Section I. INTRODUCTION

1.1. Introduction

This three-volume manual contains complete operation and maintenance instructions necessary for the **NASA** TDRSS User RF Test Set (TURFTS) (figure 1.1), hereinafter referred to as test set. The scope of volume 1 is explained in paragraph 1.2. Volume 2 contains the complete repair parts list and all the cables used with the test set. Volume 3 contains system and individual module test procedures that are necessary for testing the test set.

1.2. Scope

This manual consists of six sections as follows:

Section I. Introduction and General Information. Section 1 provides a brief explanation of the purpose of the test set, and general information as it pertains to the test set and its associated equipment.

Section II. Installation. Section II contains necessary instructions to prepare the equipment for use, or packaging for storage or shipment, and procedures for preliminary adjustments and connections.

Section III. Operation. Section III contains information on controls, indicators, and connectors, instructions for starting, operating, and stopping the equipment, and preoperation adjustments.

Section IV. Theory of Operation. Section IV contains complete functional block diagram explanations. Simplified and detailed circuit analysis of each subassembly (drawer) is also provided.

Section V. Maintenance. Section V contains procedures for preventive maintenance, operational testing, troubleshooting, assembly/disassembly and repairing the test set.

Section VI. Drawings. Section VI contains schematic diagrams, interfacing diagrams, cabling, and wiring diagrams of the test set.

1.3 Purpose

The test set (figure 1.1) provides support of spacecraft and system level testing and spacecraft on pad air link testing of TDRSS standard user transponders.

1.4 Test Set Major Components List

Table 1.1 provides nomenclature, reference designator and part number for the test set components.

Table 1.1. Test Set Components

Nomenclature	Reference Designator	Part Number
TURFTS	1	TBD
Rack	1A1	TBD
Time Interval Counter	1A1A1	HP53132A
Spectrum Analyzer	1A1A2	HP8563A
RF Distribution	1A1A3	TBD
Signal Processing Unit	1A1A4	TBD
Front Interface Panel	1A1A5	TBD
Controller and Monitor	1A1A6	TBD
Keyboard	1A1A7	TBD
Digital Oscilloscope	1A1A8	HP
Fan Assembly	1A1A9	TBD
Rack Power	1A1A10	TBD
Rear Interface Panel	1A1A11	TBD

1.5 Physical Description

The test set (figure 1.1) is comprised of one equipment Rack (1A1).

