INTEGRATION OF THE PRIMARY RECEIVER INTO
THE NAVPGSCOL SATCOM SIGNAL ANALYZER

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Project Report

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Integration of the Primary Receiver into the NAVPGSCOL SATCOM Signal Analyzer is presented. Circuit modifications and additions to the Primary Receiver, wiring information and operating procedures for the Primary Receiver Control Panel, and software development for system operation are presented in detail.
ABSTRACT

Integration of the Primary Receiver into the Naval Postgraduate School SATCOM Signal Analyzer is presented. Circuit modifications and additions to the Primary Receiver, wiring information and operating procedures for the Primary Receiver Control Panel, and software development for system operation are presented in detail.
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I. INTRODUCTION

A. BACKGROUND

This project is part of a series of Radio Frequency Interference (RFI) measurement and analysis projects undertaken by the NAVPGSCOL Satellite Communications Laboratory concerning UHF satellite communications. Previous efforts include evaluation of the AS 3018/WSC-1(V) shipboard antenna (Ref. 1), preparation of a shipboard RFI measurement package (Refs. 2-5), evaluation of shipboard RFI (Ref. 6), construction of a shipboard RFI simulator (Ref. 7) and measurement of shipboard SATCOM terminal performance in the presence of specific RFI sources (Refs. 8-10).

In March of 1977, this laboratory received funding from PME 106-1 of NAVELEX to develop, design, and construct a SATCOM Signal Analyzer at NAVPGSCOL. The purpose of this unit is to provide high-speed spectrum analysis and characterization of the outputs of UHF satellite transponders while operating in orbit. Previous efforts toward achieving this purpose include design of a computer system to provide control and signal analysis (Ref. 11) and design and construction of SATCOM Analyzer Receivers (Refs. 12-13). This report will present the integration of the Primary Receiver into the SATCOM Signal Analyzer System.
B. SPECIFIC GOALS

The specific goals in the development of this system are to (1) provide all necessary equipment to make real-time measurements at the Naval Postgraduate School and (2) to provide the necessary research and development of signal analysis techniques and equipment for possible use in a follow-on version of the Fleet Satellite Monitoring System (FSM) presently in use at Naval Communications Stations to monitor GAPFILLER and FLTSAT operations.

C. SCOPE OF THIS PROJECT

This project consists basically of three parts. First, modification to existing circuits and addition of new circuits as necessary in order to achieve satisfactory operation of the Primary Receiver. Second, complete implementation of the Primary Receiver Control Panel and establish fundamental operating procedures for the control panel. Third, create software as necessary in order to allow remote operation of the Primary Receiver from its control panel. An additional part of step three is for the system to provide a means to use the AN/WSC-3 Receiver at frequencies other than those discrete values for which it was designed.

D. APPROACH

The SATCOM Signal Analyzer is constructed around an INTERDATA 7/32 minicomputer which provides system control. Other primary units directly related to this report are the
Primary Receiver and the Receiver Control Panel as shown in Figure 1. The problem of integrating these units was approached in three steps as previously outlined. These three steps are covered in detail in subsequent section of this report.
II. PRIMARY RECEIVER

A. GENERAL REVIEW

The Primary Receiver is a phase-locked loop receiver capable of extremely accurate carrier tracking of the output of UHF communications satellites. Switching within the receiver allows selection of one of five possible IF filter bandwidths and one of three possible phase-locked loops. Each of the phase-locked loops also is capable of operating in one of four possible loop filter bandwidths. The receiver can be operated in either the Normal or Squaring Loop mode. All of these switchable functions (IFBW, VCO, LFBW, N/SQ) can be selected at the front panel of the receiver or from the Receiver Control Panel via the INTERDATA 7/32 computer. The overall system block diagram and the Primary Receiver functional block diagrams are shown in Figures 1, 2 and 3 respectively. Figure 4 shows a front panel view of the receiver. The receiver design is covered in detail in References 12 and 13.

