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QUARTERLY REPORT

Prepared On

CONTRACT NO. NOBER 81262

Prepared For

BUREAU OF SHIPS
Department of the Navy
Washington 25, D. C.

491-01

Prepared By

APPLIED RESEARCH INC.
76 South Bayles Avenue
Port Washington, N. Y.
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<td>13</td>
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</table>
1.0 ABSTRACT

1.10 This report covers work done on the development of an RF Spectro-
scope in the range from 100 MC to 1000 MC for the three month
period from May 1, 1962 to July 31, 1962. It deals with the fol-
lowing subjects:
1.11 Purpose for the development.
1.12 Names of technical personnel engaged in the development
program, together with a summary of the manhours work
performed by each.
1.13 A description of the work done during the period from
May 1, 1962 to July 31, 1962.
1.14 A project performance and schedule chart is included.
1.15 Program for the next three month interval.
2.0 PURPOSE FOR THE DEVELOPMENT

2.10 The RF Spectroscope shall be developed for the visual display of amplitude and frequency of RF signals in the frequency range of 100 MC to 1000 MC.

2.20 The frequency range of 100 MC to 1000 MC shall be displayed in four swept bands on a 5-inch oscilloscope screen.

2.30 The spectroscope shall have sweep coverage up to 300 MC electronically with high resolution, with no spurious responses and no internally generated interference.

2.40 It shall be useful as a search receiver, spectrum analyzer, noise interference analyzer or as monitoring equipment.
3.0 TECHNICAL PERSONNEL ENGAGED IN THE PROGRAM AND MAN HOURS

3.10 The following is a list of technical personnel engaged in the development of the spectroscope together with the total number of hours spent by each during the period from May 1, 1962 to July 31, 1962.

<table>
<thead>
<tr>
<th>Name</th>
<th>Total Hours Per Man</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leonard Pollachek</td>
<td>144.50</td>
</tr>
<tr>
<td>Martin Heller</td>
<td>184.00</td>
</tr>
<tr>
<td>Earl Morrison</td>
<td>171.75</td>
</tr>
<tr>
<td>Thomas Vlijmas</td>
<td>55.50</td>
</tr>
<tr>
<td>Joseph Fazzino</td>
<td>51.00</td>
</tr>
<tr>
<td>Melvin Merberg</td>
<td>10.50</td>
</tr>
<tr>
<td>Harry Brown</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>624.25</td>
</tr>
</tbody>
</table>
4.0 DESCRIPTION OF WORK

4.10 During the period covered by this report, the following tasks have been undertaken.

4.11 The power supply for the spectroscope was ordered. This consists of two different types of power supply packages. Package type No. 1 supplies all units of the spectroscope except the RF heads. Package type No. 2 supplies power to each RF head. There will be a total of four type No. 2 packages, each supplying one of the four RF heads.

4.11.1 The No. 1 type power supply package has the following design objectives:

<table>
<thead>
<tr>
<th>Output Voltage and Current</th>
<th>Regulation</th>
<th>Ripple</th>
</tr>
</thead>
<tbody>
<tr>
<td>+205 to +210 VDC at 250 MA</td>
<td>0.1%</td>
<td>2 MV RMS</td>
</tr>
<tr>
<td>+200 VDC at 100 MA</td>
<td>0.01%</td>
<td>200 µV RMS</td>
</tr>
<tr>
<td>+33 VDC at 400 MA</td>
<td>0.1%</td>
<td>1 MV RMS</td>
</tr>
<tr>
<td>+30 VDC at 350 MA</td>
<td>0.01%</td>
<td>100 µV RMS</td>
</tr>
<tr>
<td>-23 VDC at 150 MA</td>
<td>0.1%</td>
<td>1 MV RMS</td>
</tr>
<tr>
<td>-20 VDC at 150 MA</td>
<td>0.01%</td>
<td>100 µV RMS</td>
</tr>
<tr>
<td>+28 VDC at 1.5 A</td>
<td>Unregulated</td>
<td>10%</td>
</tr>
<tr>
<td>6.3 VDC adj. ±0.5V at 7.5A</td>
<td>0.25%</td>
<td>50 µV RMS</td>
</tr>
<tr>
<td>6.3 VAC at 3.0A</td>
<td>Unregulated</td>
<td></td>
</tr>
</tbody>
</table>

