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AEROFLEX

Ramp Test Set TCAS-201-2 Operation Manual

1002-8505-200
Issue-2

OPERATION MANUAL

RAMP TEST SET

TCAS-201-2

PUBLISHED BY
Aeroflex

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Cable Statement:

A double shielded and properly terminated external interface cable must be used with this equipment when interfacing with the COMM Connector.

For continued EMC compliance, all external cables must be 3 meters or less in length.

Nomenclature Statement:

In this manual the In this manual the TCAS-201, TCAS-201 Test Set, Unit, Test Set or TCAS-201 Ramp Test Set refers to the TCAS-201-2 Ramp Test Set.



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SAFETY FIRST: TO ALL OPERATIONS PERSONNEL

REFER ALL SERVICING OF UNIT TO QUALIFIED TECHNICAL PERSONNEL. THIS UNIT CONTAINS NO OPERATOR SERVICEABLE PARTS.

WARNING: USING THIS EQUIPMENT IN A MANNER NOT SPECIFIED BY THE ACCOMPANYING DOCUMENTATION MAY IMPAIR THE SAFETY PROTECTION PROVIDED BY THE EQUIPMENT.

CASE, COVER OR PANEL REMOVAL

Removing the Chassis Assembly from the Case Assembly exposes the operator to electrical hazards that can result in electrical shock or equipment damage. Do not operate this Test Set with the Chassis Assembly removed from the Case Assembly.

SAFETY IDENTIFICATION IN TECHNICAL MANUAL

This manual uses the following terms to draw attention to possible safety hazards, that may exist when operating this equipment.

CAUTION: THIS TERM IDENTIFIES CONDITIONS OR ACTIVITIES THAT, IF IGNORED, CAN RESULT IN EQUIPMENT OR PROPERTY DAMAGE (E.G., FIRE).

WARNING: THIS TERM IDENTIFIES CONDITIONS OR ACTIVITIES THAT, IF IGNORED, CAN RESULT IN PERSONAL INJURY OR DEATH.

SAFETY SYMBOLS IN MANUALS AND ON UNITS



CAUTION: Refer to accompanying documents.



AC OR DC TERMINAL: Terminal that may supply or be supplied with ac or dc voltage.



DC TERMINAL: Terminal that may supply or be supplied with dc voltage.



AC TERMINAL: Terminal that may supply or be supplied with ac or alternating voltage.



SWITCH ON/OFF (Push-Push): AC line power to the device is connected ON or disconnected OFF.

EQUIPMENT GROUNDING PRECAUTION

Improper grounding of equipment can result in electrical shock.

USE OF PROBES

Check the specifications for the maximum voltage, current and power ratings of any connector on the Test Set before connecting it with a probe from a terminal device. Be sure the terminal device performs within these specifications before using it for measurement, to prevent electrical shock or damage to the equipment.

POWER CORDS

Power cords must not be frayed, broken nor expose bare wiring when operating this equipment.

USE RECOMMENDED FUSES ONLY

Use only fuses specifically recommended for the equipment at the specified current and voltage ratings.

INTERNAL BATTERY

This unit contains a Sealed-Lead Battery, serviceable only by a qualified technician.

CAUTION: SIGNAL GENERATORS CAN BE A SOURCE OF ELECTROMAGNETIC INTERFERENCE (EMI) TO COMMUNICATION RECEIVERS. SOME TRANSMITTED SIGNALS CAN CAUSE DISRUPTION AND INTERFERENCE TO COMMUNICATION SERVICES OUT TO A DISTANCE OF SEVERAL MILES. USERS OF THIS EQUIPMENT SHOULD SCRUTINIZE ANY OPERATION THAT RESULTS IN RADIATION OF A SIGNAL (DIRECTLY OR INDIRECTLY) AND SHOULD TAKE NECESSARY PRECAUTIONS TO AVOID POTENTIAL COMMUNICATION INTERFERENCE PROBLEMS.



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INTRODUCTION - TCAS-201 RAMP TEST SET

This manual contains TCAS-201 operating instructions for ramp testing ACRBS and Mode S Transponders and TCAS equipped Interrogators. It is strongly recommended that personnel be thoroughly familiar with the contents of this manual before attempting to operate this equipment.

Refer all servicing of the TCAS-201 Test Set to qualified technical personnel.

ORGANIZATION

This manual is divided into five sections as follows:

CHAPTER 1 - OPERATION

- Section 1 - DESCRIPTION (physical description of the TCAS-201)
- Section 2 - OPERATION (installation; description of controls, connectors and indicators; performance evaluation and general operating procedures)
- Section 3 - SPECIFICATIONS
- Section 4 - SHIPPING
- Section 5 - STORAGE



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SECTION 1 - DESCRIPTION

1. GENERAL DESCRIPTION AND CAPABILITIES

1.1 DESCRIPTION

The TCAS-201 Ramp Test Set is a ruggedized simulator designed for ease of use, portability, reliability and long service life. Power is derived from an internal battery. An ac input connection is provided for battery charging, bench operation or servicing use. Most accessories (Flat Antenna, Antenna Cable, Operator's Guide, ac Power Cable, Flexible Antenna, Antenna Shield and Fuse) are kept in the Storage Compartment (Case Assembly Lid). The Tripod is stored separately. Refer to Appendix C for description of accessories.

The TCAS-201 Ramp Test Set, simulating a transponder with Mode C and Mode S capabilities, allows the user to perform the required ground tests for Follow-On Certifications as defined in the FAA Advisory Circular #20-131, Airworthiness and Operational Approval of Traffic Alert and Collision Avoidance Systems (TCAS II) and Mode S Transponders. The TCAS-201 also simulates many in-flight conditions required for Follow-On Certifications. The TCAS-201 Test Set can be used to eliminate many costly hours of flying time.

1.2 FUNCTIONAL CAPABILITIES

The TCAS-201 has the following features and capabilities:

- Accurate measurements of interrogator transmitting frequency, output power and Whisper-Shout accuracy (using Attenuation control).
- Scenario testing, simulating planned encounters with Mode C or Mode S intruders in order to activate aural and visual Traffic Advisories (TAs) and Resolution Advisories (RAs).
- Ruggedized construction designed for the conditions encountered in the ramp environment.
- Soft-press key controls for easy operation.
- Built-In-Test (BIT) for confidence testing and fault isolation.
- Non-volatile memory for storing up to ten user-programmed scenarios.
- Selectable altitude levels to test inhibit climb RAs and low altitude operation.
- Broadcast Interrogation Monitor with display of Interrogating Aircraft Address.
- Squitter generation with selectable squitter address.
- Selectable percent reply (ATCRBS) in 10% steps.
- LCD Display with automatic light sensing illumination control.
- RF, Monitor, Interrogation Video and Sync Pulse outputs for use in bench testing.
- Internal Battery allowing up to 1.5 hours of operation before recharge.
- Automatic power shutdown after approximately 15 minutes of non-use when ac power is not connected.
- Size and usability to allow one person operation on the ramp.
- Switchable TCAS I (no P4 width detection) or TCAS II (normal P4 width detection) operation.



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SECTION 2 - OPERATION

1. INSTALLATION

1.1 GENERAL

The TCAS-201 is powered by an internal battery. The Test Set contains a battery charging circuit which enables the operator to recharge the battery when connected to ac power.

NOTE: The TCAS-201 can operate continuously on ac power for servicing and/or bench tests.

Refer to 1-2-2, Figure 2 for location of controls, connectors or indicators.

1.2 BATTERY OPERATION

The internal battery is equipped to power the TCAS-201 for 1.5 hours of continuous use before needing recharging. When executing the Self Test function, the DISPLAY indicates whether the battery is usable or in need of recharging.

NOTE: When battery is low during operation, ****LOW BATTERY**** appears in the right half of the fifth line on the DISPLAY. An example is shown in 1-2-4, Figure 17. Continued operation with a low battery results in an automatic power shut down (based on voltage drop) after a few minutes.

The TCAS-201 contains an automatic time-out to conserve power. If a key is not pressed within a 15-minute time period, the Test Set shuts Off (only when using battery power).

1.3 BATTERY CHARGING

The battery charger operates whenever ac power is applied to the Test Set and the POWER Key is pressed Off. When charging, the battery reaches an 80% charge in approximately two hours. The battery should be charged every three months (minimum) or disconnected for long term inactive storage periods of more than six months.

1.4 SAFETY PRECAUTIONS

The following safety precautions must be observed during installation and operation. Aeroflex assumes no liability for failure to comply with any safety precaution outlined in this manual.

1.4.1 Complying with Instructions

Installation/operating personnel should not attempt to install or operate the TCAS-201 without reading and complying with instructions contained in this manual. All procedures contained in this manual must be performed in exact sequence and manner described.

1.4.2 Grounding Power Cord

WARNING: USING A THREE-PRONG TO TWO-PRONG ADAPTER PLUG CREATES A SHOCK HAZARD BETWEEN THE CHASSIS AND ELECTRICAL GROUND.

For ac operation, the power cord, equipped with standard three-prong plug, must be connected to a properly grounded three-prong receptacle. It is the customer's responsibility to:

- Have a qualified electrician check receptacle(s) for proper grounding.
- Replace any standard two-prong receptacle(s) with properly grounded three-prong receptacle(s).

1.4.3 Operating Safety

Due to potential for electrical shock within test equipment, the Chassis Assembly must not be removed from the Case Assembly. Battery/Voltage Instructions, component replacement and internal adjustments must only be performed by qualified service technicians.

1.4.4 CAUTION and WARNING Labels

Exercise extreme care when performing operations preceded by a CAUTION or WARNING label. CAUTION labels appear where possibility of damage to equipment exists. WARNING labels denote conditions where bodily injury or death may result.



1.5 AC POWER REQUIREMENTS

The TCAS-201 operates over a voltage range of 100 to 120 VAC at 60 Hz or 220 to 240 VAC at 50 Hz according to the internal Line Supply Switch setting (only serviceable by a qualified technician). Refer to Battery/Voltage Instructions.

The specified fuse ratings are listed in 1-2-1, Table 1.

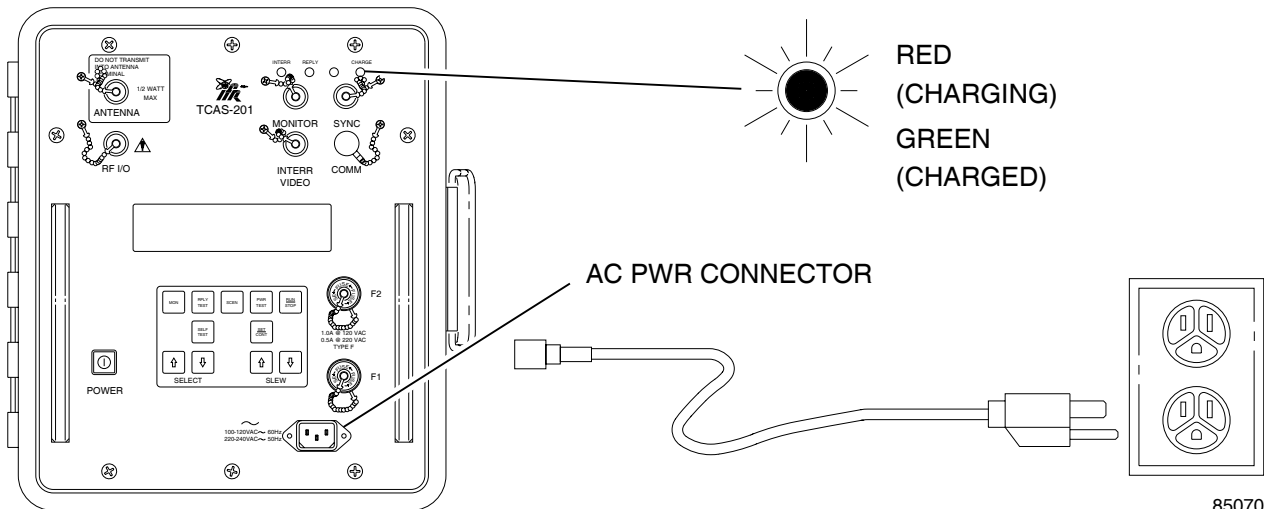
CAUTION: FOR CONTINUOUS PROTECTION AGAINST FIRE, REPLACE ONLY WITH FUSES OF THE SPECIFIED VOLTAGE AND CURRENT RATINGS.

INPUT VOLTAGE	F1 AND F2 FUSES
100 to 120 VAC	1.0 A, 250 V Fast Blo (Type F) (Aeroflex 5106-4501-000) (Bussman AGC1)
220 to 240 VAC	0.5 A, 250 V Fast Blo (Type F) (Aeroflex 5106-0000-016) (Bussman AGC1/2)

Specified Fuse Ratings
Table 1

1.6 FAA REQUIREMENTS

The Federal Aviation Administration (FAA) requires procedures for eliminating the potential for interfering with TCAS-equipped aircraft during transponder testing. Problems arise when the transponder is operating with the aircraft on the ground and the automatic altitude reporting system "pumped up." Three methods of FAA compliance are: shielding transponder antenna(s), connecting the TCAS-201 directly to the transponder under test and testing in an anechoic enclosure. The Antenna Shield provides a practical way of complying with the FAA requirement when a direct connection or anechoic enclosure is not available. Refer to Appendix C for Antenna Shield installation. Refer to para 1-2-4.4, 1-2-4.5 and 1-2-4.6 for testing procedures when using the Antenna Shield.



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Battery Recharging
Figure 1

1.7 BATTERY RECHARGING

Refer to 1-2-1, Figure 1.

STEP	PROCEDURE
1.	Verify FUSES are correct for normal operating voltage. Refer to para 1-2-1.5.
2.	Connect ac power cable between AC PWR Connector and normal operating voltage power source according to Test Set configuration. Refer to para 1-2-1.5.
3.	Verify DISPLAY is Off. If DISPLAY is On, press POWER Key.
4.	Verify CHARGE Indicator illuminates red.
5.	Allow two hours for battery charge or until CHARGE Indicator illuminates green.
NOTE: If the battery fails to accept a charge and the TCAS-201 Test Set does not operate on battery power, the battery, serviceable only by a qualified technician, requires replacement. Refer to Battery/Voltage Instructions.	

1.8 EXTERNAL CLEANING

The following procedure contains routine instructions for cleaning the outside of the Test Set.

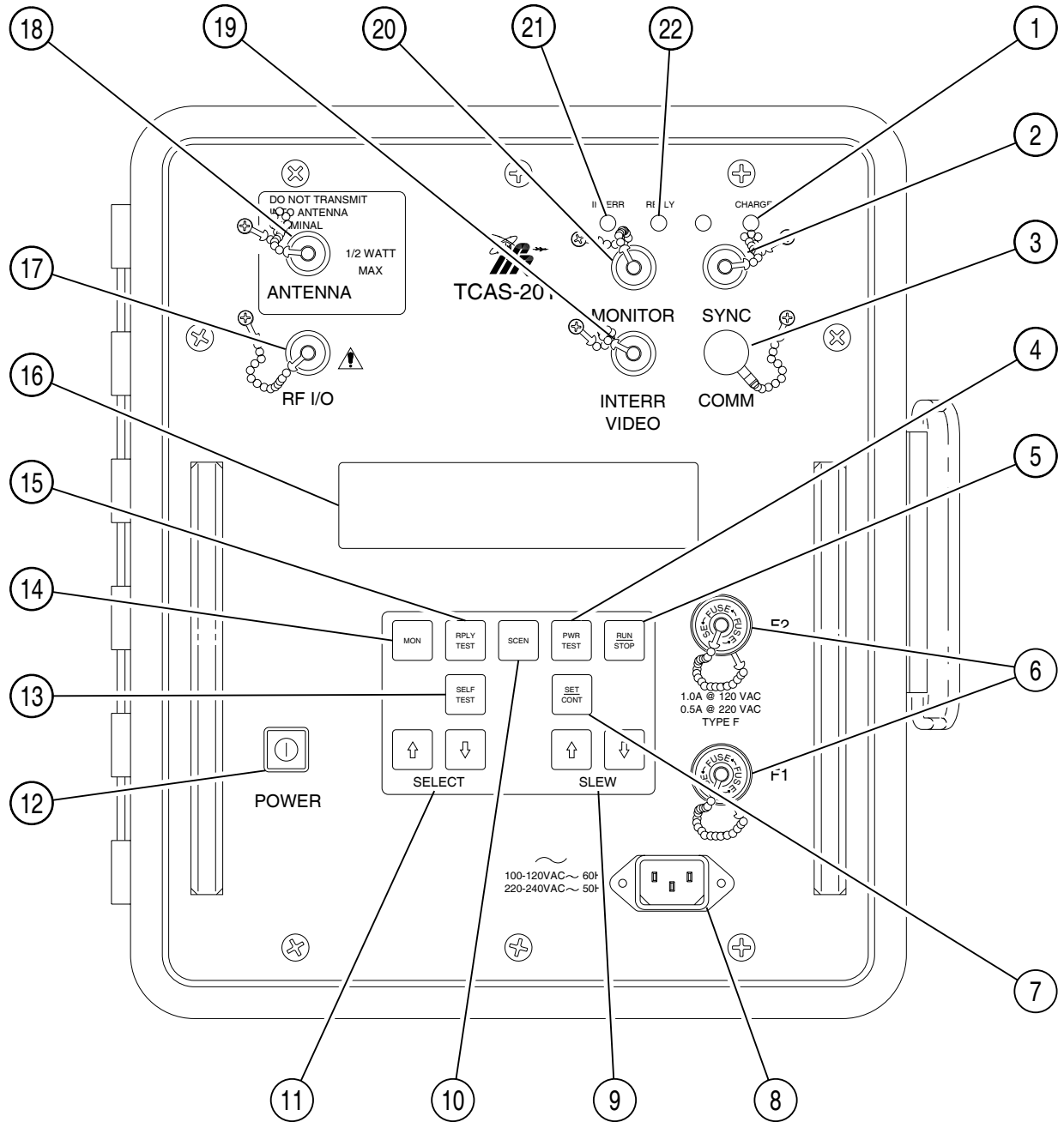
CAUTION: DISCONNECT POWER FROM TEST SET TO AVOID POSSIBLE DAMAGE TO ELECTRONIC CIRCUITS.

STEP	PROCEDURE
1.	Clean front panel buttons and display face with soft lint-free cloth. If dirt is difficult to remove, dampen cloth with water and a mild liquid detergent.
2.	Remove grease, fungus and ground-in dirt from surfaces with soft lint-free cloth dampened (not soaked) with isopropyl alcohol.
3.	Remove dust and dirt from connectors with soft-bristled brush.
4.	Cover connectors, not in use, with suitable dust cover to prevent tarnishing of connector contacts.
5.	Clean cables with soft lint-free cloth.
6.	Paint exposed metal surface to avoid corrosion.



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2. CONTROLS, CONNECTORS AND INDICATORS





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TCAS-201 Front Panel
Figure 2

CONTROLS, CONNECTORS AND INDICATORS IN NUMERIC ORDER	CONTROLS, CONNECTORS AND INDICATORS IN ALPHABETICAL ORDER
1. CHARGE Indicator	AC PWR Connector (J10050) 8
2. SYNC Connector (J10055)	ANTENNA Connector (J10057) 18
3. COMM Connector (J10053)	CHARGE Indicator 1
4. PWR TEST Key	COMM Connector (J10053) 3
5. RUN/STOP Key	DISPLAY 16
6. FUSES	FUSES 6
7. SET/CONT Key	INTERR Indicator 21
8. AC PWR Connector (J10050)	MONITOR Connector (J10056) 20
9. SLEW Keys	MON Key 14
10. SCEN Key	POWER Key 12
11. SELECT Keys	PWR TEST Key 4
12. POWER Key	REPLY Indicator 22
13. SELF TEST Key	INTERR VIDEO Connector (J10054) 19
14. MON Key	RF I/O Connector (J10058) 17
15. RPLY TEST Key	RPLY TEST Key 15
16. DISPLAY	RUN/STOP Key 5
17. RF I/O Connector (J10058)	SCEN Key 10
18. ANTENNA Connector (J10057)	SELECT Keys 11
19. INTERR VIDEO Connector (J10054)	SELF TEST Key 13
20. MONITOR Connector (J10056)	SET/CONT Key 7
21. INTERR Indicator	SLEW Keys 9
22. REPLY Indicator	SYNC Connector (J10055) 2

2.1 FRONT PANEL

Refer to 1-2-2, Figure 2.

