NOT MEASUREMENT SENSITIVE

MIL-STD-40051-2

DEPARTMENT OF DEFENSE STANDARD PRACTICE

TECHNICAL MANUALS

INTRODUCTORY INFORMATION WITH THEORY OF OPERATION



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1. SCOPE.

1.1 <u>Scope</u>. This standard establishes the technical content requirements for the preparation of introductory information with theory of operation for weapon systems and equipment Technical Manuals (TMs) and Depot Maintenance Work Requirements (DMWRs). These requirements are applicable for both paper and digital page-oriented TMs. Electronic delivery of TMs is accomplished through the use of the Introductory Information With Theory of Operation modular Document Type Definition (DTD). The DTD is available in a digital format. Refer to MIL-STD-40051 for information on obtaining this DTD. Introductory information with theory of operation requirements include applicable forms and records, descriptive information about the equipment or weapon system and an explanation of how the equipment or weapon system accomplishes its mission.

2. APPLICABLE DOCUMENTS.

The applicable documents in section 2 of MIL-STD-40051 apply to this Part.

3. **DEFINITIONS.**

The definitions in section 3 of MIL-STD-40051 apply to this Part.

4. GENERAL REQUIREMENTS.

- 4.1 <u>General</u>. Introductory information with theory of operation shall be prepared for weapon systems, major equipment, components and applicable support and interface equipment. Information required to complete all applicable forms and records, provide the user with a physical description, and functionally explain how the weapon system or equipment operates shall be included. This information shall be contained in work packages and become a part of a General Information chapter.
- 4.2 <u>Maintenance level applicability</u>. Requirements contained in this standard are applicable to all maintenance levels unless specifically noted in bold and in parentheses (i.e., **-34 only**). The labeled requirements shall be applicable to all TMs containing that maintenance level. For example, a (**-20 only**) requirement would only be applicable to the following TMs: -12, -13, -14, -20, -23, and -24.
- 4.3 <u>Standard tables</u>. Various standard tables required are noted throughout the text of this standard in bold and in parentheses (i.e., (**standard table**)). The formats and table heading names of these standard tables shall have no deviations.
- 4.4 <u>Preparation of digital data for electronic delivery.</u> Technical manual data prepared in work package format and delivered digitally in accordance with this standard shall be SGML tagged and assembled using the modular Assembly DTD and Formatting Output Specification Instance (FOSI). The DTD and FOSI have been developed in accordance with MIL-PRF-28001 and ISO 8879. Refer to MIL-STD-40051 for information on obtaining or accessing this modular DTD and FOSI. SGML tags used in the modular DTD are noted throughout the text of this standard in bracketed, bold characters (i.e., **<ginfowp>**) as a convenience for the TM author and to ensure that the tags are used correctly when developing a document instance.
- 4.4.1 <u>Use of the DTDs / FOSIs</u>. The modular DTDs referenced in this standard interpret the technical content and structure for the functional requirements contained in this standard and are mandatory for use. The modular FOSIs referenced herein interpret the style and format. As specified by the contracting activity, FOSIs or style sheets may be used to produce final reproducible paper copy for all TMs prepared in accordance with this standard.

- 4.5 <u>Content structure and format</u>. The examples provided at the rear of this Part are an accurate representation of the content structure and format requirements contained herein and shall be followed to permit the effective use of the modular DTD for Introductory Information With Theory of Operation.
- 4.6 <u>Style and format</u>. Style and format requirements for the preparation of Department of Army TMs are contained in MIL-STD-40051-1; they are considered mandatory and are intended for compliance. Preferred general style and format requirements for Army TMs shall be provided by the proponent activity.
- 4.7 <u>Work package development</u>. Technical manual data developed in accordance with this standard shall be divided into individual, stand alone units of information work packages. A work package shall consist of descriptive, operational, maintenance, troubleshooting, support, or parts information for the weapon system or equipment.
- 4.8 <u>Selective application and tailoring</u>. MIL-STD-40051 contains some requirements that may not be applicable to the preparation of all technical manuals. Selective application and tailoring of requirements contained in MIL-STD-40051 are the responsibility of the contracting activity and shall be accomplished through the use of Appendix A, Technical Manual Content Selection Matrixes, of MIL-STD-40051. The applicability of some requirements is also designated by one of the following statements: unless specified otherwise by the contracting activity; as/when specified by the contracting activity; or when specified by the procuring activity.

5. **DETAILED REQUIREMENTS.**

- 5.1 <u>Preparation of introductory information with theory of operation</u>. Introductory information with theory of operation shall be prepared as a General Information Chapter **<gim>**. This chapter shall be subdivided into individual work packages to provide the user with information for completing forms and records, descriptive data about the weapon system or equipment, and an explanation of how the weapon system or equipment works. Information shall be divided into the following work packages.
 - a. General information work package **<ginfowp>**.
 - b. General information work package **<pms-ginfowp>** (Preventive Maintenance Services Manual only).
 - c. Equipment description and data work package **<descwp>**.
 - d. Theory of operation work package <thrywp>.
 - e. Support data work package **<supdatawp>** for repair parts; special tools; Test, Measurement, and Diagnostic Equipment (TMDE); and support equipment.
- 5.1.1 <u>General information work package **<ginfowp>**</u>. This work package shall contain the content requirements provided in 5.1.1.1 through 5.1.1.19, as applicable, for the weapon system equipment.
- 5.1.1.1 <u>Scope < scope ></u>. A brief statement shall be prepared to tell what is covered in the TM (Refer to figure 1.) As applicable, the following information shall also be included.
 - a. Type of manual.
 - b. Model number(s) and equipment name(s).

- c. Purpose of equipment.
- d. Special inclusions in the manual, such as drill procedures or on-vehicle loading plans.
- 5.1.1.2 <u>Maintenance forms, records, and reports <mfrr></u>. The following statement shall be included.

"MAINTENANCE FORMS, RECORDS, AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by (as applicable) DA PAM 738-750, Functional Users Manual for the Army Maintenance Management System (TAMMS); DA PAM 738-751, Functional Users Manual for the Army Maintenance Management Systems - Aviation (TAMMS-A); or AR 700-138, Army Logistics Readiness and Sustainability."

In addition, for conventional and chemical ammunition TMs, add the following statement.

"Accidents involving injury to personnel or damage to material will be reported on DA Form 285 (Accident Report) in accordance with AR 385-40. Explosives and ammunition malfunctions will be reported in accordance with AR 75-1."

When applicable, add references to SB 742-1, Ammunition Surveillance Procedures.

5.1.1.3 <u>Reporting equipment improvement recommendations <eir></u>. The following statement shall be included.

"REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your (insert equipment short item name) needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to the address specified in DA PAM 738-750, Functional Users Manual for the Army Maintenance Management System (TAMMS), or as specified by the contracting activity. We will send you a reply."

5.1.1.4 <u>Hand receipt (HR) manuals <handreceipt></u>. The following statement may be included in operator's/unit maintenance manuals.

