technical publication deficiencies by any convenient means.

### DISTRIBUTION

The Electronics Installation and Maintenance Book is transmitted to using activities through automatic distribution procedures. Activities not already on the EIMB distribution list and those requiring changes to the list should submit correspondence to the following:

Commander, Naval Ship Engineering Center  
Department of the Navy  
Washington, D. C. 20360  
Attn: Technical Data and Publications Section  
(SEC 6181C)

Activities desiring extra copies of EIMB handbooks or binders should submit requisitions directly to Naval Supply Depot, Philadelphia, Pennsylvania. Complete instructions for ordering publications are given in the Navy Stock List of Forms and Publications, NAVSUP Publication 2002.







## SECTION 1 INTRODUCTION

### PURPOSE.

The purpose of the Handbook of Electronic Circuits, NAVSHIPS 900,000.102, is to provide Naval personnel with an informative reference which describes electron-tube, semiconductor, and other circuits employed in all types of electronic equipment and to support information contained in equipment technical manuals.

### USE.

The Handbook of Electronic Circuits will find use as a convenient reference for personnel in three general categories, as follows:

a. **Experienced Technician.** The experienced technician will have no great difficulty in coping with maintenance problems because of previous experience and developed maintenance skills. This individual will use the handbook as reference or review material and to increase his knowledge of electronics as new circuits are added to the handbook.

b. **Technician Out-of-School.** This category of technician is represented by the individual who has completed Navy training courses and has been in the fleet for some time, but his experience is limited to equipments covered in training courses and to equipment types serviced and maintained during his tour of duty with the fleet. The handbook should prove extremely valuable to this individual, especially when confronted with newer equipments, because the circuit descriptions in the handbook will help familiarize him with circuits employed in the newer equipment. Furthermore, it is likely that the technical manuals accompanying newer type equipments will refer the reader to the Handbook of Electronic Circuits, NAVSHIPS 900,000.102, for information on basic functional circuits, rather than discussing the circuits in detail.

c. **Trainee or Student In-School.** The trainee or student should find the information contained in the handbook useful as reference material while in training and later as review and reference material while on duty with the fleet. As a training aid, the individual circuit descriptions may be used as suggested material for reading assignments.

The reader of the Handbook of Electronic Circuits may readily locate the circuit of interest by consulting the Table of Contents. Each circuit description includes information on the circuit application, its important characteristics, an analysis of circuit theory and operation, and a failure analysis based upon signal output indications. Since only basic circuits are presented and described, some variations in design will be found in production equipments because of one or more of the following factors: distributed inductance, capacitance, and resistance; mechanical and physical layout of component parts; circuit deviations necessitated by peculiarities in design and licensing agreements; modifications to enable operation under environmental extremes; etc. However, if the reader thoroughly understands the operation of a basic circuit presented in the handbook, he can reason out the circuit

variations without too much difficulty.

The semiconductor device has become one of the outstanding scientific achievements in the electronics field in recent years. As a result, new techniques of circuit design, miniaturization, reliability, and maintenance concepts are being developed. These advances mean that the electronics technician must be prepared to maintain electronic equipments in which semiconductors are employed. To ensure that he will have the circuit information available for attaining proficiency in the maintenance of semiconductor equipment, this handbook includes semiconductor equivalents of the electron-tube circuits, whenever such equivalents exist, and in addition, includes some semiconductor circuits for which there are no electron-tube equivalents.

The Handbook of Electronic Circuits is used as supporting information for technical manuals covering electronic equipment. Technical manuals written and produced in accordance with recent publication specifications do not require a detailed theory treatment of so-called "standard" circuits, but instead may refer to the Handbook of Electronic Circuits for a discussion of a particular functional circuit. Since the Handbook of Electronic Circuits describes a basic functional circuit and may not describe a circuit identical with the circuit employed in the equipment, the equipment technical manual discusses the circuit differences which are unique and peculiar to the equipment, or differences which represent changes or modifications to the basic functional circuit described in the handbook. Thus, the handbook will describe a basic circuit which is typical and performs a given function. If necessary, the equipment technical manual will treat only circuit differences in detail, building upon the discussion given in the Handbook of Electronic Circuits.

### SCOPE.

Preliminary studies made by the National Bureau of Standards leading toward electronic circuit standardization indicate that a large percentage of circuit functions could be standardized without adverse effect on equipment performance. Further, many circuits already in use for several years represent designs which have proven to be extremely reliable and have undergone only minor improvements since their initial use. Today there exists a large number of commercial and military equipments employing similar circuits to perform identical electrical functions. Thus, many similar electronic circuits can be reduced to a "common-denominator" circuit representing a basic circuit from which others performing an identical electronic function have been derived either through modification or other engineering improvements. As a result, the technician is frequently confronted by new equipments introduced to the fleet which contain circuits reflecting design improvements.