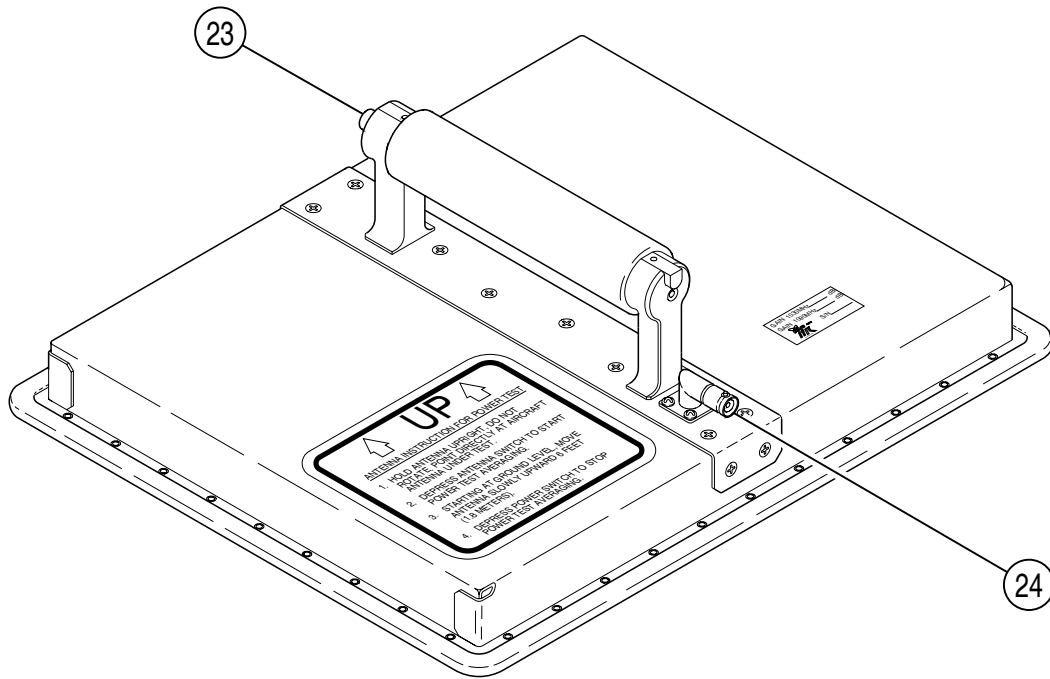
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1.	<p>CHARGE Indicator</p> <p>LED indicates the charger is active (ac applied with Test Set Off). Red indicates when battery is charging and green indicates battery is more than 80% charged.</p>	8.	<p>AC PWR Connector (J10050) </p> <p>Provides the input for an external ac power source (100 to 120 VAC at 60 Hz or 220 to 240 VAC at 50 Hz) for recharging the battery or operating the Test Set. The operating voltage range depends on the Line Supply Switch Setting, only serviceable by a qualified technician. Refer to Battery/Voltage Instructions.</p>
2.	<p>SYNC Connector (J10055)</p> <p>BNC type connector provides Oscilloscope Sync. Long pulse goes from low to high before a reply and from high to low before an interrogation.</p>	9.	<p>SLEW Keys</p> <p>Used to:</p> <ul style="list-style-type: none"> ● Adjust values in Scenario Test, Reply Test and Monitor screens. ● Select Signal Type and adjust Attenuation in Diagnostics screen. ● Set parameters and select memory storage in Setup Menus. <p>Variable slew rates are available, depending on item being edited. Keeping SLEW Key pressed provides greater rate of change, in most instances, than pressing and releasing.</p>
3.	<p>COMM Connector (J10053)</p> <p>LEMO type connector not used at this time.</p>	10.	<p>SCEN Key</p> <p>Enters Scenario Test screen (for programming intruder scenarios) onto the DISPLAY.</p>
4.	<p>PWR TEST Key</p> <p>Enters Power & Frequency screen onto the DISPLAY.</p>	11.	<p>SELECT Keys</p> <p>Used to select:</p> <ul style="list-style-type: none"> ● Items to edit in Setup Menus, Scenario Test screens and Reply Test screens. ● Diagnostics screen from Self Test screen.
5.	<p>RUN/STOP Key</p> <p>Initiates or terminates Scenario Test, Reply Test or Monitor actions. The RUN/STOP Key also activates the store or recall operation in the Setup #1 Menu screen.</p>	12.	<p>POWER Key </p> <p>Applies power to the Test Set; push On (I) or push Off (O).</p> <p>NOTE: When operating on battery power, an internal automatic time-out removes power from the Test Set following 15 minutes of no key activity.</p>
6.	<p>FUSES</p> <p>Provide safe operation with ac input power applied to the TCAS-201. Refer to para 1-2-1.5 for correct fuse size and type.</p>		
7.	<p>SET/CONT Key</p> <p>Enters Setup Menus onto the DISPLAY. Pressing once from any other screen enters the Setup #1 Menu onto the DISPLAY. Setup #1 Menu allows the user to set initial or default test parameters and control data storage. Pressing once from the Setup #1 Menu enters the Setup #2 Menu onto the DISPLAY. Setup #2 Menu allows the user to set DISPLAY characteristics and Scenario Test Range and Altitude limitations.</p>		

ITEM	DESCRIPTION	ITEM	DESCRIPTION
13.	<p>SELF TEST Key</p> <p>Enters Self Test screen onto the DISPLAY.</p>	19.	<p>INTERR VIDEO Connector (J10054)</p> <p>BNC type connector provides demodulated (linearly detected) interrogation (only when direct connection with UUT is used) for use with an Oscilloscope.</p>
14.	<p>MON Key</p> <p>Enters Monitor screens onto the DISPLAY. When operating in ATCRBS, the TCAS-201 displays the Whisper-Shout Monitor screen. When operating in Mode S, the TCAS-201 displays the Surveillance Monitor screen. Pressing the MON Key from the Surveillance Monitor screen enters the Broadcast Monitor screen onto the DISPLAY.</p>	20.	<p>MONITOR Connector (J10056)</p> <p>BNC type connector provides interrogation and reply pulses clipped at 50% amplitude point to preserve pulse shape.</p>
15.	<p>RPLY TEST Key</p> <p>Enters Reply Test screen onto the DISPLAY. The intruder selected in the Setup #1 Menu determines whether the TCAS-201 displays the ATCRBS or Mode S Reply Test screen.</p>	21.	<p>INTERR Indicator</p> <p>Illuminates when the Test Set receives a valid interrogation signal.</p>
16.	<p>DISPLAY</p> <p>LCD readout displays various test screens.</p>	22.	<p>REPLY Indicator</p> <p>Illuminates when the Test Set generates a reply signal.</p>
17.	<p>RF I/O Connector (J10058) </p> <p>CAUTION: MAXIMUM INPUT POWER MUST NOT EXCEED +58 DBM (631 W).</p> <p>TNC type connector provides for RF input and output when directly connected with the UUT (Direct Connect).</p>		
18.	<p>ANTENNA Connector (J10057)</p> <p>CAUTION: DO NOT TRANSMIT DIRECTLY INTO ANTENNA TERMINAL. MAXIMUM OVER-THE-AIR INPUT POWER MUST NOT EXCEED 0.5 W.</p> <p>BNC type connector is used with the Test Set Antenna (Flat Antenna or Flexible Antenna). Over-the-air testing of the UUT is accomplished through this connector. The connector cover, when attached, provides the 50 Ω load required when connecting the RF I/O Connector to the UUT (Direct Connect) or running the Self Test.</p>		

2.2 FLAT ANTENNA

Refer to 1-2-2, Figures 2 and 3.

ITEM	DESCRIPTION
23.	ANTENNA PUSH BUTTON Switch Starts or stops testing, same as the RUN/STOP Key.
24.	FLAT ANTENNA Connector (J29001) BNC type connector is used to connect Flat Antenna to TCAS-201 Test Set.



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Flat Antenna
Figure 3



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3. PERFORMANCE EVALUATION

3.1 GENERAL

The TCAS-201 is equipped with a Self Test for quick performance evaluation and Diagnostics for signal verification. Self Test checks the Digital Module (Digital IF PC Board Assembly and Front Panel Pulse PC Board Assembly functions), Power Supply/Battery and RF Module (RF Assembly functions) for operational capability. Diagnostics are used to verify the TCAS-201 is transmitting correct replies and accurately reading incoming power levels.

Refer to 1-2-2, Figure 2 for location of controls, connectors and indicators.

3.2 SELF TEST

Refer to 1-2-3, Figure 4.

STEP	PROCEDURE
1.	Press POWER Key.
2.	Press SELF TEST Key to enter Self Test screen. (The TCAS-201 displays results of the last Self Test.)
3.	Terminate ANTENNA Connector (J10057) with 50 Ω load connector cover.
4.	Press RUN/STOP Key to initiate Self Test. (The top line displays test names while testing and indicates PASSED or FAILURE at completion. The TCAS-201 displays an eight-digit hexadecimal error code with any failure indications. Also, the TCAS-201 displays a PASSED or FAILED indication for each module/assembly.)
5.	Verify all modules/assemblies passed test.

NOTE: If Self Test indicates a failure, refer to 1-2-3, Table 2 for error code definitions. If battery fails, refer to para 1-2-1.6 for Battery Recharging. If any other failure occurs, refer maintenance to qualified service technicians.

```

** SELF TEST - PASSED **
      RF MODULE: PASSED
      DIGITAL MODULE: PASSED
POWER SUPPLY/BATTERY: PASSED

Press run to start
    
```

```

** SELF TEST - FAILURE 00000002 **
      RF MODULE: FAILED
      DIGITAL MODULE: PASSED
POWER SUPPLY/BATTERY: PASSED

Press run to start
    
```

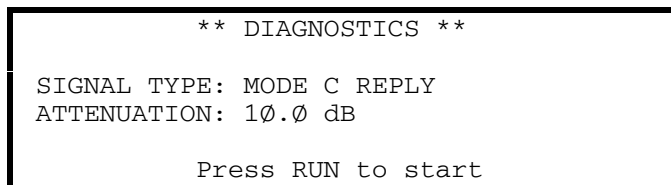
Sample Self Test Screens
Figure 4

TEST	GROUP	VERIFIES	FAILURE CODE (H)	RUNNING ORDER
LO Control	RF	Valid ON/OFF status	00000001	2
LO Detect	RF	LO is locked.	00000002	12
RF Detect	RF	TX level out/attenuation	00000004	13
Battery	Power Supply/ Battery	Voltage is within correct voltage range.	00000010	1
Non-Volatile RAM Battery	Power Supply/ Battery	Battery has sufficient power for RAM to retain memory.	00000020	Only on power-up
DSP Initialization	Digital	Handshake routine	00000040	14
UART	Digital	RS-232 loop back	00400000	8
RAM	Digital	Dual Port RAM (DPR)	01000000	3
		Video RAM	02000000	4
		Non-Volatile RAM	04000000	6
		Display RAM	08000000	5
Attenuator #1	Digital	Level at endline diodes	10000000	9
Attenuator #2	Digital	Level at midline diodes	20000000	9
LO Compensation	Digital	DCXO control voltage	40000000	11
LED	Digital	Interrogation and reply drivers	80000000	7
<p>NOTE: Multiple failures are indicated by the sum of the error codes.</p> <p>NOTE: If the DPR Test fails, the Self Test does not run the subsequent RAM tests.</p>				

Self Test Error Code Definitions
Table 2

3.3 DIAGNOSTICS

Refer to 1-2-3, Figure 5.



Sample Diagnostics Screen
Figure 5

CAUTION: DO NOT OPERATE DIAGNOSTICS WITH ANTENNA CONNECTED TO TCAS-201 TEST SET. TRANSMISSION SIGNALS USED IN DIAGNOSTICS MAY INTERFERE WITH OTHER AREA TRANSPONDER OPERATION AND/OR VIOLATE FCC RULES AND REGULATIONS, PART 87, GOVERNING SIGNAL TRANSMISSIONS FOR LAND TEST STATIONS.

STEP	PROCEDURE
1.	Press SELF TEST Key to enter Self Test screen.
2.	Press either of the SELECT Keys to enter Diagnostics screen.

CAUTION: MAXIMUM INPUT TO THE RF I/O CONNECTOR CANNOT EXCEED +59 dBm (800 W).

3. Connect an interrogator to RF I/O Connector, for testing TCAS-201 interrogation decoder.
- NOTE:** Reply generation may be tested by running Diagnostics Test with or without connecting anything to the TCAS-201 Test Set.
4. Use SLEW Keys to change values or signal type. Use SELECT Keys to change items. (Cursor line indicates item selected.)

STEP	PROCEDURE
●	<p>SIGNAL TYPE:</p> <p>Set reply or test signal transmitted by TCAS-201. (The same reply signal is used in the Reply and Scenario Tests.) Refer to 1-2-3, Table 3 for choice of signals.</p> <p>NOTE: Reply type signals are transmitted with a fixed PRF of 100. The Test Set does not need to be interrogated to send out replies. Information loaded into respective Reply Test screens determine the data sent in replies.</p>
●	<p>ATTENUATION:</p> <p>Set attenuation of incoming signal and TCAS-201 output, from 0.0 to 50.0 dB. (A single SLEW Key depression changes value by 0.5 dB. Constant SLEW Key depression changes value in 1.0 dB steps.)</p>
5.	<p>Press RUN/STOP Key to initiate test.</p> <p>NOTE: If SIGNAL TYPE: is set to DSP MEASURE =, a number appears after the = sign corresponding to the incoming CW signal amplitude as calculated by the DSP.</p>
6.	<p>Press RUN/STOP Key to terminate test.</p>

SIGNAL TYPE	DEFINITION	USED IN
MODE C REPLY	ATCRBS Reply	Scenario and Reply Testing
DF0 ACQUISITION	Mode S Reply	Replies to UF0 or UF16, when AQ=1 and RL=0
DF0 TRACKING	Mode S Reply	Replies to UF0 or UF16, when AQ=0 and RL=0
DF11 SQUITTER	Mode S Squitter	Transmitting Squitters
DF16 ACQUISITION	Mode S Reply	Replies to UF0 or UF16, when AQ=1 and RL=1
DF16 TRACKING	Mode S Reply	Replies to UF0 or UF16, when AQ=0 and RL=1
CW	Continuous Wave	TCAS-201 Calibration
NULL	No Signal	TCAS-201 Calibration
DSP_MEASURE	(not an output signal) Average calculation of input CW signal level	TCAS-201 Calibration

Diagnostics Signal Definitions
Table 3

4. GENERAL OPERATING PROCEDURES

4.1 GENERAL

This section contains operating instructions for the TCAS-201 Ramp Test Set. The general procedures contained in the operating instructions identify the Controls, Connectors, Indicators and Display Screens used in TCAS-201 operation. Also included is a general outline of what tests can be performed with the TCAS-201 Test Set and a recommended test procedure. For specific Unit Under Test (UUT) Procedures, refer to the appropriate UUT Manual.

Refer to 1-2-2, Figures 2 and 3 for location of controls, connectors and indicators.

The TCAS-201 Ramp Test Set tests the operation and installation of the TCAS interrogator in a ramp environment. The Test Set incorporates four basic functions:

- **Scenario Test** (SCEN Key) provides simulated encounters with intruding Mode S or Mode C aircraft.
- **Reply Test** (RPLY TEST Key) allows the user to generate Mode S or Mode C replies to TCAS interrogations. The TCAS-201 becomes a programmable Reply Generator.
- **Monitor** (MON Key) provides a convenient way to look at Mode S interrogation information, TCAS Broadcast Messages and ATRBS Whisper-Shout sequences.
- **Power & Frequency** (PWR TEST Key) accurately measures Peak Pulse Power or Effective Radiated Power (ERP) and Frequency of the interrogator.

Hierarchy of Operation:

- Initiating Test Set operation from Scenario Test screen or Start-up screen also enables Reply Test and Monitor functions (dynamic operation).
- Initiating Test Set operation from Reply Test screen also enables the Monitor function (static operation).
- Initiating Test Set operation from any Monitor screen enables only the Monitor function (Replies are not generated).

NOTE: Any screen may be entered or exited as desired. Edits may be entered while the TCAS-201 is performing a test operation.

4.2 START-UP

Refer to 1-2-4, Figure 6.

4.2.1 General

Pressing the TCAS-201 Test Set POWER Key causes the Start-Up screen to appear on the DISPLAY. Information contained in this screen indicates software versions of the Microprocessing Unit (MPU) and Digital Signal Processor (DSP) used. The Start-Up screen also provides easy access to the Scenario Test function (para 1-2-4.2.2). After approximately ten sec without any Keypad operation, the TCAS-201 replaces the Start-Up screen on the DISPLAY with the last screen used before power was removed.

```

** TCAS-201 RAMP TEST SET **
MPU VERS # 4.00, DSP VERS # 1.00

RECALL/RUN SCENARIO #0

SLEW scenario - RUN to recall/execute
    
```

Start-Up Screen
Figure 6

4.2.2 Scenario Test Operation From Start-Up Screen

STEP	PROCEDURE
1.	Use SLEW Keys to select scenario from 0 to 9. (The default is the last scenario stored or recalled.)
2.	Press RUN/STOP Key to recall selected scenario from storage. (The DISPLAY shows the Scenario Test screen.)
3.	Position Test Set according to stored information in Setup #1 Menu screen. Refer to storage logs in TCAS-201 Operator's Guide or press SET/CONT Key to view Setup #1 Menu screen.
4.	Press RUN/STOP Key to initiate Scenario Test.

4.3 SETUP

4.3.1 Setup #1 Menu

Refer to 1-2-4, Figure 7.

The UUT distance and antenna information established in Setup #1 Menu screen determines the attenuation critical to power measurements in the Power & Frequency function (500 ft [152.4 m] = 0 dB attenuation). The storage and recall of scenarios are also accomplished from Setup #1 Menu screen.

```

** SETUP #1 **
INTRUDER TYPE: ATCRBS
UUT DIST: HORIZ=30 ft VERT=6 ft
ALT REPORTING: ON
STORE:0 RECALL:0
GAIN_1030= 9.3 dB LOSS=1.0 dB
    
```

```

** SETUP #1 - MONITOR/REPLY RUNNING **
INTRUDER TYPE: MODE-S SQUITTERS: ON
UUT DIST: HORIZ=150 ft VERT=16 ft
ALT REPORTING: ON
STORE:0 RECALL:0
GAIN_1030= 9.3 dB LOSS=1.0 dB
    
```

```

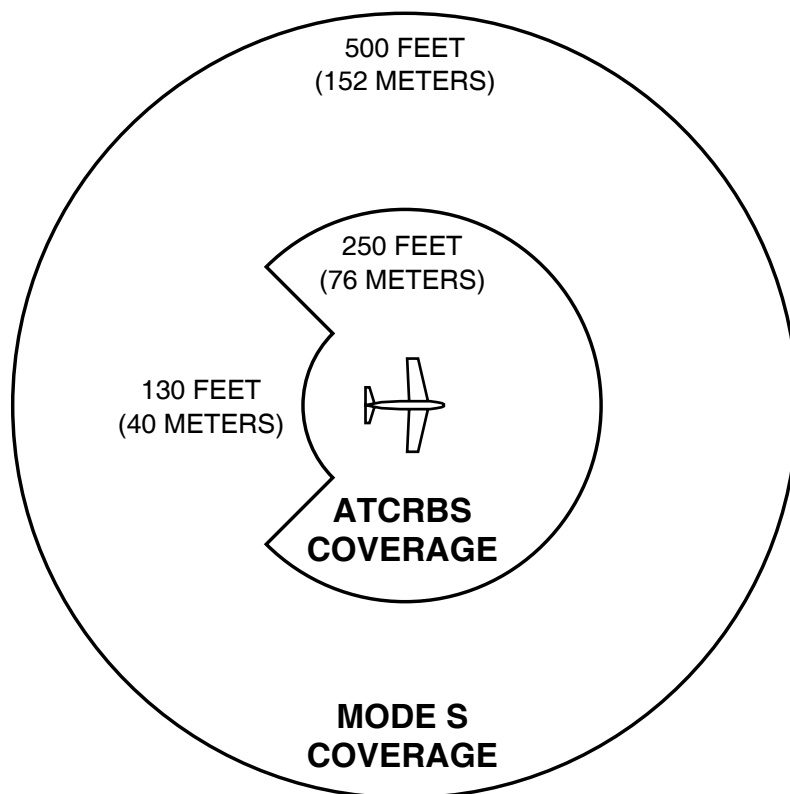
** SETUP #1 - SCENARIO RUNNING **
INTRUDER TYPE: MODE-S SQUITTERS: OFF
UUT DIST: HORIZ=150 ft VERT=16 ft
ALT REPORTING: ON
STORE:0 RECALL:0
GAIN_1030= 9.3 dB LOSS=1.0 dB
    
```

Sample Setup #1 Menu Screens
Figure 7

NOTE: Setup information should be entered before conducting test operations.

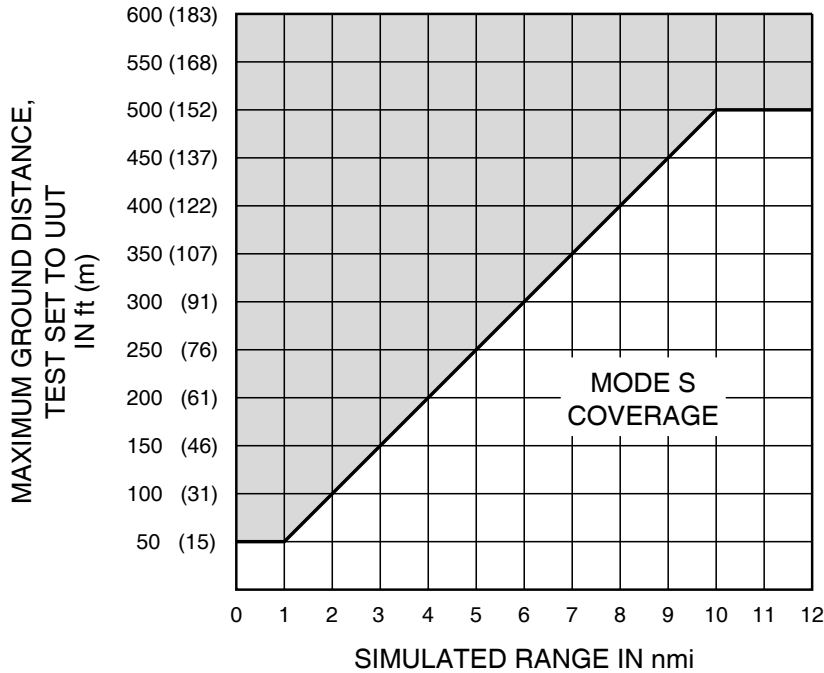
STEP	PROCEDURE
1.	<p>Position TCAS-201 Test Set Antenna within effective coverage area shown in 1-2-4, Figure 8; depending on mode of operation (ATCRBS or Mode S). Position Test Set as follows:</p> <ul style="list-style-type: none"> ● Place Test Set in a line-of-sight path from UUT Antenna to Test Set Antenna. ● For best power measurements, place Test Set so large objects are not between Test Set and UUT aircraft. Refer to 1-2-4, Figure 19.

STEP	PROCEDURE
	<ul style="list-style-type: none"> ● Due to high density power reduction in some TCAS interrogators, Mode S effective coverage distance may be dependent upon the TCAS-201 simulated range. For those units, place Test Set according to 1-2-4, Figure 9. For simulated ranges within 1 nmi, position Test Set Antenna within 50 ft (15.24 m) of UUT Antenna. ● To average out the ramp multipath component in the Power & Frequency function, place the Test Set at a horizontal distance <12 times the vertical distance (distances between the Test Set Antenna and UUT Antenna). (If not, the Test Set displays ** BAD HORIZ/VERT ** in the fourth line of the Setup #1 Menu screen.)



