

NAVSHIPS 92671

T. O. 33A1-13-53-1

INSTRUCTION BOOK

for

OSCILLOSCOPE
AN/USM-38

TRAD ELECTRONICS CORPORATION
ASBURY PARK, NEW JERSEY

PUBLISHED BY DIRECTION OF THE CHIEF, BUREAU OF SHIPS,
AND ACCEPTED BY THE SECRETARY OF THE AIR FORCE.

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**AN/USM-38
 MAINTENANCE**

between the V INPUT jack and the MARKER OUT jack. If downward vertical deflection of the sweep now results, the indication is that the difficulty exists external to the oscilloscope. Possible troubles would include (a) a short circuit in the cable connecting the input signal and (b) a defect within the equipment under test.

(3) In the event that in (1) above no indication of vertical deflection was observed, apply a suitable signal to the V. DIRECT direct connection to the vertical deflection plates. If deflection is noted, trouble has been localized internal to the oscilloscope in the vertical channel after the vertical step-attenuator.

b. OTHER CIRCUITS — Other internal circuits of the oscilloscope may be checked using methods similar to that given in a above. Refer to Table 3-1, Routine Check Chart, for detailed methods.

9. LOCATION OF ELECTRON TUBES — The name and location of each electron tube is given in Figure 4-1.

10. TROUBLESHOOTING (See Table 4-2)

a. TEST EQUIPMENT REQUIRED - The following test equipments or suitable equivalents will be employed in determine minimum repair and calibration specifications, for the AN/USM-38, Oscilloscope.

- | | |
|------------------|------------------------|
| 1. TS-460 ()/U | Impedance bridge |
| 2. HP 650A | Signal Generator |
| 3. SG-106/MPQ-25 | Generator |
| 4. AN/PSM-6 | Multimeter |
| 5. TS-505A | Electronic Multimeter |
| 6. AN/USM-50 | Oscilloscope |
| 7. TV-2/U | Electron Tube Test Set |

b. LOCATION OF MAINTENANCE INFORMATION – A chart of troubles and their probable causes is given in paragraph 12. Instructions are given in paragraph 13 for obtaining access to the inside of the oscilloscope for trouble correction or the removal of a subassembly. Included in this section are paragraphs indicating methods of testing and adjusting the special circuits contained in the oscilloscope. Diagrams showing printed wiring, normal waveforms, voltages and resistances from tube pins and critical points are shown in figure 4-4 thru 4-20. This information should be used for checking operation and locating faults within the circuits. Paragraph 11 gives detailed information on special techniques required to properly service printed wiring, and should be consulted before attempting any repair or replacement of parts. Illustrations showing the interior of the oscilloscope and subassemblies are included in figures 4-1 thru 4-17. The main schematic diagram figure 4-23 and the block diagram figure 4-22 are essential guides to circuit analysis and troubleshooting.

11. MAINTENANCE AND REPAIR OF PRINTED WIRING CIRCUITS.

a. GENERAL – A printed wiring circuit consists basically of a laminated plastic board having a thin sheet of copper bonded to one side. In forming the wiring a photo-etching process is used to remove unwanted parts of the copper while the wiring design remains intact. Component parts are mounted by extending their leads through holes pierced in the board. The leads are cut and crimped, and the complete assembly is then dipped into melted solder to make all connections simultaneously. The copper sheet wiring also picks up a coating of solder which increases its current carrying capacity. Finally, a coating of synthetic varnish is applied to both sides of the board to prevent leakage or other effects of moisture and dust.

b. TROUBLESHOOTING – Troubleshooting printed wiring circuits differ only slightly from troubleshooting conventional wiring. Circuit tracing of the printed board is generally easier. Test points

