DA-9150A
10.2 METER WHIP
ANTENNA SIMULATOR

OPERATION AND MAINTENANCE MANUAL

SUNAIR 3101 SW Third Avenue, Ft. Lauderdale, FL 33315-3389

SECTION I

GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This manual contains information necessary to install, operate, and maintain the DA-9150A Antenna Simulator.
Installation information is in Section II. Operating instructions are in Section III. Theory of operation is in Section IV. Maintenance and Repair Procedures are in Section V. information in this manual applies to all equipment configurations, unless otherwise stated in the text or illustrations.

1.2 DESCRIPTION

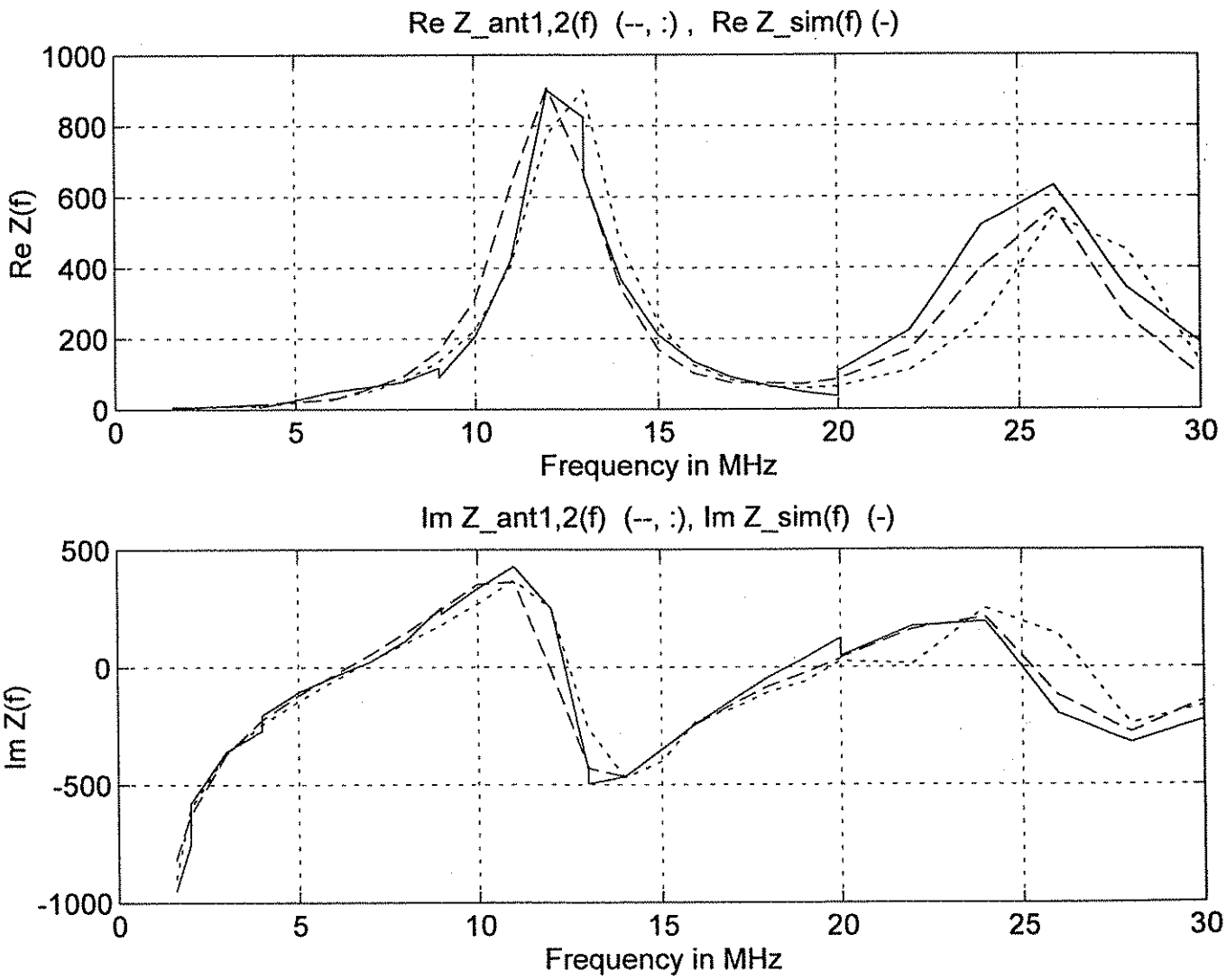
The DA-9150A Antenna Simulator's purpose is to simulate the impedance properties of a two section, 35' fiberglass whip antenna from 1.6 to 29.999 MHz. The DA-9150A is capable of constantly absorbing a maximum input power of 1 kW. The input connector is connected to an antenna coupler, preferably the SUNAIR CU-9150. The output connector is connected to a 50 Ohm load.
The DA-9150A case is sturdy, fully gasketed and meets all environmental requirements for exposed locations.