B. ADDITIONS AND MODIFICATIONS

In order to provide for remote operation of the receiver and to complete its operational tests in a manner such that design specifications were satisfied, certain circuit additions or modifications were necessary. New circuits or those requiring major modifications are covered in detail below. Minor circuit modifications are tabulated and/or discussed briefly as necessary.
Figure 2 - Primary Receiver, System Interconnections
Figure 4 - Primary Receiver Front Panel Layout
1. **Receiver Control Circuits**

The control circuits to provide the previously discussed switching functions and automatic operation were developed using SSI and MSI logic circuits. These circuits are implemented on two universal PC boards designated PLL11 and PLL12. The functions being controlled are VCO and Loop Filter Bandwidth, IF Bandwidth, Normal or Squaring Loop, Local or Remote Operation, Reset of VCO. The control boards also provide IN/OUT of lock status information, and control of the front panel indicator lights. The inputs to the control boards come from either the front panel (local operation) or from Control Panel C2 (remote operation). Schematic diagrams and component layouts for the control boards are shown in Figures 5 through 8. Tables I and II list the wiring connections for the boards.

2. **Manual Gain Control Circuit**

The MGC circuit is constructed on a piece of universal printed circuit board and mounted in the left rear corner of the receiver. The MGC potentiometer is mounted next to the board. The MGC manually sets the operating level of the IF Amp and provides a front panel meter indication of that level as a percentage of the amplifier's capability. The schematic and component layout for the MGC are shown in Figures 9 and 10. The indicator (L1) and 8 ohm resistors are discussed in other section (II-B-3 and 4) of this report.
Figure 7 - Control Board PLL-11 Component Layout
Figure 8 - Control Board PLL-12 Component Layout
<table>
<thead>
<tr>
<th>PIN</th>
<th>TO</th>
<th>PIN</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+5</td>
<td>A</td>
<td>+5</td>
</tr>
<tr>
<td>2</td>
<td>30 KHZ SW.</td>
<td>B</td>
<td>+28</td>
</tr>
<tr>
<td>3</td>
<td>10 KHZ SW.</td>
<td>C</td>
<td>PLL4 &quot;CON&quot;</td>
</tr>
<tr>
<td>4</td>
<td>3 KHZ SW.</td>
<td>D</td>
<td>N/C</td>
</tr>
<tr>
<td>5</td>
<td>1 KHZ SW.</td>
<td>E</td>
<td>J9p10, PLL12-3</td>
</tr>
<tr>
<td>6</td>
<td>.2 KHZ SW.</td>
<td>F</td>
<td>PLL12-4</td>
</tr>
<tr>
<td>7</td>
<td>REMOTE SW.</td>
<td>H</td>
<td>J9p32</td>
</tr>
<tr>
<td>8</td>
<td>LOCAL SW.</td>
<td>J</td>
<td>N/C</td>
</tr>
<tr>
<td>9</td>
<td>NORM SW.</td>
<td>K</td>
<td>PLL4 &quot;CD&quot;, J9p3, J9p9</td>
</tr>
<tr>
<td>10</td>
<td>SQ. SW.</td>
<td>L</td>
<td>PLL5, 6, 7</td>
</tr>
<tr>
<td>11</td>
<td>S1-1, S2-1</td>
<td>M</td>
<td>+28</td>
</tr>
<tr>
<td>12</td>
<td>S1-2, S2-2</td>
<td>N</td>
<td>SQ. LIGHT</td>
</tr>
<tr>
<td>13</td>
<td>S1-3, S2-3</td>
<td>P</td>
<td>NORM LIGHT</td>
</tr>
<tr>
<td>14</td>
<td>S3-2, S4-2</td>