"HAND RECEIPT (HR) MANUALS

This manual has a companion document with a TM number followed by "-HR" (which stands for Hand Receipt). TM X-XXXX-XXX-10-HR consists of preprinted hand receipts that list end item related equipment (i.e., COEI, BII, and AAL) that must be accounted for. As an aid to property accountability, additional HR manuals may be requisitioned through normal publication channels."

5.1.1.5 <u>Corrosion prevention and control **<cpcdata>**</u>. A statement similar to the following shall be prepared.

"CORROSION PREVENTION AND CONTROL (CPC)

Corrosion Prevention and Control (CPC) of Army materiel is a continuing concern. It is important that any corrosion problems with this item be reported so that the problem can be corrected and improvements can be made to prevent the problem in future items.

While corrosion is typically associated with rusting of metals, it can also include deterioration of other materials, such as rubber and plastic. Unusual cracking, softening, swelling, or breaking of these materials may be a corrosion problem.

If a corrosion problem is identified, it can be reported using SF 368, Product Quality Deficiency Report. Use of key words such as "corrosion," "rust," "deterioration," or "cracking" will ensure that the information is identified as a CPC problem.

The form should be submitted to the address specified in DA PAM 738-750, Functional Users Manual for the Army Maintenance Management System (TAMMS)."

For **aircraft TMs**, this information shall include a reference to TM 55-1500-343-23 (Organizational and Intermediate Avionic Cleaning and Corrosion Prevention/Control).

- 5.1.1.6 <u>Destruction of Army materiel to prevent enemy use <destructmat></u>. Reference shall be made to the appropriate TM(s) covering the destruction of Army materiel to prevent enemy use as provided by the proponent activity.
- 5.1.1.7 <u>Preparation for storage or shipment **processor**. Reference shall be made to the preparation for storage or shipment procedures, including packaging and administrative storage, found in the applicable maintenance instructions work package.</u>
- 5.1.1.8 <u>Warranty information **<wrntyref>**</u>. When the TM covers equipment that is under warranty and a Warranty Technical Bulletin (WTB) is published, the applicable WTB shall be referenced. When a WTB is not published, the following statement shall be included.

"WARRANTY INFORMATION

The (insert name of equipment) is warranted for (insert miles or other timeframe as appropriate). The warranty starts on the date found in block 23 of DA Form 2408-9, Equipment Control Record. Report all defects to your supervisor, who will take appropriate action."

- 5.1.1.9 <u>Nomenclature cross-reference list < nomenreflist ></u>. A cross-reference list shall be prepared when unofficial nomenclature (common name) is approved by the proponent activity. (Refer to figure 1.)
- 5.1.1.10 <u>List of abbreviations / acronyms <loa></u>. A list shall be prepared, consisting of all abbreviations, acronyms, signs, or symbols used in the TM. (Refer to figure 1.) For **aircraft TMs only**, a statement shall be prepared that abbreviations are in accordance with MIL-STD-12, except when the abbreviation stands for a marking actually found in the aircraft.
- 5.1.1.11 Quality Assurance (QA) (depot and aviation only) <qainfo>. When specified by the contracting activity, reference shall be made to the pertinent QA TM(s) or include the appropriate general QA information. If QA information is not referenced but is included in the TM, it shall be stated that the text of each quality assurance procedure or step in the TM is preceded (and highlighted) by the addition of "QA." The abbreviation "QA" shall be defined either in a note or in the text. For aircraft maintenance TMs, include a reference to FM 1-500.
- 5.1.1.12 <u>Safety, care, and handling **<sftyinfo>**</u>. The following general precautions and safety regulations shall be prepared.

- a. For ammunition TMs, information shall be prepared to comply with AR 385-62. References to applicable Army Regulations (ARs) for range safety and danger zones during training and combat shall be included. Explanations and official definitions shall be prepared for such safety-related terms as "misfire," "hangfire," and "cook-off," which describe characteristics associated with the specific items(s) covered by the TM under preparation. A reference to TM 9-1300-206 shall be made for general ammunition care, handling, and safety.
- b. For TMs covering equipment with radioactive parts or components, information shall be prepared to comply with Nuclear Regulatory Commission provisions, and references to applicable ARs and safety TMs on radioactive materials shall be included. If additional coverage on radioactive materials is needed, but is not included in applicable TMs, instructions shall be prepared as required. In addition, the following information shall be prepared for inclusion throughout the TM.
 - (1) Nuclear warning notices shall be placed at the beginning of any instruction covering procedures that will expose personnel to a nuclear radiation hazard.
 - (2) Procedures to be followed prior to maintenance actions, or in the event of breakage of radioactive parts or components, including safety, care, and handling instructions.
 - (3) Radioactive parts or components shall be shown and identified on a parts location diagram or illustration, and warning notices.
 - (4) A list of radioactive parts or components and the type and quantity of radioactive material involved shall be included as part of equipment data. (Refer to 5.1.3.)
 - (5) Instructions for the disposal of radioactive material, such as the requirement to double bag in plastic all broken tritium sources.
- c. Electrostatic Discharge (ESD) control standards for the protection of electrical and electronic parts, assemblies, and equipment shall be prepared. The ESD classes shall be identified. (Refer to MIL-STD-1686 and MIL-HDBK-263.) (For classifications of ESD marking procedures, refer to MIL-STD-40051-1.)
- 5.1.1.13 <u>Nuclear hardness <hcp></u>. If equipment covered in the TM has nuclear survivability requirements (i.e., overpressure and burst, thermal radiation, electromagnetic pulse, or transient radiation effects on electronics), it shall be so stated. (Refer to MIL-STD-40051-1 for marking Hardness Critical Process (HCP) procedures.) The following statement shall be included.

"NUCLEAR HARDNESS

All hardness critical procedures in this manual are marked with the acronym **HCP** as follows:

- 1. When an entire task, including all paragraphs and procedures, is considered hardness critical, only the task title will be marked by the acronym **HCP**, placed before the title.
- 2. When only certain processes and steps within the work package are hardness critical, only the applicable processes and steps will be marked by placement of the acronym **HCP** between each applicable step number and the text."

- 5.1.1.14 <u>Security measures for electronic data **<secref>**</u>. Instructions for handling, loading, purging, overwriting, or unloading classified electronic data under usual or unusual conditions, shall be developed. Instructions shall meet the requirements of current regulations as they pertain to automation security.
- 5.1.1.15 <u>Calibration < calref></u>. Equipment requiring calibration shall be identified, and reference shall be made to the publication containing the applicable calibration procedure.
- 5.1.1.16 <u>Engineering Change Proposals (ECPs)</u> (**depot only**) **<ecp>**. The following statement shall be included.

"ENGINEERING CHANGE PROPOSALS

Engineering Change Proposals (ECPs) will be submitted using DD Form 1693 (Engineering Change Proposal [Short Form]). (Refer to MIL-STD-973, Configuration Management, for instructions.) Completed forms should be mailed directly to (enter the name and address of the responsible command or activity). A reply will be furnished to you."