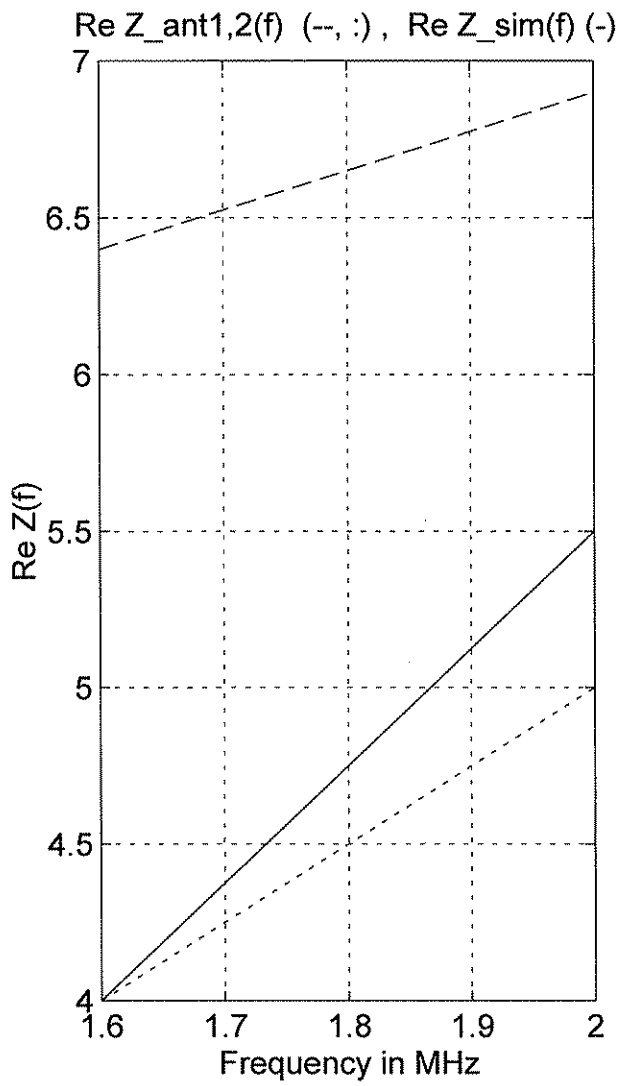
Antenna Simulator DA-9150A

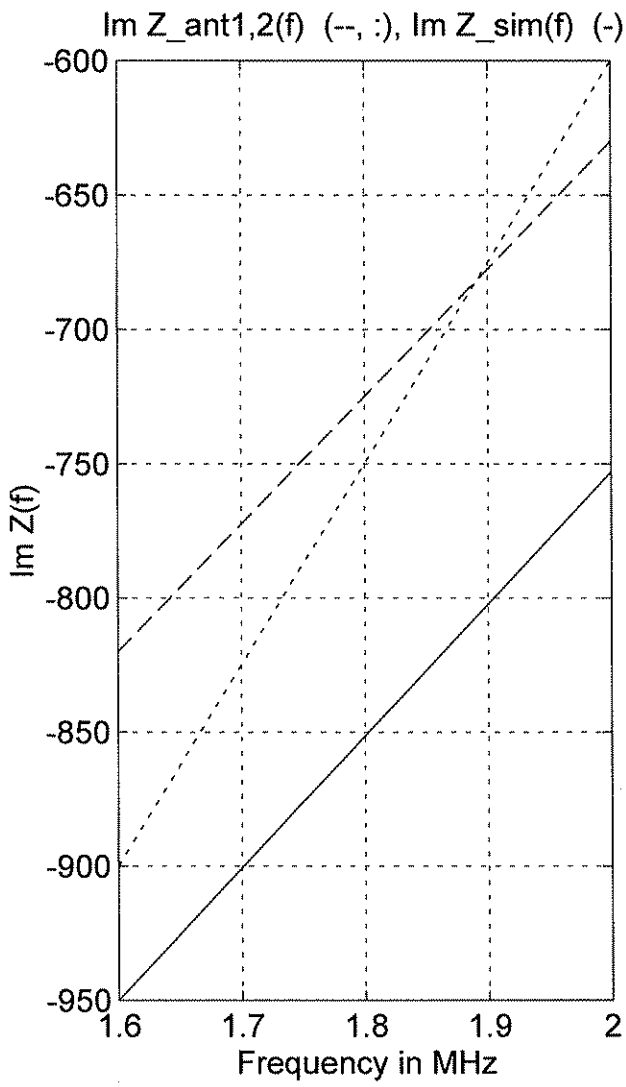
Measured data of real 35 foot whip, Shakespeare 222 (indices $_{ant1*,2}$) compared with achieved data through the prototype antenna simulator networks (index $_{sim**}$).

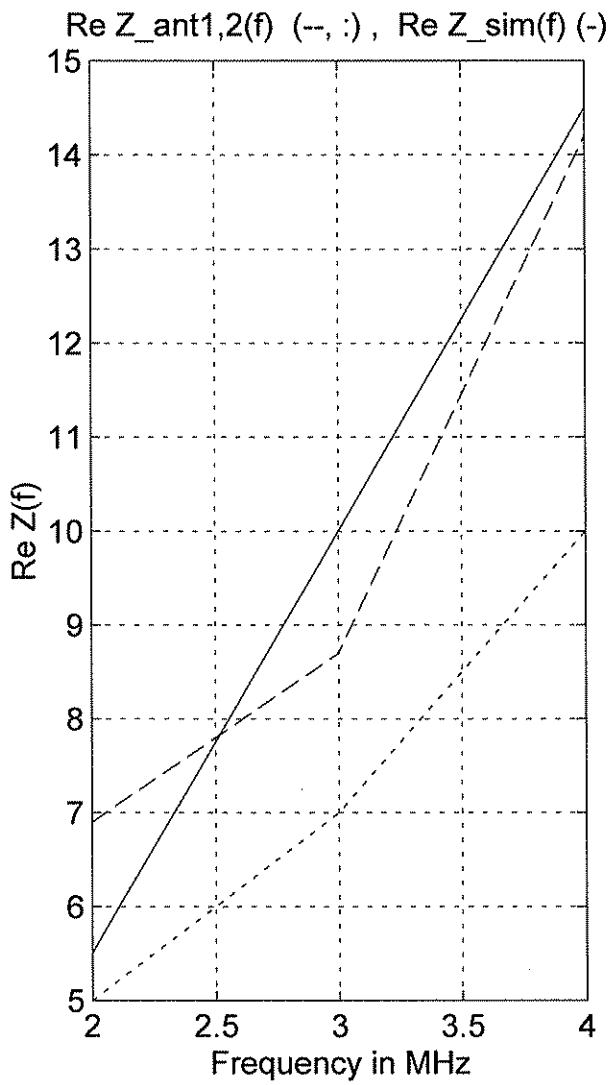
- * data measured with HP 4195A network analyzer
- ** data measured with HP 4193A vector impedance meter