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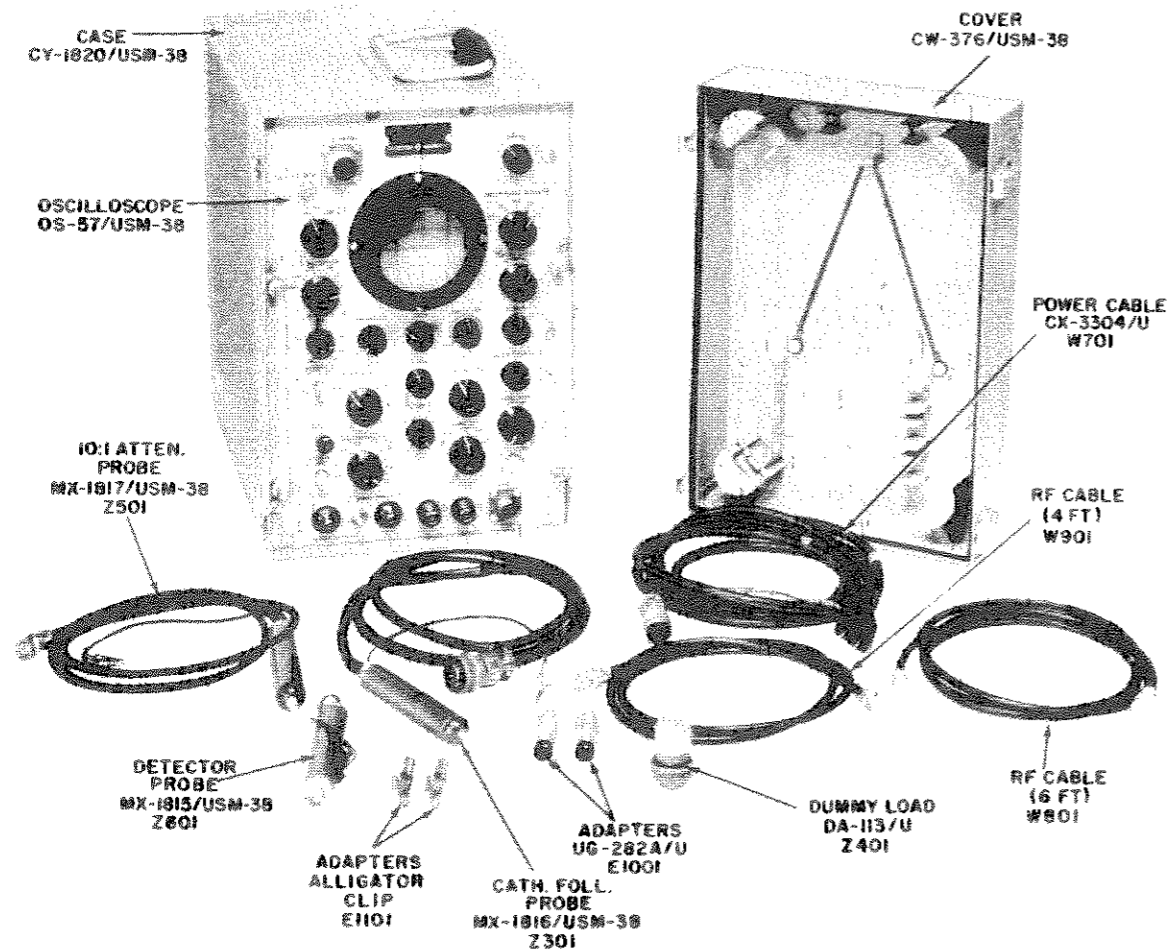


Figure 1-1. Oscilloscope AN/USM-38.

SECTION 1 GENERAL DESCRIPTION

1. PURPOSE AND BASIC PRINCIPLES (See figure 1-1)

a. Oscilloscope AN/USM-38 is a portable, light weight test instrument intended for general purpose use in testing and maintaining radar and other electronic equipment at the location of that equipment. It provides the means for observing visually the amplitude, duration, and shape of electrical wave-forms. Its application causes a minimum of disturbance in the functional operation of the circuit being tested. The test set is contained in a combination case and cover, equipped with a carrying handle. The cover has facilities for storing accessory cables, adapters, test leads, and the instruction book.

b. The basic device in the oscilloscope is a cathode ray tube which consists of an evacuated glass envelope containing an electron gun that forms and directs a focused beam of electrons to a fluorescent screen located at one end of the tube. The inherent electrical charge of an electron permits it to be deflected in its path by an electrical field. The extremely small mass and inertia of the electron beam allows almost instantaneous deflection. To facilitate electrostatic deflection, two sets of plates are placed within the tube at right angles to the path of the beam. The application of suitable voltages to the deflection plates results in vertical and horizontal motion of the electron beam. Since the signals to be observed vary greatly in amplitude, duration, and rate of recurrence, it is necessary to further the adaptability of the basic cathode ray tube through the use of attenuators, amplifiers, specialized circuits, and external coupling devices. The functional relationships of the principal component electrical circuits are shown in the block diagram of figure 4-22.