TCAS-201 Effective Test Coverage
Figure 8

8518013



8505001

Mode S Coverage Within 12 nmi Simulated Range
Figure 9

STEP	PROCEDURE	STEP	PROCEDURE
●	Multipath cancellation can reduce effective Test Set range at low angles and low UUT Antenna height from the ramp. For best results, the UUT Antenna height from the ramp should be >18 in (46 cm). Position Test Set Antenna to set reflection angle (UUT Antenna to Test Set Antenna to ramp) >10°.	●	When testing ATCRBS operation through bottom UUT Antenna, position Test Set Antenna ≤94 ft (28.65 m) from UUT Antenna. For exclusive bottom antenna testing, position Test Set Antenna so distance to top UUT Antenna(s) is approximately five times greater than distance to bottom UUT Antenna. Use aircraft body to shield top UUT Antenna(s) from Test Set Antenna. Approximately 5 ft (1.52 m) is the suggested distance for testing the bottom UUT Antenna.
●	If testing is conducted inside a building, position the Test Set Antenna as close as possible to the applicable UUT Antenna(s).		
●	Position Test Set Antenna ≤20 ft (6.1 m) if covering UUT Antenna being tested with Antenna Shield (complying with FAA requirements when UUT simulates altitude).		For direct connection, connect UUT to TCAS-201 RF I/O Connector and adjust Setup #1 Menu screen (HORIZ= field to 0 and LOSS: field according to cable used). (Test Set displays ** DIRECT CONNECT ** in the fourth line. The TCAS-201 simulates 53 ft [16.15 m] of distance and provides 19.5 dB attenuation through a direct connection.)

STEP	PROCEDURE
	<p>LOSS=</p> <p>Enter Coaxial Cable Loss, in dB, of Antenna Cable used with the TCAS-201 Test Set or direct connect cable. Loss is noted on Antenna Cable included with the Test Set. A single SLEW Key depression changes loss by 0.1 dB and continuous depression changes loss in 0.5 dB increments. Maximum loss is 9.9 dB.</p>
4.	<p>If desired, perform procedure in para 1-2-4.3.2 to edit Setup #2 Menu screen or press any key to exit Setup #1 Menu screen.</p>

4.3.2 Setup #2 Menu

Refer to 1-2-4, Figure 10.

Setup #2 Menu allows the operator to control visual performance of the DISPLAY and dynamic operation limits. Visual performance control includes adjustment of DISPLAY characteristics for direct sunlight, overcast skies or as desired by the operator. Setup #2 Menu sets the dynamic operation limits for range and altitude. Setting maximum and minimum range and altitude limits provides for repeatable scenarios that only run through the limits required for that particular test.

STEP	PROCEDURE
1.	<p>From Setup #1 Menu screen, press SET/CONT Key to enter Setup #2 Menu screen. (TCAS-201 displays information from last Setup #2 Menu. If power was deactivated since the last Setup #2 Menu operation, the TCAS-201 defaults the CONTRAST: and BACKLIGHT: fields to 0.)</p>
2.	<p>Enter information using SELECT Keys to select items and SLEW Keys to change values. (Cursor line underneath indicates item selected.)</p>

CONTRAST:

Adjust DISPLAY contrast by setting an offset from **-50** (darkest contrast) to **+50** (lightest contrast). (A single SLEW Key depression changes contrast offset by one and continuous depression changes contrast offset in increments of five.)

```

** SETUP #2 **
CONTRAST: +0          BACKLIGHT: +0
RANGE MAX: +30 nm    MIN: 0 nm
ALT MAX: +126,700 ft  MIN: 0 ft
MODE: TCAS-II
  
```

Sample Setup #2 Menu Screen
Figure 10

STEP

PROCEDURE

BACKLIGHT:

Adjust DISPLAY backlight by setting an offset from **-50** (darkest backlight) to **+50** (brightest backlight). (A single SLEW Key depression changes backlight offset by one and continuous depression changes backlight offset in increments of five.)

NOTE: Offsetting backlight in the positive direction increases current usage up to 10% and is not recommended when operating on battery power. Setting BACKLIGHT: field to ≤ 0 reduces current drain.

RANGE MAX:

Set the maximum range limit from **0** to **30 nm** (nautical miles) for Scenario Test operation. (When the scenario reaches maximum range [outgoing intruder], the TCAS-201 Test Set becomes an incoming intruder starting at the maximum range and returning to the UUT along the same flight path. Single SLEW Key depressions change range by 1 nmi and continuous depression changes range in 5 nmi increments.)

RANGE MIN:

Set the minimum range limit from **0** to **30 nm** for Scenario Test operation. (When the scenario reaches minimum range [incoming intruder], the TCAS-201 Test Set becomes an outgoing intruder starting at the minimum range and departing along the same flight path. Single SLEW Key depressions change range by 1 nmi and continuous depression changes range in 5 nmi increments.)

NOTE: The Setup #2 Menu screen prohibits an operator from entering maximum settings (range or altitude) below minimum settings or minimum settings above maximum settings.

STEP

PROCEDURE

ALT MAX:

Set the maximum altitude limit from **-1000** to **126,700 ft** for Scenario Test operation. (When the scenario reaches maximum altitude [climbing intruder], the TCAS-201 Test Set becomes a descending intruder starting at the maximum altitude. Single SLEW Key depressions change altitude by 100 ft and continuous depression changes altitude in 1000 ft increments.)

ALT MIN:

Set the minimum altitude limit from **-1000** to **126,700 ft** for Scenario Test operation. (When the scenario reaches minimum altitude [descending intruder], the TCAS-201 Test Set becomes a climbing intruder starting at the minimum altitude. Single SLEW Key depressions change altitude by 100 ft and continuous depression changes altitude in 1000 ft increments.)

NOTE: In the Scenario Test function (para 1-2-4.4), when range reaches minimum or maximum limits, altitude direction automatically reverses. The simulated altitude of the TCAS-201 is the same each time the minimum range is reached. The UUT simulated altitude can be adjusted accordingly for testing purposes. The process maintains the same TCAS-201 simulated flight path throughout the running of one scenario (unless edits are made while running).

MODE:

Set to **TCAS-II** to detect and reply accordingly to All-Call interrogations or **TCAS-I/SKY** to reply with currently simulated mode (ATCRBS or Mode S) to any All-Call interrogations.

3. Press any key to exit Setup #2 Menu screen.

4.3.3 Data Storage

Data storage is used to save data from all screens. Setup Menu, Reply Test and Scenario Test data can be stored to provide up to ten different preset test operations. Applications vary with operator preferences, TCAS systems, aircraft and the ramp environments. The number of applications is extensive. Guidelines set forth in applicable RTCA documents (DO-185), FAA Advisory Circulars (#20-131) and each particular UUT manual are recommended. Some suggested items to be considered when setting and storing data are:

- ATCRBS or Mode S intruders (Setup #1 Menu)
- Multiple UUT Antenna distances (Setup #1 Menu)
- Variable Display conditions (Setup #2 Menu)
- Dynamic intruders with variable closing rates (Scenario Test)
- Encounters with intruders descending or climbing at variable rates (Scenario Test)
- Static intruders for bearing checks (Reply Test)
- Multiple Mode S addresses and variable discrete switch settings during Reply Generation (Reply Test [Mode S])

Data received from the UUT can also be saved. Information currently in the Monitor and Power & Frequency screens are stored each time the storage procedure is accomplished. In addition to manually storing received data, the TCAS-201 automatically stores the latest test information until a new test (any function) is run.

The same default information is initially stored in each of the ten storage locations.

STEP	PROCEDURE
1.	Enter desired data into Setup, Scenario Test and Reply Test screens.
2.	Press SET/CONT Key to enter Setup #1 Menu screen.
3.	Use SELECT Keys to select STORE: field for storage or RECALL: field for recall.

STEP	PROCEDURE
4.	Use SLEW Keys to select storage location number from 0 to 9 .
5.	Press RUN/STOP Key to initiate storage or recall action. (A period displayed to the right of the storage number indicates the desired action has occurred.)
6.	Using pencil or erasable marker, annotate storage information in storage logs located in the TCAS-201 Operator's Guide.

4.3.4 RAM Reset

RAM Reset clears all stored memory and resets all parameters with default values.

To accomplish a RAM Reset, simultaneously press both SELECT Keys and the POWER Key.

NOTE: All previously stored information is lost when RAM Reset is accomplished.

4.4 SCENARIO TEST

Refer to 1-2-4, Figure 11.

Scenario Test provides simulated planned encounters with Mode C or Mode S intruders. Scenario Test is used to verify aural and visual TCAS operation (Traffic and Resolution Advisories). Dynamic operation allows simulation of a complete and changeable flight into and out of the TCAS range of operation. Altering the range rate or altitude rate with the scenario running simulates two-stage scenarios or second order dynamic encounters. Intruding flight patterns, programmed from the Scenario Test screen, can be saved in data storage. Initially, the same general default scenario is loaded into each of the ten storage locations.

STEP	PROCEDURE
1.	Connect UUT to RF I/O Connector for direct connection or Flat Antenna (facing towards UUT Antenna) to Antenna Connector.
2.	Perform Setup Procedure according to para 1-2-4.3.
3.	If direct connection is not used, perform one of the following: <ul style="list-style-type: none"> • Either shield with Antenna Shield (refer to Appendix C) or disconnect and terminate UUT Antenna not being tested. Deactivate other area transponders or position transponders at least three times the Setup #1 Menu horizontal distance from Flat Antenna.

```

** SCENARIO TEST - RUNNING **
INTRUDER TYPE: ATCRBS      TIME:1:25;0:04
RANGE: 12.80 nm           RATE:+540 kt
ALT: 8000 ft              RATE:+1500 fpm
STATUS: NON-THREAT
W-S SEQUENCE INTERVAL: 1.00 sec

```

```

** SCENARIO TEST - RUNNING **
INTRUDER TYPE: ATCRBS      TIME:0:41;0:06
RANGE: 3.95 nm           RATE:+350 kt
ALT: 10,000 ft           RATE:+0 fpm
STATUS: PROXIMITY
W-S SEQUENCE INTERVAL: 1.00 sec

```

```

** SCENARIO TEST - RUNNING **
INTRUDER TYPE: MODE-S      TIME:0:39;0:46
RANGE: 5.86 nm           RATE:+540 kt
ALT: 9157 ft             RATE:+1500 fpm
STATUS: TRAFFIC
SURVEILLANCE INTERVAL: 1.00 sec

```

```

** SCENARIO TEST - RUNNING **
INTRUDER TYPE: MODE-S      TIME:0:23;1:02
RANGE: 3.49 nm           RATE:+540 kt
ALT: 9552 ft             RATE:+1500 fpm
STATUS: RESOLUTION
SURVEILLANCE INTERVAL: 1.00 sec

```

Sample Scenario Test Screens
Figure 11

STEP **PROCEDURE**

- If UUT simulates altitude, shield UUT Antenna being tested with Antenna Shield. Refer to Appendix C. Either shield with another Antenna Shield or disconnect and terminate UUT Antenna(s) not being tested. Deactivate other area transponders or position transponders >50 ft (15.24 m) from the Flat Antenna. Position Flat Antenna ≤20 ft (6.1 m) from UUT Antenna being tested.

4. Press SCEN Key to enter Scenario Test screen.
5. Use SELECT Keys to select items and SLEW Keys to change values. (Cursor line underneath indicates item selected.)

RANGE:

Enter simulated distance, in nautical miles, between intruding aircraft (TCAS-201) and UUT aircraft. (Single SLEW Key depressions change range by 0.1 nmi and continuous depression changes range in 1.0 nmi increments.)

NOTE: Hardware limitations provide a minimum range delay of 0.3 nmi.
RANGE: field values set <0.3 nmi = 0.3 nmi.

RANGE: RATE:

Enter simulated velocity, from **0** to **50 kt**, of intruding aircraft. (The sign in front of the value indicates flight towards the UUT [+] [closing] or away from the UUT [-] [departing] and is changed independently from the velocity value. Single SLEW Key depressions change velocity by 10 knots and continuous depression changes velocity in 50 knot increments.)

NOTE: **RANGE:** and **RANGE: RATE:** fields determine the first value in the **TIME:** field (time until or after simulated encounter).

STEP **PROCEDURE**

ALT:

Enter simulated altitude, in feet above sea level, of the intruding aircraft (TCAS-201). (In ATCRBS mode, single SLEW Key depressions change altitude by 100 ft. In Mode S, single SLEW Key depressions change altitude by 25 ft up to 50,200 ft and by 100 ft for altitudes ≥50,200 ft. For all modes, continuous depression changes altitude in 1000 ft increments.)

ALT: RATE:

Enter simulated altitude change rate, from **0** to **±10,000 fpm**, of intruding aircraft. (The sign in front of the value indicates climbing [+] or descending [-]. Single SLEW Key depressions change rate by 100 fpm and continuous depression changes rate in 500 fpm increments.)

5. Press RUN/STOP Key to initiate Scenario Test. (The top line indicates the Scenario test is running. Test runs continuously, repeating same flight pattern as dictated by the values input in the Scenario Test screen and limitations set in the Setup #2 Menu screen. The TCAS-201 uses the same flight path going towards and moving away from the UUT.)

6. Monitor the following constantly changing fields as desired:

TIME:

The Scenario Test screen displays two different times, both in minutes and sec. The first time indicates time until or after simulated encounter (when the UUT and TCAS-201 simulates occupying the same airspace). The starting first time is dependent on the values inserted in the **RANGE:** and **RANGE: RATE:** fields. The first time decreases when closing in on the UUT and increases when departing from the UUT.

The second time displayed is the total running time of the current or latest Scenario Test operation. For both times, the minimum time displayed is 0:00 and the maximum time displayed is 9:59.

STEP PROCEDURE

RANGE:

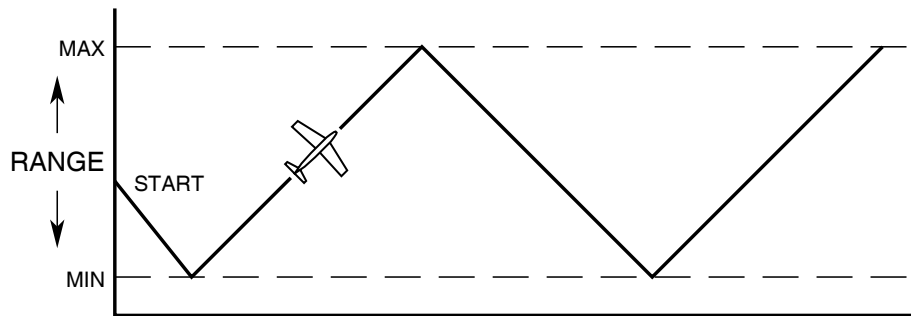
Range moves through the limits established in the Setup #2 Menu screen at the rate set in the Scenario Test screen. The Scenario Test maintains the same flight pattern for the incoming and outgoing intruder throughout the running of a single scenario (refer to 1-2-4, Figure 12) and repeats continuously until the test operation is terminated (Step 7).

STEP PROCEDURE

ALT:

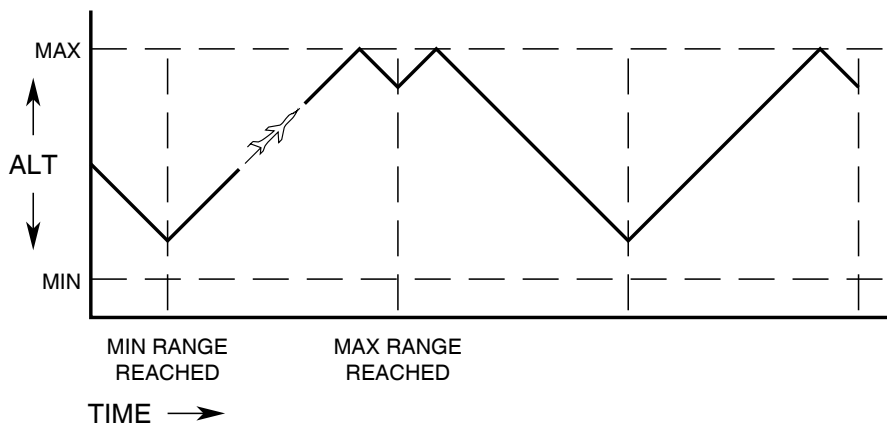
Altitude moves through the limits established in the Setup #2 Menu screen at the rate set in the Scenario Test screen. Similar to range, altitude changes are symmetrical, maintaining the same levels with the outgoing pattern as with the incoming pattern (refer to 1-2-4, Figure 13).

NOTE: The ALT: field may not reach limits established in Setup #2 Menu screen if the RANGE: field reaches set limits first. To maintain set flight pattern, the altitude direction reverses automatically when the RANGE: field reaches minimum or maximum limits.



8518019

Sample Intruder Flight Pattern (Range Factor)
Figure 12



8518020

Sample Intruder Flight Pattern (Altitude Factor)
Figure 13

STEP **PROCEDURE**

STATUS:

Verify TCAS UUT visual operation with the simulated TCAS-201 status (in relationship to UUT) shown in the STATUS: field.

NOTE: There are usually two to three sec of delay (target acquisition time) between the start of TCAS-201 operation and when the UUT acquires the Test Set as a target. When only one UUT Antenna is being tested, the target acquisition time increases. Refer to Appendix E for the target acquisition time probabilities.

The TCAS-201 displays four different status indications:

- **NON-THREAT**

Range is >4 nmi and time until encounter is >40 sec.

- **PROXIMITY**

Range is ≤4 nmi and time until encounter is >40 sec.

- **TRAFFIC**

Time until encounter is ≤40 sec and >25 sec.

- **RESOLUTION**

Time until encounter is ≤25 sec.

INTERVAL:

Verify bottom line displays **W-S SEQUENCE INTERVAL** (ATCRBS intruders) or **SURVEILLANCE INTERVAL** (Mode S intruders).

Verify time interval (start of one sequence or interrogation to the start of another sequence or interrogation).

If TCAS-201 displays: **NO WHISPER-SHOUT SEQUENCE** or **NO SURVEILLANCE**, no sequence or interrogation was received within the 1.27 sec window for interval time.

7. Press RUN/STOP Key to terminate test operation.

STEP **PROCEDURE**

8. Press any key to exit Scenario Test screen.

4.5 REPLY TEST

Refer to 1-2-4, Figure 14.

4.5.1 ATCRBS Operation

In ATCRBS Reply Test, the TCAS-201 becomes a Mode C Reply Generator or Transponder. If ATCRBS Reply Test operation is initiated from the ATCRBS Reply Test screen, the TCAS-201 simulates a stationary Mode C Transponder (static operation). If ATCRBS Reply Test operation is initiated from the Scenario Test screen, the TCAS-201 simulates a moving or intruding aircraft, equipped with a Mode C Transponder (dynamic operation). The ATCRBS Reply Test can be used to evaluate the ability of the UUT to receive and decode ATCRBS replies. TCAS bearing accuracy can be evaluated by running the test from specific test locations. Range can be used to evaluate the ability of the UUT to accurately see the delay and provide correct range information. Altitude can be used to verify the ability of the UUT to decode Mode C replies. The TCAS-201 simulates a transponder providing increasingly poor reception by decreasing the %REPLY: field.

STEP	PROCEDURE
1.	Connect UUT to TCAS-201 RF I/O Connector or TCAS-201 Flat Antenna (facing towards UUT Antenna) to Antenna Connector.
2.	Perform the Setup Procedure according to para 1-2-4.3. Set INTRUDER TYPE: to ATCRBS .
3.	If direct connection is not used, perform one of the following: <ul style="list-style-type: none"> • Either shield with Antenna Shield (refer to Appendix C) or disconnect and terminate UUT Antenna not being tested. Deactivate other area transponders or position transponders at least three times the Setup #1 Menu horizontal distance from Flat Antenna. • If UUT simulates altitude, shield UUT Antenna being tested with Antenna Shield. Refer to Appendix C. Either shield with another Antenna Shield or disconnect and terminate UUT Antenna(s) not being tested. Deactivate other area transponders or position transponders >50 ft (15.24 m) from the Flat Antenna. Position Flat Antenna ≤20 ft (6.1 m) from UUT Antenna being tested.

```

** ATCRBS REPLY TEST **

RANGE: 12.80 nm  ALTITUDE: 8,000 ft
%REPLY: 100

Press RUN to start

```

```

** ATCRBS REPLY TEST - RUNNING **

RANGE: 11.77 nm  ALTITUDE: 8,172 ft
%REPLY: 100

W-S SEQUENCE INTERVAL: 1.01 sec

```

Sample ATCRBS Reply Test Screens
Figure 14



STEP **PROCEDURE**

4. Press RPLY TEST Key to enter ATCRBS Reply Test screen. (The TCAS-201 displays information from the last Mode C reply transmitted.)
5. Use SELECT Keys to select items and SLEW Keys to change values. (Cursor line underneath indicates item selected.)

RANGE:

The RANGE: field is the same as in Scenario Test. Refer to para 1-2-4.4.

ALTITUDE:

Enter simulated altitude, in feet above sea level, of the intruding aircraft (TCAS-201). Single SLEW Key depressions change altitude by 100 ft and continuous depression changes altitude in 1000 ft increments. Minimum altitude is -1000 ft and maximum altitude is 126,700 ft.

%REPLY:

Enter the desired ratio between the number of replies transmitted by the TCAS-201 and the number of valid interrogations received.

6. Press RUN/STOP Key to initiate ATCRBS Reply Test.

W-S SEQUENCE INTERVAL:

The TCAS-201 displays time from the start of one whisper-shout sequence to the start of the next whisper-shout sequence. The TCAS-201 looks for the interval between 0.53 sec (time to display information) and 1.27 sec (1.0 sec is nominal). If the interval is >1.27 sec, the bottom line indicates **NO WHISPER-SHOUT SEQUENCE** was received.

7. Monitor TCAS for correct threat indications.

NOTE: There are usually two to three sec of delay (target acquisition time) between the start of TCAS-201 operation and when the UUT acquires the Test Set as a target. When only one UUT Antenna is being tested, the target acquisition time increases. Refer to Appendix E for the target acquisition time probabilities.

STEP **PROCEDURE**

8. Press RUN/STOP Key to terminate test operation.
9. Press any key to exit ATCRBS Reply Test screen.

4.5.2 Mode S Operation

Refer to 1-2-4, Figure 15.