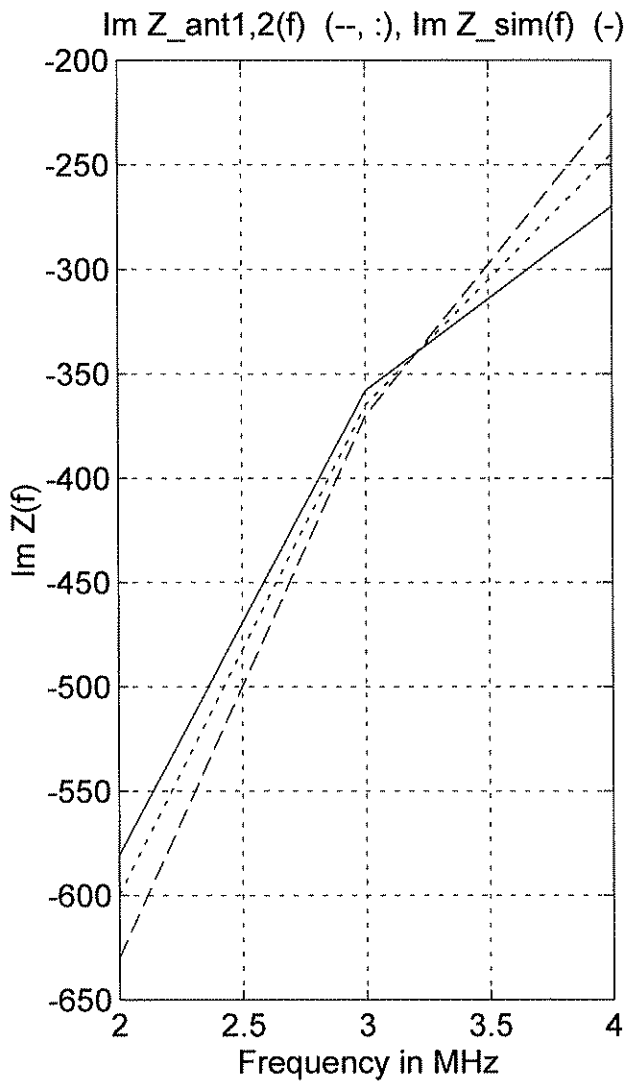
f/MHz	Re $Z(f)_{ant1}$	Im $Z(f)_{ant1}$	Re $Z(f)_{ant2}$	Im $Z(f)_{ant2}$	Re $Z(f)_{sim}$	Im $Z(f)_{sim}$
1.6	(6)	(-817)			4	-952
1.999	6.9	-650	5	-600	5.5	-753
2.0	6.9	-650	5	-600	5.5	-581
3.0	8.7	-370	7	-365	10	-358
3.999	14.2	-230	10	-245	14.5	-270
4.0	14.2	-230	10	-245	6.1	-205
5.0	23	-120	20	-145	26	-107
6.0	37	-32	30	-55	50	-39
7.0	57	+53	50	+25	63	+23
8.0	92	+145	80	+100	78	+111
8.999	165	+245	135	+180	118	+254
9.0	165	+245	135	+180	90	+225
10.0	310	+353	225	+270	206	+334
11.0	630	+363	410	+370	423	+429
12.0	907	-20	775	+250	900	+250
12.999	670	-425	900	-260	824	-438
13.0	670	-425	900	-260	658	-496
14.0	340	-465	465	-470	366	-465
15.0	170	-350	250	-400	212	-350
16.0	101	-240	125	-225	135	-237
17.0	76	-155	85	-175	92	-137
18.0	75	-81	65	-105	69	-41
19.0	72	-25	60	-62	50	+38
19.999	86	+40	65	+25	37	+123
20.0	86	+40	65	+25	108	+47
21.0	115	+99				
22.0	167	+160	110	+14	222	+173
23.0	258	+210				
24.0	400	+212	250	+250	520	+193
25.0	545	+100				
26.0	565	-120	545	+140	631	-198
27.0	420	-265				
28.0	260	-276	450	-240	343	-320
29.0	151	-217				
29.999	95	-143	135	-165	189	-225

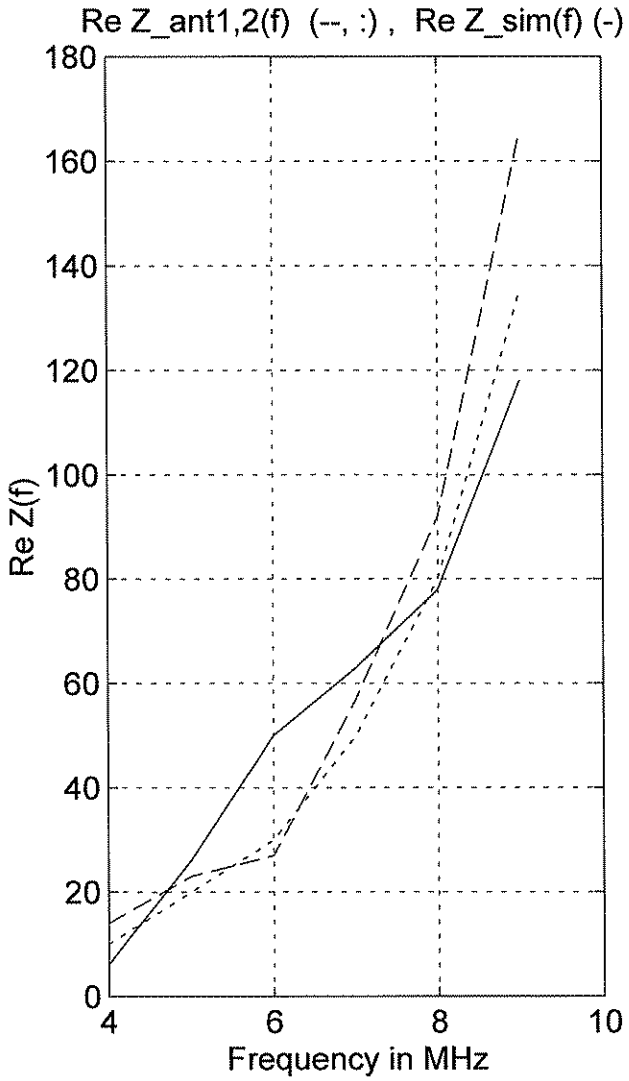

Re Z_ant1,2(f) (--, :) , Re Z_sim(f) (-)
Re Z(f)
1000
800
600
400
200
0
0
5
10
15
20
25
30
Frequency in MHz
Im Z_ant1,2(f) (--, :), Im Z_sim(f) (-)
Im Z(f)
500
0
-500
-1000
0
5
10
15
20
25
30
Frequency in MHz

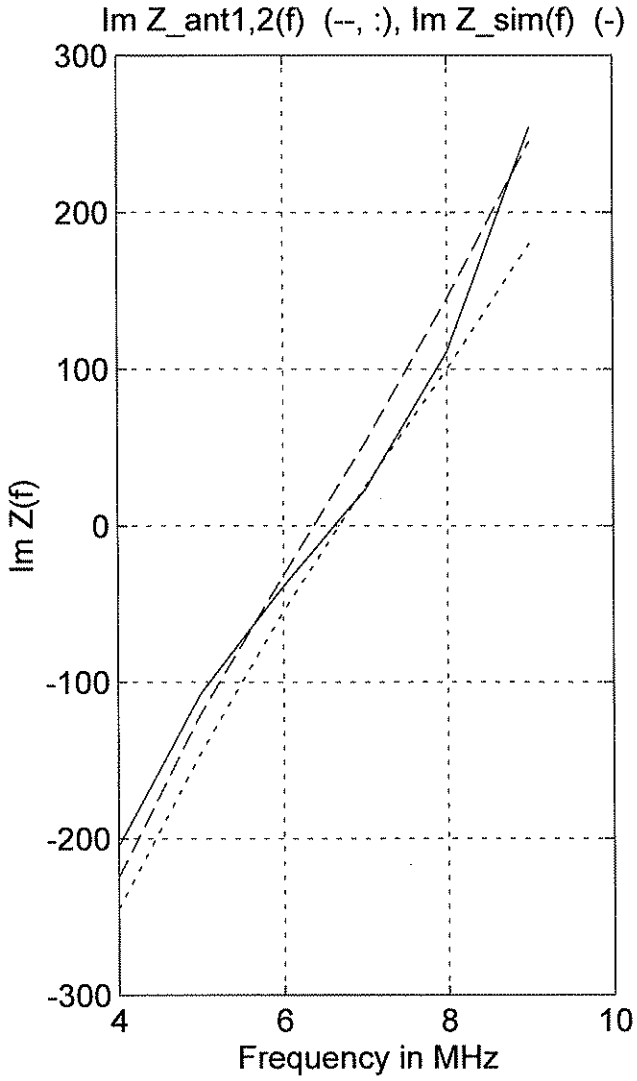

Re Z_ant1,2(f) (--, :) , Re Z_sim(f) (-)
7
6.5
6
5.5
5
4.5
4
Re Z(f)
1.6
1.7
1.8
1.9
2
Frequency in MHz