2. DESCRIPTION OF COMPONENTS

a. OSCILLOSCOPE SET AN/USM-38 consists of the compon-

TABLE 1-1. EQUIPMENT SUPPLIED

QTY. PER EQUIP.	NAME OF UNIT	NOMENCLATURE	OVER-ALL DIMENSIONS	VOL. CU. FT.	WEIGHT
1	Oscilloscope	OS-57/USM-38	9" x 13" x 15-1/8"	1.0	36 lbs.
1	Power Cable	CX-3304/U	8 ft. lg.	-	10 oz.
1	RF Cable	(W901)	4 ft. lg.	-	4 1/2 oz.
1	RF Cable	(W801)	5 1/2 ft. lg.	-	6 1/2 oz.
1	Detector Probe	MX-1815/USM-38	6" lg.	-	2 1/2 oz.
1	CF Probe	MX-1816/USM-38	6" lg.	-	10 oz.
1	Attenuator Probe	MX-1817/USM-38	6" lg.	-	5 1/2 oz.
1	Oscilloscope Cover	CW-376/USM-38	9-5/16" x 13-13/32" x 3"	-	1 oz.
1	Dummy Load	DA-113/U	1-1/8" dia. x 1-11/16" lg.	-	1 oz.
2	Connector Adapter	UG-282A/U	1 1/4" lg.	-	1 oz.
2	Alligator Clip	-	-	-	-
2	Fuses	(Spares)	-	-	-
1	Allen Wrench No. 6	-	-	-	-
1	Allen Wrench No. 8	-	-	-	-

ents listed in table 1-1. The following sub-paragraphs describe the separate units of the test set.

b. OSCILLOSCOPE OS-57/USM-38 - The general form of Oscilloscope OS-57/USM-38 is shown in figure 1-1. It consists of the sheet aluminum protective case, front panel, and chassis assembly. The case mounts a carrying handle, the fittings required to attach Cover CW-376/USM-38, and a retractable stand. A small removable cover plate is located on the rear of the case to provide access to the H DIRECT and V DIRECT connections to the deflection plates of the cathode ray tube. All operating controls, connectors, and fuses are conveniently located on the front panel of the oscilloscope. The screen of the cathode ray tube is visible through a green plastic filter and an inscribed scale. The internal construction of the oscilloscope consists of a rectangular frame and chassis assembly containing the power supply, wiring harness, printed wiring assemblies, tubes, and various component parts. Electrical and operating characteristics are given in tabular form in paragraph 3 of this section. Figure 4-22 shows a block diagram of the functions and relationships of the major circuits.

c. OSCILLOSCOPE COVER CW-376/USM-38 - The front cover for the oscilloscope is fabricated from sheet aluminum, and is equipped with hasps that permit its complete removal from the case. The cover contains storage facilities for the furnished adapters, cables, test leads, spare fuses and instruction book. (See table 1-1).

d. ATTENUATOR PROBE MX-1817/USM-38 - This test lead consists of a four foot length of non-detachable coaxial cable, type RG-62/U, terminated at one end in a BNC coaxial plug, type UG-260/U. The other end is terminated in a shielded cylinder-shaped probe, 5 1/2 inches long, having a pointed contact tip and a grounding alligator clip lead. This probe provides a 10 to 1 signal voltage reduction when connected to the vertical amplifier, at jack J102, SIGNAL INPUT. Intended for general purpose use in contacting the circuit being tested, it passes the test signal with a minimum of frequency distortion. It contains a series 9 megohm resistor shunted by a frequency compensating ceramic trimmer capacitor which is adjusted at the factory for standard characteristics.

This probe is capable of handling up to 500 volts total.

e. DETECTOR PROBE MX-1815/USM-38 - This item is a detachable type, cylindrical-shaped, test probe 6 inches long by 3/4 inch diameter, terminated in one end with a contact tip and a grounding alligator clip lead. The other end terminates in a BNC coaxial receptacle, type UG-1094/U. This probe is normally connected to the oscilloscope by means of the coaxial test cable, W801 or W901, and is used to demodulate radio frequency signals for the visual observation of modulation envelopes. It can be used to indicate the voltage level of signals up to 400 mc in frequency, for alignment adjustment of radio receivers, and in signal tracing techniques for troubleshooting. When using the detector probe the input impedance is 20,000 ohms paralleled with 7 uuf. The maximum signal level permissible is 125 volts peak inverse. The probe housing contains a crystal diode rectifier and low-pass filter network (See figure 4-23).