5.1.1.17 Deviations and exceptions (depot only) <deviation>. The following statement shall be included.

"DEVIATIONS AND EXCEPTIONS

Requests for deviations or exceptions to this Depot Maintenance Work Requirement (DMWR) will be processed in accordance with DESCOM-R 702-1 (Depot Quality Systems)."

5.1.1.18 Mobilization requirements (depot only) <mobreq>. The following statement shall be included.

"MOBILIZATION REQUIREMENTS

All requirements of this DMWR will be exempted or revised in the event of mobilization. Only those procedures necessary to return the (insert equipment name) to a serviceable condition will be performed. The exemptions and revisions are explained in supporting information work package (insert appropriate work package sequence number)."

- 5.1.1.19 <u>Copyright credit line **<copyrt>**</u>. When a copyright credit line is required (refer to MIL-STD-40051-1), the information shall appear as the last paragraph of the general information work package.
- 5.1.2.1 <u>Scope</u>. Refer to paragraph 5.1.1.1 for scope requirements.
- 5.1.2.2 <u>Inspection requirements <inspec-req></u>. The following statement shall be included.

"This manual contains complete requirements for intermediate (when applicable) and periodic inspection for (insert aircraft model) aircraft. It does not contain instructions for repair, adjustment, or other means of rectifying conditions, nor does it contain instruction for troubleshooting to find causes for malfunctioning. Specific tolerances, limits, etc., can be found in the applicable maintenance manuals. Use of the alphabetical index in the applicable manuals will facilitate locating the required information."

5.1.2.3 Maintenance activities **<scope>**. The following statement shall be included.

"The inspections prescribed by this manual will be performed at a specific period by Aviation Unit Maintenance (AVUM) activities with assistance of Aviation Intermediate Maintenance (AVIM) and Depot Maintenance activities when required."

5.1.2.4 General information **<geninfo>**. The following statement shall be included.

"INSPECTION REQUIREMENTS.

The inspection requirements contained herein are stated in such a manner as to establish when certain equipment is to be inspected and what conditions are desired/undesired (figure 2). Compliance with the provisions outlined herein is required in order to ensure that latent defects are discovered and corrected before malfunctioning or serious trouble results. Inspection requirements are arranged, as nearly as possible, according to the manner in which they will be performed. The requirements are divided into groups and listed under area headings (figure 4).

INSPECTION INTERVALS

The inspection intervals designated herein will not be exceeded except in actual operational emergencies as explained herein. It is the commander's responsibility to determine (on an individual aircraft basis) when inspection intervals may be exceeded. For this purpose, operational emergencies are conditions of combat, or conditions of disaster which necessitate flight to evacuate aircraft or personnel. When aircraft are operated beyond the normal inspection due-time because of such emergency situation, a circled red X status symbol and an appropriate statement (to include authority) must be entered in block 16 and 17 of DA Form 2408-13 (Aircraft Status Information Record) until such time as the inspection is complete. Since safety may be jeopardized when inspections are delayed to meet emergency requirements, commanders will assure that the aircraft status symbol reverts to a red "X" and that delayed inspections are accomplished immediately upon termination of the actual emergency. When unusual local conditions of environment, utilization, mission, experience of flight crew and maintenance personnel, periods of inactivity, etc., are encountered, the maintenance officer will, at his discretion, increase the scope and/or frequency of maintenance of inspections as necessary to ensure safe flight.

SPECIFIC NON-INSTALLED EQUIPMENT ON AIRCRAFT

This manual may contain inspection requirements applicable to specific equipment not installed on your aircraft. Those requirements should be disregarded.

DA FORMS

DA Form 2408-13 will be used to record all deficiencies or shortcomings discovered during the daily inspection. DA Form 2404, Equipment Inspection and Maintenance Worksheet, will be used as a work sheet to record all deficiencies or shortcomings discovered during accomplishment of the intermediate or periodic inspection. Upon completion of the inspection, all uncorrected deficiencies or shortcomings listed on DA Form 2404 will be entered on DA Form 2408-13 prepared for that date or DA Form 2408-14, Uncorrected Fault Record (Aircraft), (For intermediate and periodic inspection.)

SPECIAL INSTRUCTIONS

- a. The columns headed I and P are used to indicate the requirements for Intermediate (when applicable) and Periodic inspections respectively. When item is required with a frequency other than that indicated by these column headings, the proper frequency is indicated in the appropriate column. For example, when a given item is required at each 3rd intermediate inspection, "3rd" is entered in the I column, opposite the pertinent item. To use the chart, perform all preventive maintenance service items indicated in the pertinent inspection column. The types of inspections are defined as follows:
 - I Intermediate inspection which is performed at (insert flying hours as specified by the aircraft maintenance schedule) flying hours after completion of the periodic inspection.
 - P Periodic inspection is performed every (insert flying hours as specified by the aircraft maintenance schedule) flying hours.
- b. Work time requirements to accomplish each inspection are stated at top of the checklist. The work time requirements for individual items within the checklist are stated in the W/T column opposite the pertinent item.

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), located in the back of the applicable aircraft maintenance manual (when using the 2028 from the maintenance manual, ensure the publication number and title refer to this PMS) directly to (*insert address of proponent*). You may also send in your recommended changes via electronic mail or by fax. Our fax number is (*insert DSN and commercial number of proponent*). Our e-mail address is: (*insert address of proponent*). A reply will be furnished to you.

INSPECTION AREAS

Inspection areas are shown in figure 1."

- 5.1.3 Equipment description and data work package **<descwp>**. This work package shall contain the descriptive data requirements listed in 5.1.3.1. through 5.1.3.5, as applicable. For **depot only**, an end item DMWR shall identify components of the end item/system that are not covered by the DMWR, but are covered in a lower level TM(s).
- 5.1.3.1 Equipment characteristics, capabilities, and features **<eqpinfo>**. An overall description of the equipment **<eqpdesc>** shall be prepared, including general capabilities, special features, and other like information (e.g., applications, limitations) which will be helpful in the operation and maintenance of the equipment. The information may be in narrative format or may be tabular. (Refer to figure 2.)
 - a. The equipment type shall be stated, as shall the following equipment features: portability or mobility, operational and special environment, and remote control.
 - b. Components and their functions shall not be described unless essential to continuity. For functional data, reference shall be made to theory of operation.