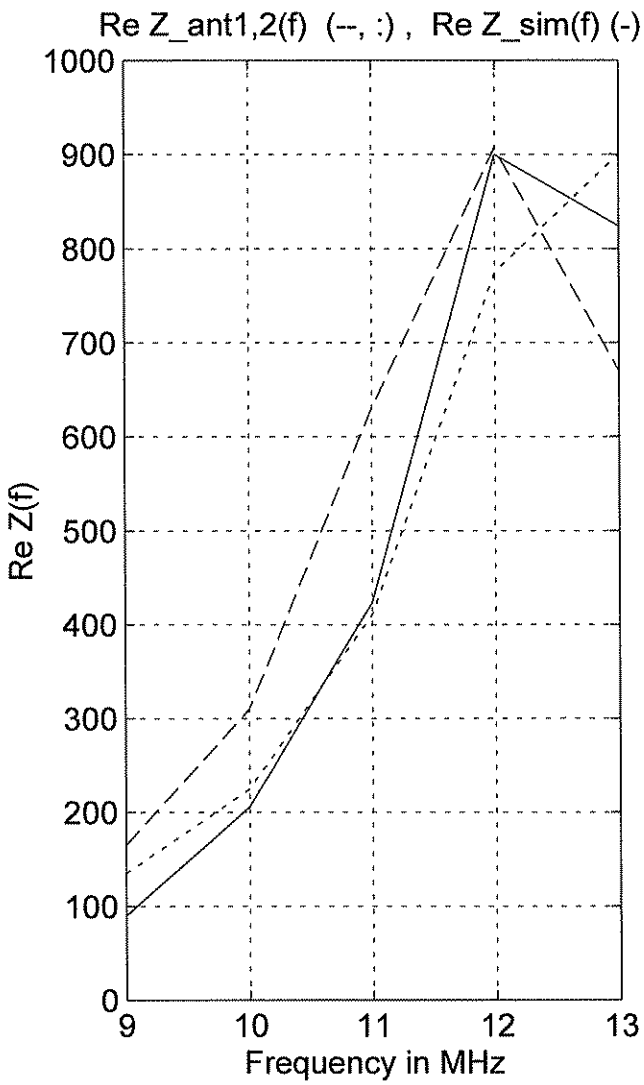

Im Z_ant1,2(f) (--, :), Im Z_sim(f) (-)
-600
-650
-700
-750
-800
-850
-900
-950
Im Z(f)
1.6
1.7
1.8
1.9
2
Frequency in MHz

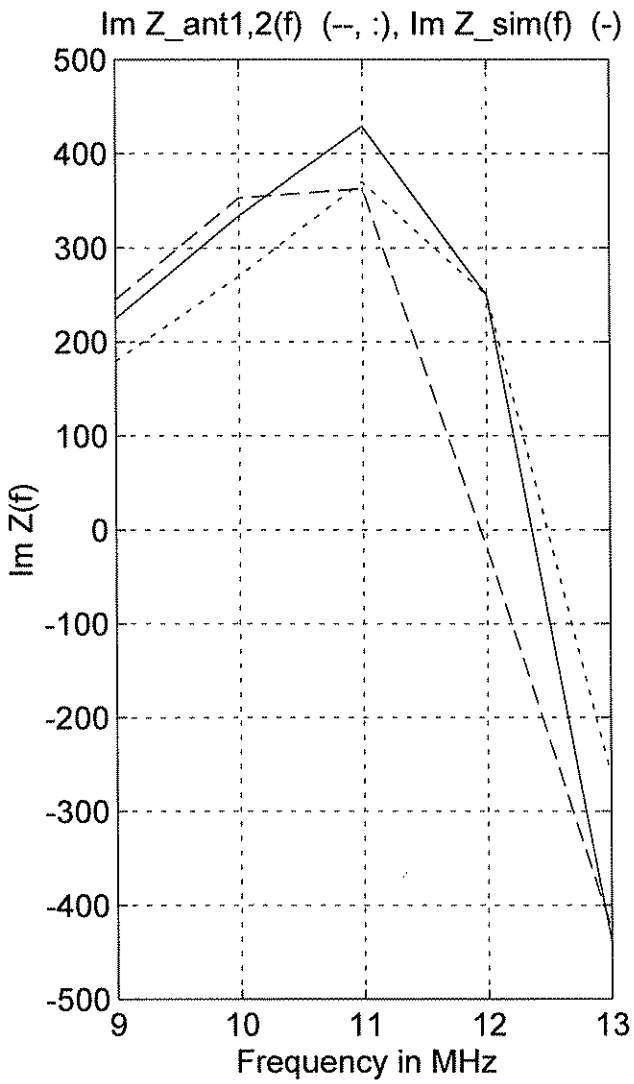

Re Z_ant1,2(f) (--, :) , Re Z_sim(f) (-)
Re Z(f)
Frequency in MHz
15
14
13
12
11
10
9
8
7
6
5
2
2.5
3
3.5
4