f. CATHODE FOLLOWER PROBE MX-1816/USM-38 - The cathode follower probe consists of a non-detachable five foot length of cable terminated at one end in a five contact AN type connector, and at the other end in a 3/4 inch diameter cylinder-shaped probe having a contact tip and a grounding alligator clip lead. It is used to sample signal voltage in circuits where capacitive or resistive loading, caused by the insertion of a test probe, must be kept at a minimum in order to prevent signal distortion or detuning without introducing any appreciable attenuation. This probe contains a sub-miniature electron tube V301 connected in a cathode follower circuit. The circuit is such that the input impedance is 8 megohms with parallel capacitance not exceeding 10 uuf. The low impedance of the cathode follower output circuit permits the passage of the signal to the oscilloscope input at jack J101, CF PROBE, without changing the frequency response of the observed signal. This probe will handle a signal input of 5 volts rms without introducing appreciable distortion.

g. DUMMY LOAD DA-113/U - This adapter consists of a 5-pin male AN type connector that mates with the vertical channel input jack, CF PROBE, J101. It is modified with a special shield cap, and contains 75 ohms resistance connected between pins A and E.

Pin E of jack J101 is grounded; pin A is connected internally to the center terminal of the coaxial jack J102, SIG INPUT. The purpose of this adapter is to reduce the input impedance of the vertical channel of the oscilloscope, at the SIG INPUT jack J102, to 75 ohms. When using this adapter no probes of any kind should be used for the vertical input; direct connection is made between the low impedance source of test signal and the SIG INPUT jack using coaxial cable furnished. The power dissipation rating of this termination is 1 watt; therefore, the applied dc or rms voltage should not exceed 8.5 volts.

h. RF CABLES - Two coaxial cables, one six-foot (W801), and one four-foot (W901) in length are supplied for general purpose use in connecting Oscilloscope OS-57/USM-38 to equipments being tested, to the Detector Probe MX-1815/USM-38, and to the Attenuator Probe MX-1817/USM-38. These cables consist simply of a length of RG-62/U coaxial cable terminated at both ends in BNC coaxial fittings type UG-260/U.

i. POWER CABLE CX-3304/U - The ac power supply cable for the oscilloscope is an eight-foot length of three conductor, rubber-covered, power cable terminated at one end in a three contact AN type connector that mates with receptacle J106, POWER, located on the front panel. The other end of the cable is terminated in a molded two-prong power plug from which extends a six-inch length of grounding conductor terminated in an alligator clip.

j. ADAPTER UG-282A/U - This adapter combines a BNC type coaxial plug and a spring loaded binding post. It is used to connect single wire test leads to the BNC type receptacles on the front panel of the oscilloscope. Two of these adapters are furnished with the equipment.

k. ALLIGATOR CLIP - This adapter is a combination of a phone tip jack and an alligator clip; it is used to connect the furnished test probes to terminal lugs, test points, and the like.

3. REFERENCE DATA

- a. Nomenclature Oscilloscope AN/USM-38
- b. Contract number NObsr-59445
- c. Contractor Trad Electronics Corp.
Asbury Park, New Jersey

- d. Cognizant Naval Inspector Inspector of Naval Material, USN, Naval Industrial Reserve Shipyard, Port Newark, Newark 5, N.J.
- e. Sine wave response Flat within 3 db from 10 cycles to 6 megacycles per second.
- f. Transients response 0.06 microseconds rise
- g. Square wave response Less than 10 percent tilt for 50 cycles square wave.
- h. Polarity Positive for upward deflection. Negative for downward deflection.
- i. Input impedances
 - V INPUT 1 megohm paralleled by 35 uuf.
 - V INPUT with external adapter . 75 ohms
 - V INPUT with 10:1 attenuator probe 10 megohms paralleled by 15 uuf.
 - V INPUT with detector probe 20,000 ohms paralleled by 7 uuf.
 - CF PROBE with cathode follower probe 8 megohms paralleled by 10 uuf.
 - V DIRECT 3.9 megohms paralleled by 20 uuf.
 - H DIRECT 3.9 megohms paralleled by 20 uuf
 - + EXT SYNC 1.5 megohm paralleled by 25 uuf
 - EXT SYNC 1.5 megohm paralleled by 75 uuf.
 - Z AXIS INPUT 680 ohms paralleled by 20 uuf.