In Mode S Reply Test, the TCAS-201 becomes a Mode S Reply (DF0, DF11 and DF16) Generator or Transponder. Operating the same as in the ATRBS Reply Test, the Test Set has static operation if initiated from the Mode S Reply Test screen or dynamic operation if initiated from the Scenario Test screen. The Mode S Reply Test can be used to evaluate the ability of the TCAS interrogator to receive, decode and respond to Mode S replies. The message fields allow the user to program capability information and various advisories to the TCAS interrogator.

STEP	PROCEDURE
1.	Connect UUT to TCAS-201 RF I/O Connector or TCAS-201 Flat Antenna (facing towards UUT Antenna) to ANTENNA Connector.
2.	Perform the Setup Procedure according to para 1-2-4.3. Set INTRUDER TYPE: to MODE-S .

STEP	PROCEDURE
3.	If direct connection is not used, perform one of the following: <ul style="list-style-type: none"> ● Either shield with Antenna Shield (refer to Appendix C) or disconnect and terminate UUT Antenna not being tested. Deactivate other area transponders or position transponders at least three times the Setup #1 Menu horizontal distance from Flat Antenna. ● If UUT simulates altitude, shield UUT Antenna being tested with Antenna Shield. Refer to Appendix C. Either shield with another Antenna Shield or disconnect and terminate UUT Antenna(s) not being tested. Deactivate other area transponders or position transponders >50 ft (15.24 m) from the Flat Antenna. Position Flat Antenna ≤20 ft (6.1 m) from UUT Antenna being tested.
4.	Press RPLY TEST Key to enter Mode S Reply Test screen. (The TCAS-201 displays information from the last Mode S reply transmitted.)

```

** MODE S REPLY TEST **
RANGE: 12.80 nm ALTITUDE: 8000 ft
VS:0 SL:0 RIa:8 RIt:3 CA:0
ARA:0000 RAC:0 CLI:0 VDS:30
AA:01FF37
Press RUN to start

```

```

** MODE S REPLY TEST - RUNNING **
RANGE: 11.00 nm ALTITUDE: 8300 ft
VS:0 SL:0 RIa:8 RIt:3 CA:0
ARA:0000 RAC:0 CLI:0 VDS:30
AA:01FF37
SURVEILLANCE INTERVAL: 1.00 sec

```

Sample Mode S Reply Test Screens
Figure 15



STEP PROCEDURE

5. Use **SELECT** Keys to select items and **SLEW** Keys to change values. (Cursor line underneath indicates item selected.)

NOTE: All Mode S reply information is programmed by the operator and is used in the Mode S replies transmitted by the TCAS-201 in Scenario Test and/or Reply Test functions.

RANGE:

The **RANGE:** field is the same as in Scenario Test. Refer to para 1-2-4.4.

ALTITUDE:

Enter simulated altitude, in feet above sea level, of the intruding aircraft (TCAS-201). Single **SLEW** Key depressions change altitude by 25 ft up to 50,200 ft and by 100 ft for altitudes $\geq 50,200$ ft. Continuous depression changes altitude in 1000 ft increments. Minimum altitude is -1000 ft and maximum altitude is 126,700 ft.

NOTE: Refer to Appendix B for detailed descriptions of the following displayed Downlink Format (DF) fields and subfields. All fields are displayed in hexadecimal. Unless otherwise specified, both single and continuous **SLEW** Key depressions change values by 1.

VS:

Enter Vertical Status. Enter **0** into **VS:** field to indicate intruding aircraft (TCAS-201) is airborne or **1** to indicate intruding aircraft is on the ground. (The TCAS-201 transmits the **VS:** field in DF0 and DF16.)

STEP PROCEDURE

SL:

Enter simulated TCAS-201 Sensitivity Level (refer to 1-2-4, Table 4). (The TCAS-201 transmits the **SL:** field in DF0 and DF16.)

NOTE: The **SL:** field contains simulated sensitivity level information and does not actually set the TCAS-201 to a particular Sensitivity Level.

INPUT DATA	DEFINITION
0	No Sensitivity Level reported
1	Operates at Sensitivity Level 1
2	Operates at Sensitivity Level 2
3	Operates at Sensitivity Level 3
4	Operates at Sensitivity Level 4
5	Operates at Sensitivity Level 5
6	Operates at Sensitivity Level 6
7	Operates at Sensitivity Level 7

SL: Field Valid Data
Table 4

Rla:

Enter air-to-air Reply Information for an acquisition report. Set **Rla:** field, containing airspeed data, from **8** to **E** according to 1-2-4, Table 5. (The TCAS-201 transmits the **Rla:** field in DF0 and DF16 when interrogator requests an acquisition report.)

Rla: FIELD INPUT DATA	DEFINITION (AIRSPEED)
8	No data available
9	≤ 75 kts
A	> 75 kts and ≤ 150 kts
B	> 150 kts and ≤ 300 kts
C	> 300 kts and ≤ 600 kts
D	> 600 kts and ≤ 1200 kts
E	> 1200 kts

RI: Field (Acquisition) Valid Data
Table 5

STEP

PROCEDURE

RI:

Enter air-to-air Reply Information for a tracking report. Set RI: field, containing TCAS capability data, to **0**, **3** or **4** according to 1-2-4, Table 6. (The TCAS-201 transmits the RI: field in DF0 and DF16 when interrogator requests a tracking report.)

RI: FIELD INPUT DATA	DEFINITION (TCAS CAPABILITY)
0	No on-board TCAS
3	On-board TCAS has vertical-only resolution ability.
4	On-board TCAS has vertical and horizontal resolution ability.

RI: Field (Tracking) Valid Data
Table 6

CA:

Enter transponder Capability (refer to 1-2-4, Table 5). (The TCAS-201 transmits the CA: field in DF11 [squitter transmissions].)

INPUT DATA	DEFINITION
0	No communications capability (surveillance only)
1	Comm-A and Comm-B capability
2	Comm-A, Comm-B and Comm-C capability
3	Comm-A, Comm-B, Comm-C and Comm-D capability

CA: Field Valid Data
Table 7

STEP

PROCEDURE

ARA:

Enter simulated TCAS resolution advisory report. Refer to 1-2-4, Table 8 to set ARA: field, indicating all current Active Resolution Advisories being transmitted by the intruding aircraft (TCAS-201). The ARA: field for the TCAS-201 consists of two two-digit sections. Set first section (left) from **00** to **3F**. Set second section (right) from **00** to **FF**. Single SLEW Key depressions change value by 1 and continuous depression changes value by 10h. (The TCAS-201 transmits the ARA: field in DF16 [part of MV field].)

INPUT DATA	DEFINITION
0001	Don't turn right.
0002	Don't turn left.
0004	Turn right.
0008	Turn left.
0010	Don't climb faster than 2000 fpm.
0020	Don't climb faster than 1000 fpm.
0040	Don't climb faster than 500 fpm.
0080	Don't climb.
0100	Descend.
0200	Don't descend faster than 2000 fpm.
0400	Don't descend faster than 1000 fpm.
0800	Don't descend faster than 500 fpm.
1000	Don't descend.
2000	Climb.

NOTE: Data codes are added together to indicate multiple active resolution advisories are being transmitted.

ARA: Field Valid Data
Table 8

STEP PROCEDURE

RAC:

Enter simulated TCAS Resolution Advisory Complements. Refer to 1-2-4, Table 9 to set the RAC: field indicating current active Resolution Advisory Complements, if any, being received from all other TCAS aircraft with on-board resolution capability. (The TCAS-201 transmits the RAC: field in DF16 [part of MV field].)

INPUT DATA	DEFINITION
0	No resolution advisory complements
1	Don't turn right.
2	Don't turn left.
4	Don't climb.
8	Don't descend.
<p>NOTE: The sum of the Input Data codes indicates multiple active resolution advisories are being received.</p>	

RAC: Field Valid Data
Table 9

CLI:

Enter Coordination Lock Indicator, **0** for Off or **1** for On. (The TCAS-201 transmits the CLI: field in DF16 [part of MV field].)

VDS:

Enter MV message field content definition. Single SLEW Key depressions change value by 1 and continuous depression changes value in 10h increments. Set the VDS: field to 30 for coordination reply messages (default value). (The TCAS-201 transmits the VDS: field in DF16 [part of MV field].)

AA:

Enter TCAS-201 Aircraft Address. The TCAS-201 AA: field contains three two-digit sections. Set each section from **00** to **FF**. Single SLEW Key depressions change value by 1 and continuous depression changes value in 10h increments. (The TCAS-201 transmits the AA: field in DF11 [squitter transmissions].)

STEP PROCEDURE

NOTE: The address entered in the AA: field combined with the computed parity of DF0 and DF16 forms the AP fields transmitted in both DF0 and DF16.

6. Press RUN/STOP Key to initiate Mode S Reply Test.

SURVEILLANCE INTERVAL:

The TCAS-201 displays time from the start of one interrogation to the start of the next interrogation. The TCAS-201 looks for the interval between 0.53 sec (time to display information) and 1.27 sec (1.0 sec is nominal). If the interval is >1.27 sec, the bottom line indicates **NO SURVEILLANCE**. If interrogation level is too low to be decoded, **SURVEILLANCE SIGNAL LOW** is displayed in the bottom line. If interrogation level is too high to be decoded, **SURVEILLANCE SIGNAL SATURATED** is displayed in the bottom line. If interrogation data is not found (no SPR), **SURVEILLANCE SPR NOT FOUND** is displayed in the bottom line.

7. Monitor TCAS for correct threat indications.

NOTE: There are usually two to three sec of delay (target acquisition time) between the start of TCAS-201 operation and when the UUT acquires the Test Set as a target. When only one UUT Antenna is being tested, the target acquisition time increases. Refer to Appendix E for the target acquisition time probabilities.

8. Press RUN/STOP Key to terminate test operation.
9. Press any key to exit Mode S Reply Test screen.

4.6 MONITOR

4.6.1 ATCRBS Operation

Refer to 1-2-4, Figure 16.

When in ATCRBS mode, the TCAS-201 Test Set monitors the Whisper-Shout sequence. The Whisper-Shout Monitor screen provides information used to verify whisper-shout steps and Side Lobe Suppression (SLS). By conducting several tests from different points around the aircraft (refer to para 1-2-4.8), the capabilities of the TCAS interrogator concerning coverage (directional and/or omnidirectional), whisper-shout sequence operation and interrogation timing are effectively evaluated.

STEP	PROCEDURE
1.	Connect UUT to TCAS-201 RF I/O Connector or TCAS-201 Flat Antenna (facing towards UUT Antenna) to ANTENNA Connector.
2.	Perform the Setup Procedure according to para 1-2-4.3. Set INTRUDER TYPE: to ATCRBS .
3.	If UUT simulates altitude and direct connection is not used, shield UUT Antenna being tested with Antenna Shield. Refer to Appendix C. Position Flat Antenna ≤ 20 ft (6.1 m) from UUT Antenna being tested.

```

** WHISPER-SHOUT MONITOR **
RANGE: 12.80 nm      ALT: 10,000 ft
ATTEN: 0.0 dB       NO SUPP:
S1:      P2:      BOTH:
SPACING:
NO WHISPER-SHOUT SEQUENCE

```

```

** WHISPER-SHOUT MONITOR - RUNNING **
- MONITOR ONLY -
ATTEN: 0.0 dB       NO SUPP: 1
S1: 0      P2: 0      BOTH: 0
SPACING: 4.3 ms
W-S SEQUENCE INTERVAL: 1.01 sec

```

Sample ATCRBS Monitor Screens
Figure 16

STEP **PROCEDURE**

4. Press MON Key to enter Whisper-Shout Monitor screen. (The TCAS-201 displays information from the last received or recalled whisper-shout sequence. The latest sequence is displayed if TCAS-201 is already in the running mode.)
5. Use SELECT Keys to select items and SLEW Keys to change values. (Cursor line underneath indicates item selected.)

RANGE:

The RANGE: field is the same as in Scenario Test. Refer to para 1-2-4.4.

ALT:

The ALT: field is the same as the ALTITUDE: field in ATRCBS Reply Test. Refer to para 1-2-4.5.1.

NOTE: Range and altitude are only shown when test operation is initiated from Scenario Test or Reply Test screens. When test operation is initiated from any Monitor screen, the TCAS-201 Test Set does not generate replies. Range and altitude, not being applicable, are not shown. When it does apply, range and altitude established in any screen is the same for the entire TCAS-201 Test Set and may be adjusted from the Scenario Test, Reply Test or Monitor screens.

ATTEN:

Set attenuation of incoming signals (UUT interrogations). (The same attenuation is set for outgoing signals [TCAS-201 replies] when Scenario Test or Reply Test functions have been initiated. The TCAS-201 sets a default value internally based upon the UUT distance information entered in Setup #1 Menu.)

NOTE: Attenuation may be changed using the Whisper-Shout Monitor screen, but the default value is restored upon exit from the screen.

STEP **PROCEDURE**

6. Press RUN/STOP Key to initiate Monitor mode. (The TCAS-201 displays latest whisper-shout sequence information.)

The top line indicates running Monitor by displaying: **** WHISPER-SHOUT MONITOR - RUNNING ****. The second line indicates operation initiated from the ATRCBS Monitor screen by displaying: **- MONITOR ONLY-**.

NO SUPP:

The TCAS-201 displays the number of processed interrogations, received in latest sequence, without detected S1 (whisper-shout suppression) and P2 (SLS) pulses. These interrogations solicit replies.

NOTE: If a Scenario or Reply Test has been activated, the TCAS-201 sends the number of replies indicated in the NO SUPP: field.

S1:

The TCAS-201 displays the number of processed interrogations, received in latest sequence, containing a detected S1 pulse, but without a detected P2 pulse.

NOTE: S1: field added with NO SUPP: field provides the number of whisper-shout steps received in latest sequence from the UUT Antenna directed towards the Test Set.

P2:

The TCAS-201 displays the number of interrogations, received in latest sequence, containing a detected P2 pulse, but without a detected S1 pulse. This information can be used to verify correct SLS operation when the TCAS-201 is positioned between the directional antenna lobes. The P2: field indicates interrogations not directed towards the Test Set.

BOTH:

The TCAS-201 displays the number of processed interrogations, received in latest sequence, containing both detected S₁ and P₂ pulses. The BOTH: field added to the P2: field indicates the number of total interrogations not directed towards the Test Set (from the other UUT Antennas).

SPACING:

The TCAS-201 displays the minimum time spacing, in ms, between any two successive interrogations received in latest sequence.

W-S SEQUENCE INTERVAL:

The W-S SEQUENCE INTERVAL: field is the same as in ATRBS Reply Test. Refer to para 1-2-4.5.1.

7. Press RUN/STOP Key to terminate test operation.
8. Press any key to exit Whisper-Shout Monitor screen.

4.6.2 Mode S Operation

Refer to 1-2-4, Figure 17.

When in Mode S, the TCAS-201 Test Set monitors for Uplink Formats (UF) 0 or 16. Mode S monitoring consists of two different Monitor screens. The primary screen, Surveillance Monitor, is a general monitoring screen displaying the contents of the major interrogation fields incorporated in UF0 and UF16. Information is displayed in hexadecimal and can be used to verify interrogator bit accuracy. The secondary screen, Broadcast Monitor, verifies the TCAS Broadcast is transmitted in UF16 approximately every ten sec. The Test Set detects a TCAS Broadcast when the AA address field decoded from the AP field in UF16 has all ones.

STEP	PROCEDURE
1.	Connect UUT to TCAS-201 RF I/O Connector or TCAS-201 Flat Antenna (facing towards UUT Antenna) to Antenna Connector.
2.	Perform the Setup Procedure according to para 1-2-4.3. Set INTRUDER TYPE: to MODE-S .
3.	If UUT simulates altitude and direct connection is not used, shield UUT Antenna being tested with Antenna Shield. Refer to Appendix C. Position Flat Antenna ≤ 20 ft (6.1 m) from UUT Antenna being tested.
4.	Press MON Key to enter Surveillance Monitor screen. (The TCAS-201 displays information from the last received or recalled Mode S interrogation.)
5.	Use SELECT Keys to select items and SLEW Keys to change values. (Cursor line underneath indicates item selected.)

```

** SURVEILLANCE MONITOR **
UF:    RANGE: 12.80 nm ALT: 8000 ft
RL:    AQ:    UDS:    LCK:    MTB:
CVC:   VRC:   CHC:   HRC:   ESB:
MID:

          Press RUN to start
    
```

```

** BROADCAST MONITOR **
UF:    RANGE: 12.80 nm ALT: 8000 ft
RL:    AQ:    UDS:    MID:
INTERVAL:          COUNT: 0

          Press RUN to start
    
```

```

** BROADCAST MONITOR - RUNNING **
UF:    - MONITOR ONLY -
RL:    AQ:    UDS:    MID:
INTERVAL:          COUNT: 0
          ** LOW BATTERY **
SURVEILLANCE INTERVAL: 1.00 sec
    
```

Sample Mode S Monitor Screens
Figure 17

STEP **PROCEDURE**

RANGE:

The RANGE: field is the same as in Scenario Test. Refer to para 1-2-4.4.

ALT:

The ALT: field is the same as the ALTITUDE: field in Mode S Reply Test. Refer to para 1-2-4.5.2.

NOTE: Range and altitude operation function the same as in ATCRBS Monitor operation. Refer to para 1-2-4.6.1.

6. Press RUN/STOP Key to initiate Monitor mode. (The TCAS-201 displays information for the latest received interrogation.)

The top line indicates running Monitor by displaying: **** SURVEILLANCE MONITOR - RUNNING ****. The second line indicates operation initiated from the Mode S Monitor screen by displaying: **- MONITOR ONLY-**.

Refer to Appendix B for detailed description of the following displayed Uplink Format fields and subfields.

UF:

Uplink Format number, as received in the Mode S interrogation, is displayed in decimal form.

RL:

Reply Length field, sent in UF0 and UF16, indicates request for transponder (TCAS-201) to reply with DF0 if set to 0 or DF16 if set to 1.

AQ:

Acquisition field, sent in UF0 and UF16, indicates request for transponder (TCAS-201) to reply with capability (tracking) report if set to 0 or airspeed (acquisition) report if set to 1.

UDS:

The UDS: field, sent in UF16 (part of MU field), defines the content of the MU message field. The UDS: field indicates TCAS Resolution Advisories Lock Requests or Resolution Messages if set to 30 or TCAS Broadcast Messages if set to 32.

STEP **PROCEDURE**

LCK:

If set to 1, the Lock field indicates request for the transponder (TCAS-201) to send information for TCAS Resolution Advisory (transponder is a collision threat to the interrogator) and is received in UF16 (part of MU field).

MTB:

If set to 1, the Multiple Threat Bit, received in UF16 (part of MU field), indicates the interrogator is receiving more than one collision threat.

CVC:

Refer to 1-2-4, Table 10 for the Cancel Vertical Resolution Advisory Complement, received in UF16 (part of MU field).

CVC: FIELD	DEFINITION
0	No cancellation
1	Cancel, don't descend.
2	Cancel, don't climb.

CVC: Field Display Data
Table 10

VRC:

Refer to 1-2-4, Table 11 for the Vertical Resolution Advisory Complement, received in UF16 (part of MU field).

VRC: FIELD	DEFINITION
0	No complement sent
1	Don't descend.
2	Don't climb.

VRC: Field Display Data
Table 11

CHC:

Refer to 1-2-4, Table 12 for the Cancel Horizontal Resolution Advisory Complement, received in UF16 (part of MU field).

CHC: FIELD	DEFINITION
0	No cancellation
1	Cancel, don't turn left.
2	Cancel, don't turn right.

CHC: Field Display Data
Table 12

STEP PROCEDURE

HRC:

Refer to 1-2-4, Table 13 for the Horizontal Resolution Advisory Complement, received in UF16 (part of MU field).

HRC: FIELD	DEFINITION
0	No complement sent
1	Intruder TCAS sense is turn left/Don't turn left.
2	Intruder TCAS sense is turn left/Don't turn right.
5	Intruder TCAS sense is turn right/Don't turn left.
6	Intruder TCAS sense is turn right/Don't turn right.

HRC: Field Display Data
Table 13

ESB:

Refer to 1-2-4, Table 14 for the Encoded/Vertical Sense Bits, received in UF16 (now VSB, part of MU field) to verify Vertical Resolution Advisory Complements.

CVC: FIELD	VRC: FIELD	VALID ESB: FIELD
0	0	0
0	1	E
0	2	7
0	3	9
1	0	B
1	1	5
1	2	C
1	3	2
2	0	D
2	1	3
2	2	A
2	3	4
3	0	6
3	1	8
3	2	1
3	3	F

ESB: Field Display Data
Table 14

STEP PROCEDURE

MID:

The MID: field, received in UF16 (part of MU field), displays the discrete Mode S address of the TCAS interrogator.

SURVEILLANCE INTERVAL:

The SURVEILLANCE INTERVAL: field is the same as in Mode S Reply Test. Refer to para 1-2-4.5.2.

- Press MON Key to enter Broadcast Monitor. (The TCAS-201 displays information from last received TCAS Broadcast. Unless specified, the information and editing fields are the same as in the Surveillance Monitor screen.)

The top line indicates running Monitor by displaying: **** BROADCAST MONITOR - RUNNING ****. The second line indicates operation initiated from the Mode S Monitor screen by displaying: **- MONITOR ONLY-**.

INTERVAL:

The INTERVAL: field displays the time interval, in sec, between the latest two TCAS Broadcast Messages received (nominally ten sec for each interrogator).

NOTE: TCAS Broadcast Messages are jittered ± 0.2 sec off the nominal ten sec interval time. The TCAS Broadcast Message may also be staggered between the directional antennas causing shorter intervals, if detected.

COUNT:

The COUNT: field displays the number of TCAS Broadcast Messages received during the test operation.

- Press RUN/STOP Key to terminate test operation.
- Press any key to exit Monitor screen.

4.7 POWER & FREQUENCY

Unless otherwise specified, refer to 1-2-4, Figure 18.

The Test Set accurately measures Effective Radiated Power (ERP) and transmitting frequency of the TCAS interrogator. The TCAS-201 uses Mode S squitters to obtain the power and frequency readings. The TCAS-201 transmits squitters starting with the address loaded in the AA: field (Mode S Reply Test screen) and uses up to 512 different addresses. Readings are figured from detected interrogations received from the squitters.