- c. When equipment covered varies in scope and application or has several applications within an end item, a brief explanation of the multiple usage and a simple diagram showing all aspects of a typical application shall be prepared.
- d. For **ammunition TMs**, packing and packaging information shall be prepared, including number of rounds per pack.
- 5.1.3.2 <u>Location and description of major components **<locdesc>**</u>. Equipment location information shall be prepared including external and internal views of the equipment used to show general features and all major components. (Refer to figure 2.) This information shall not duplicate information contained in the equipment data requirements and the equipment characteristics, capabilities, and features.
 - a. The equipment and weapon systems configuration shall be described as follows.
 - (1) A description of system areas and compartments shall be prepared, and the system equipment and components contained in the areas shall be identified. To identify and locate the listed system equipment the configuration description shall be supported by separate illustrations of each compartment and area. (Refer to figure 2.) For **aircraft only**, a station diagram showing fuselage station, water line, and butt line, etc. shall be included. (Refer to figure 3.)
 - (2) The subsystems or equipment comprising the system shall be identified and described. Other equipment which is installed in the subject system compartments and areas need not be listed in the text or called out in the illustrations if they do not directly affect the operation or maintenance of the subject system. Descriptions of operator-attended equipment shall include general statements about the nature and purpose of the controls and indicators. The text shall be supported by illustrations.
 - (3) Descriptions and illustrations of associated-system equipment shall be limited to the major units of that equipment. The descriptions shall be more concise than those of the subject system equipment; otherwise, the same requirements shall apply. In the descriptions, emphasis shall be placed on associated systems equipment that constitutes operational or functional interfaces with the subject system. Such units shall be included in the system illustrations.
 - b. When the equipment is designed for use with other equipment, one or more diagrams shall be prepared to illustrate the use of the equipment. Only information pertaining to the user shall be prepared.
 - c. Location and contents of end item and major component identification plates shall be illustrated. Modification information, and warranty plates, stencils, or location of serial numbers shall be illustrated.
- 5.1.3.3 <u>Differences between models <eqpdiff></u>. Significant differences affecting interchangeability shall be identified. Specifically, differences associated with equipment models or units of the same model shall be indicated that would affect operator or maintenance actions. These differences shall be related explicitly to equipment model, part number, or serial number ranges in such a manner that the TM user can identify the specific equipment configuration involved. When model differences exist but have no effect on operation or maintenance, this fact shall be stated. (Refer to figure 2.)

5.1.3.4 Equipment data **<eqpdata>**.

- a. Performance data shall be prepared, including numerical and other standard-related data applying to operational and maintenance functions. The equipment data shall summarize the specific capabilities and limitations of the equipment and other critical data needed by the TM user for maintenance of the equipment. Vehicle and cargo space dimensions and metric and other equivalents shall be included. (Refer to figure 2.)
- b. For systems, a list of the environmental control requirements, such as limited temperature, humidity, or other limited conditions shall be prepared. Reference shall be made to the work package(s) containing information on damage to be expected from exceeding these limits and procedures for minimizing the damage.
- c. A summary shall be prepared that lists the effects of weather conditions on equipment affecting system capability or causing equipment damage. This summary shall include references to any special servicing procedures that must be accomplished because of climatic changes, such as adding antifreeze to coolants.
- d. Instructions for the use, transportation, handling, storage, or disposal of such substances as fuels, toxic and hazardous substances, chemicals, ordnance, and munitions shall be prepared. These instructions shall meet the applicable requirements of the Federal Environmental Protection Standards (standards to be provided by the contracting activity).
- e. The energy efficiency rating shall be included for products that directly consume energy in normal operations and that commonly have a method of expressing energy efficiency.
- 5.1.3.5 <u>Equipment configuration < eqpconfig></u>. For equipment which can be configured several different ways, information on the various possible configurations shall be prepared. (Refer to figure 2.)
- 5.1.4 <u>Theory of operation work package **<thrywp>**.</u> Theory of operation shall be prepared to provide the maintenance technician with adequate background information to support and perform maintenance tasks and troubleshooting on the weapon system, equipment or components. The amount of detail and complexity of the theory of operation presentation shall be in accordance with the Logistic Support Analysis (LSA) maintenance concept, the Maintenance Allocation Chart (MAC) or an approved maintenance plan. Theory of operation shall be provided as described in 5.1.4.1.
- 5.1.4.1 Theory presentation. Theory of operation shall consist of a functional narrative to explain the weapon system, equipment and component operation (electrical/electronic, hydraulic, pneumatic, and mechanical). Block diagrams, functional flow diagrams, schematics and other illustrations shall be included to support the text. Basic theory, normally found in textbooks, shall not be included. If the TM covers more than one model of equipment, or more than one configuration of weapon system, differences shall be explained or separate work packages may be used. Additional theory requirements are outlined below. (Refer to figures 4, 5 and 6.)
 - a. When necessary, introductory general information **<geninfo>** may precede the theory of operation narrative.
 - b. For simple systems or equipment/components, all theory may be included in a single work package.

- c. If the relative complexity of the weapon system/equipment is such that it is reasonable to first present the theory of the end item as a unit and then present the theory of its major systems <systhry>, subsystems <ssysthry>, and components (<lruthry> or <sruthry>), it shall be presented in a series of work packages. This shall be done to facilitate use and understanding.
- d. Theory narrative shall be to a depth necessary to support the technician in fault isolation to the level directed by the LSA and or maintenance plan. The operation of the weapon system and related systems/components shall be presented in a logical flow. Significant input, output, and control signals, supply voltages and power supply output voltages shall be identified. If the equipment operates in more than one mode, each mode shall be explained and supported by functional block diagrams. Theory of operation shall describe detailed circuitry of all repairable components as directed by the LSA/maintenance plan. Internal circuits, their relationship to each other, input and output signals, waveforms and time-phase relationship to significant waveforms shall be included when required to understand detailed equipment operation. Theory shall not be prepared for non-repairable, throw-away components.
- 5.1.5 Supporting data work package for repair parts, special tools, TMDE, and support equipment <supdatawp>.

NOTE

The following work package applies only to unit (-20), Aviation Unit Maintenance (AVUM), direct support (-30), Aviation Intermediate Maintenance (AVIM), general support (-40), and depot (overhaul) maintenance, and any combination of those maintenance levels (i.e., -23, -34, etc.).

This work package shall include a reference to the common tools and equipment; special tools, TMDE, and support equipment; and the repair parts as shown in 5.1.5.1 through 5.1.5.3.

5.1.5.1 <u>Common tools and equipment</u>. The following statement shall be included.

"COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE), CTA 50-970, Expendable/Durable Items (Except: Medical, Class V, Repair Parts, and Heraldic Items), or CTA 8-100, Army Medical Department Expendable/Durable Items, as applicable to your unit."

- 5.1.5.2 Special tools, TMDE, and support equipment. A reference to the Repair Parts and Special Tools List (RPSTL) and MAC shall be included. When no special tools or equipment are required, it shall be so stated. If tools are to be fabricated, reference to the Illustrated List of Manufactured Items work package shall be made.
- 5.1.5.3 Repair parts. One of the two following statements shall be included.

"Repair parts are listed and illustrated in the repair parts and special tools list (*insert TM number of RPSTL*)."

"Repair parts are listed and illustrated in supporting information work package (*insert appropriate work package sequence number*) of this manual."