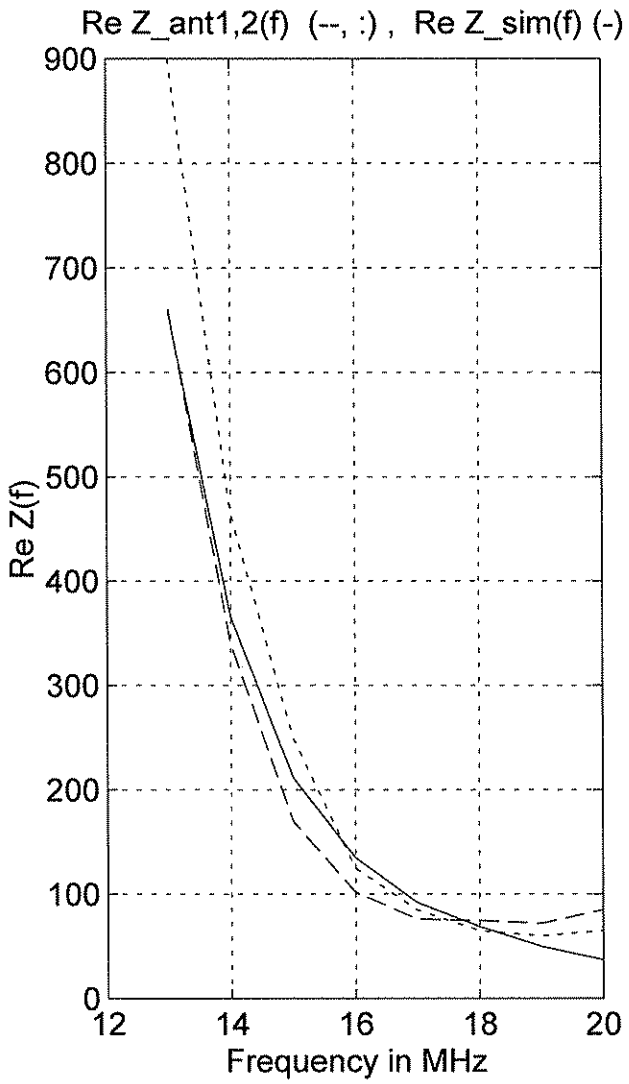

Im Z_ant1,2(f) (--, :), Im Z_sim(f) (-)
Im Z(f)
Frequency in MHz
-200
-250
-300
-350
-400
-450
-500
-550
-600
-650
2
2.5
3
3.5
4

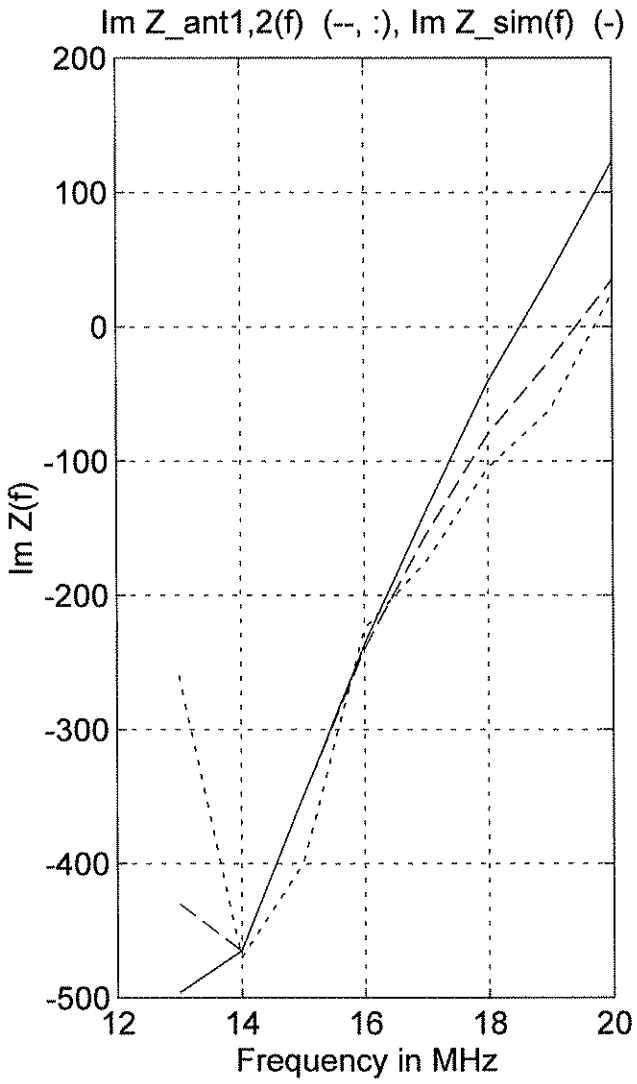

Re Z_ant1,2(f) (--, :) , Re Z_sim(f) (-)
180
160
140
120
100
80
60
40
20
0
Re Z(f)
4
6
8
10
Frequency in MHz

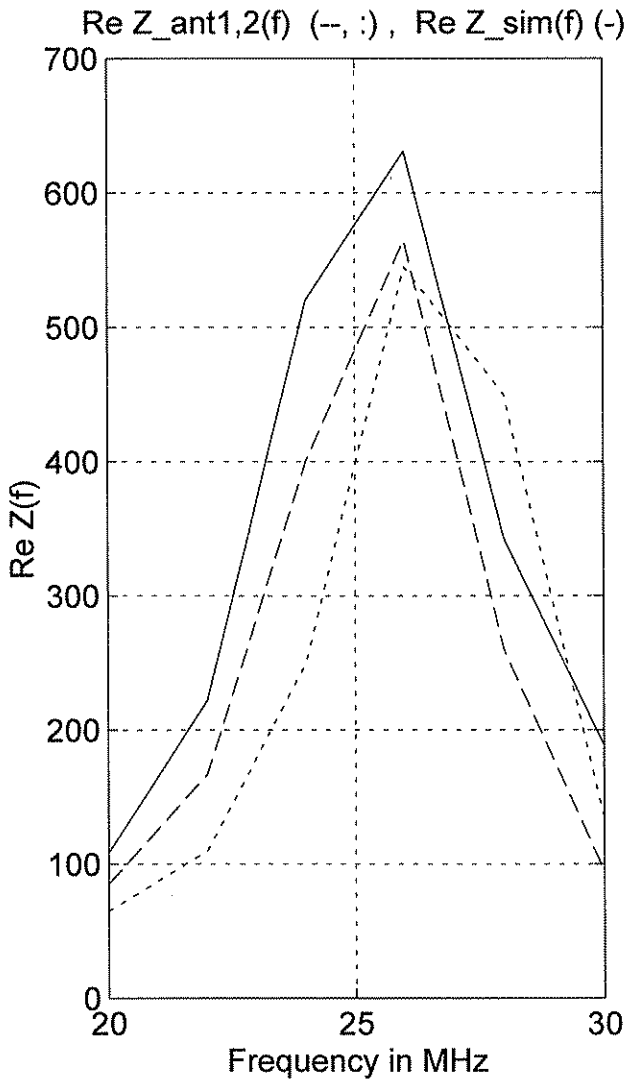

Im Z_ant1,2(f) (--, :), Im Z_sim(f) (-)
300
200
100
0
-100
-200
-300
Im Z(f)
4
6
8
10
Frequency in MHz