STEP	PROCEDURE
1.	Connect UUT to TCAS-201 RF I/O Connector or TCAS-201 Flat Antenna to Antenna Connector.
2.	Perform the Setup Procedure according to para 1-2-4.3.
3.	Press PWR TEST Key to enter Power & Frequency screen. (The TCAS-201 displays information from the last Power & Frequency test operation.)
4.	Face Flat Antenna towards UUT Antenna. If direct connection is used, terminate ANTENNA Connector with 50 Ω load (connector cover).
5.	Press RUN/STOP Key or ANTENNA PUSH BUTTON Switch to initiate Power & Frequency function. If direct connection is used, go to Step 7.

STEP	PROCEDURE
NOTE:	The TCAS-201 displays accurate power and frequency readings when Flat Antenna faces UUT Antenna at the Setup Procedure distance and according to 1-2-4, Figure 19. For more accuracy, perform Step 6 to further reduce multipath errors on the ramp.
6.	Starting from ground level, move Flat Antenna upward 6 ft (1.8 m) at <1 ft/sec (0.3 m/sec). <ul style="list-style-type: none"> ● Do not move towards or away from UUT or the Setup #1 UUT DIST: HORIZ= becomes inconsistent. ● Do not rotate Flat Antenna or power levels are reduced. ● Move Flat Antenna below and above the median height the same distance for the same amount of time to obtain an accurate power average. (Median height is Flat Antenna height from the ground, required to obtain Setup #1 UUT DIST: VERT= height between the Flat and UUT Antennas.)
7.	After ≥30 sec, press RUN/STOP KEY or ANTENNA PUSH BUTTON Switch to terminate test operation.
8.	Press any key to exit Power & Frequency screen.

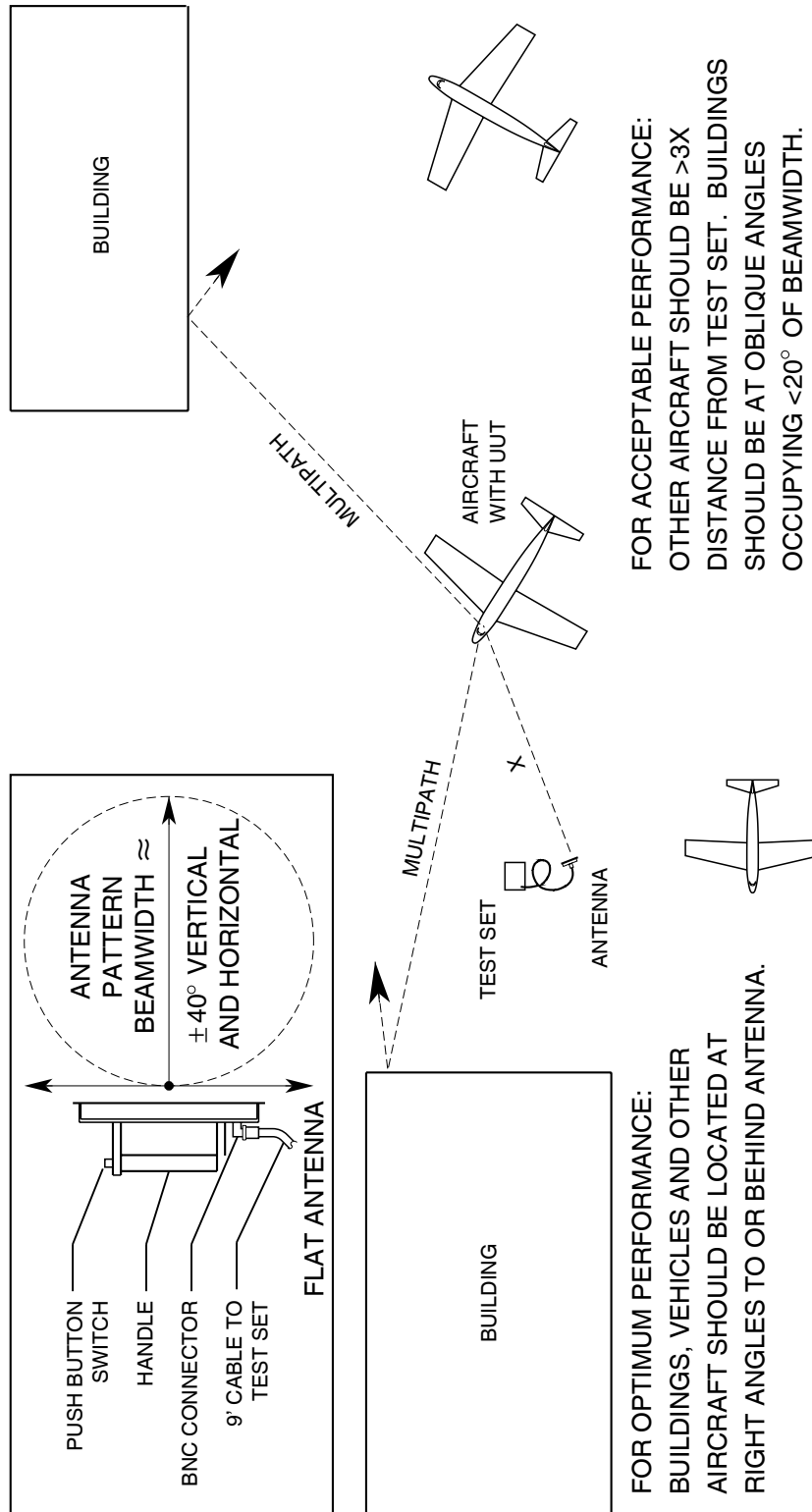
```

** POWER & FREQUENCY **
      ERP      FREQ
CURRENT:  49.4 dBm    1030.000 MHz
AVERAGE:  50.2 dBm    1030.000 MHz
INTERRS:   1
      Press RUN to start
    
```

```

** POWER & FREQUENCY - RUNNING **
      ERP      FREQ
CURRENT:  49.4 dBm    1030.000 MHz
AVERAGE:      dBm           MHz
INTERRS:   1
W-S SEQUENCE INTERVAL: 1.00 sec
    
```

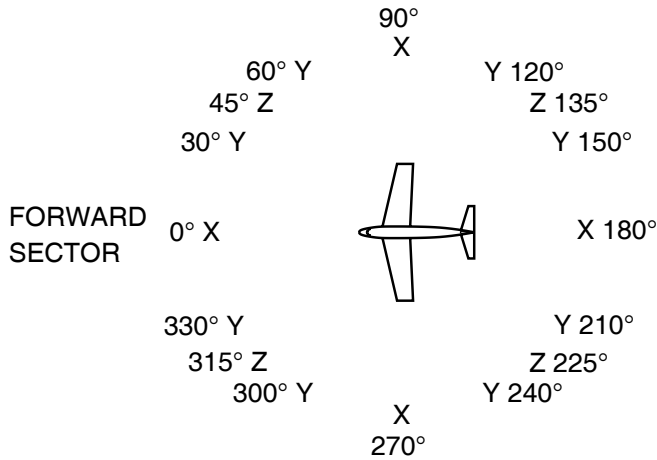
Sample Power & Frequency Screens
Figure 18



8518002

Suggested Layout to Reduce Multipath Errors
Figure 19

4.8 RECOMMENDED TEST PROCEDURE



NOTE: X, Y AND Z REPRESENT TEST LOCATIONS. (NUMBER)° IS BEARING.

8518014

Recommended Test Locations
Figure 20

STEP	PROCEDURE	STEP	PROCEDURE
INITIAL SETUP			
1.	Position Test Set at Forward Sector Test Location, according to 1-2-4, Figure 20, ≤50 ft (15.24 m) from and in line of sight with TCAS top antenna.	7.	For an exact simulated encounter, set UUT for a simulated altitude equal to the altitude of the TCAS-201 at minimum range.
2.	Press SET /CONT Key to enter Setup #1 Menu screen.	8.	Press RUN/STOP Key to initiate test operation.
3.	Select RECALL: field and slew to 0 (default scenario) or desired Mode S Scenario Test number.	NOTE: ANTENNA PUSH BUTTON Switch can be used for RUN/STOP Key.	
4.	Press RUN/STOP Key to initiate storage recall action.	9.	Verify UUT visual and aural operation:
5.	Use SELECT Keys and SLEW Keys to enter position, UUT Antenna and Test Set Flat Antenna information.	●	Verify Traffic Advisory at 40 sec until encounter time.
TCAS ADVISORY OPERATION AND BEARING ACCURACY		●	Verify Resolution Advisory at 25 sec until encounter time.
6.	Press SCEN Key to enter SCENARIO Test screen. See 1-2-4, Figure 21.	●	Verify TCAS bearing reads 0° (±15°).
		10.	Press RUN/STOP Key to terminate test operation.

```

** SCENARIO TEST **
INTRUDER TYPE: MODE-S    TIME:1:00;0:00
  RANGE: 10.00 nm        RATE:+600 kt
   ALT: 10000 ft         RATE:+500 fpm
STATUS: NO THREAT
      Press RUN to start
    
```

Default Scenario Test Screen
Figure 21

STEP	PROCEDURE
TCAS BROADCAST OPERATION	
11.	Press MON Key twice to enter TCAS Broadcast Monitor screen.
12.	Press RUN/STOP Key to initiate test operation.
13.	Verify TCAS Broadcast Interval, INTERVAL: is 10 sec (± 0.2 sec) and MID: field contains correct UUT address.
14.	Press RUN/STOP Key to terminate test operation.
TCAS OPERATES AT EVERY STEP IN W-S SEQUENCE.	
15.	Press SET/CONT Key to enter Setup #1 Menu screen.
16.	Set INTRUDER TYPE: field to ATCRBS .
17.	Press MON Key to enter ATCRBS Monitor screen.
18.	Press RUN/STOP Key to initiate test operation.
19.	Starting at 0.0 , slew ATTN: field up in 1.0 dB steps, verifying NO SUPP: field is ≥ 1 at each step. Continue until S1: field is 0.
20.	Press RUN/STOP Key to terminate test operation.
UUT POWER (ERP) AND FREQUENCY	
21.	Press PWR TEST Key to enter Power & Frequency screen.
22.	Press RUN/STOP Key to initiate test operation. Run test for >30 sec.
23.	Verify power (ERP) = 49.0 dBm (± 2 dBm) and frequency (FREQ) = 1030 MHz (± 0.01 MHz).
24.	Press RUN/STOP Key to terminate test operation.
25.	Reposition Test Set To a "Y" Test Location shown in 1-2-4, Figure 20. Stay at same distance from UUT as established in Steps 1 through 5.

STEP	PROCEDURE
TCAS BEARING ACCURACY	
26.	Press RPLY TEST Key to enter ATCRBS Reply Test screen.
27.	Press RUN/STOP Key to initiate test operation.
28.	Verify TCAS bearing is correct ($\pm 15^\circ$).
29.	Press RUN/STOP Key to terminate test operation.
30.	Reposition Test Set to a "Z" Test Location shown in 1-2-4, Figure 20. Stay at same distance from UUT as established in Steps 1 through 5.
SLS PATTERN AT CROSSOVER	
31.	Press MON Key to enter ATCRBS Monitor screen.
32.	Press RUN/STOP Key to initiate test operation.
33.	Verify NO SUPP: field is ≥ 2 .
34.	Press RUN/STOP Key to terminate test operation.
UUT ANTENNA PATTERN AT CROSSOVER	
35.	Press PWR TEST Key to enter Power & Frequency screen.
36.	Press RUN/STOP Key to initiate test operation. Run test for >30 sec.
37.	Verify power (ERP) is ≤ 3 dB below the greater ERP of the two adjacent "X" Test Locations.
38.	Press RUN/STOP Key to end test operation.
39.	Perform Steps 21 through 24 and 26 through 29 from all "X" Test Locations shown in 1-2-4, Figure 20. Stay at same distance from UUT as established in Steps 1 through 5.
40.	Perform Steps 25 through 29 from all "Y" Test Locations shown in 1-2-4, Figure 20.
41.	Perform Steps 30 through 38 from all "Z" Test Locations shown in 1-2-4, Figure 20.

SECTION 3 - SPECIFICATIONS

NOTE: Specifications are subject to change without notice.

SIGNAL GENERATOR (REPLY CHARACTERISTICS)

RF SIGNAL

Output Frequency:	1090 MHz (± 10 kHz), DCXO controlled
Level (referenced to P_1/F_1):	-67.35 dBm (± 2 dB) at RF I/O Connector (19.5 dB Attenuation) manually adjustable from nominal in 0.5 dB steps
Attenuation:	
Range:	0 to 50 dB (automatically set according to antenna separation distance specified in Setup or manually set in 0.5 dB steps [Whisper-Shout Monitor])
Accuracy:	± 0.5 dB (0 to 40 dB)

GENERATED REPLIES

Reply Modes:	C (with or without Altitude Reporting) S (Downlink Formats [DF] 0, 16) (Squitter DF11)
--------------	---

PULSE CHARACTERISTICS (Measured at 50% Amplitude Points)

Spacing:

ATCRBS:

F_1 to F_2 :	20.30 μ s (± 50 ns)
F_1 to C_1 :	1.45 μ s (± 50 ns)
F_1 to A_1 :	2.90 μ s (± 50 ns)
F_1 to C_2 :	4.35 μ s (± 50 ns)
F_1 to A_2 :	5.80 μ s (± 50 ns)
F_1 to C_4 :	7.25 μ s (± 50 ns)
F_1 to A_4 :	8.70 μ s (± 50 ns)
F_1 to B_1 :	11.60 μ s (± 50 ns)
F_1 to D_1 :	13.05 μ s (± 50 ns)
F_1 to B_2 :	14.50 μ s (± 50 ns)
F_1 to D_2 :	15.95 μ s (± 50 ns)
F_1 to B_4 :	17.40 μ s (± 50 ns)
F_1 to D_4 :	18.85 μ s (± 50 ns)

Mode S:

P_1 to P_2 :	1.00 μ s (± 50 ns)
P_1 to P_3 :	3.50 μ s (± 50 ns)
P_1 to P_4 :	4.50 μ s (± 50 ns)
P_1 to D_1 :	8.00 μ s (± 50 ns)
D_1 to $D(n=2$ to $112)$:	(1.0 μ s times $[n-1]$) (± 50 ns)



SIGNAL GENERATOR (REPLY CHARACTERISTICS) (cont)

PULSE CHARACTERISTICS (Measured at 50% Amplitude Points) (cont)

Widths:

ATCRBS:	0.45 μ s (\pm 50 ns)
Mode S:	
P ₁ through P ₄ :	0.50 μ s (\pm 50 ns)
D ₁ through D ₁₁₂ :	0.50 μ s (\pm 50 ns) pulse width in a 1.00 μ s (\pm 50 ns) chip (bit) width (PPM data: first half = "1", second half = "0".)

Rise and Fall Times:

Rise Time (All Modes):	50 to 100 ns
Fall Time (All Modes):	50 to 200 ns

Amplitude Levels:

All Pulses:	\pm 1 dB relative to F ₁ (ATCRBS) or P ₁ (Mode S) level
-------------	---

DISPLAYED FUNCTIONS

Percent Reply: 0 to 100%

Resolution: 10%

Accuracy: \pm 1%

Range Delay (Selected Range plus Antenna Separation Distance):

Range: 0.5 to 30 nmi

Resolution: 50 ns steps

Accuracy: \pm 0.02 nmi

Range Rate: -1200 to +1200 kts

Resolution: 10 kts

Accuracy: \pm 10%

Altitude Range: -1000 to +126,700 feet

Resolution: 100 feet

Altitude Rate: -10000 to +10000 fpm

Resolution: 100 fpm

Accuracy: \pm 10%

Mode S Address: Selectable

Squitter Control: ON or OFF

Range: 0.8 to 1.2 seconds



UUT MEASUREMENTS (INTERROGATIONS)

Frequency (Mode S) (Average over 30 sec of Operation):

Range:	1029.9 to 1030.1 MHz
Accuracy:	± 10 kHz
Resolution:	1 kHz

Power (Mode S) (Average over 30 sec of Operation):

Direct Connection-Peak Pulse Power:

Range:	+46 to +58 dBm (40 to 631 W)
Accuracy:	± 1 dB
Resolution:	0.1 dB

Effective Radiated Power (ERP) (Mode S):

Range:	+48 to +56 dBm (63 to 398 W)
--------	------------------------------

Detectable Modes: ATCRBS Only All-Call (Mode C)
Mode S Uplink Formats 0 and 16

Pulse Spacing:

ATCRBS (Mode C All-Call):

S ₁ to P ₁ :	
Accepts:	2.0 μ s (± 200 ns)
Rejects:	± 1.0 μ s
P ₁ to P ₃ :	
Accepts:	21.0 μ s (± 200 ns)
Rejects:	± 1.0 μ s
P ₁ to P ₄ :	
Accepts:	23.0 μ s (± 250 ns)
Rejects:	± 1.0 μ s

Mode S:

P ₁ to P ₂ :	
Accepts:	2.0 μ s (± 100 ns)
Rejects:	± 1.0 μ s
P ₁ to SPR:	
Accepts:	4.75 μ s (± 100 ns)
Rejects:	± 1.0 μ s

Simulated Transponder MTL: +44.25 dBm (± 2 dB) at RF I/O Connector (19.5 dB Attenuation) manually adjustable from nominal in 0.5 dB steps

ATCRBS Suppression Detection:

Rejects:	P ₂ or S ₁ >0.5 dB above Level of P ₁ (<10% replies)
Accepts:	P ₂ or S ₁ >0.5 dB below MTL (>90% replies)



TEST ANTENNA

Remote Antenna VSWR:	<1.5:1
Gain:	9.5 dB typically, specified on the antenna
Range:	6 ft (1.83 m) to 500 ft (152.4 m)

BATTERY OPERATION

Duration:	1.5 hours before recharge at 25° C
Automatic Shutoff:	After 15 min of non-use

POWER REQUIREMENTS

Source Voltage and Frequency:	100 to 120 VAC at 60 Hz 220 to 240 VAC at 50 Hz
Power Consumption:	37 W Maximum 34 W Nominal at 115 VAC 26 W Nominal at 230 VAC
Nominal Input Current:	0.4 A at 115 VAC 0.2 A at 230 VAC

FUSE REQUIREMENTS

F1 and F2:	
100 to 120 VAC:	1.0 A, 250 V, Type F
220 to 240 VAC:	0.5 A, 250 V, Type F

SAFETY

This instrument is designed to comply with the requirements of EN61010-1/IEC1010-1, for Class 1 portable equipment and is for use in a pollution degree 2 environment. The equipment is designed to operate from an installation category II supply, to environmental conditions specified in para 1.4 of EN61010-1.

OPERATIONAL ENVIRONMENTAL CONSIDERATIONS

This instrument operates over temperature extremes of -20° to +50° C.

SECTION 4 - SHIPPING

1. SHIPPING TEST SETS

1.1 INFORMATION

Test Sets returned to factory for calibration, service or repair must be repackaged and shipped according to the following conditions:

Authorization

Do not return any products to factory without first receiving authorization from Aeroflex Customer Service Department.

CONTACT: Aeroflex
Customer Service

Telephone: (800) 835-2350
FAX: (316) 524-2623
email: service@aeroflex.com

Tagging Test Sets

All Test Sets must be tagged with:

- Identification and address of owner.
- Nature of service or repair required.
- Model Number.
- Serial Number.

Shipping Containers

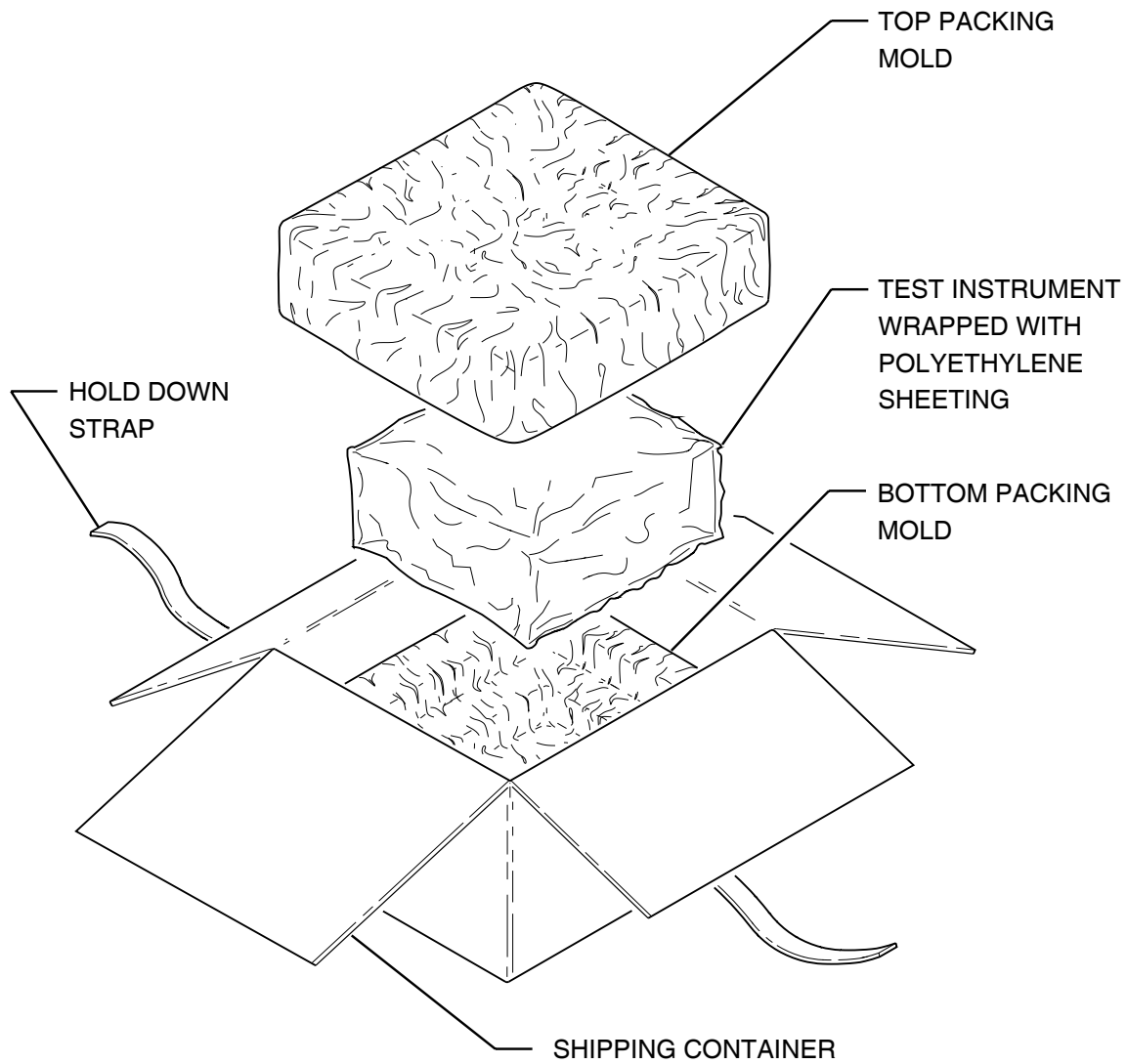
Test Sets must be repackaged in original shipping containers using original packing molds. If original shipping containers and materials are not available, contact Aeroflex Customer Service for shipping instructions.