6. **NOTES**.

The notes in section 6 of MIL-STD-40051 apply to this Part.

TM 11-6625-3178-14

TRANSPORTABLE ELECTRONIC SHOP GENERAL INFORMATION

0021 00

SCOPE

This technical manual contains instructions for operation, checks, and adjustments, and corrective maintenance for the AN/TSM-191(V)* Transportable Electronic Shop (shelter). The shelter provides a field level direct maintenance level, protected test facility which is used to support and improve the operational readiness of Army electronic and avionic systems.

Type of Manual: Operator, Unit, Direct, and General Support Maintenance.

Model Number and Equipment Names: AN/TSM-191(V)2 Transportable Electronic Shop, AN/TSM-192(V)3 Transportable Electronic Shop, AN/TSM-191(V)4 Transportable Electronic Shop.

Purpose of Equipment: The shelter provides a field level direct support maintenance level, protected test facility which is used to support and improve the operational readiness of Army electronic and avionic systems.



AN/TSM-191(V)2



AN/TSM-191(V)3



AN/TSM-191(V)4

FIGURE 1. Example of a general information work package.

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TRANSPORTABLE ELECTRONIC SHOP GENERAL INFORMATION -Continued

0021 00

MAINTENANCE FORMS, RECORDS, AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by (as applicable) DA PAM 738-750, Functional Users Manual for the Army Maintenance Management System (TAMMS); DA PAM 738-751, Functional Users Manual for the Army Maintenance Management System - Aviation (TAMMS-A); or AR 700-138, Army Logistics Readiness and Sustainability.

REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your shelter needs Improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to the address specified in DA PAM 738-750, or as specified by the contracting activity. We will send you a reply.

CORROSION PREVENTION AND CONTROL (CPC)

Corrosion Prevention and Control (CPC) of Army materiel is a continuing concern. It is important that any corrosion problems with this item be reported so that the problem can be corrected and improvements can be made to prevent the problem in future items.

While corrosion is typically associated with rusting of metals, it can also include deterioration of other materials, such as rubber and plastic. Unusual cracking, softening, swelling, or breaking of these materials may be a corrosion problem.

If a corrosion problem is identified, it can be reported using SF 368, Product Quality Deficiency Report. Use of key words such as "corrosion", "rust", "deterioration", or "cracking" will ensure that the information is identified as a CPC problem.

The form should be submitted to the address specified in DA PAM 738-750.

DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE

For procedures to destroy this equipment to prevent its use by the enemy, refer to TM 750-244-2, Procedures for Destruction of Electronic Materiel to Prevent Enemy Use.

NOMENCLATURE CROSS-REFERENCE LIST

Common Name Official Nomenclature

Shelter Transportable Electronic Shop (all models)
AN/TSM-191(*) Transportable Electronic Shop (all models)

0021 00-2

FIGURE 1. Example of a general information work package - Continued.

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TRANSPORTABLE ELECTRONIC SHOP GENERAL INFORMATION - Continued

0021 00

LIST OF ABBREVIATIONS/ACRONYMS

Abbreviation/Acronym

ac

Alternating Current

BIT

Built-in Test

C

Celsius

ECU

Environmental Control Unit

MCPE

Modular Collective Protection Equipment

SAFETY, CARE, AND HANDLING

The following procedures should be observed when handling all ESD sensitive components and units containing such components. Failure to observe all of these precautions can cause permanent damage to the electrostatic device. This damage can cause the device to fail immediately or at a later date when exposed to an adverse environment.

- 1. Turn off and/or disconnect all power, signal sources and loads used with the unit.
- 2. Place the unit on a grounded non-conductive work surface.
- Ground the repair operator using a non-conductive wrist strap or other device using 1 megaohm series resistor to protect the operator.
- 4. Ground any tools (including soldering equipment) that will contact the unit. Contact with the operator's hand provides a sufficient ground for tools that are otherwise electrically isolated.
- 5. All electrostatic sensitive replacement components are shipped in non-conductive foam or tubes and must be stored in the original shipping container until installed.
- 6. When these devices and assemblies are removed from the unit, they should be placed on the non-conductive work surface or in non-conductive containers.
- 7. When not being worked on, place deconnected circuit boards in plastic bags that have been coated or impregnated with a non-conductive material.
- Do not handle these devices unnecessarily or remove them from their packages until actually used or tested.

TM 11-6625-3178-14

TRANSPORTABLE ELECTRONIC SHOP EQUIPMENT DESCRIPTION AND DATA

0042 00

EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

The Transportable Electronic Shop, AN/TSM-191(*) is a truck mounted, modified S-280C/G electrical equipment shelter which contains an Electrical-Electronic Equipment Test Station AN/USM-632(*), an Environmental Control Unit (ECU), Modular Collective Protection Equipment (MCPE) (applies to AN/TSM-191(V)2 and AN/TSM-191(V)3 only), a power distribution system and interconnecting cables. The shelter is a front-line automatic test system used to perform diagnostic checks and troubleshoot designated electronic susystems. The modified S-280C/G shelter provides housing, equipment and work space for the AN/USM-632(*). The AN/USM-632(*) performs computer controlled testing on suspected faulty Units Under Test (UUTs).

The test station is installed in a truck mounted shelter. The shelter cooling and heating is provided by a built in ECU which allows operation under a wide range of weather conditions. Environmental protection against chemical and biological contamination is provided by the MCPE (applies to AN/TSM-191(V)2 and AN/TSM-191(V)3 only). The shelter is powered by an external power source. The test station is capable of running self-test and self-alignment programs with fault isolation routines. Tests and isolates faults in UUTs automatically via computer controlled test programs.

LOCATION AND DESCRIPTION OF MAJOR COMPONENTS

EXTERIOR COMPONENTS

The following paragraph applies to both models of ECU's.

NOTE

Horizontal ECU is used only on AN/TSM-191(V)3. Vertical ECU is used only on AN/TSM-191(V)2 and AN/TSM-191(V)4.