<td>R</td>
<td>REMOTE LIGHT, J10p1</td>
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<tr>
<td>15</td>
<td>S3-3, S4-3</td>
<td>S</td>
<td>LOCAL LIGHT, J10p3</td>
</tr>
<tr>
<td>16</td>
<td>S3-1, S4-1</td>
<td>T</td>
<td>UNLOCK LIGHT, J10p5</td>
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<tr>
<td>17</td>
<td>N/C</td>
<td>U</td>
<td>LOCK LIGHT, J10p7</td>
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<tr>
<td>18</td>
<td>N/C</td>
<td>V</td>
<td>J9p16</td>
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<tr>
<td>19</td>
<td>N/C</td>
<td>W</td>
<td>J9p17</td>
</tr>
<tr>
<td>20</td>
<td>N/C</td>
<td>X</td>
<td>J9p18</td>
</tr>
<tr>
<td>21</td>
<td>N/C</td>
<td>Y</td>
<td>J9p19</td>
</tr>
<tr>
<td>22</td>
<td>GND</td>
<td>Z</td>
<td>+28, +5 RET</td>
</tr>
<tr>
<td>FROM</td>
<td>TO</td>
<td>FROM</td>
<td>TO</td>
</tr>
<tr>
<td>------</td>
<td>---------------------</td>
<td>------</td>
<td>---------------------</td>
</tr>
<tr>
<td>1</td>
<td>+5</td>
<td>A</td>
<td>+5</td>
</tr>
<tr>
<td>2</td>
<td>N/C</td>
<td>B</td>
<td>PLL5, 6, 7-K3</td>
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<tr>
<td>3</td>
<td>PLL11-E</td>
<td>C</td>
<td>VC02-3 LIGHT</td>
</tr>
<tr>
<td>4</td>
<td>PLL11-F</td>
<td>D</td>
<td>VC02-10 LIGHT</td>
</tr>
<tr>
<td>5</td>
<td>J9p35</td>
<td>E</td>
<td>VC02-30 LIGHT</td>
</tr>
<tr>
<td>6</td>
<td>J9p34</td>
<td>F</td>
<td>VC02-100 LIGHT</td>
</tr>
<tr>
<td>7</td>
<td>N/C</td>
<td>G</td>
<td>VC01-.3 LIGHT</td>
</tr>
<tr>
<td>8</td>
<td>VC01-.3/VC02-3/VC03-10</td>
<td>J</td>
<td>VC01-1 LIGHT</td>
</tr>
<tr>
<td>9</td>
<td>VC01-1/VC02-10/VC03-30</td>
<td>K</td>
<td>N/C</td>
</tr>
<tr>
<td>10</td>
<td>VC01-3/VC02-30/VC03-100</td>
<td>L</td>
<td>+28</td>
</tr>
<tr>
<td>11</td>
<td>VC01-10/VC02-100/VC03-300</td>
<td>M</td>
<td>VC01 3 LIGHT</td>
</tr>
<tr>
<td>12</td>
<td>ALL VC03</td>
<td>N</td>
<td>VC01 10 LIGHT</td>
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<td>13</td>
<td>ALL VC02</td>
<td>P</td>
<td>VC03 10 LIGHT</td>
</tr>
<tr>
<td>14</td>
<td>ALL VC01</td>
<td>R</td>
<td>PLL9 (S1)</td>
</tr>
<tr>
<td>15</td>
<td>N/C</td>
<td>S</td>
<td>PLL9 (S0)</td>
</tr>
<tr>
<td>16</td>
<td>N/C</td>
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<td>X</td>
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<td>J9p36</td>
<td>Y</td>
<td>PLL5, 6, 7-K2</td>
</tr>
<tr>
<td>22</td>
<td>GND</td>
<td>Z</td>
<td>GND</td>
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</table>
Figure 10 - MGC Board Component Layout
3. **Coaxial Switching**

As previously covered, the coaxial switch operation is handled by the control circuits. The indicators for IF bandwidth are operated through the coaxial switches as shown in Figure 11. The additional indicator (L1), which is physically on the MGC board, is added to show when the switching has taken place (i.e., if L1 is ON then S1, S2, S3, and S4 have switched to the appropriate position). This was done to eliminate any doubt about whether or not a switch was at fault when troubleshooting.