Freight Costs

All freight costs on non-warranty shipments are assumed by the customer. (See "Warranty Packet" for freight charge policy on warranty claims.)

1.2 REPACKING PROCEDURE

- Make sure bottom packing mold is seated on floor of shipping container.
- Carefully wrap Test Set with polyethylene sheeting to protect finish.
- Place Test Set into shipping container, making sure Test Set is securely seated in bottom packing mold.
- Place top packing mold over top of Test Set and press down until mold rests solidly in bottom packing mold.
- Close shipping container lids and seal with shipping tape or an industrial stapler. Tie all sides of container with break resistant rope, twine or equivalent.



Repacking Procedure
Figure 1

SECTION 5 - STORAGE

1. STORING TEST SETS

Perform the following storage precautions whenever the Test Set is stored for extended periods:

- Disconnect Test Set from any electrical power source.
- Disconnect and store ac power cable and other accessories with Test Set.
- Cover Test Set to prevent dust and debris from covering and entering Test Set.



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APPENDIX A - CONNECTOR PIN-OUT TABLES

1. TABLE OF I/O CONNECTORS

CONNECTOR	TYPE	SIGNAL NAME	SIGNAL TYPE	INPUT/OUTPUT
J10050	IEC-320	AC PWR	ac Line Power	INPUT
J10053	LEMO	COMM	RS-232C	INPUT/OUTPUT
	Refer to Appendix A, Table 2 for COMM Connector Pin-Out description.			
J10054	BNC	INTERR VIDEO	VIDEO (Direct Connection Only)	OUTPUT
J10055	BNC	SYNC	TTL	OUTPUT
J10056	BNC	MONITOR	TTL VIDEO	OUTPUT
J10057	BNC	ANTENNA	RF	INPUT/OUTPUT
J10058	TNC	RF I/O	RF	INPUT/OUTPUT

I/O Connectors
Table 1

2. COMM CONNECTOR (J10053) PIN-OUT TABLE

PIN NO.	SIGNAL NAME	SIGNAL TYPE	INPUT/OUTPUT	POLARITY
1	EXT SYNC	TTL	OUTPUT	RISING EDGE
2	EXT PULSE	TTL	INPUT	ACTIVE LOW
3	EXT DPSK IN	TTL	INPUT	
4	EXT DPSK OUT	CMOS	OUTPUT	
5	SPARE			
6	TXD	BIPOLAR	OUTPUT	
7	DTR	BIPOLAR	OUTPUT	ACTIVE LOW
8	RXD	BIPOLAR	INPUT	
9	CTS	BIPOLAR	INPUT	ACTIVE LOW
10	GND		OUTPUT	GROUND

Pin-Out for COMM Connector
Table 2



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APPENDIX B - SIGNAL FORMATS

1. OPERATING GOALS

Mode S combines secondary surveillance radar and a ground-air-ground data link system to provide aircraft surveillance and communications necessary for supporting automated ATC in dense traffic environments. Mode S provides common-channel interoperation with the ATC beacon system and may be implemented over an extended ATCRBS-to-Mode S transition period. In supporting ATC automation, Mode S provides the reliable communications necessary for data link services.

2. MODE S MESSAGE CONTENT

2.1 ADDRESS/PARITY (FIELD AP)

All discrete Mode S interrogations (56-bit or 112-bit) and replies (except the All Call reply) contain the 24-bit discrete address of the Mode S transponder upon which 24 error-detecting parity check bits are overlaid. In the All Call reply, the 24 parity check bits are overlaid on the address of the Mode S interrogator. The text of the reply includes the discrete address of the transponder.

2.2 SURVEILLANCE

The primary function of Mode S is surveillance. For the Mode S transponder, this function is accomplished by using short (56-bit) transmissions in both directions. In these transmissions, the aircraft reports altitude (DF04) or ATCRBS 4096 code as well as flight status (airborne, on the ground, alert, Special Position Identification [SPI], etc.).

2.3 DATA LINK COMMUNICATIONS

The discrete addressing and digital encoding allow Mode S transmissions to be used as digital data links. Interrogation and reply formats of the Mode S system contain sufficient coding space to transmit data. Most Mode S data link transmissions are handled as one 56-bit message included as part of long 112-bit interrogations or replies. The transmissions include the message in addition to surveillance data, and is generally used in place of a surveillance interrogation and/or reply.

An efficient transmission of longer messages is accomplished by the extended length message (ELM) capability (UF24 and DF24). Using this capability, a sequence of up to sixteen 80-bit message segments (each with a 112-bit transmission) is transmitted, either ground-to-air or air-to-ground and is acknowledged with a single reply/interrogation. ELMs do not contain surveillance data and thus cannot substitute for a surveillance interrogation-reply cycle.

3. SIGNAL FORMATS

Signal formats for uplink and downlink messages are outlined in Chapter 2, RTCA DO-181 and Chapter 2, Volume I of RTCA DO-185. Tables 1, 2, 3, 4 and 5 in Appendix B contain the signal formats and definitions. Data is expressed in decimal unless otherwise specified. Refer to Appendix B, Table 6 for conversion to hexadecimal, octal or binary.



FORMAT

NO.	UF	
0	(0 0000)	— 3 —(RL:1)— 4 —(AQ:1) (BD:8)— 10 — (AP:24).....Short Air-Air Surveillance
1	(0 0001)	————— 27 or 83 ————— (AP:24)
2	(0 0010)	————— 27 or 83 ————— (AP:24)
3	(0 0011)	————— 27 or 83 ————— (AP:24)
4	(0 0100)	(PC:3) (RR:5) (DI:3) (SD:16) (AP:24).. Surveillance, Altitude Request
5	(0 0101)	(PC:3) (RR:5) (DI:3) (SD:16) (AP:24).. Surveillance, Identity Request
6	(0 0110)	————— 27 or 83 ————— (AP:24)
7	(0 0111)	————— 27 or 83 ————— (AP:24)
8	(0 1000)	————— 27 or 83 ————— (AP:24)
9	(0 1001)	————— 27 or 83 ————— (AP:24)
10	(0 1010)	————— 27 or 83 ————— (AP:24)
11	(0 1011)	(PR:4) (II:4)————— 19 ————— (AP:24).....Mode S Only All Call
12	(0 1100)	————— 27 or 83 ————— (AP:24)
13	(0 1101)	————— 27 or 83 ————— (AP:24)
14	(0 1110)	————— 27 or 83 ————— (AP:24)
15	(0 1111)	————— 27 or 83 ————— (AP:24)
16	(1 0000)	— 3 —(RL:1)— 4 —(AQ:1)— 18 —(MU:56) (AP:24)..... Long Air-Air Surveillance
17	(1 0001)	————— 27 or 83 ————— (AP:24)
18	(1 0010)	————— 27 or 83 ————— (AP:24)
19	(1 0011)	————— 27 or 83 ————— (AP:24)
20	(1 0100)	(PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24).....Comm-A, Altitude Request
21	(1 0101)	(PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24)..... Comm-A, Identity Request
22	(1 0110)	————— 27 or 83 ————— (AP:24)
23	(1 0111)	————— 27 or 83 ————— (AP:24)
24	(1 1xxx)	(RC:2) (NC:4) (MC:80) (AP:24).....Comm-C (ELM)

- NOTE:** (XX:M) represents a field designated XX containing M number of assigned bits.
- NOTE:** —N— represents free coding space with N available bits, coded as Zeros for transmission.
- NOTE:** For Uplink Formats (UF) 0 through 23, the format number corresponds to the binary code in the first 5 bits of the interrogation. Format number 24 is arbitrarily defined as the format beginning with Ones in the first two bit positions. The following three bits (xxx) vary with the interrogation content.
- NOTE:** All formats are shown for completeness, although a number of them are unused.

Overview of Mode S Interrogation Formats
Table 1



**FORMAT
NO. DF**

0	(0 0000)	(VS:1) (CC:1)-1-(SL:3)-2-(RI:4)-2-(AC:13) (AP:24)	.....	Short Air-Air Surveillance
1	(0 0001)	_____ 27 or 83 _____	(P:24)	
2	(0 0010)	_____ 27 or 83 _____	(P:24)	
3	(0 0011)	_____ 27 or 83 _____	(P:24)	
4	(0 0100)	(FS:3) (DR:5) (UM:6) (AC:13) (AP:24)	.....	Surveillance, Altitude Reply
5	(0 0101)	(FS:3) (DR:5) (UM:6) (ID:13) (AP:24)	.....	Surveillance, Identity Reply
6	(0 0110)	_____ 27 or 83 _____	(P:24)	
7	(0 0111)	_____ 27 or 83 _____	(P:24)	
8	(0 1000)	_____ 27 or 83 _____	(P:24)	
9	(0 1001)	_____ 27 or 83 _____	(P:24)	
10	(0 1010)	_____ 27 or 83 _____	(P:24)	
11	(0 1011)	(CA:3) (AA:24) (PI:24)	.....	All Call Reply/Squitter
12	(0 1100)	_____ 27 or 83 _____	(P:24)	
13	(0 1101)	_____ 27 or 83 _____	(P:24)	
14	(0 1110)	_____ 27 or 83 _____	(P:24)	
15	(0 1111)	_____ 27 or 83 _____	(P:24)	
16	(1 0000)	(VS:1)-2-(SL:3)-2-(RI:4)-2-(AC:13)(MV:56)(AP:24)	.....	Long Air-Air Surveillance
17	(1 0001)	(CA:3) (AA:24) (ME:56) (PI:24)	.....	Extended Squitter
18	(1 0010)	_____ 27 or 83 _____	(P:24)	
19	(1 0011)	_____ 27 or 83 _____	(P:24)	
20	(1 0100)	(FS:3) (DR:5) (UM:6) (AC:13) (MB:56) (AP:24)	.....	Comm-B, Altitude Reply
21	(1 0101)	(FS:3) (DR:5) (UM:6) (ID:13) (MB:56) (AP:24)	.....	Comm-B, Identity Reply
22	(1 0110)	_____ 27 or 83 _____	(P:24)	
23	(1 0111)	_____ 27 or 83 _____	(P:24)	
24	(1 1xxx)	(KE:1) (ND:4) (MD:80) (AP:24)	.....	Comm-D (ELM)

NOTE: (XX:M) represents a field designated XX containing M number of assigned bits.

NOTE: (P:24) represents a 24-bit field reserved for parity information.

NOTE: —N— represents free coding space with N available bits, coded as Zeros for transmission.

NOTE: For Downlink Formats (DF) 0 through 23, the format number corresponds to the binary code in the first 5 bits of the reply. Format number 24 is arbitrarily defined as the format beginning with Ones in the first two bit positions. The following three bits (xxx) vary with the reply content.

NOTE: All formats are shown for completeness, although a number of them are unused.

Overview Of Mode S Reply Formats
Table 2

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
AA		24	9-32	X	The aircraft address announced in the clear, used in DF=11, 17.
AC		13	20-32	X	The altitude code used in formats DF=0, 4, 16 and 20. All bits are Zeros if altitude information is not available. Contains metric altitude if M-bit (26) is One.
AP		24 24	33-56 89-112	X X	Parity overlaid on the Address appears at the end of all transmissions, uplink and downlink, with the exception of format DF=11.
AQ		1	14	X	Designates formats UF=0, 16 as acquisition transmissions. Bit 14 (RI, DF=0, 16), repeats AQ as received by transponder.
BD		8	15-22	X	Contains the identity of the ground-initiated Comm-B register contents to appear in the MV field of the corresponding reply, used in UF=0.
CA		3	6-8	X	Used in DF=11, Squitter or All Call reply, to report transponder capability. Codes are: 0 = Level 1, no communications capability (surveillance only,) Transponder accepts UF=0, 4, 5, 11; Transponder transmits DF=0, 4, 5, 11. 1 = Level 2, Comm-A and Comm-B capability, Transponder accepts UF=0, 4, 5, 11, 20, 21; Transponder transmits DF=0, 4, 5, 11, 20, 21. 2 = Level 3, Comm-A, Comm-B and uplink ELM capability, Transponder accepts UF=0, 4, 5, 11, 20, 21, 24; Transponder transmits DF=0, 4, 5, 11, 20, 21. 3 = Level 4, Comm-A, Comm-B, uplink and downlink ELM capability, Transponder accepts UF=0, 4, 5, 11, 20, 21, 24; Transponder transmits DF=0, 4, 5, 11, 20, 21, 24. 4 = Level 2, 3 or 4; ability to set code 7, and is on the ground. 5 = Level 2, 3 or 4; ability to set code 7, and is airborne. 6 = Level 2,3 or 4; ability to set code 7. 7 = DR≠0 or FS=3,4 or 5. NOTE: Codes 4-7 are for squitters only.
CC		1	7	X	Indicates transponder has ability to support crosslink capability (decode the contents of the UF=0 BD field and respond with the contents of the specified ground-initiated Comm-B register in the MV field of the corresponding DF=16 reply. Used in DF=0.

Overview of Format Definitions
Table 3



FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT																																								
DF		5	1-5	X	The first field in all downlink formats is the transmission descriptor.																																								
DI		3	14-16	X	Identifies coding contained in the SD codes are: 0 = SD has Interrogator Identifier (IIS). 1 = SD contains (IIS, MBS, MES, LOS, RSS, TMS). 2-6 = Not assigned.																																								
DR		5	9-13	X	Requests extraction of downlink messages from the transponder by the interrogator and appears in formats DF=4, 5, 20, 21. The codes are: 0 = No downlink request. 1 = Request to send Comm-B message (B bit set), 2 = TCAS information available. 3 = TCAS information available and request to send Comm-B message. 4 = Comm-B Broadcast #1 available. 5 = Comm-B Broadcast #2 available. 6 = TCAS information and Comm-B Broadcast #1 available. 7 = TCAS information and Comm-B Broadcast #2 available. 8-15 = Not assigned. 16-31 = Request to send n-segments, signified by 15 + n. Codes 1-15 take priority over codes 16-31.																																								
FS		3	6-8	X	Reports flight status of aircraft and is used in formats DF=4, 5, 20, 21. Codes are:																																								
					<table border="1"> <thead> <tr> <th>CODE</th> <th>ALERT</th> <th>SPI</th> <th>AIRBORNE</th> <th>ON THE GROUND</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>no</td> <td>no</td> <td>yes</td> <td>no</td> </tr> <tr> <td>1</td> <td>no</td> <td>no</td> <td>no</td> <td>yes</td> </tr> <tr> <td>2</td> <td>yes</td> <td>no</td> <td>yes</td> <td>no</td> </tr> <tr> <td>3</td> <td>yes</td> <td>no</td> <td>no</td> <td>yes</td> </tr> <tr> <td>4</td> <td>yes</td> <td>yes</td> <td colspan="2">either</td> </tr> <tr> <td>5</td> <td>no</td> <td>yes</td> <td colspan="2">either</td> </tr> <tr> <td colspan="5">6, 7 are not assigned.</td> </tr> </tbody> </table>	CODE	ALERT	SPI	AIRBORNE	ON THE GROUND	0	no	no	yes	no	1	no	no	no	yes	2	yes	no	yes	no	3	yes	no	no	yes	4	yes	yes	either		5	no	yes	either		6, 7 are not assigned.				
CODE	ALERT	SPI	AIRBORNE	ON THE GROUND																																									
0	no	no	yes	no																																									
1	no	no	no	yes																																									
2	yes	no	yes	no																																									
3	yes	no	no	yes																																									
4	yes	yes	either																																										
5	no	yes	either																																										
6, 7 are not assigned.																																													
ID		13	2-32	X	The 4096 identification code, numbers , as, set by the pilot, in DF=5, 21.																																								
II		4	10-13	X	Identifies the interrogator and appears in UF=11, the Mode S Only All Call. NOTE: The same information may also appear in the IIS subfields.																																								

Overview of Format Definitions
Table 3 (cont)



FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
KE		1	4	X	Defines the content of the ND and MD fields in Comm-D replies, DF=24.
MA		56	33-88	X	Messages directed to the aircraft, part of Comm-A interrogations, UF=20, 21.
	ADS	8	33-40	X	Defines the content of the MA message field in Comm-A requests and is expressed in two groups of 4 bits each, ADS1 (33-36) and ADS2 (37-40).
	ADS1	4	33-36	X	Part of the A-Definition Subfield and is set to 0 for TCAS Sensitivity Level Commands.
	ADS2	4	37-40	X	Part of the A-Definition Subfield and is set to 5 for TCAS Sensitivity Level Commands.
	SLC	4	41-44	X	Sensitivity Level Command for the TCAS aircraft. The codes are: 0 = No command. 1 = Not Assigned. 2 = Select TA_ONLY mode of operation. 3 = Set TCAS Sensitivity Level to 3. 4 = Set TCAS Sensitivity Level to 4. 5 = Set TCAS Sensitivity Level to 5. 6 = Set TCAS Sensitivity Level to 6. 7 = Set TCAS Sensitivity Level to 7. 8-14 = Not Assigned. 15 = Cancel previous Sensitivity Level.
MB		56	33-88	X	Messages to be transmitted to interrogator, part of the Comm-B replies, DF=20, 21. The field contains Data Link, Capability Reports or Aircraft Identification Reports or TCAS Resolution Advisory Reports.
	ACS	20	45-64	X	Comm-A capability subfield reports data link service(s) supported by the installation. If all bits are Zeros, no Comm-A data link services are supported.
	AIS	48	41-88	X	Aircraft Identification, reported when a surveillance or Comm-A interrogation (UF=4, 5, 20, 21) contains RR=18 and DI=anything but 7. AIS contains up to eight 6-bit characters as defined in Table 4.

Overview of Format Definitions
Table 3 (cont)



FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
MB	ARA	14	41-54	X	TCAS Resolution Advisory Report indicating current Active Resolution Advisories (if any) generated by own TCAS unit against one or more threat aircraft. Each bit indicates a specific resolution advisory with One being active and Zero being inactive. Bit indications are: 41-Climb. 42-Don't descend. 43-Don't descend faster than 500 FPM. 44-Don't descend faster than 1000 FPM. 45-Don't descend faster than 2000 FPM. 46-Descend. 47-Don't climb. 48-Don't climb faster than 500 FPM. 49-Don't climb faster than 1000 FPM. 50-Don't climb faster than 2000 FPM. 51-Turn left. 52-Turn right. 53-Don't turn left. 54-Don't turn right.
	BCS	16	65-80	X	Comm-B capability subfield reports installed data sources that can be accessed by the ground for transmission via a ground-initiated Comm-B. If all bits are Zeros, no data is accessible by a ground-initiated Comm-B.
	BDS	8	33-40	X	Defines the content of the MB message field in reply to ground-initiated Comm-B and is expressed in two groups of 4 bits each, BDS1 (33-36) and BDS2 (37-40).
	BDS1	4	33-36	X	Corresponds with RR in UF=4, 5, 20, 21. The codes are: 0 = MB contains Air-initiated Comm-B. 1 = MB contains Data Link Capability Report. 2 = MB contains Aircraft Identification. 3 = MB contains TCAS Resolution Advisory. 4-15 = Not assigned.
	BDS2	4	37-40	X	Basic report uses BDS2=0. More complex Mode S installations report additional capabilities in various formats assigned to BDS2 codes other than 0 as requested by interrogator, specified in the RRS subfield of SD.
	CFS	4	41-44	X	Continuation subfield contains the BDS2 value of the next additional capability report available from the installation.

Overview of Format Definitions
Table 3 (cont)



FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
MB	ECS	8	81-88	X	Data Link Capability subfield reports ELM capability of installation. No ELM data link services are supported if all bits are Zeros.
	MTE	1	60	X	Multiple Threat Encounter bit indicates ≥ 2 simultaneous TCAS threats.
	RAC	4	55-58	X	Resolution Advisory Complements subfield indicates currently active resolution, advisory complements (if any) received from all other TCAS aircraft with on-board resolution capability. Bits are set to One when active and Zero when inactive. Bit indications are: 55-Don't descend. 56-Don't climb. 57-Don't turn left. 58-Don't turn right.
	RAT	1	59	X	Resolution Advisory Terminated indicator is set to One for 18 seconds (± 1 second) following termination of a previously reported resolution advisory.
	TID	26	33-88	X	Threat Identity Data subfield contains data according to TTI field. If TTI=1, TID contains Mode S address of threat in bits 63-85 (bits 87-88 are Zero). If TTI=2, TID contains altitude, range and bearing data.
	TIDA	13	63-75	X	Threat Identity Data, Altitude subfield reports Mode C altitude code of the threat.
	TIDB	6	83-88	X	Threat Identity, Bearing subfield reports most recent bearing of the threat.
	TIDR	7	76-82	X	Threat Identity, Range subfield reports most recent range of the threat.
	TTI	2	61-62	X	Threat Type Indicator subfield defines type of data in TID field.
	MC		80	9-88	X	Comm-C field contains one segment of a sequence of segments transmitted to the transponder in the ELM mode. MC is part of UF=24.
IIS		4	9-12 (if RC=0 to 2) or 25-28 (if RC=3)	X	Interrogator Identifier subfield reports the identity of the interrogator (See SD and UM fields).