4.11.2 The No. 2 type power supply package has the following design objectives:

<table>
<thead>
<tr>
<th>Output Voltage and Current</th>
<th>Regulation</th>
<th>Ripple</th>
</tr>
</thead>
<tbody>
<tr>
<td>+200 VDC at 0.1A</td>
<td>0.1%</td>
<td>2 MV RMS</td>
</tr>
<tr>
<td>6.3 VDC at 3.0A</td>
<td>0.25%</td>
<td>15 MV RMS</td>
</tr>
</tbody>
</table>

4.12 The Tektronix Model RM15 Mod. 101 was ordered as the oscilloscope for the spectroscope during this period. This scope was chosen in preference to the Hughes Memoscope which was at first considered for use with the spectroscope. The advantages of the Model RM15 over the Hughes Memoscope are as follows:
4.12.1 It has a more intense, sharper trace.

4.12.2 It is physically shorter and conserves cabinet space.

4.12.3 Its front panel layout is more compatible with the rest of the spectroscope.

4.12.4 It costs less.

4.12.5 It operates from a 50 CPS to 400 CPS source without modification.

4.12.6 The Tektronix scope has a self-contained delay line and wide band video amplifier appropriate for the display of spectrum signature.

4.13 During this period, the 775 MC to 30 MC converter, Unit No. 1A7A10, Dwg. No. B600813, Fig. 1 and photo Fig. 2, was breadboarded. The unit was aligned and tested. It has the following characteristics:

4.13.1 Input Signal Frequency: 775 MC

4.13.2 Local Oscillator Frequency: 402.5 MC (the second harmonic or 805 MC is used)

4.13.3 LO Power: 100 MW at 402.5 MC

4.13.4 Output Frequency: 30 MC

4.13.5 Conversion Gain: Greater than 0 DB

4.13.6 Overall Bandwidth (3 DB Points): 3 MC

4.14 The 30 MC to 775 MC converter, Unit No. 1A7A14, Dwg. No. B600814, Fig. 3 and photo Fig. 2, was designed and breadboarded during this period. It was aligned and tested. It has the following characteristics:

4.14.1 Input Signal Frequency: 30 MC

4.14.2 Local Oscillator Frequency: 402.5 MC (the second harmonic or 805 MC is used)
4.14.3 LO Power: 100KW at 402.5 MC
4.14.4 Output Frequency: 775 MC
4.14.5 Conversion Gain: Greater than 0 DB
4.14.6 Bandwidth (1 DB): 4 MC

4.15 During this period, the 402.5 MC local oscillator, Unit 1A7A13, Dwg. No. A600812, Fig. 4 and photo Fig. 2, was designed and breadboarded. The unit was aligned and tested. At each of its two output ports is available at 402.5 MC greater than 150 MW of power into 50 ohms.

4.16 The power IF amplifier-linear detector, Unit 1A7A8, Dwg. No. D600802, Fig. 5 and photo Fig. 6, was designed and breadboarded during this period. It was aligned and tested. It has the following characteristics:

4.16.1 Dynamic Range: >35 DB
4.16.2 Output Voltage (Video): >20 volts
4.16.3 Bandwidth (3 DB): 7 MC
4.16.4 Data of DC output voltage versus input voltage at 775 MC for the power IF amplifier-linear detector is presented in Table I below:

<table>
<thead>
<tr>
<th>Input Volts (RMS)</th>
<th>775 MC</th>
<th>Output Volts DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>+6</td>
<td>0.45</td>
<td>21.0</td>
</tr>
<tr>
<td>0</td>
<td>0.225</td>
<td>10.5</td>
</tr>
<tr>
<td>-6</td>
<td>0.112</td>
<td>4.9</td>
</tr>
<tr>
<td>-12</td>
<td>0.056</td>
<td>2.2</td>
</tr>
<tr>
<td>-18</td>
<td>0.028</td>
<td>0.88</td>
</tr>
<tr>
<td>-24</td>
<td>0.014</td>
<td>0.32</td>
</tr>
<tr>
<td>-30</td>
<td>0.007</td>
<td>0.10</td>
</tr>
</tbody>
</table>

4.16.5 A plot of Table I is given in Fig. 7.
4.17 During this period, a lin-log IF amplifier, Unit 1A7A7, Dwg. No. D600806, Fig. 8, was designed and breadboarded. In the log mode of operation, the original breadboard model was sensitive to input signal level. Oscillation occurred when the input signal approached a critical level of -10 DBM. Below and above this level the amplifier was stable. In addition, the amplifier saturated too soon on large input signals. As a result, the dynamic range of the amplifier was too restricted. Accordingly, the breadboard was modified in the following manner:

4.17.1 Four transistor stages of the lin-log amplifier, which comprise the feedback section, were reduced to two stages. The two stages are each emitter followers. By reducing the gain of the feedback section, the lin-log amplifier in the log mode was made stable and its dynamic range increased.

4.17.2 The characteristics of the lin-log IF amplifier are as follows:

- Center Frequency: 775 MC
- Bandwidth (3 DB): 6 MC
- Linear Mode Gain: 45 DB
- Log Mode Gain: 35 DB (for small signals)

4.18 A lin-log IF preamplifier Unit 1A7A17, Dwg. No. C600853, Fig. 9, and photo Fig. 10, was designed and breadboarded during this period. It operates in front of the lin-log IF amplifier and, together with the latter, gives a gain of better than 60 DB in the lin mode of operation for small signals. The lin-log IF preamplifier has the following characteristics:

4.18.1 Center Frequency: 775 MC
4.18.2 Bandwidth (3 DB): 16 MC

4.18.3 Linear Mode Gain: 23 DB

4.18.4 Log Mode Gain: 20 DB (for small signals)

4.18.5 A test was conducted to determine the overall amplitude response from the input of the lin-log preamplifier to the output of the power IF amplifier—linear detector in the log mode. Results are presented in Table II below. Refer to block diagram, Dwg. No. R700449, Fig. 11.

Table II

<table>
<thead>
<tr>
<th>775 MC input at Lin-Log IF Preamplifier in DBM</th>
<th>Linear Detector Output Volts DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>0</td>
</tr>
<tr>
<td>-85</td>
<td>0.02</td>
</tr>
<tr>
<td>-80</td>
<td>0.06</td>
</tr>
<tr>
<td>-75</td>
<td>0.18</td>
</tr>
<tr>
<td>-70</td>
<td>0.4</td>
</tr>
<tr>
<td>-65</td>
<td>0.74</td>
</tr>
<tr>
<td>-60</td>
<td>1.08</td>
</tr>
<tr>
<td>-55</td>
<td>1.35</td>
</tr>
<tr>
<td>-50</td>
<td>1.46</td>
</tr>
<tr>
<td>-45</td>
<td>1.50</td>
</tr>
<tr>
<td>-40</td>
<td>1.55</td>
</tr>
<tr>
<td>-35</td>
<td>1.58</td>
</tr>
<tr>
<td>-30</td>
<td>1.60</td>
</tr>
<tr>
<td>-25</td>
<td>1.60</td>
</tr>
<tr>
<td>-20</td>
<td>1.62</td>
</tr>
<tr>
<td>-15</td>
<td>1.67</td>
</tr>
<tr>
<td>-10</td>
<td>1.73</td>
</tr>
<tr>
<td>-5</td>
<td>1.82</td>
</tr>
<tr>
<td>0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

4.18.6 A plot of Table II is shown in Fig. 12.

4.19 During this period, the lin-log IF amplifier was relocated in the overall system. This was done for the following reason. In the log mode, the bandpass of the lin-log IF amplifier increases as its input signal is made larger. The lin-log amplifier has been placed in front of the second set of IF bandpass defining filters in order that the overall desired system...
bandpass remain constant in the log mode of operation. A new
block diagram showing the current arrangements of components
in the system is given in Dwg. No. R700449, Fig. 11.