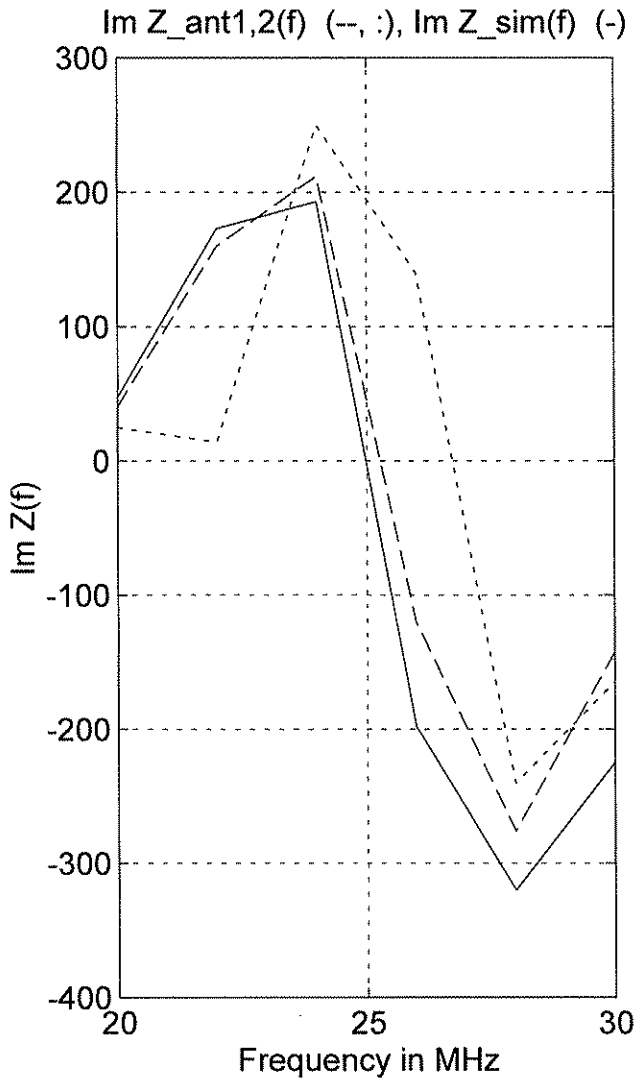

Re Z_ant1,2(f) (--, :) , Re Z_sim(f) (-)
1000
900
800
700
600
500
400
300
200
100
0
Re Z(f)
9
10
11
12
13
Frequency in MHz


Im Z_ant1,2(f) (--, :), Im Z_sim(f) (-)
500
400
300
200
100
0
-100
-200
-300
-400
-500
Im Z(f)
9
10
11
12
13
Frequency in MHz


Re Z_ant1,2(f) (--, :) , Re Z_sim(f) (-)
900
800
700
600
500
400
300
200
100
0
Re Z(f)
12
14
16
18
20
Frequency in MHz


Im Z_ant1,2(f) (--, :), Im Z_sim(f) (-)
200
100
0
-100
-200
-300
-400
-500
Im Z(f)
12
14
16
18
20
Frequency in MHz


Re Z_ant1,2(f) (--, :) , Re Z_sim(f) (-)
700
600
500
400
300
200
100
0
Re Z(f)
20
25
30
Frequency in MHz


Im Z_ant1,2(f) (--, :), Im Z_sim(f) (-)
300
200
100
0
-100
-200
-300
-400
Im Z(f)
20
25
30
Frequency in MHz

SECTION II

INSTALLATION

2.1 GENERAL INSTALLATION PROCEDURES AND REQUIREMENTS

1. Carefully plan radio/amplifier/coupler/antenna simulator locations, observing the following requirements before starting installation.

2. Provide best possible RF ground for all equipment. Use flat copper strap 1" wide or #6 (or larger) wire and make connections to the ground terminal of all system components. Leads to ground system should be as short as possible.

After the system grounds have been installed, connect the station ground system to the antenna simulator ground terminal.

3. Provide the maximum separation between coupler/antenna simulator and the radio with its associated wiring. 100 feet is the recommended minimum distance and up to 250 feet separation may be used.

4. Make sure that the 50 Ohm dummy load and the DA 9150A are not

SECTION III

OPERATION

3.1 GENERAL

The DA-9150A Antenna Simulator operates with the CU-9150 Automatic Digital Antenna Coupler and an appropriate 50 Ohm termination.

3.2 OPERATING THE DA-9150A

Ensure that the Transceiver RT-9000(A), LPA-9600/LPA-9500 and CU-9150 are installed properly. Refer to Section II of the applicable manuals. Connect the output of the CU-9150 Digital Antenna Coupler to the input of the DA-9150A Antenna Simulator and further the output of the DA-9150A to a 50-Ohm load. After doing this there is no further manual operation necessary, since the passive LC-networks of the DA-9150A are designed to automatically match the 50-Ohm load to the appropriate antenna impedance.

SECTION IV

THEORY OF OPERATION

4.1 GENERAL

The DA-9150A is an analog antenna simulator designed for the use with the LPA-9600 1 kW Linear Power Amplifier, the Sunair 9000 series Exciters and Transceivers and the CU-9150 Digital Antenna Coupler. The simulator is rated for a maximum average input power of 1 kW.