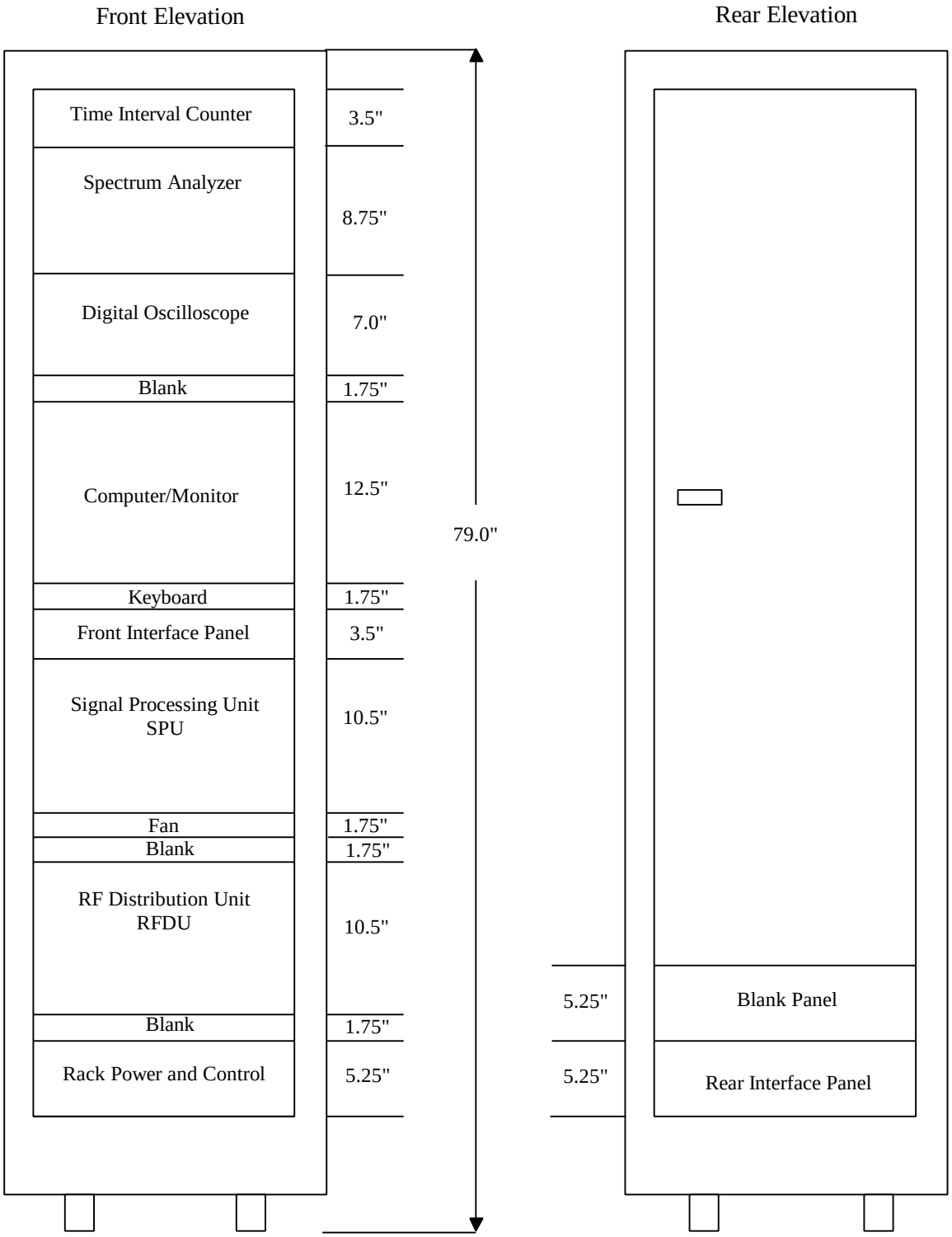

Figure 1-1. Rack Elevation

Insert Figure 1-4 RF Distribution Unit

Insert Figure 1-3 Signal Processing Unit

1.6 Test Set Electrical Characteristics

Tabulated data on the test set electrical characteristics is provided in table 1.2. Electrical characteristics of each assembly drawer are described separately in table 1.3. For this manual, **dBm** is defined as dB from 1 mW into 50 ohms.

Table 1.2. Test Set Overall Electrical Characteristics

PARAMETER	CHARACTERISTIC
RETURN LINK/DOWNLINK	
Frequency Range	2200 MHz to 2300 MHz synthesized in 1 Hz increments
Input Signal	-120 dBm to -70 dBm
Noise Figure	2.5 dB Maximum
Carrier Tracking	
Modulation Modes	QPSK Modulation Self Test Forward Link (F/L) and Return Link (R/L) modes 1, 2, and 3. Baseband data and/or Subcarrier with PSK data.
PN Code Selection	85 Choices per STDN No. 108 in all modulation modes as well as NASDA and ESA.
Data Demodulator	100 BPS to 150 KBPS in I Channel 100 BPS to 3 MBPS in Q Channel
FORWARD LINK/UPLINK	
Frequency Range	2025 MHz to 2120 MHz synthesized in 1 mHz increments
Carrier Phase Noise	TBD degrees RMS in a 60 Hz LBW
Output Level	Continuously adjustable over 1 dB range from +5 dBm to -163 dBm with 0.5 dB accuracy.
Modulation Type	QPSK Modulation with PN codes and/or Data. Self test Return Link (R/L) modes 1, 2, and 3 and Forward Link (F/L). BPSK and Carrier with baseband data and/or subcarrier with PSK data.
PN Code Selection	85 Choices per STDN No. 108 in all modulation modes as well as NASDA and ESA.
PN Chip Rate	Coherent with the carrier at a ration of 31/(96 x 221)
External Data Rate	Input to I Channel only 100 BPS to 150 KBPS.