- j. Output voltages
 - MARKER OUT 3 volts peak open circuit; 5.7K ohms minimum load impedance.
 - + TRIGGER OUT 100 volts peak; 2,000 ohms maximum internal impedance.

- k. Input sensitivity and voltage limits

	Signal Volts		Total Peak Volts
	Min.	Max.	
V INPUT	0.1 rms*	150 rms*	600
V INPUT with attenuator probe	1 rms*	500 peak	500
V INPUT with detector probe		125 peak	500
CF PROBE with cathode follower probe	0.15 rms*	5 rms*	500
V DIRECT	50V peak		500
H DIRECT	75V peak		500
EXT SYNC	.05 peak	100 peak	500
EXT SYNC with attenuator probe	.05 peak	500 peak	500
Z AXIS INPUT	+1.0*peak	+50*peak	No DC

*= Volts per inch

- l. Sweep time 1 to 100,000 microseconds per inch continuously adjustable.
- m. Sweep circuit Triggered or periodic
- n. Calibration 0 to 1 volts peak to peak of line frequency flat-topped wave for calibrating signal amplifier.
- o. Timing markers Synchronized with sweep and available at intervals of 1, 10 and 100 microseconds.
- p. Trigger pulse output 100 volts peak, 1.5 microsecond pulse, having a rise time of 0.5 microseconds. Repetition rate

continuously variable from 40 to 5000 times per second.

- q. Sweep delay and expansion Allows any 10% of trace to be expanded by a factor of 9.
- r. Cathode ray tube:
 - Screen diameter Three inches, 1½ inches total deflection, ¾ inch for pulse.
 - CRT type JAN 3WP1

SECTION 2 THEORY OF OPERATION

1. GENERAL ELECTRICAL CHARACTERISTICS OF OSCILLOSCOPE OS-57/USM-38 (See figure 4-22, Block Diagram)

a. VERTICAL DEFLECTION CHANNEL - The vertical deflection channel consists basically of a broad-banded amplifier having relatively flat frequency response from 10 cycles to 6 megacycles per second permitting the display of a large variety of waveshapes with little distortion. Sufficient attenuation and gain control is included in this amplifier to permit the application of signals in a wide range of magnitude. The circuit is arranged so that periodic, non-periodic, and random recurring waveshapes can be observed. When desired, the amplifier can be disconnected and connection made directly to the vertical deflection plates of the crt. The peak to peak voltage value of signals in the vertical channel can be measured by comparison with an internally generated

calibrated voltage. The signal for display is applied to the vertical channel at V INPUT jack J102. Attenuator AT101, V MULTIPLIER, is a six-position step attenuator controlling the input signal level to the Preampifier circuits which include amplifier V101, and one-half V102 connected as a cathode follower to match the input impedance to Delay Line DL101. The calibrated comparison voltage, variable from 0 to 1 volt amplitude by the CAL VOLTS control is introduced to the vertical channel only when the CAL switch S102 is set in ON position. The second triode section of V102 is used to amplify a portion of the signal for use in synchronizing the sweep circuit. The delay line delays the signal in the vertical channel for approximately 0.4 microseconds; thus allowing the sweep to start slightly ahead of the vertical deflection. The Cathode Follower V103 circuit properly terminates the delay line and includes the continuously variable control V GAIN % R123. The signal is further amplified by the Vertical Driving Amplifier V104, to drive the push-pull Vertical Output amplifiers V105, V106. The vertical output is fed to the vertical deflection plates of the cathode ray tube V107. The input circuit to the vertical deflection plates includes the vertical positioning control V. POS and also the facilities for making direct connections.

b. HORIZONTAL DEFLECTION - The primary purpose of the internal sweep circuits is to develop a horizontal deflection voltage that varies linearly with time. Specialized circuits are included that control the sweep duration, repetition rate, and allow synchronization with signals from various sources.

(1) HORIZONTAL OUTPUT AMPLIFIER - This amplifier converts the positive going linear voltage output from the sweep circuits to a push-pull voltage which is applied to the horizontal deflection plates of the cathode ray tube. The sweep voltage input to this stage is clamped by V125B so that the horizontal deflection starts at the same point for all sweep waveforms and repetition rates. The horizontal positioning control H. POS is connected in the clamp circuit.

(2) GATE GENERATOR - This generator is a balanced multivibrator, using one-half of V121 and one-half of V122, and is