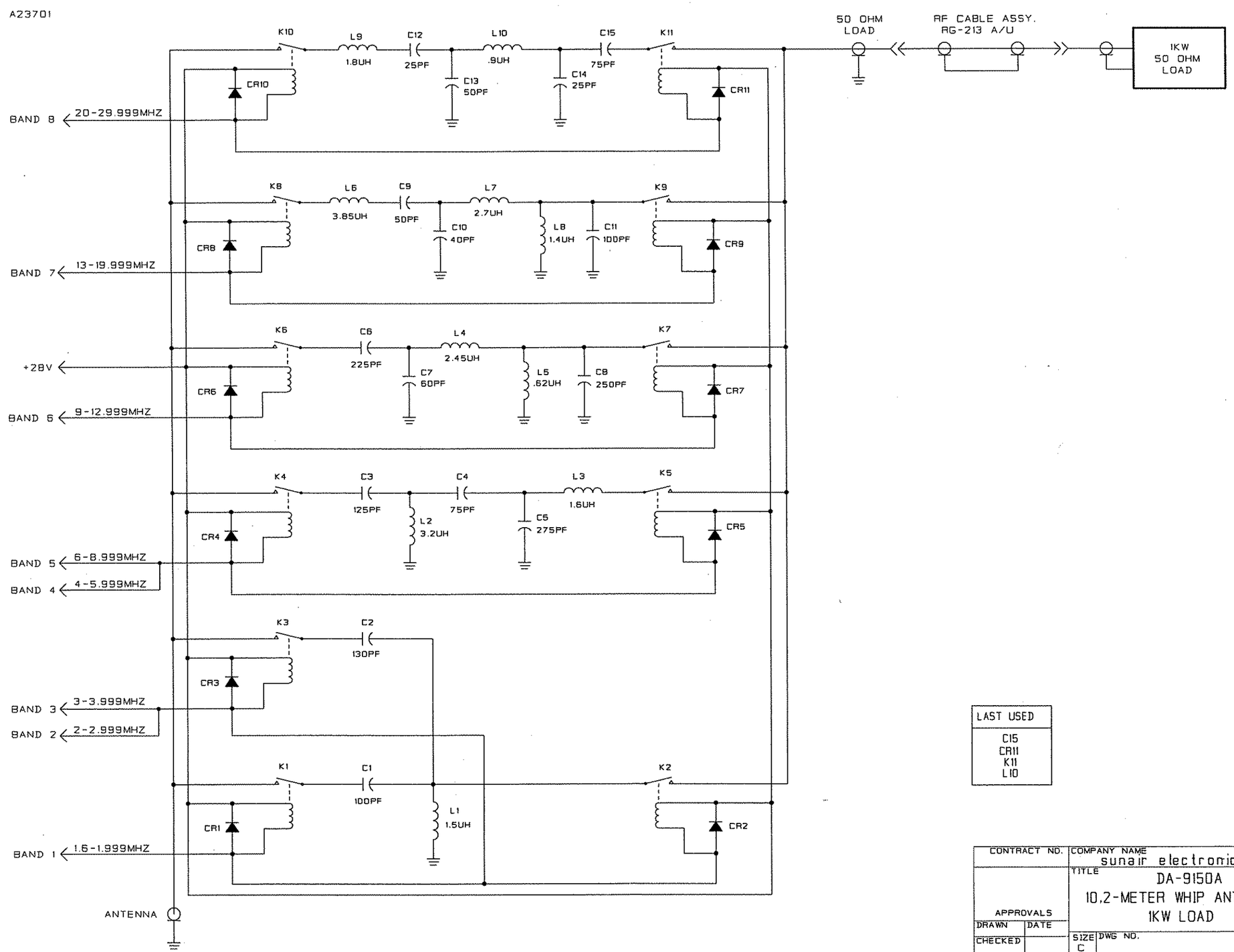
1.2 ANTENNA IMPEDANCE SIMULATING NETWORK

In the case of impedance simulating over a broad range of frequencies the problem is to come up with a network that has approximately the same complex impedance function $Z_{sim}(f)$ like the actual "real world" antenna. To meet these requirements over a range of frequencies from 1.6 to 30 MHz (HF band) with only one network is rather difficult and complicated. To reduce the given problem to a reasonable and cost effective state, the overall HF band was divided into eight sub-bands (1.6 to 1.99 MHz, 2.0 to 2.99 MHz, 3.0 to 3.99 MHz, 4.0 to 5.99 MHz, 6.0 to 8.99 MHz, 9.0 to 12.99 MHz, 13.0 to 19.99 MHz and 20.0 to 29.99 MHz). Now it is far easier to find networks that realize the following equation:

$$L_2 = \int_{\Omega} \left\| Z_{ant}(j\omega) - Z_{sim}(j\omega) \right\|^2 d\omega \rightarrow 0$$

These networks are purely passive LC-networks with series/shunt inductors/capacitors terminated by a 50-Ohm load. At low frequencies (below 4 MHz) the impedance of a typical 35' whip antenna has a rather small real and large negative imaginary component. That leaves the solution for a simulating network rather simple: a series capacitor and a shunt coil in parallel to the 50-Ohm resistor. With higher frequencies the networks also get more complex as one has to realize reactive crossover points as well as reactive and resistive maximums and minimums. Fortunately modern technology nowadays provides us with powerful circuit analyzing tools which perform component optimization according to above-mentioned equation, i.e. finding the minimum of the error function.

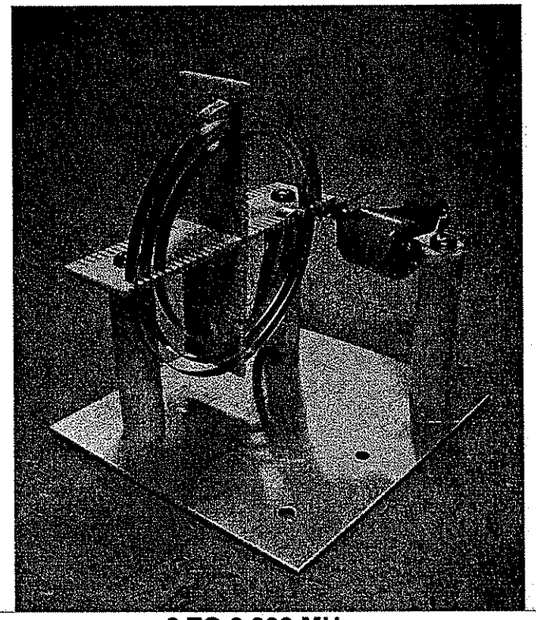
Frequency information, which determines the simulating network, is supplied to the simulator via the channel lines.



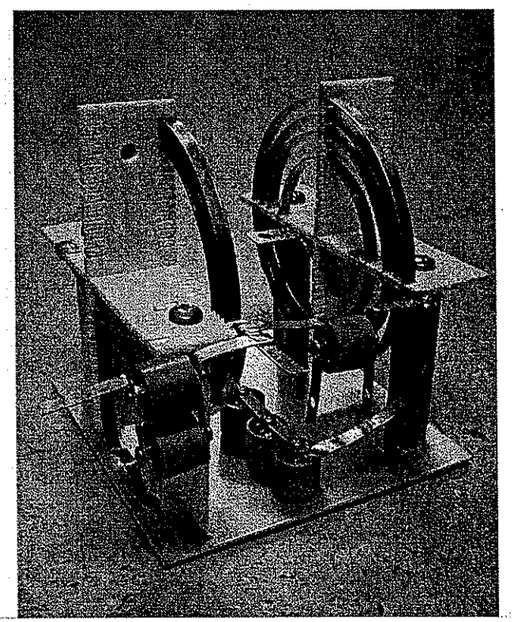
LAST USED
C15
CR11
K11
L10

CONTRACT NO.		COMPANY NAME sunair electronics, inc.	
APPROVALS		TITLE DA-9150A 10,2-METER WHIP ANTENNA, 1KW LOAD	
DRAWN	DATE		
CHECKED		SIZE C	DWG NO. / REV 01
ISSUED		SCALE / FSCM NO. A2370	SHEET 1/1