4.20 During this period, two bandpass crystal filters were ordered
and received. Each crystal filter is centered at 30 MC. Crystal
filter No. 1 has a 3 DB bandwidth of 5 KC. Crystal filter No. 2
has a 3 DB bandwidth of 25 KC. Each of the crystal filters ex-
hibited excessive spurious responses outside of its pass band
under test. Each filter exhibited erratic behavior in testing.
The filters were returned to the manufacturer for correction.

4.20.1 The results of tests performed on Crystal Filter No. 1
are as follows:

- Insertion Loss: -6.3 DB
- Peak to Valley Ripple Across Flats: 0.6 DB
- Bandwidth -3 DB: 4.3 KC
- Bandwidth -6 DB: 5.8 KC
- Bandwidth -60 DB: 19.3 KC
- Spurious Responses: >-64 DB low side to 16 MC
                             >-70 DB high side to 49 MC

4.20.2 The results of tests performed on Crystal Filter No. 2
are as follows:

- Insertion Loss: -2.7 DB
- Peak to Valley Ripple Across Flats: 0.4 DB
- Bandwidth -3 DB: 24.6 MC
- Bandwidth -6 DB: 27.7 MC
- Bandwidth -60 DB: 95.8 MC
- Spurious Responses: >-57 DB to 25 MC
                             >-57 DB to 49 MC

4.21 During this period, all units of the spectroscope have been

- 9 -
completed by engineering and released for fabrication.

4.22 A project performance and schedule chart is given in Dwg. No. SF-138, Fig. 13.
5.0 PROGRAM FOR THE NEXT THREE MONTH INTERVAL

5.10 During the next interval, it is expected that the following tasks will be completed.

5.11 All individual units will be fabricated.

5.12 The units will be final tested and assembled and wired in the cabinet.

5.13 Final system testing will be completed.
**REVISIONS**

<table>
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<tr>
<th>ISSUE</th>
<th>DESCRIPTION</th>
<th>DATE</th>
<th>BY</th>
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<td>B</td>
<td>ELECTRICALLY REVISED</td>
<td>11-9-62</td>
<td>R.D.</td>
</tr>
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**Diagram:**

- **J2**: OUTPUT
- **J3**:
  - A → +33VDC, 45 MA
  - B → -33VDC
C9-20 PVRN
POWER INPUT

<table>
<thead>
<tr>
<th>LAST COMP</th>
<th>REF DESIG</th>
</tr>
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<tbody>
<tr>
<td>C</td>
<td>J</td>
</tr>
<tr>
<td>28</td>
<td>3</td>
</tr>
</tbody>
</table>

ALL DIMENSIONS IN INCHES, UNLESS OTHERWISE SPECIFIED TOLERANCES:
FRACTIONS ± 1/64  ANGLES ± 1/8°
DECIMALS .XX ± .010  .XXX ± .005

MATERIAL: ________________________________

FINISH: ________________________________

APPLICATION: ________________________________

491-01  501580
C → SPARE
D → +6.3 VDC
E → 1.2 A
F → B-
G → 200VDC
H → FIL GND
I → -23VDC
J → 5.5 MA
K → 10 MA
L → +23VDC

NOTE
1. UNLESS OTHERWISE NOTED
   ALL CAPACITORS IN UUF
   ALL RFC = ARI 800
   ALL RESISTORS ARE 1/2W

COMP  REF  DESIG
L  Q  R  RFC  V
9 1 15 17 3

W:1-15 3 ALL CAPACITORS IN UUF
W:1-17 3 ALL RFC = ARI 800
W:1-17 3 ALL RESISTORS ARE 1/2W
NOTE:
1. UNLESS OTHERWISE SPECIFIED
   ALL CAPACITORS ARE IN μF
   ALL RESISTORS ARE 1/2 W