Table 1.3. Assembly (drawer) Electrical Characteristics

Parameter	Characteristic
RF DISTRIBUTION 1A1A3	
Input signal attenuation (for return link)	0 - 70 dB in 10 dB steps
Test Translator conversion loss (S-band forward to S-band return)	42 dB nominal
Input/output impedance	50 ohms, VSWR of 1.3:1 or less
Translator time delay (S-band forward to S-band return)	15 nanoseconds nominal
Return link conversion gain Noise figure	62 dB nominal 2.5 dB nominal
SIGNAL PROCESSING UNIT 1A1A4	
Modes of operation	Three return link modes: Mode 1: Long($2^{18} - 2^{8}$) I&Q channel codes Mode 2: Short($2^{11} - 1$) I&Q channel codes Mode 3: Long($2^{18} - 2^{8}$) I channel code One forward link mode: Short ($2^{10} - 1$) I channel code Long ($2^{18} - 2^{8}$) Q channel code
Channel track	Selectable I or Q channel
Telemetry power ratio	I:Q = 1:1, 1:2, 1:4, or 10:1
Tracking range	$\pm$ 200 KHz
Carrier Loop BW Acquisition threshold	30 Hz, 70 Hz, 500 Hz, 1000 Hz Data Rate Threshold 1.5 KBPS TBD dBm 5 KBPS TBD dBm 50 KBPS TBD dBm
Baseband filters	I channel TBD Q channel TBD

1.7 Test Set Interfaces

This paragraph contains tabulated data of RF interfaces (table 1.4) and external interfaces (table 1.5) that is required for operating the test set.

Table 1.4. Test Set RF Interface Connectors

Type	Signal	From	To
BNC to BNC	Scope Select A	A4A1J1	A5J1
BNC to BNC	Scope Select A	A5J1	A8 CH 1
BNC to BNC	Scope Select B	A4A1J2	A5J2
BNC to BNC	Scope Select B	A5J2	A8 CH 2
BNC to BNC	Scope Sync	A4A1J3	A5J3
BNC to BNC	Scope Sync	A5J3	A8 CH 3
SMA to TNC	10 MHz Reference 1	A4A2J1	A5J5
TNC to BNC	10 MHz Reference 1	A5J5	A2 EXT Ref
SMA to TNC	10 MHz Reference 2	A4A2J2	A5J6
TNC to BNC	10 MHz Reference 2	A5J6	A1 EXT Ref
SMA to TNC	10 MHz Reference 3	A4A2J3	A5J7
TNC to TNC	10 MHz Reference 3	A5J7	A11J13
TNC to SMA	10 MHz Standard	A5J4	A4A2J4
TNC to TNC	10 MHz Standard	A3J2	A5J4
SMA to SMA	50 MHz Reference	A4A2J4	A4A4J2
SMA to SMA	280 MHz Reference	A4A2J5	A4A3J5
SMA to SMA	70 MHz Reference 1	A4A2J6	A4A5J6
SMA to SMA	70 MHz Reference 2	A4A2J7	A4A6J6
SMA to SMA	110 MHz Reference	A4A2J8	A4A3J6
SMA to TNC	Transmitter Long Code Epoch	A4A3J1	A5J13
TNC to BNC	Transmitter Long Code Epoch	A5J13	A1 CH-1
SMA to TNC	Transmitter I PN Code	A4A3J2	A5J11
TNC to TNC	Transmitter I PN Code	A5J11	A3J9
SMA to TNC	Transmitter Q PN Code	A4A3J3	A5J12
TNC to TNC	Transmitter Q PN Code	A5J12	A3J8
SMA to SMA	50 MHz Reference	A4A3J4	A4A4J2
SMA to TNC	Transmitter Local Oscillator	A4A3J7	A5J8
TNC to TNC	Transmitter Local Oscillator	A5J8	A3J1
SMA to SMA	110 MHz Reference	A4A3J8	A4A4J4
SMA to TNC	Translator Local Oscillator	A4A3J9	A5J9
TNC to TNC	Translator Local Oscillator	A5J9	A3J12

Table 1.4. Test Set RF Interface Connectors, Cont.