ENVIRONMENTAL CONTROL UNIT (ECU)

The ECU is a compact, electric motor driven unit which provides filtered, cooled air (and heated air, as required) to maintain the service conditions of the AN/USM-632(*). The horizontal unit has a cooling compacity of 36,000 BTU/hr and a heating capacity of 31,200 BTU/hr. The input power requirements for the horizontal ECU are three phase, 208 delta volts ac, 50/60Hz at 13.5 kw. The vertical unit has a cooling capacity of 36,000 BTU/hr and a heating capacity of 28,600 BTU/hr. The input power requirements for the vertical ECU are three phase, 208 delta volts ac, 400 Hz at 11.0kw. A detailed description of both model air conditioners can be found in the technical manuals referenced in WP 0205 00

MODULAR COLLECTIVE PROTECTION EQUIPMENT (MCPE)

The MCPE removes toxic gases and dust from air supplied to the shelter in a Nuclear, Biological Chemical (NBC) environment. The MCPE consists of an XM20 external Integrated Protective Entrance (external IPE) and an XM93-100 CFM Gas-Particulate Filter Unit (GPFU). The external IPE is a collapsible assembly which provides a pressurized transition area between the shelter and the outside contaminated environment. The external IPE assembly consists of top and bottom pan assemblies, support assemblies and a biological and chemical resistant fabric assembly that attaches to the pan assemblies. The fabric forms the entrance assembly walls and has a zipper sewn in which forms the access door to the protective entrance from the outside contaminated zone. A door assembly consists of inner and outer door assemblies. The protective entrance assembly mounts to the outside of the outer door. During non-NBC operation, the entrance is collapsed against the outer door. In this operating mode, the outer door functions as a normal shelter door to allow access to the shelter and ventilation for shelter personnel. During NBC operation, the entrance assembly is erected and access to the shelter is through the inner door and the zipper door on the entrance assembly. A Protective Entrance Module (PEM) is mounted in the roof shell of the top pan assembly. When the entrance assembly is errect, the PEM provides white or blackout (red) lighting, decontamination purge timing and low pressure warning for the protective entrance.

0042 00-1

FIGURE 2. Example of an equipment description and data work package.

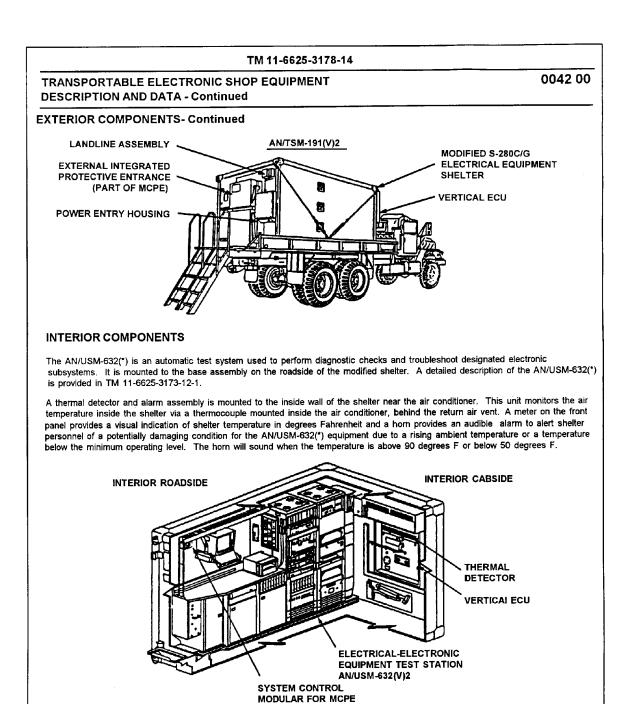


FIGURE 2. Example of an equipment description and data work package - Continued.

TM 11-6625-31-78-14

TRANSPORTABLE ELECTRONIC SHOP EQUIPMENT DESCRIPTION AND DATA - Continued

0042 00

DIFFERENCES BETWEEN MODELS

Table 1 summarizes the difference between the three models of the shelter covered in this manual.

Table 1. Differences Between Models.

EQUIPMENT DESCRIPTION	AN/TSM-191(V)2 P/N A3070220-4	AN/TSM-191(V)3 P/N A3100860-2	AN/TSM-191(V)4 P/N A3143250
Electrical-Electronic Equipment Test Station Model AN/USM-632(V)2	х		x
Electrical-Electronic Equipment Test Station Model AN/USM0-632(V)3	-	X	-
Air Conditioner, Verticle, Compact, Keco Model: F36T4-2SB	x		x
Air Conditioner, Horizontal, Compact, Keco Model: F36H-2S	_	x	_
Frequency Converter, Avionic Instruments, Model: 4A3000-1B-HRP	X		x
Filter Unit, Gas-Particulate, 100 CFM, Model: XM93	x	X	
Entrance, Protective, Integrated, Extenal, Pressurized, Model: XM20	x	X	-

EQUIPMENT DATA

Table 2 provides information pertaining to the operational, electrical, mechanical, and environmental characteristics of the shelter.

Table 2. Equipment Data.

ITEM	AN/TSM-191(V)2	AN//TSM-191(V)4	AN/TSM-191(V)3
Mechanical Characteristics:			
Length	186.00 in. exterior	166.00 in. exterior	200,00 in. exterior
	138,00 in. exterior	138.00 in, interior	138.00 in. interior
Width	87.00 in. exterior	87.00 in. exterior	87.00 in. exterior
	81.50 in. interior	81.50 in. interior	81,50 in. interior
Height	83,38 in. exterior	83.38 in. exterior	86.38 in. exterior
	77.12 in, interior	77.12 in. interior	77,12 in. interior
Weight	7.805 lb	7,416 lb	7,630 lb
Cubage	787.09 cu. ft.	735.09 in, cu. ft.	870.09 in. cu. ft.
Electrical		1	1
Characteristics:		1	

FIGURE 2. Example of an equipment description and data work package - Continued.

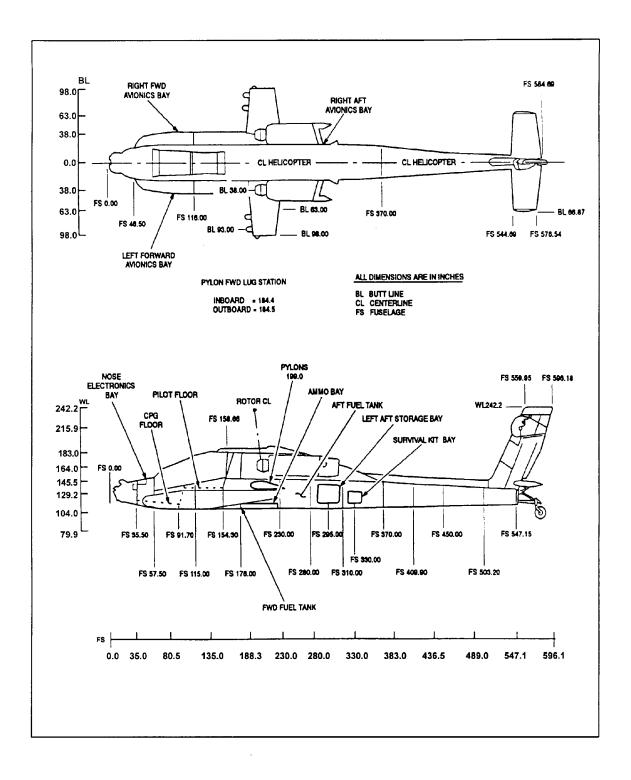


FIGURE 3. Example of a station diagram.