4. **Lamp Test Circuit**

A lamp test switch was installed on the front panel of A6 in order to monitor the indicators for failure. This switch has to do two things. First, it must interface with the existing IFBW coaxial switching and indicator circuit, and second, it must interface with the lamp drivers on the control boards. The circuit used to accomplish this is shown in Figure 12. Due to the current surge when testing all lamps, current limiting resistors were added to the 28 volt supply line. These resistors are physically located on the MGC board (R1, R2, R3). The steering diodes used with the IFBW switches are mounted on the respective switches.

5. **Additional Amplification**

Initial tests showed that the received signal level at the hard limiter was not sufficiently high to saturate the hard limiter. For this reason, another stage of amplification
Figure 11 - IF Bandwidth Coaxial Switching
was added at the IF level. The amplifier used is a Watkins-Johnson model number 6200-352 which provides an additional 28 db of gain. A second additional amplifier (12 db) was added in the RF group for the same reason.

6. **Splitter**

An Anzac THV-50 power splitter was added immediately following the first mixer in order to provide a second input path to the AN/WSC-3 Receiver. By properly processing any input signal, it can be converted for use on one of the WSC-3 channels. Thus, the WSC-3 can now be used to demodulate a signal which was originally not transmitted at one of the WSC-3 channel center frequencies.

7. **Minor Modifications**

Other minor modifications to the existing receiver circuits are tabulated in Table III. Tables IV and V list the pin connections for back panel plugs J9 and J10 respectively. These plugs provide the interconnections to control panel C2 and the Interdata computer. Figure 13 is a wiring diagram for the front panel.

8. **Alignment**

The LFBW and VCO alignment is outlined in Table VI.

C. **OPERATIONAL TESTS**

All switching functions and the ability to lock on and track a received signal were tested and found to be satisfactory. A test scheme was developed and used to verify the
actual bandwidth using the various loop filter and IF filter combinations. The results of the tests showed the actual bandwidth to be very near the selected bandwidth. A computer simulator was used to test the remote operation capability of the control circuits. Again the results of the test were satisfactory.

At this point the receiver was judged complete and operating as designed. Therefore, the project moved to step two, the Primary Receiver Control Panel (C2).
<table>
<thead>
<tr>
<th>PC BOARD</th>
<th>MINOR MODIFICATIONS</th>
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<tr>
<td>ALL</td>
<td>Add power supply filter capacitors as necessary.</td>
</tr>
<tr>
<td>PLL 1</td>
<td>Change R1 to 20K pot. for meter adjust.</td>
</tr>
<tr>
<td>PLL 2</td>
<td>Change R9 to 5K pot. for meter adjust. Change R3 to 4.7K, R4 to 39 and R5 to 1.8K due to design error.</td>
</tr>
<tr>
<td>PLL 3</td>
<td>Change R5 to 5K pot. for meter adjust. Change R3 to 4.7K, R4 to 39 and R5 to 1.8K due to design error. Remove R7 and replace with short.</td>
</tr>
<tr>
<td>PLL 5, 6, 7</td>
<td>Add power to Pin 13 of IC2.</td>
</tr>
<tr>
<td>PLL 9</td>
<td>GND enable on IC1. Change R1 to 1K and R2 to 510. Individually GND each VCO and bypass each VCO PS connection.</td>
</tr>
<tr>
<td>Front Panel</td>
<td>Change AUTO button to read REMOTE. Change MAN button to read LOCAL.</td>
</tr>
<tr>
<td>PLL 2, 3</td>
<td>Add .1 ufd capacitor between wiper arm of P1 and GND.</td>
</tr>
<tr>
<td>PIN</td>
<td>FROM</td>
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<tr>
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<td>1</td>
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<td>+ 5 RET</td>
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</tr>
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<td>8-24</td>
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TABLE VI - LOOP FILTER AND VCO ALIGNMENT PROCEDURES

LOOP FILTER ALIGNMENT (PLL 5, 6, 7)

1. Connect oscilloscope to the output terminals of the appropriate board (PLL 5, 6 or 7).
2. Place the loop filter board input switch in the 'SHORT' position.
3. Place the loop filter board integrating capacitor switch in the 'SHORT' position.
4. Observe oscilloscope and adjust P1 for a 0 vdc level at the output of the loop filter board.