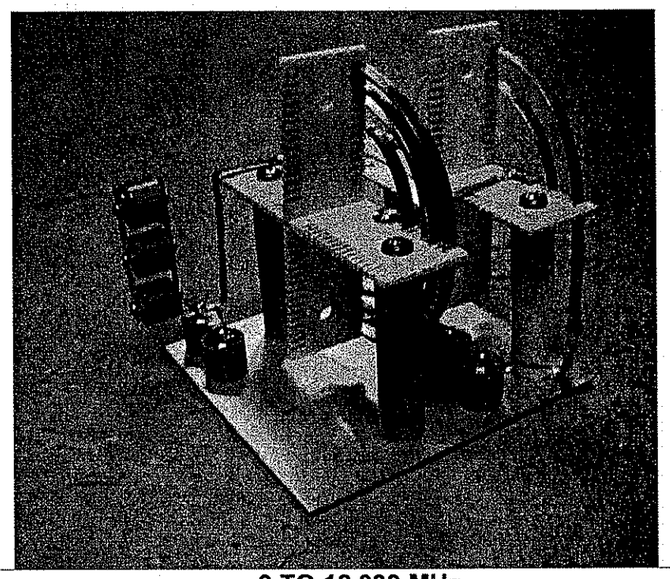
PROTOTYPES OF SIMULATING NETWORKS



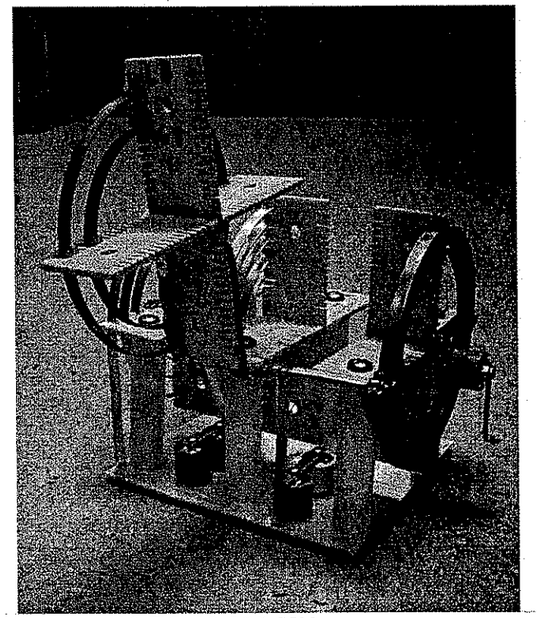
2 TO 3.999 MHz



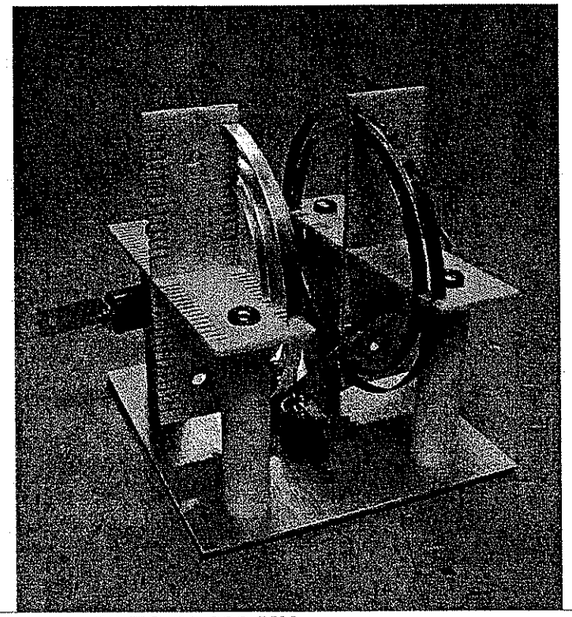
4 TO 8.999 MHz



9 TO 12.999 MHz



13 TO 19.999 MHz



20 TO 29.999 MHz

APPENDIX
TABLE of ABBREVIATIONS

ADDR Address
AGC Automatic Gain Control
ALC Automatic Level Control
AM Amplitude Modulation
AME Amplitude Modulation Equivalent
AMP/AMPL Amplifier
ARQ Automatic Request
AUD Audio
AUTO Automatic
AUX Auxiliary
BAUD A variable unit of data transmission speed (bits per second)
BELL U.S. Telephone standards
BFO Beat Frequency Oscillator
BITE Built In Test Equipment
BRD Board
CH /CHAN /CHL/CHN Channel
CLR Clear
CMOS Complementary Metal Oxide Semiconductor
CPLR Coupler
CPU Computer
CW Carrier Wave
dB Decibel
dBm Decibels referred to 1 milliwatt across 600 ohms
DSBSC Double Sideband Suppressed Carrier
DSP Display
DUART Dual Asynchronous Receive/Transmit
EEPROM Electrically Erasable and Programmable Read Only Memory
EPROM ElectricallyProgrammable ReadOnly Memory
EMI Electromagnetic Radiation Interference
ENTR Enter
FAX Facsimile
FEC Forward Error Correction
FREQ Frequency
FSK Frequency Shift Keying
FWD Forward
GRP Group
HF High Frequency
Hz Hertz
IC Integrated Circuit
IF Intermediate Frequency
I/O Input/Output
IONCAP Ionospheric Communications Analysis and Prediction
kHz Kilohertz
kW Kilowatt
ISB Independent Sideband
LCD Liquid Crystal Display
LCL Local
LED Light Emitting Diode
LK Link
LO Local Oscillator
LP/LPX Lincompex
LRU Lowest Repairable Unit
LSB Lower Sideband
LT Light
LVL Level
MAN Manual
M CH Manual Channel
MED Medium
MHz Megahertz
MIC Microphone
MIL-STD Military Standard
MNL Manual
ms Millisecond
MTTR Mean Time To Repair
MTR Meter
NAR Narrow
O.D. Olive Drab
PA Power Amplifier
PC Printed Circuit
PEP Peak Envelope Power
PLL Phase-Locked Loop
P/N Part Number
PNL Panel
POSTSL Post-Selector
PRESEL Pre-Selector
PTT Push-To-Talk
PWR Power
RCV/RX Receive
REFL Reflected
REV Revision
RF Radio Frequency
RFI Radio Frequency Interference
RFL Reflected
RMT Remote
RS232 Computer control, hardwired up to 50 feet maximum
RS422 Computer control, hardwired up to 4000 feet maximum
RS485 Computer control, hardwired for multiple users
RTTY Radio Teletype
SEL Select
SLO Slow
S MTR Signal Strength Meter
SPKR Speaker
SPLX Simplex
SRAM Static Random Access Memory
SSB Single Sideband
TCXO Temperature Controlled Crystal Oscillator
TGC Transmit Gain Control
THD Total Harmonic Distortion
TTL Transistor Transistor Logic
TX/XMT Transmit
USB Upper Sideband
UTC Universal Time
VCO Voltage Controlled Oscillator
VHF Very High Frequency
VRMS Volts Root Mean Square
VSWR Voltage Standing Wave Ratio
W Watt
WPM Words Per Minute
* (Asterisk) Indicates function selected