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TRANSPORTATION ELECTRONICS SHOP CONTROLS THEORY OF OPERATION

0015 00

SYSTEM OPERATION

POWER ENTRY HOUSING AND SECONDARY INPUT POWER FILTER

Three phase input power from an external source, i.e. diesel powered genarator or facility power, is cabled to the power entry housing and connected to the power input connector. Inside the housing, each phase line and the neutral line are wired to four independent surge arresters and the primary input power filter. The surge arresters protect the circuits within the shelter from transients caused by lightning, induction, switching surges and Electro Magnetic Pulse (EMP). When a surge voltage exceeds the sparkover voltage of the arrester, the arrester becomes a short circuit and remains so until the transient has been by-passed and the line automatically returns to normal. The primary input power filter suppresses condition of noise caused by Electro Magnetic Interference (EMI), into and out of the shelter over the input power lines. A secondary input power filter is connected in series with the primary input power filter to ensure protection of shelter circuits from transient voltages below the sparkover voltage of the EMP protectors coming in through the power lines.

POWER DISTRIBUTION ASSEMBLY (PDA)

The PDA consists of a base assembly which houses the circuit protection and the power distribution panel which contains circuit breakers and indicators. The circuit protection devices consist of an over/under voltage-relay, a phase sequence relay and an over current relay. If a condition exists in a circuit that does not meet the parameters of any one of these devices, that fault will cause the MAIN POWER circuit breaker to reset to the OFF position, thereby removing power to the internal circuits of the shelter and causes the AC POWER FAULT light to come on. When set to ON, the MAIN POWER circuit breaker applies power to the inputs of the other breakers and three green power indicators showing power applied for each phase will come on. As each of the remaining circuit breakers are set to ON, the corresponding indicators will come on providing a visual indication of power applied to each circuit.

ENVIRONMENTAL CONTROL UNIT (ECU)

(Horizontal ECU is used only on the AN/TSM-191(V)3 model of the shelter. Vertical ECU is used only on the AN/TSM-191(V)2 and AN/TSM-191(V)4 models of the shelter.) Once started, the air conditioner operates automatically due to the relationship of the components, controls and instruments. With the model selector switch in the OFF position, all electrical components are isolated from electrical power except for the crankcase heater. This device must be energized for 30 minutes prior to operation in the coolmode. The following operating modes of the ECU are controlled by the mode selector switch.

Ventilation

Ventilation is provided in the VENT position by energizing the fan motor which forces air out of the evaporator discharge louver. The amount of outdoor air used for ventilation is determined by the position of the fresh air damper.

Cooling

With the mode selector in the COOL position, the fan motors are energized and 30 seconds later the compressor is energized. Once started, all the fan motors and compressor run continuously. The temperature selector controls the amount of cooling.

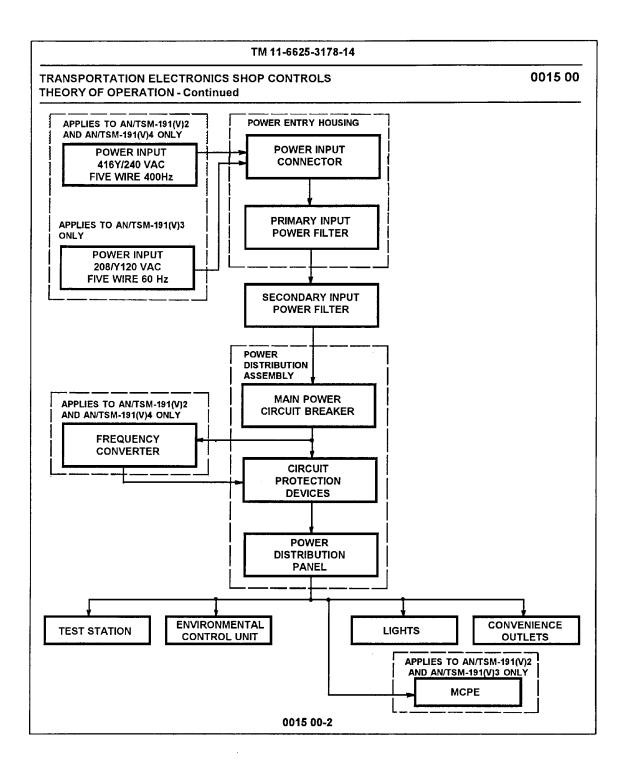


FIGURE 4. Example of system theory of operation - Continued.

TM 1-1520-238-T-9

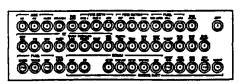
APU SUBSYSTEM THEORY OF OPERATION

0022 00

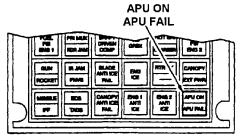
GENERAL

The pilot center circuit breaker panel, APU fire panel assembly and pilot caution/warning panel provide the controls and indications for the APU.

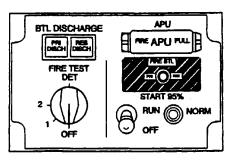
- 1. Pilot Center Circuit Breaker Panel. The pilot center circuit breaker panel FUEL APU, FUEL BST, and APU HOLD circuit breakers provide circuit protection and 28 VDC for APU operation.
- 2. Pilot Caution/Warning Panel. The pilot caution/warning panel provides the pilot with APU ON and APU FAIL indications.
 - a. APU ON indicator. The APU ON indicator lights when the APU reaches 95% rpm.
 - b. APU FAIL indicator. The APU FAIL indicator lights when oil pressure drops below 75 psig, except when the START/RUN/OFF switch is in the START position.
- 3. APU Fire Panel Assembly. The APU fire panel assembly controls APU start/run operation and APU fire indication.



PILOT CENTER CIRCUIT BREAKER PANEL



PILOT CAUTION/WARNING PANEL



APU FIRE PANEL ASSEMBLY

FIGURE 5. Example of subsystem theory of operation.

TM 1-1520-238-T-9

APU SUBSYSTEM THEORY OF OPERATION - Continued

0022 00

GENERAL - Continued

- a. APU FIRE PULL handle. The APU FIRE PULL handle wams the pilot that a fire exists in the APU shroud assembly or SDC area. When FIRE TEST DET switch is set to 1, the APU FIRE PULL handle lights to indicate the upper flame detector circuits and components are functioning. When FIRE TEST DET switch is set to 2, the APU FIRE PULL handle lights to indicate the lower flame detector circuits and components are functioning. When the APU FIRE PULL handle is pulled, the APU fuel shutoff valve is closed and the selected fire bottle is discharged.
- b. 55%/NORM switch. The 55% position is used during cold weather starts when the outside air temperature is 0°F (-18°C) or below. The NORM position is used during normal starts when the outside air tempera ture is above 0°F (-18°C).
- c. START/RUN/OFF switch. The START position initiates the APU start sequence. The START position is spring-loaded to the RUN position. The RUN position allows steady state automatic APU operation. In the OFF position, no voltage is supplied to the APU.

THEORY OF OPERATION

APU circuit breaker (CB148) and APU HOLD circuit beaker (CB10) protect the APU start system circuitry from excessive current and provide 24VDC from the battery to the APU fire panel assembly for START/RUN power.