Type	Signal	From	To
SMA to TNC	Receiver Long Code Epoch	A4A4J1	A5J14
TNC to BNC	Receiver Long Code Epoch	A5J14	A1 CH-2
SMA to TNC	Receiver Local Oscillator	A4A4J5	A5J10
TNC to TNC	Receiver Local Oscillator	A5J10	A3J3
SMA to SMA	SPN Local Oscillator	A4A4J6	A4A5J4
SMA to SMA	TKPN Local Oscillator	A4A4J7	A4A5J5
SMA to SMA	IPN Local Oscillator	A4A4J8	A4A6J4
SMA to SMA	QPN Local Oscillator	A4A4J9	A4A6J5
SMA to TNC	Spectrum Analyzer Monitor	A4A5J1	A5J15
TNC to TNC	Spectrum Analyzer Monitor	A5J15	A3J6
TNC to TNC	Spectrum Analyzer Monitor	A3J5	A2 RF-IN
SMA to SMA	Tracked 370 MHz IF Output	A4A5J7	A4A6J7
SMA to SMA	70 MHz IF Monitor	A4A6J3	A4A5J2
SMA to TNC	I Channel Recovered Data	A4A8J1	A5J17
TNC to TNC	I Channel Recovered Data	A5J17	A11J5
SMA to TNC	I Channel Recovered Clock	A4A8J2	A5J18
TNC to TNC	I Channel Recovered Clock	A5J18	A11J6
SMA to TNC	Q Channel Recovered Data	A4A8J3	A5J19
TNC to TNC	Q Channel Recovered Data	A5J19	A11J7
SMA to TNC	Q Channel Recovered Clock	A4A8J4	A5J20
TNC to TNC	Q Channel Recovered Clock	A5J20	A11J8
SMA to TNC	GN Modulation Out	A4A12J3	A5J23
TNC to TNC	GN Modulation Out	A5J23	A3J15
TNC to TNC	370 MHz IF Out	A3J4	A5J16
TNC to SMA	370 MHz IF In	A5J16	A4A5J3
TNC to TNC	TDRS User Commands In	A11J10	A5J21
TNC to SMA	TDRS User Commands In	A5J21	A4A10J1
TNC to TNC	GN User Commands In	A11J9	A5J22
TNC to SMA	GN User Commands In	A5J22	A4A12J1
N to N	Diplexed S-Band Signal	A11J2	A3J10
TNC to N	Transmit Only S-Band	A3J11	A11J3
N to TNC	Receive Only S-Band	A11J4	A3J7
BNC to BNC	Ext. I Channel Bit Sync Input	A11J11	A4J4
BNC to BNC	Ext. Q Channel Bit Sync Input	A11J12	A4J5
TWAX to TWAX	TONS Sync Input	A11J14	A4J6
DB25 to DB25	RS232 Remote Control	A11J15	A6 COM1

Table 1.5. Test Set External Interface Connectors

Type	Signal	From	To
N	Diplexed S-Band Signal	A11J2	DUT
N	Transmitted S-Band Signal Output	A11J3	DUT
N	Received S-Band Signal Input	A11J4	DUT
TNC	I Channel Conditioned Data Output	A11J5	User Interface
TNC	I Channel Conditioned Clock Output	A11J6	User Interface
TNC	Q Channel Conditioned Data Output	A11J7	User Interface
TNC	Q Channel Conditioned Clock Output	A11J8	User Interface
TNC	User Provided GN Command Subcarrier Input	A11J9	User Interface
TNC	User Provided SN Command Data Input	A11J10	User Interface
BNC	External I Channel Bit Sync Input	A11J11	User Interface
BNC	External Q Channel Bit Sync Input	A11J12	User Interface
TNC	10 MHz Reference Output	A11J13	
TWINAX	TONS Sync Input	A11J14	User Interface
DB25	Remote Serial Control	A11J15	User Interface
120VAC 20A	AC Power Input	A11J1	