Overview of Format Definitions
Table 3 (cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
	SRS	16	9-24	X	If a Comm-C interrogation (UF=24) contains RC=3, the SRS subfield contains a list of segment request-authorizations for DELMs in the 16-bit (9-24) SRS subfield. Starting with bit 9, denoting the first segment, each of the following bits is set to One if the transmission of the corresponding segment is requested. Refer to Table 5.
MD		80	9-88	X	Comm-D field, part of DF=24, contains one segment of a sequence of segments transmitted by the transponder in the ELM mode. It may contain a summary of received MC segments of an uplink ELM.
	TAS	16	17-32	X	Reports segments received in a Comm-C sequence. Starting with bit 17 denoting the first segment, each successive bit is One if the corresponding segment was received. TAS appears if KE=1 in the same reply. Refer to Table 5 for values.
ME		56	33-88	X	Extended squitter message, part of DF=17, contains broadcast messages.
MU		56	33-88	X	Field, part of the long air-air surveillance interrogation UF=16, contains information used in air-to-air exchanges (TCAS, Resolution Messages and TCAS Broadcast Messages).
	CHC	3	47-49	X	Cancel Horizontal Resolution Advisory Complement. In TCAS Resolution Messages transmitted by TCAS without horizontal resolution capability, CHC is set to 0. The codes are: 0 = No cancellation. 1 = Cancel, don't turn left. 2 = Cancel, don't turn right. 3-7 = Not assigned.
	CVC	2	43-44	X	Cancel Vertical Resolution Advisory Complement. The codes are: 0 = No cancellation. 1 = Cancel, don't descend. 2 = Cancel, don't climb. 3 = Not assigned.

Overview of Format Definitions
Table 3 (cont)



FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
	HRC	3	50-52	X	Horizontal Resolution Advisory Complement. In TCAS Resolution Messages transmitted by TCAS without horizontal resolution capability, HRC is set to 0. The codes are: 0 = No horizontal resolution advisory complement sent. 1 = Intruder TCAS sense is turn left/do not turn left. 2 = Intruder TCAS sense is turn left/do not turn right. 3-4 = Not assigned. 5 = Intruder TCAS sense is turn right/do not turn left. 6 = Intruder TCAS sense is turn right/do not turn right. 7 = Not assigned.
MU	HSB	5	56-60	X	Encoded Sense Bits for Horizontal Resolution Complements provide a parity coding field protecting the six horizontal sense bits (CHC and HRC) and are used in TCAS III Resolution Messages.
	MID	24	65-88	X	Contains discrete address of interrogating aircraft and is in TCAS Resolution Advisories Lock Requests, TCAS Resolution Messages and TCAS Broadcast Messages. NOTE: TCAS Broadcast Message is sent at 10-second intervals.
	MTB	1	42	X	Multiple Threat Bit indicates more than one TCAS threat when set to One and no more than one threat when set to Zero.
	UDS	8	33-40	X	Defines the content of the MU message field and is expressed in two 4-bit groups, UDS1 (33-36) and UDS2 (37-40).
	UDS1	4	33-36	X	Is set to 3 for TCAS Resolution Messages and TCAS Broadcast Messages.
	UDS2	4	37-40	X	Is set to 0 for TCAS Resolution Messages or set to 2 for TCAS Broadcast Messages.
	VRC	2	45-46	X	Vertical Resolution Advisory, Complement. The codes are: 0 = No vertical resolution advisory complement sent. 1 = Don't descend. 2 = Don't climb. 3 = Not assigned.

Overview of Format Definitions
Table 3 (cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT																																																																																																																																								
MU	VSB	4	61-64	X	<p>Encoded Sense Bits for Vertical Resolution Complements provide a parity coding field to protect four vertical sense bits (CVC and VRC) in all TCAS Resolution Messages. If bits 43-46 do not agree with bits 61-64, the TCAS receiver assumes an error and disregards message. Bits are as follows:</p> <table border="1"> <thead> <tr> <th>43</th> <th>44</th> <th>45</th> <th>46</th> <th>61</th> <th>62</th> <th>63</th> <th>64</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> </tbody> </table>	43	44	45	46	61	62	63	64	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	1	1	1	0	0	1	1	1	0	0	1	0	1	0	0	1	0	1	1	0	1	0	1	0	1	0	1	0	1	1	0	1	1	0	0	0	1	1	1	0	0	1	0	1	0	0	0	1	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	0	1	0	1	0	1	1	0	1	0	0	1	1	0	0	0	1	1	0	1	1	0	1	1	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1
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MV		56	33-88	X	Field, part of the long air-air surveillance reply DF=16, contains information used in air-to-air exchanges (Coordination Reply Message).																																																																																																																																								
	ARA	14	41-54	X	Same as in MB field.																																																																																																																																								
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	VDS	8	33-40	X	Defines the content of the MV message field and is expressed in two 4-bit groups, VDS1 (33-36) and VDS2 (37-40).																																																																																																																																								
	VDS1	4	33-36	X	Is set to 3 for Coordination Reply Message.																																																																																																																																								
	VDS2	4	37-40	X	Is set to 0 for Coordination Reply Message.																																																																																																																																								
NC		4	5-8	X	Provides the segment number transmitted in an uplink ELM and is part of a Comm-C interrogation, UF=24.																																																																																																																																								
ND		4	5-8	X	Provides the segment number transmitted in a downlink ELM and is part of a Comm-D reply, DF=24.																																																																																																																																								

Overview of Format Definitions
Table 3 (cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
PC		3	6-8	X	<p>Contains operating commands to the transponder and is part of surveillance and Comm-A interrogations UF=4, 5, 20, 21. The codes are:</p> <ul style="list-style-type: none"> 0 = No changes in transponder state. 1 = Non-selective All Call lockout. 2 = Not assigned. 3 = Not assigned. 4 = Cancel B. 5 = Cancel C. 6 = Cancel D. 7 = Not assigned.
PI		24	33-56	X	<p>Contains the parity overlaid on the interrogator identity code. PI is part of the reply, DF=11, to the Mode S Only All Call.</p>
PR		4	6-9	X	<p>Field contains commands to the transponder specifying the reply probability to the Mode S Only All Call interrogation, UF=11 containing the PR. A command to disregard any lockout state can also be given. The assigned codes are:</p> <ul style="list-style-type: none"> 0 = Reply with probability = 1. 1 = Reply with probability = 1/2. 2 = Reply with probability = 1/4. 3 = Reply with probability = 1/8. 4 = Reply with probability = 1/16. 5,6,7 = Do not Reply. 8 = Disregard lockout, reply with probability = 1. 9 = Disregard lockout, reply with probability = 1/2. 10 = Disregard lockout, reply with, probability = 1/4. 11 = Disregard lockout, reply with probability = 1/8. 12 = Disregard lockout, reply with probability = 1/16. 13, 14, 15 = Do not reply. <p>NOTE: On receipt of a Mode S Only All Call containing a PR code other than 0 or 8, transponder executes a random process and makes a reply decision for the interrogation in accordance with the commanded probability. Random occurrence of replies enables interrogator to acquire closely spaced aircraft when replies would otherwise synchronously garble each other.</p>

Overview of Format Definitions
Table 3 (cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
RC		2	3-4	X	Designates transmitted segment as initial, intermediate or final if coded 0, 1 or 2 respectively. RC=3 is used to request Comm-D DELMs by the transponder. RC is part of Comm-C interrogation, UF=24.
RI		4	14-17	X	Information in DF=0, 16. The codes are: 0 = No on-board TCAS. 1 = Not assigned. 2 = On-board TCAS with resolution capability inhibited. 3 = On-board TCAS with vertical-only resolution capability. 4 = On-board TCAS with vertical and horizontal resolution capability. 5-7 = Not assigned. 8 = No maximum airspeed data available. 9 = Airspeed is ≤ 75 kts. 10 = Airspeed is > 75 kts and ≤ 150 kts. 11 = Airspeed is > 150 kts and ≤ 300 kts. 12 = Airspeed is > 300 kts and ≤ 600 kts. 13 = Airspeed is > 600 kts and ≤ 1200 kts. 14 = Airspeed is > 1200 kts. 15 = Not assigned.
RL		1	9	X	Command, sent in UF=0, 16; solicits DF=0 reply if Zero and DF=16 reply if One (only if transponder is associated with Airborne Collision Avoidance System [ACAS] equipment). Otherwise, in UF=0, Zero solicits DF=0 reply and One solicits no reply. In UF=16, Zero solicits DF=16 reply and One solicits no reply.

Overview of Format Definitions
Table 3 (cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT																					
RR		5	9-13	X	Contains length and content of interrogator requested reply. RR is part of surveillance and Comm-A interrogations UF=4, 5, 20, 21.																					
<table border="1"> <thead> <tr> <th>RR CODE</th> <th>REPLY LENGTH</th> <th>MB CONTENT</th> </tr> </thead> <tbody> <tr> <td>0-15</td> <td>Short</td> <td>N/A</td> </tr> <tr> <td>16</td> <td>Long</td> <td>Air initiated Comm-B</td> </tr> <tr> <td>17</td> <td>Long</td> <td>Data link capability</td> </tr> <tr> <td>18</td> <td>Long</td> <td>Aircraft Identification</td> </tr> <tr> <td>19</td> <td>Long</td> <td>Resolution Advisories</td> </tr> <tr> <td>20-31</td> <td>Long</td> <td>Not Assigned</td> </tr> </tbody> </table>						RR CODE	REPLY LENGTH	MB CONTENT	0-15	Short	N/A	16	Long	Air initiated Comm-B	17	Long	Data link capability	18	Long	Aircraft Identification	19	Long	Resolution Advisories	20-31	Long	Not Assigned
RR CODE	REPLY LENGTH	MB CONTENT																								
0-15	Short	N/A																								
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17	Long	Data link capability																								
18	Long	Aircraft Identification																								
19	Long	Resolution Advisories																								
20-31	Long	Not Assigned																								
					NOTE: If first bit of RR code is One, decimal equivalent of last four bits of RR code designates code for BDS1 in reply (ground initiated). BDS2 is assumed to be Zero if not specified by DI=7 and RRS.																					
SD		16	17-32	X	Contains control codes, as specified by the DI field affecting transponder protocol and is part of surveillance and Comm-A interrogations UF=4, 5, 20, 21.																					
	IIS	4	17-20	X	Interrogator Identifier subfield contains the self-identification code of the interrogator and is numerically identical to the II code transmitted by the interrogator in Mode S Only All Calls. IIS codes are 0 through 15; IIS=0 is not a valid interrogator identifier for multisite purposes. IIS is sent only when DI=0, 1 or 7.																					
	LOS	1	26	X	Lockout subfield, if set to One, initiates a multisite All Call lockout to Mode S Only All Calls (UF=11) from the Interrogator indicated in IIS of the interrogation. If LOS is set to Zero, no change in lockout state is commanded. LOS is sent only if DI=1 or 7.																					
	MBS	2	21-22	X	Multisite Comm-B subfield, sent when DI=1, is assigned the following codes: 0 = No Comm-B action. 1 = Comm-B reservation. 2 = Comm-B closeout.																					

Overview of Format Definitions
Table 3 (cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
	MES	3	23-25	X	<p>Multisite ELM subfield, sent when DI=1, contains reservation and closeout commands for ELM as follows:</p> <p>0 = No ELM action. 1 = Comm-C reservation. 2 = Comm-C closeout. 3 = Comm-D reservation. 4 = Comm-D closeout. 5 = Comm-C reservation and Comm-D closeout. 6 = Comm-C closeout and Comm-D reservation. 7 = Comm-C and Comm-D closeouts.</p>
	RRS	4	21-24	X	<p>Reply Request subfield, sent when DI=7, contains coding corresponding to the requested BDS2 code.</p>
	RSS	2	27-28	X	<p>Reservation Status subfield, sent when DI=1, requests transponder to report reservation status in the UM field. The codes are:</p> <p>0 = No request. 1 = Report Comm-B reservation status. 2 = Report Comm-C reservation status. 3 = Report Comm-D reservation status.</p>
SD	TMS	4	29-32	X	<p>Tactical Message subfield, sent when DI=1 or 7, contains coding for linking the Comm-A message segments. The codes are:</p> <p>0 = No Action. 1 = Unlinked, Priority. 2 = Unlinked, Acknowledge. 3 = Unlinked, Priority, Acknowledge. 4 = Linked 1st Segment, Single ADS. 5 = Linked 1st Segment, Single ADS Priority. 6 = Linked 1st Segment, Single ADS Acknowledge. 7 = Linked 1st Segment, Single ADS, Priority, Acknowledge. 8 = Linked 1st Segment, Multiple ADS. 9 = Linked 1st Segment, Multiple ADS, Priority. 10 = Linked 1st Segment, Multiple ADS, Acknowledge. 11 = Linked 1st Segment, Multiple ADS, Priority, Acknowledge. 12 = Second Segment. 13 = Third Segment. 14 = Final Segment. 15 = Not Assigned.</p>

Overview of Format Definitions
Table 3 (cont)



FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
SL		3	9-11	X	<p>Reports the current operating sensitivity level of the TCAS unit and is a part of air-air surveillance replies, DF=0, 16. The codes are:</p> <p>0 = No TCAS sensitivity level reported. 1 = TCAS operates at sensitivity level 1. 2 = TCAS operates at sensitivity level 2. 3 = TCAS operates at sensitivity level 3. 4 = TCAS operates at sensitivity level 4. 5 = TCAS operates at sensitivity level 5. 6 = TCAS operates at sensitivity level 6. 7 = TCAS operates at sensitivity level 7.</p> <p>NOTE: The SL field has no meaning for aircraft with RI=0 (no on-board capability to generate resolution, advisories).</p>
UF		5	1-5	X	The first field in all uplink formats is the transmission descriptor in all interrogations.
UM		6	14-19	X	Contains transponder status readouts in replies DF=4, 5, 20, 21.
UM	IDS	2	18-19	X	<p>Identifier Designator subfield reports the type of reservation made by the interrogator identified in IIS and corresponds with the RSS subfield of SD. Assigned coding is:</p> <p>0 = No information available. 1 = Comm-B reservation active. 2 = Comm-C reservation active. 3 = Comm-D reservation active.</p>
	IIS	4	14-17	X	Interrogator Identifier subfield reports the identity of the interrogator that has made a multisite reservation.
VS		1	6	X	Indicates aircraft is airborne when Zero or aircraft is on the ground when One. VS is a part of DF=0, 16.

Overview of Format Definitions
Table 3 (cont)

				B5	0	0	1	1
				B6	0	1	0	1
B4	B3	B2	B1					
0	0	0	0			P	SP	0
0	0	0	1		A	Q		1
0	0	1	0		B	R		2
0	0	1	1		C	S		3
0	1	0	0		D	T		4
0	1	0	1		E	U		5
0	1	1	0		F	V		6
0	1	1	1		G	W		7
1	0	0	0		H	X		8
1	0	0	1		I	Y		9
1	0	1	0		J	Z		
1	0	1	1		K			
1	1	0	0		L			
1	1	0	1		M			
1	1	1	0		N			
1	1	1	1		O			
SP=SPACE code								

6-Bit Character Set for AIS Subfield
Table 4

SRS OR TAS SUBFIELD VALUE		NUMBER OF SEGMENTS
OCTAL	HEXADECIMAL	
100000	8000	1
140000	C000	2
160000	E000	3
170000	F000	4
174000	F800	5
176000	FC00	6
177000	FE00	7
177400	FF00	8
177600	FF80	9
177700	FFC0	10
177740	FFE0	11
177760	FFF0	12
177770	FFF8	13
177774	FFFC	14
177776	FFFE	15
177777	FFFF	16

Valid Values for SRS and TAS Subfields
Table 5

BINARY	OCTAL	DECIMAL	HEXADECIMAL
000	0	0	0
001	1	1	1
010	2	2	2
011	3	3	3
100	4	4	4
101	5	5	5
110	6	6	6
111	7	7	7
1000	10	8	8
1001	11	9	9
1010	12	10	A
1011	13	11	B
1100	14	12	C
1101	15	13	D
1110	16	14	E
1111	17	15	F
10000	20	16	10

Number Systems Conversion
Table 6



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APPENDIX C - AUXILIARY EQUIPMENT

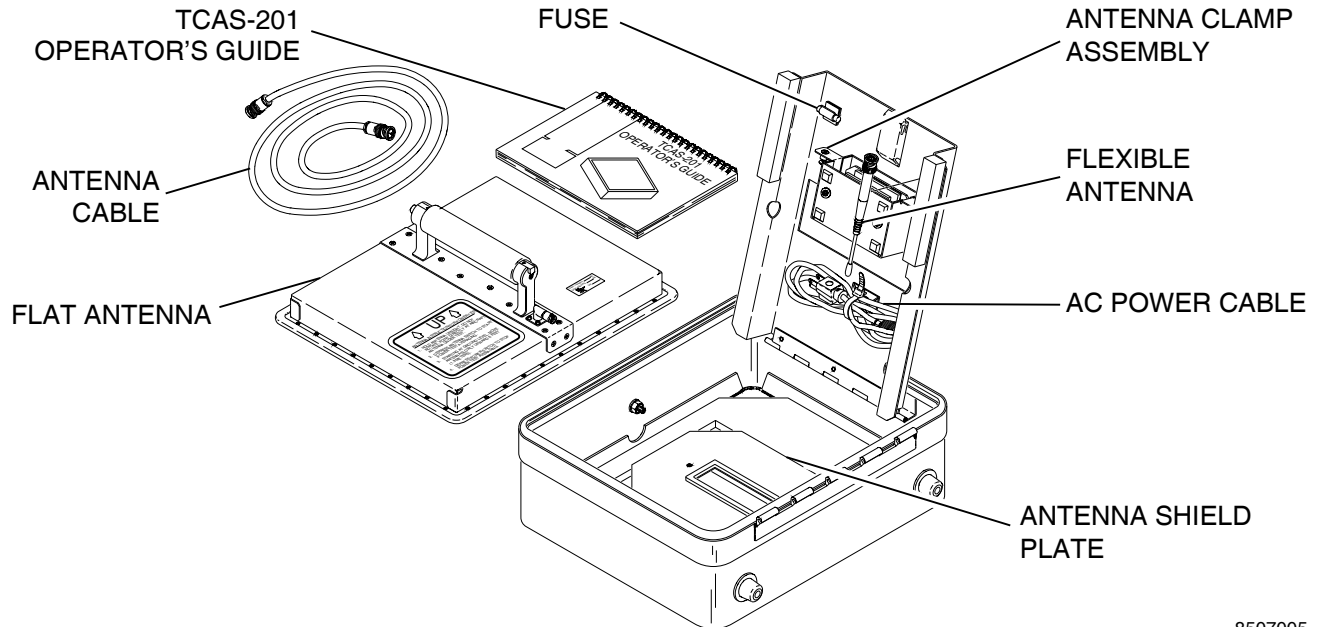
Refer to 1-2-2, Figure 2 for connectors and indicators.

1. STORAGE COMPARTMENT

Refer to Appendix C, Figure 1.

ITEM	DESCRIPTION
● Antenna Clamp Assembly:	Used with Antenna Shield Plate to cover UUT Antenna not being tested.
● Flexible Antenna:	RF monopole antenna used with Test Set when power accuracy is not critical and a direct connection is not convenient.
● ac Power Cable:	Used to connect ac power from an external source to AC PWR Connector.
● Antenna Shield Plate:	Used with Antenna Clamp Assembly to cover UUT Antenna not being tested.

ITEM	DESCRIPTION
● Flat Antenna:	RF antenna used with Test Set when power accuracy is most critical.
● Antenna Cable:	BNC to BNC coaxial cable used to connect FLAT ANTENNA Connector to ANTENNA Connector.
● TCAS-201 Operator's Guide:	Weatherproof guide used in the ramp environment.
● Fuse:	Spare FUSE.



Auxiliary Equipment
Figure 1

8507005

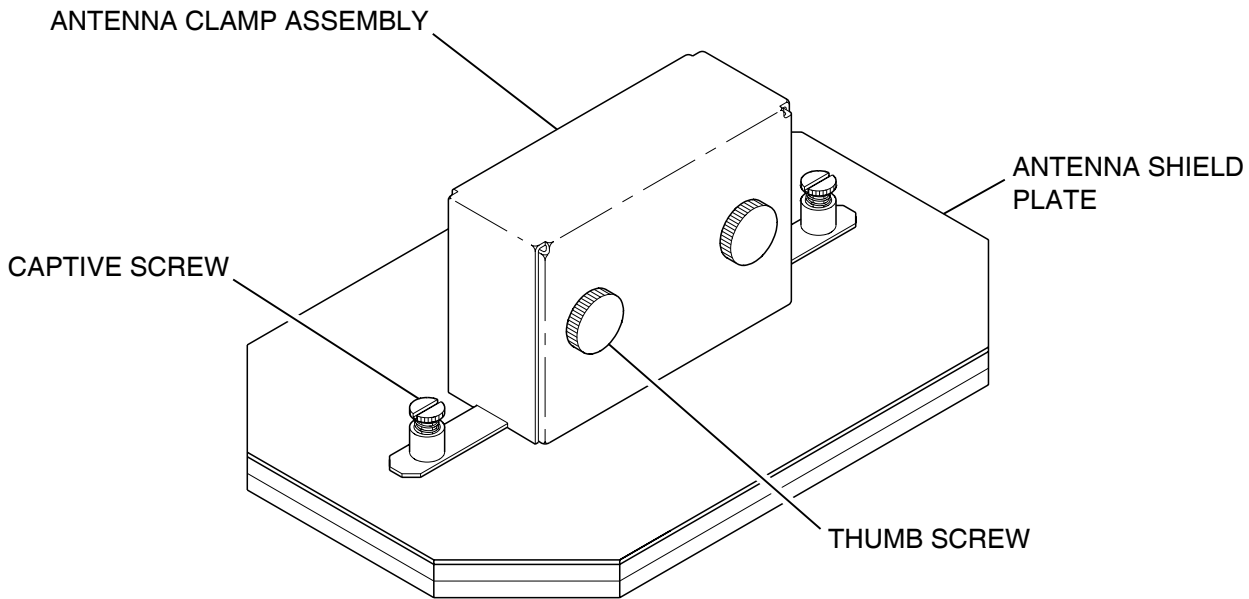
2. TRIPOD

The tripod holds the Test Set Antenna during stationary ramp testing.