When the START/RUN/OFF switch is set to the START position, FUEL APU circuit breaker (CB9) supplies 28 VDC to the APU fuel boost pump and APU fuel shutoff valve.

- 1. The APU shutoff valve provides automatic control of fuel flow from the aft fuel cell to the APU fuel boost pump.
- 2. The APU fuel boost pump provides a positive fuel flow to the APU fuel solenoid valve.
- 3. The APU fuel solenoid valve is opened by the APU controller when the APU reaches 5% rpm, providing fuel to the APU fuel control.

FUEL BST circuit breaker (CB57) supplies 28 VDC to the time delay relay and to the APU controller. The SDC time delay relay de-energizes the shaft driven compressor throttle valve for 60 seconds. The APU controller initiates, controls and monitors the start sequence, normal operation and automatic shutdown as follows.

The hydraulic start solenoid valve is energized open by the APU controller. The hydraulic start solenoid
valve opens to release 3000 psi hydraulic pressure from the utility hydraulic accumulator through the
hydraulic starter. APU rotation begins.

FIGURE 5. Example of subsystem theory of operation - Continued.

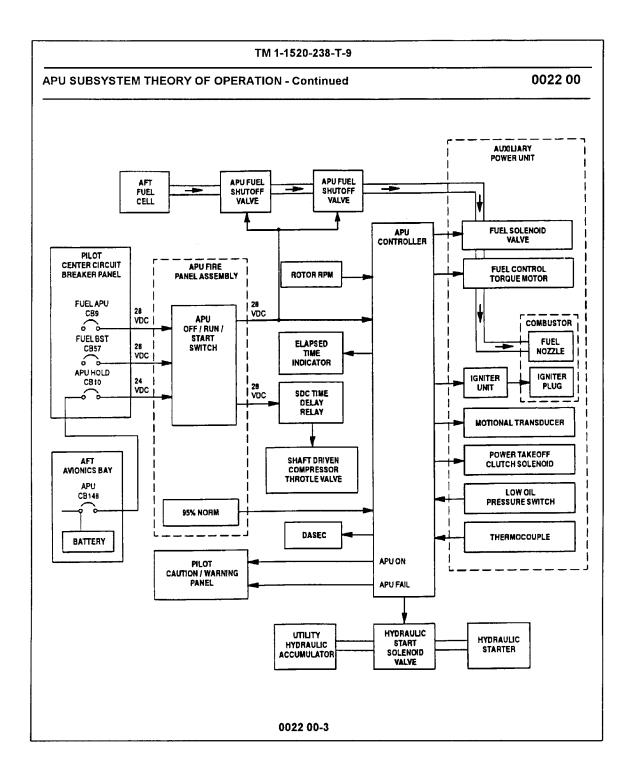


FIGURE 5. Example of subsystem theory of operation - Continued.

TM 11-6625-3278-40

AN/USM-620 DETAILED THEORY OF OPERATION

0411 00

POWER MODULE SECTION

The Power Module Section provides DC voltages and forced air cooling for TR 503 Tracking Generator. This section describes each module within TM 5003 Power Module. Refer to figures 23 through 26 for schematic diagrams.

A3A10 Main Interface CCA

Sends DC and AC voltages, and the PWR signal, to each of three plug-in sockets. PWR indicates when the main power supply is operating.

DC Voltages are +8, +26, and -26 V. Transformer A3T500 couples AC power from A3A14 Line Filter CCA to secondary voltage taps. AC voltages are 25 and 18 V. A 16 VAC feedback signal connects to A3A10J1110. This signal is rectified by A3A11CR1561 to supply power for A3A11U1550. The current sense input to A3A11U1550 also uses this supply.

The PWR signal from A3A10Q1125 drives pin 6 of each plug-in socket. The signal is normally high when power is on. A3A11U1850 pin 7 controls the status of PWR. Pin 7 is normally low. A3A11U1850 pin 7 toggles high when triggered by A3A11U1720A or by A3A11U1550.

A3A11 Secondary Supply CCA

Contains a secondary rectifier circuit, a control logic and drivers circuit, an over-voltage and over-current detectors circuit, and a control circuit regulator. The secondary rectifier circuit produces DC voltages. The control logic and drivers circuit produces a 20 kHz drive signal. The output regulator circuit produces a 40 kHz clock signal and sets the +8 V output level. The over-voltage and over-current detectors circuit limits duty cycle when output voltage or current is too high. The control circuit regulator produces reference voltages and the PWR signal.

The secondary rectifier circuit produces +26, +8, -26 VDC supplies. Each supply connects to plug-in sockets on A3A10 Main Interface CCA. Transformer A3A11T1210 couples the 20 kHz drive signal to diode rectifiers. Diodes A3A11CR1010 and A3A11CR1020 produce the +26 V supply. Diode A3A11CR500 provides the +8 V supply. Diodes A3A11CR1021 and A3A11CR1120 produce the -26 V supply. Transformer A3A11T1000 regulates power by producing over-voltage feedback that controls the duty cycle of the 20 kHz drive signal. Diodes A3A11CR1502, A3A11CR1510, A3A11CR1511, and A3A11CR1512 rectify the output of A3A11T1000. The resulting DC voltage drives A3A11U1540B, a comparator within the over-voltage and over-current detectors circuit.

The control logic and drivers circuit produces a 20 kHz drive signal for the 20 kHz output amplifier. Transistors A3A11Q1400 and A3A11Q1401 produce the 20 kHz output. Current is supplied by the +10 V source (A3A11U1550 pin 10). Duty cycle of the 20 kHz signal changes to control regulation. Gates A3A11U1610A and A3A11U1610B receive four input signals to control 20 kHz switching. A high on any input causes A3A11Q1400 and A3A11Q1401 to conduct. During power on or power off, A3A11Q1650 also controls A3A11Q1400 and A3A11Q1401 through A3A11R1511 and A3A11R1520. Flip-flop A3A11U1720A controls A3A11U1610 pins 5 and 10. This signal is normally high. Refer to over-voltage and over-current detectors circuit description for details of operation. Multivibrator A3A11U1720B drives A3A11U1610 pins 3 and 12. A3A11U1720B ensures that A3A11Q1400 and A3A11Q1401 never conduct at the same time. The minimum dead time (time when A3A11Q1400 and A3A11Q1401 are both off) is controlled by the time constant of A3A11R1610 and A3A11C1710. The voltage charge on A3A11C1730 and A3A11C1831 also affects dead time. During turn on, current from the supply is limited until these capacitors reach full charge. The 40 kHz clock signal drives A3A11U1720B pin 11 to provide timing. Monostable A3A11U1600A drives A3A11U1610 pins 4 and 11. A3A11U1600A limits duty cycle when output voltages are too high. Refer to output regulator circuit description for details of operation. Divide by two flip-flop A3A11U1600B drives A3A11U1600B converts the drive signal from 40 kHz to 20 kHz.

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