Frequently, it is up to the individual to familiarize himself with new equipment by means of the technical manual supplied with the equipment. Furthermore, circuits may be incorporated which are totally unfamiliar to the individual. In this case the use of the Handbook of Electronic Circuits should prove extremely valuable,

since the circuit or group of circuits in question can likely be reduced to one or more "common-denominator" circuits. When these basic circuits, described in the handbook, are understood by the individual, similar circuits employed in new equipment, together with their modifications or differences, can be more readily understood by the individual.

The Handbook of Electronic Circuits has been divided into sections based upon the circuit function, rather than being classified according to use as communications, radar, or sonar equipment. Several sections are devoted to general circuit information applicable to either electron-tube or semiconductor circuits. When an electron-tube circuit is described, generally the most common or likely tube type (triode, pentode) is utilized in the handbook description. Where the basic electronic theory is the same for either electron-tube or semiconductor circuits, the basic theory is discussed within the description of the electron-tube circuit and referenced from the semiconductor circuit description; thus, repetition of text is reduced.

Section 2, General Information on Electron Tube Circuits, and Section 3, General Information on Semiconductor Circuits, contain general information applicable to electron-tube and semiconductor circuits, respectively. Paragraph numbers are used throughout these two sections to enable quick reference, when necessary, from circuit descriptions given in other sections of the handbook. Other sections of the handbook contain specific information relating to each of the various categories of electronic circuits and do not employ paragraph numbers. When it is necessary to locate a particular circuit description, the Table of Contents must be used to determine the number of the page on which the circuit of interest will be found.

Each description of an electronic circuit employing an electron tube or semiconductor is divided into four main parts: application, characteristics, circuit analysis, and failure analysis.

a. **Application.** This part of the circuit description states briefly how the circuit is employed, its common uses, and the types of equipments employing the circuit.

b. **Characteristics.** This part of the circuit description consists of short statements concerning technical data and other useful information to assist in circuit identification.

c. **Circuit Analysis.** The circuit analysis section of the description is written to outline in general terms the circuit function and to name the component parts of the circuit, to describe critical elements or component parts in detail, and to present the theory of operation of the circuit. A schematic with reference designations is used to illustrate the circuit; the associated text utilizes the reference designations when discussing the circuit. Actual values of parts do not normally appear in the text or on the schematic. Additional illustrations, such as idealized waveforms and simplified diagrams, are provided where deemed necessary to supplement the text.

d. **Failure Analysis.** This portion of the circuit description is written from an output-indication standpoint based upon possible degradation of performance, changing values of components, etc. The critical circuit components affecting amplitude, time (or frequency), and waveshape

are treated in the circuit analysis section. These critical components are again mentioned in the failure analysis discussion, but in this instance from the standpoint of the output signal observed.

The failure analysis discussion is intended to assist the reader in the development of a logical approach to trouble shooting. The failure analysis, as written for an individual circuit, does not pin-point (or name) parts which "could be" defective but, in effect, encourages the reader to think logically and determine defective or deteriorating parts from the output indications noted. The text, therefore, discusses in broad terms the various troubles that might logically be suspected as the cause of an abnormal (output) indication.

Abnormal output indications observed in equipments are actually symptoms which can be elaborated upon to further localize trouble within a functional circuit. Output indications as discussed in the text elaborate on the circuit analysis text to assist the reader in analyzing a failure; thus, an arbitrary conclusion as to the source of trouble or failure is discouraged and logical reasoning is stimulated. Typical indications discussed are: no output, distorted output, low output, and incorrect output frequency. In these discussions, the reader's attention is called to the improper function within the electronic circuit. Furthermore, so-called "critical" parts (or components) were discussed in the circuit analysis portion of the circuit description from the theoretical and operational standpoint; thus, a complete story is given for the circuit. Logical thinking, therefore, can be applied to the problem of localizing the failure within the circuit after the reader has studied the entire circuit description given in the handbook.

#### HANDBOOK CHANGES.

The handbook, as sectionalized, permits the future addition of circuits to keep the handbook abreast of electronic developments. Also, the layout of the handbook is designed to permit the addition of new electron-tube or semiconductor circuits, as well as to permit the revision of the existing circuits.

Changes to this handbook will be issued in, or publicized by, the Electronic Information Bulletin (EIB), NAVSHIPS 900,022A. Recommendations for changes and corrections to the handbook should be addressed to Chief, Bureau of Ships (Code 679A2).