VCO ALIGNMENT (PLL 9)

1. Short the input to the VCO to be aligned (VCO 1, 2, or 3) by shorting the output of the appropriate loop filter board (PLL 5, 6 or 7). DO NOT SHORT ACROSS R2 AT THE VCO INPUT.
2. While observing the HP frequency counter (immediately below the receiver) adjust the VCO rest frequency to 950 kHz. PLL 9 must be removed and turned upside down to make this adjustment.
III. RECEIVER CONTROL PANEL C-2

A. GENERAL

The receiver control panel (C2) is located in equipment rack 8 and is made up of fifty-four momentary pushbutton switches and indicators. Its purpose is to allow remote operation of the Primary Receiver (A6) from the operator's console. The control panel duplicates all of the receiver front panel controls and in addition it provides for selection of a satellite, channel number or center frequency, and mode of operation of the system. The panel layout is shown in Figures 14 and 15. Figure 16 is a wiring diagram for the panel.

B. CONTROL PANEL CIRCUIT BOARDS

There are two circuit boards associated with the control panel. They are the Matrix Board which establishes a unique address for each control panel switch and the Light Board which drives the control panel indicators. The general design concept for these is covered in Reference 11. The schematics for these circuits are shown in Figures 17 and 18. Figures 19 and 20 show the component layout and Tables VII and VIII the pin connection for the circuit boards. Figure 21 shows the switch addresses generated by the Matrix Board and Figure 22 identifies the associated indicator lamps.
**FREQUENCY PLAN**

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**LOOP BANDWIDTH**

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**LOCK**

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**VCO 2**

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**LOOP TYPE**

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**VCO 3**

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**AN/WSC-3**

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**OPTIONS**

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<th>ENT REQD</th>
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<table>
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Figure 15 - Control Panel C2 Layout
Figure 17 - Control Panel Matrix Board
Figure 18 - Control Panel Light Board
Figure 19 - Control Panel Matrix Board Component Layout
TABLE VII - MATRIX BOARD PIN CONNECTIONS

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<td>N/C</td>
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<td>D</td>
<td>SATNO</td>
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<td>E</td>
<td>SIN 040</td>
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<tr>
<td>F</td>
<td>CMD 070</td>
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<tr>
<td>H</td>
<td>N/C</td>
</tr>
<tr>
<td>J</td>
<td>N/C</td>
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<tr>
<td>K</td>
<td>N/C</td>
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<td>L</td>
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<td>M</td>
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<td>S</td>
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Opposite Side (Top)

1-18  Ground
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Opposite Side (Bottom)

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Ground
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<th>0110</th>
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<th>1001</th>
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**Figure 21 - Control Panel Switch Address Identification**
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</table>

Figure 22 – Control Panel Indicator Lamp Identification
C. CONTROL PANEL OPERATION

The purpose of control panel C2 is to provide a remote control location, at the SATCOM Signal Analyzer operator's console, for control of the Primary Receiver (A6). The control panel buttons are grouped into six categories with the following functions: (1) receiver action, (2) satellite frequency plan selection, (3) type of data to be entered, (4) numerical data entry, (5) options, and (6) operator information indicators.

1. Receiver Action Buttons

There are nineteen buttons in this category and their sole purpose is to duplicate the receiver front panel controls. This is done by providing the appropriate control data, via the computer, to PLL11 and PLL12 of the receiver.

2. Satellite Frequency Plan Selection

There are six buttons of this type whose purpose is to choose a predetermined frequency plan. Four of these buttons are functional, the other two are for future use only. The frequency plans currently in use are shown in Tables IX and X.