SCHEMATIC
LIN-LOG IF AMPL.
UNIT 1A7A7

APPLIED RESEARCH INC.
PORT WASHINGTON
NEW YORK
### Revisions

<table>
<thead>
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<th>Issue</th>
<th>Description</th>
<th>Date</th>
<th>By</th>
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<tbody>
<tr>
<td>B</td>
<td>Interchange C18 with C19</td>
<td>10/16/62</td>
<td>HB</td>
</tr>
</tbody>
</table>

#### Diagram

- **J3**
  - Seal Electro 3002
- **C13**: 7 F.T.
- **RFC 5**
- **C15**: 47 S.Q.
- **C14**: 47 S.Q.
- **J2**: RF Output
- **RFC 3**
- **L6**
- **C10**: 8-8.5

#### Note

1. All capacitors in µµf
2. R3 & R4 selected for 1WMA tube current
3. F0 = 775 MC

---

#### Circuit Diagram

- **J4**
  - C5-20PVRN
- **C20**: 1K F.T.
- **RFC12**
- **C21**: 1K S.O.
- **RFC15**
- **A → B+ 200V**
- **B → B+ GND**
- **D → FILG 6.3VDC**
NOTE
1. ALL CAPACITORS IN \mu F
2. R3 & R4 SELECTED FOR
   10MA TUBE CURRENT
3. F0 = 775 MC

J4
C5-20PVRN

RF OUTPUT

- 20 -
Input of Lim-log IF
pre-amplifier to
output of system
$f_0 = 2.75$
<table>
<thead>
<tr>
<th></th>
<th>FEB</th>
<th>MARCH</th>
<th>APRIL</th>
<th>MAY</th>
<th>JUN</th>
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<tr>
<td>1. ENGINEERING DEVELOPMENT</td>
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<td>2. MECHANICAL DESIGN</td>
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<td>4. FINAL TEST</td>
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- Work completed
- Work to be completed

All dimensions in inches, unless otherwise specified tolerances:
- Fractions ± 1/64
- Angles ± 1/8
- Decimals XX ± 0.010
- XXX ± 0.05

Material: 

Finish: 

Job No. Next Assembly Application

Ogilvie Press, Inc., Brooklyn 17, N.Y. Ultraviolet No. 490M
<table>
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**ARCH APRIL MAY JUNE JULY AUG SEPT**

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</tbody>
</table>

**DIMENSIONS IN INCHES, UNLESS OTHERWISE SPECIFIED TOLERANCES:

- MILLIMETERS: XX ± .010
- MILLIMETERS: XXX ± .005

- ANGLES ± 1/2°
- ANGLES ± 1/3°
- TANGENTS ± 1/64 ANGLES

**APPLIED RESEARCH INC.**
*PORT WASHINGTON NEW YORK*

**SPECTROSCOPE PROJECT PERFORMANCE AND SCHEDULE CHART**

**DRAWN BY WILLIAMS**

**CHECKED**

**APPROVED**

**DRAWN BY**

**APPROVED**

**SCALE**

**UNIT WT.**

**DWG. SIZE**

**ISSUE**

**SF-138**

**2**
UNIT IA7S2

UNIT IA7A10
CONVERTER 775MC TO 30MC 5435(1)

UNIT IA7A11
XTAL FILTER
f0 = 30MC
BW = 3DBPIS:
25KC
NBE = GOODBPI:
180KC
IL = 4DB

UNIT IA7A12
XTAL FILTER
f0 = 30MC
BW = 3DBPIS:
5KC
NBE = GOODBPI:
20KC
IL = 4DB

UNIT IA7S5
CORK RELAY SPDT
DK#318-010382-3

UNIT IA7A13
LOCAL OSCILLATOR
f0 = 402.5MC
PO. 750 MW/OUTPUT

UNIT IA7A16
L.P. FILTER
f0 = 450 MC
IL > 1DB