3. ANTENNA SHIELD PROCEDURE

Refer to Appendix C, Figure 2.

STEP	PROCEDURE
1.	Position Antenna Clamp Assembly inside the slot in the Antenna Shield Plate, aligning captive screws into the respective screw holes.
2.	Tighten captive screws.
3.	Cover UUT Antenna with Antenna Shield. Loosen Thumbscrews if necessary.
	NOTE: It may be necessary to remove UUT Antenna Guard if access to UUT Antenna is restricted.
4.	Secure Antenna Shield by tightening thumbscrews.



8107007

Antenna Shield
Figure 2



**APPENDIX D - METRIC/BRITISH IMPERIAL CONVERSION TABLE
WITH NAUTICAL DISTANCE CONVERSIONS**

TO CONVERT:	INTO:	MULTIPLY BY:	TO CONVERT:	INTO:	MULTIPLY BY:
cm	feet	0.03281	meters	feet	3.281
cm	inches	0.3937	meters	inches	39.37
feet	cm	30.48	m/sec	ft/sec	3.281
feet	meters	0.3048	m/sec	km/hr	3.6
ft/sec	km/hr	1.097	m/sec	miles/hr	2.237
ft/sec	knots	0.5921	miles	feet	5280
ft/sec	miles/hr	0.6818	miles	km	1.609
ft/sec ²	cm/sec ²	30.48	miles	meters	1609
ft/sec ²	m/sec ²	0.3048	miles	nmi	0.8684
grams	ounces	0.03527	miles/hr	ft/sec	1.467
inches	cm	2.54	miles/hr	km/hr	1.609
kg	pounds	2.205	miles/hr	knots	0.8684
kg/cm ²	psi	0.0703	nmi	feet	6080.27
km	feet	3281	nmi	km	1.8532
km	miles	0.6214	nmi	meters	1853.2
km	nmi	0.5396	nmi	miles	1.1516
km/hr	ft/sec	0.9113	ounces	grams	28.34953
km/hr	knots	0.5396	pounds	kg	0.4536
km/hr	miles/hr	0.6214	psi	kg/cm ²	0.0703
knots	ft/sec	1.689	100 ft	km	3.048
knots	km/hr	1.8532	100 ft	miles	1.894
knots	miles/hr	1.1516	100 ft	nmi	1.645



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APPENDIX E - TARGET ACQUISITION TIME PROBABILITY TABLE

The following table shows the probability of target acquisition time increasing by more than a specified time (in addition to the normal two to three seconds). The table indicates, for example, there is a 10% probability the target acquisition time increases by more than ten seconds.

NOTE: The table only applies when testing one UUT Antenna. Other UUT Antennas are shielded, disabled or out of the line of sight path with the TCAS-201.

INCREASE IN TARGET ACQUISITION TIME	PROBABILITY PERCENTAGE
>3 seconds	91%
>4 seconds	76%
>5 seconds	59%
>6 seconds	44%
>7 seconds	31%
>8 seconds	22%
>9 seconds	15%
>10 seconds	10%
>11 seconds	7%
>12 seconds	4%
>13 seconds	3%
>14 seconds	2%
>15 seconds	1%
>16 seconds	0.7%
>17 seconds	0.4%
>18 seconds	0.3%
>19 seconds	0.2%
>20 seconds	0.1%

Target Acquisition Time Probability
Table 1



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APPENDIX F - ABBREVIATIONS

A		C	
A	Amperes	C	Celsius or Centigrade
AA	Announced Address	CA	Transponder Capability
AC	Altitude Code	CC	Crosslink Capability
AC	Alternating Current	ccw	Counterclockwise
ac	Alternating Current	CFS	Continuation Subfield
ACAS	Airborne Collision Avoidance System	CHAN	Channel
ACS	Comm-A Capability Subfield	CHC	Cancel Horizontal Resolution Advisory
A/D	Analog to Digital	CLI	Coordination Lock Indicator
ADC	Analog to Digital Converter	CLOS	Closeout
ADLP	Airborne Data Link Processor	cm	Centimeter (10 ⁻² Meters)
ADS	A-Definition Subfield	Cont	Continued
AIS	Comm-A Capability Subfield	CPU	Central Processing Unit
ALT	Altitude	CTS	Clear to Send
AP	Address Parity	CVC	Cancel Vertical Resolution Advisory Complement
AQ	Acquisition Special	CW	Continuous Wave
ASCII	American National Standard Code for Information Interchange	cw	Clockwise
ATC	Air Traffic Control	D	
ATC	ATCRBS (screen abbreviation)	D/A	Digital to Analog
ATCRBS	Air Traffic Control Radar Beacon System	DABS	Discrete Address Beacon System
ATE	Automatic Test Equipment	DAC	Digital to Analog Converter
ATTEN	Attenuation	dB	Decibel
AUTO	Automatic	dB _i	Decibels above isotropic
AVG	Average	dB _m	Decibels above one milliwatt
B		dB W/m ²	Decibels above one watt per square meter
BCS	Comm-B Capability Subfield	DCD	Data Carrier Detect
BD	Comm-B Data	DCXO	Digitally Compensated Crystal Oscillator
BDS	B-Definition Subfield	DELM	Downlink Extended Length Message
BIT	Built In Test	DF	Downlink Format
bps	Bits per Second	DI	Designator Identification
BR	Bridge Rectifier	DMM	Digital Multimeter
BT	Battery	DPSK	Differential Phase Shift Keying
		DR	Downlink Request
		DSP	Digital Signal Processor
		DSR	Data Set Ready
		DTR	Data Terminal Ready

P		S	
PC	Personal Computer	SCOPE	Oscilloscope
PC	Printed Circuit	SCPI	Standard Commands for Programmable Instruments organization
PC	Protocol		
PI	Parity/Interrogator Identity	SD	Special Designator
PLCS	Places	Sec	Second
PN	Part Number	SL	Sensitivity Level
PPM	Pulse Position Modulation	SLM	Standard Length Message
ppm	Parts per Million	SLS	Side-Lobe Suppression
PR	Probability of Reply	SPI	Special Identifier Pulse
PRF	Pulse Repetition Frequency	SQTR	Squitter
PROM	Programmable Read Only Memory	SRQ	Service Request
		SRS	Segment Request Subfield
psi	Pounds per Square Inch	SSR	Secondary Surveillance Radar
PWM	Pulse Width Modulation	SYNC	Synchronous
PWR	Power		
R		T	
RAM	Random Access Memory	TAS	Transmission Acknowledgment Subfield
RAC	Resolution Advisory Complement	TCAS	Traffic Alert and Collision Avoidance System
RAT	Resolution Advisory Termination	TID	Threat Identity Data
RC	Reply Control	TMS	Tactical Message Subfield
RCI	Remote Control Interface	Trig	Trigger
RCVD	Received	TTI	Threat Type Indicator
RCVR	Receiver	TTL	Transistor-Transistor Logic
Ref	Reference	TX	Transmit
RF	Radio Frequency	TXD	Transmit Data
RI	Reply Information Air-to-Air		
RL	Reply Length	U	
RMS	Root Mean Square	UDS	U-Definition Subfield
ROM	Read Only Memory	UELM	Uplink Extended Length Message
RR	Reply Request		
RRS	Reply Request Subfield	UF	Uplink Format
RSS	Reservation Status Subfield	UM	Utility Message
RTCA	Requirements and Technical Concepts for Aviation organization	UUT	Unit Under Test
		V	
RTS	Request to Sent	V	Volt
RX	Receive	VAC	Volts, Alternating Current
RXD	Receive Data	VCO	Voltage Controlled Oscillator
		Vdc	Volts, Direct Current
		VDS	V-Definition Subfield
		VERS	Version
		VRAM	Video Random Access Memory
		VRC	Vertical Resolution Advisory Complement
		Vrms	Volts Root Mean Square
		VS	Vertical Status
		VSB	Vertical Sense Bits
		VSWR	Voltage Standing Wave Ratio



W

W Watt
W-S Whisper-Shout

X

XMTR Transmitter
Xon/Xoff Software Handshake
XPDR Transponder

INDEX

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OPERATION MANUAL
TCAS-201

FOR QUALIFIED SERVICE PERSONNEL ONLY

BATTERY/VOLTAGE INSTRUCTIONS



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WARNING:

HIGH VOLTAGE EQUIPMENT

THIS EQUIPMENT CONTAINS CERTAIN CIRCUITS AND/OR COMPONENTS OF EXTREMELY HIGH VOLTAGE POTENTIALS, CAPABLE OF CAUSING SERIOUS BODILY INJURY OR DEATH. WHEN PERFORMING ANY OF THE PROCEDURES CONTAINED IN THIS MANUAL, HEED ALL APPLICABLE SAFETY PRECAUTIONS.

SAFETY FIRST: TO ALL SERVICE PERSONNEL

REFER ALL SERVICING OF UNIT TO QUALIFIED TECHNICAL PERSONNEL.

WARNING: USING THIS EQUIPMENT IN A MANNER NOT SPECIFIED BY THE ACCOMPANYING DOCUMENTATION MAY IMPAIR THE SAFETY PROTECTION PROVIDED BY THE EQUIPMENT.

CASE, COVER OR PANEL REMOVAL

Removing the Chassis Assembly from the Case Assembly exposes the technician to electrical hazards that can result in electrical shock or equipment damage.

SAFETY IDENTIFICATION IN TECHNICAL MANUAL

This manual uses the following terms to draw attention to possible safety hazards, that may exist when operating or servicing this equipment.

CAUTION: THIS TERM IDENTIFIES CONDITIONS OR ACTIVITIES THAT, IF IGNORED, CAN RESULT IN EQUIPMENT OR PROPERTY DAMAGE (E.G., FIRE).

WARNING: THIS TERM IDENTIFIES CONDITIONS OR ACTIVITIES THAT, IF IGNORED, CAN RESULT IN PERSONAL INJURY OR DEATH.

SAFETY SYMBOLS IN MANUALS AND ON UNITS



CAUTION: Refer to accompanying documents.



AC OR DC TERMINAL: Terminal that may supply or be supplied with ac or dc voltage.



DC TERMINAL: Terminal that may supply or be supplied with dc voltage.



AC TERMINAL: Terminal that may supply or be supplied with ac or alternating voltage.



SWITCH ON/OFF (Push-Push): AC line power to the device is connected ON or disconnected OFF.

EQUIPMENT GROUNDING PRECAUTION

Improper grounding of equipment can result in electrical shock.

USE OF PROBES

Check specifications for the maximum voltage, current and power ratings of any connector on the Test Set before connecting it with a probe from a terminal device. Be sure the terminal device performs within these specifications before using it for measurement, to prevent electrical shock or damage to the equipment.

POWER CORDS

Power cords must not be frayed, broken nor expose bare wiring when operating this equipment.

USE RECOMMENDED FUSES ONLY

Use only fuses specifically recommended for the equipment at the specified current and voltage ratings.

WARNING: THE TCAS-201 USES A SEALED-LEAD-BATTERY PACK. THE FOLLOWING WARNINGS CONCERNING LEAD-ACID BATTERIES MUST BE HEEDED:

- DO NOT RECHARGE OUTSIDE THE TCAS-201.
- DO NOT CRUSH, INCINERATE OR DISPOSE OF IN NORMAL WASTE.
- DO NOT SHORT CIRCUIT OR FORCE DISCHARGE AS THIS MIGHT CAUSE THE BATTERY TO VENT, OVERHEAT OR EXPLODE.

CAUTION: INTEGRATED CIRCUITS AND SOLID STATE DEVICES SUCH AS MOS FETS, ESPECIALLY CMOS TYPES, ARE SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGES RECEIVED FROM IMPROPER HANDLING, THE USE OF UNGROUNDED TOOLS AND IMPROPER STORAGE AND PACKAGING. ANY MAINTENANCE TO THIS UNIT MUST BE PERFORMED WITH THE FOLLOWING PRECAUTIONS:

- BEFORE USE IN A CIRCUIT, KEEP ALL LEADS SHORTED TOGETHER EITHER BY THE USE OF VENDOR-SUPPLIED SHORTING SPRINGS OR BY INSERTING LEADS INTO A CONDUCTIVE MATERIAL.
- WHEN REMOVING DEVICES FROM THEIR CONTAINERS, GROUND THE HAND BEING USED WITH A CONDUCTIVE WRISTBAND.
- TIPS OF SOLDERING IRONS AND/OR ANY TOOLS USED MUST BE GROUNDED.
- DEVICES MUST NEVER BE INSERTED INTO NOR REMOVED FROM CIRCUITS WITH POWER ON.
- PC BOARDS, WHEN TAKEN OUT OF THE SET, MUST BE LAID ON A GROUNDED CONDUCTIVE MAT OR STORED IN A CONDUCTIVE STORAGE BAG. REMOVE ANY BUILT-IN POWER SOURCE, SUCH AS A BATTERY, BEFORE LAYING PC BOARDS ON A CONDUCTIVE MAT OR STORING IN A CONDUCTIVE BAG.
- PC BOARDS, IF BEING SHIPPED TO THE FACTORY FOR REPAIR, MUST BE PACKAGED IN A CONDUCTIVE BAG AND PLACED IN A WELL-CUSHIONED SHIPPING CONTAINER.




CAUTION: SIGNAL GENERATORS CAN BE A SOURCE OF ELECTROMAGNETIC INTERFERENCE (EMI) TO COMMUNICATION RECEIVERS. SOME TRANSMITTED SIGNALS CAN CAUSE DISRUPTION AND INTERFERENCE TO COMMUNICATION SERVICES OUT TO A DISTANCE OF SEVERAL MILES. USERS OF THIS EQUIPMENT SHOULD SCRUTINIZE ANY OPERATION THAT RESULTS IN RADIATION OF A SIGNAL (DIRECTLY OR INDIRECTLY) AND ENSURE COMPLIANCE WITH INSTRUCTIONS IN FAA CIRCULAR AC 170-6C, DATED FEBRUARY 19, 1981.

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer to Figure 1.

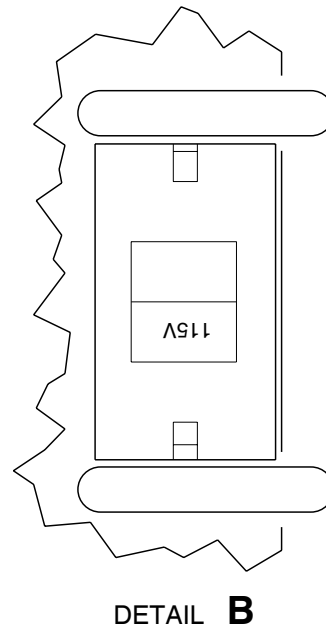
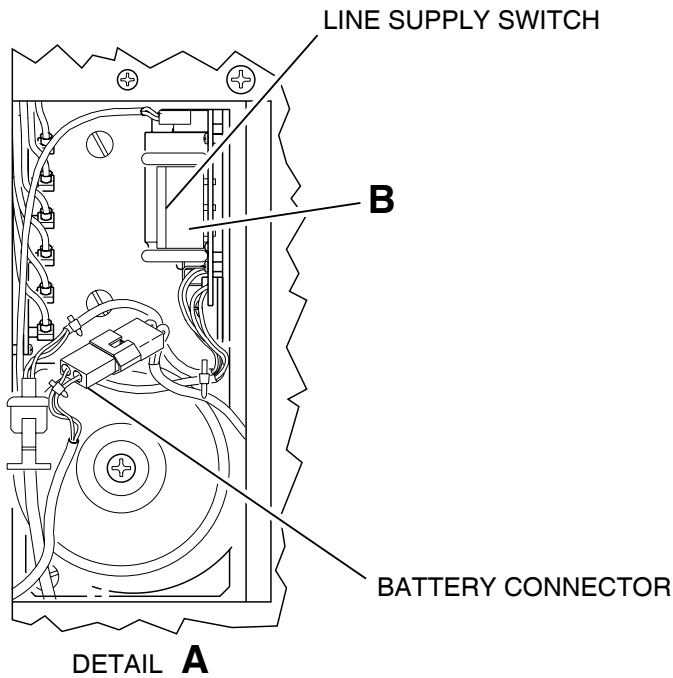
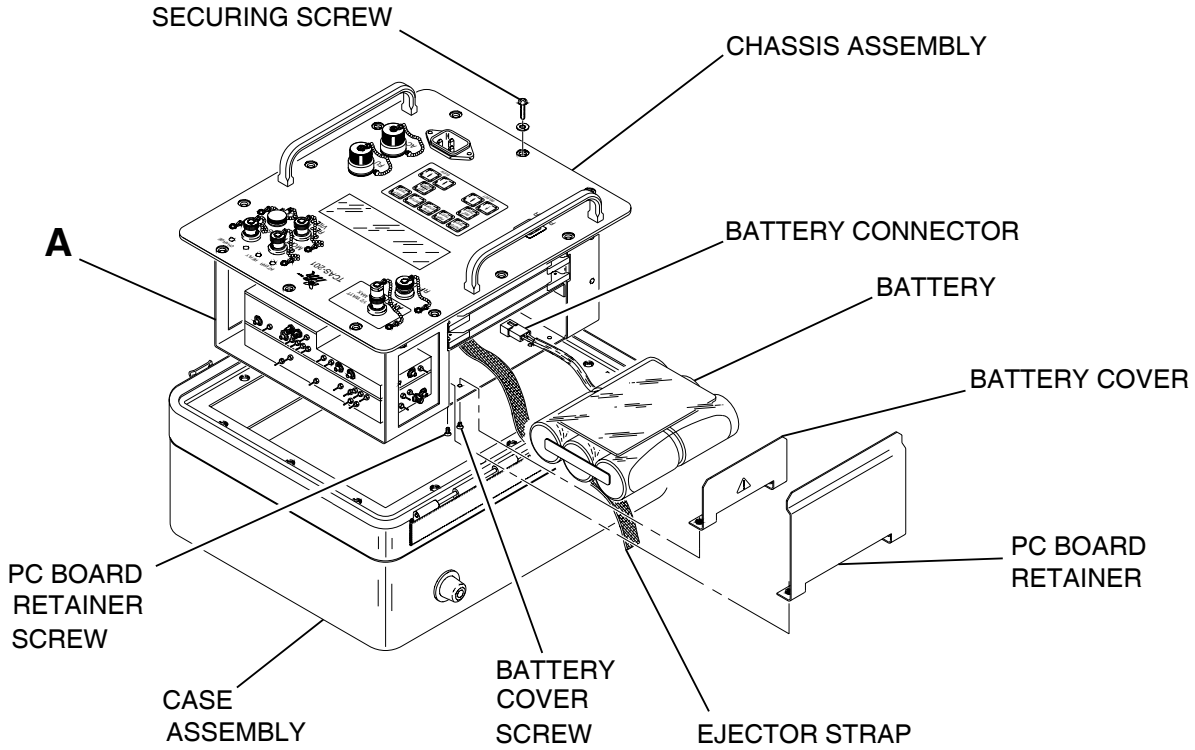
BATTERY REPLACEMENT

STEP	PROCEDURE
1.	Verify TCAS-201 is Off and not connected to ac power.
2.	Remove 12 securing screws and lift Chassis Assembly from Case Assembly.
3.	Pull out battery connector from underneath middle of Chassis Assembly and disconnect.
4.	Remove two screws from bottom of Chassis Assembly and remove PC board retainer.
5.	Remove two screws from bottom of Chassis Assembly and remove battery cover.
6.	Pull ejector strap to remove battery from Chassis Assembly.
	WARNING: DISPOSE OF OLD BATTERY ACCORDING TO STANDARD SAFETY PROCEDURES.
	CAUTION: REPLACE ONLY WITH THE BATTERY SPECIFIED BY AEROFLEX. DO NOT ATTEMPT TO INSTALL A NON-RECHARGEABLE BATTERY.
7.	Install new battery in front of ejector strap.
8.	Reinstall battery cover and two battery cover screws in Chassis Assembly.
9.	Reinstall PC board retainer and two PC board retainer screws in Chassis Assembly.
10.	Connect battery connector and tuck back underneath middle of Chassis Assembly.

STEP	PROCEDURE
11.	Reinsert Chassis Assembly into Case Assembly.
12.	Reinstall 12 securing screws.
	CAUTION: REPLACING NYLON WASHERS IS RECOMMENDED TO MAINTAIN WATER RESISTANCE CAPABILITY WHEN REINSTALLING CHASSIS ASSEMBLY INTO CASE ASSEMBLY.

LINE SUPPLY SWITCH

STEP	PROCEDURE
1.	Verify TCAS-201 is Off and not connected to ac power.
2.	Remove 12 securing screws and lift Chassis Assembly from Case Assembly.
3.	Position Chassis Assembly for access to Line Supply Switch.
4.	If power source is 100 to 120 VAC at 60 Hz, set Line Supply Switch to 115 . If power source is 220 to 240 VAC at 50 Hz, set Line Supply Switch to 230 .
5.	Reinsert Chassis Assembly into Case Assembly.
6.	Reinstall 12 securing screws.
	CAUTION: REPLACING NYLON WASHERS IS RECOMMENDED TO MAINTAIN WATER RESISTANCE CAPABILITY WHEN REINSTALLING CHASSIS ASSEMBLY INTO CASE ASSEMBLY.



8507025

Battery Removal and Line Supply Switch Location
Figure 1

As we are always seeking to improve our products, the information in this document gives only a general indication of the product capacity, performance and suitability, none of which shall form part of any contract. We reserve the right to make design changes without notice.

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UNITED KINGDOM	Tel: [+44] (0) 1438 742200 Toll Free: 0800 282388 (UK only)	Fax: [+44] (0) 1438 7276
USA	Tel: [+1] (316) 522 4981 Toll Free: 800 835 2352 (US only)	Fax: [+1] (316) 522 1360

The logo for AEROFLEX features a stylized 'A' with a blue triangle at its base, followed by the word 'AEROFLEX' in a bold, sans-serif font. The logo is set against a white background with a blue swoosh underneath.

Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven, customer-focused.