3. Data Entry Buttons

These three buttons specify what type of numerical data is about to be entered. They are used in conjunction with the Numerical Entry Buttons and have no real meaning if used alone. The possible data types are a channel number, frequency, or mode of operation.
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### TABLE X - FLTSAT FREQUENCY PLAN

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<td>317.245</td>
<td>244.145</td>
</tr>
<tr>
<td>11</td>
<td>A</td>
<td>317.055</td>
<td>243.955</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.155</td>
<td>244.055</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.255</td>
<td>244.155</td>
</tr>
</tbody>
</table>

**53**
<table>
<thead>
<tr>
<th>Channel</th>
<th>Plan</th>
<th>Uplink</th>
<th>Downlink</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>317.060</td>
<td>243.960</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.160</td>
<td>244.060</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.260</td>
<td>244.160</td>
</tr>
<tr>
<td>13</td>
<td>A</td>
<td>317.065</td>
<td>243.970</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.165</td>
<td>244.070</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.265</td>
<td>244.170</td>
</tr>
<tr>
<td>14</td>
<td>A</td>
<td>317.070</td>
<td>243.970</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.170</td>
<td>244.070</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.270</td>
<td>244.170</td>
</tr>
<tr>
<td>15</td>
<td>A</td>
<td>317.075</td>
<td>243.975</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.175</td>
<td>244.075</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.275</td>
<td>244.175</td>
</tr>
<tr>
<td>16</td>
<td>A</td>
<td>317.080</td>
<td>243.980</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.180</td>
<td>244.080</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.280</td>
<td>244.180</td>
</tr>
<tr>
<td>17</td>
<td>A</td>
<td>317.085</td>
<td>243.985</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.185</td>
<td>244.085</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.285</td>
<td>244.185</td>
</tr>
<tr>
<td>18</td>
<td>A</td>
<td>317.090</td>
<td>243.990</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.190</td>
<td>244.090</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.290</td>
<td>244.190</td>
</tr>
<tr>
<td>19</td>
<td>A</td>
<td>317.095</td>
<td>243.995</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.195</td>
<td>244.095</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.295</td>
<td>244.195</td>
</tr>
<tr>
<td>20</td>
<td>A</td>
<td>317.100</td>
<td>244.000</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.200</td>
<td>244.100</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.300</td>
<td>244.200</td>
</tr>
<tr>
<td>21</td>
<td>A</td>
<td>317.110</td>
<td>244.010</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>317.210</td>
<td>244.110</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>317.310</td>
<td>244.210</td>
</tr>
<tr>
<td>22</td>
<td>A</td>
<td>294.200</td>
<td>260.600</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>295.300</td>
<td>261.700</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>295.900</td>
<td>262.300</td>
</tr>
</tbody>
</table>
4. **Numerical Entry Buttons**

There are fifteen buttons in this group (includes decimal point, clear entry, enter, A and B). After the data type is specified, these buttons are used to enter the actual data.

5. **Option Buttons**

There were originally four option buttons on the panel to be used for "unforseen needs". These have all been used and function as the "Panel On Control", "Panel Off Control", "VCO Reset", and "Entry Required" indicator.

6. **Indicator Lamps**

In addition to the switches on the control panel, there are seven operator information indicators. These are used to prompt the operator to take some action or merely to provide him with some necessary information.

A detailed description of each button and indicator and its function is contained in Table XI.

D. **AN/WSC-3**

The source of signal input to the AN/WSC-3 Receiver (used in a different section of the Satellite Communications Monitoring System) is selected at the C2 panel. In the "NORMAL" case, the signal goes from antenna to RF group to WSC-3. This is done when the received signal is at one of the WSC-3 channel frequencies. If the received signal is not directly on a WSC-3 channel frequency, and the WSC-3 is to be used,
<table>
<thead>
<tr>
<th>Group</th>
<th>Name</th>
<th>Number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VC01-ALL</td>
<td>13-16</td>
<td>Send control data to A6 to select VCO and LFBW.</td>
</tr>
<tr>
<td>1</td>
<td>VC02-ALL</td>
<td>24-27</td>
<td>Light appropriate lamps on C2 and A6.</td>
</tr>
<tr>
<td>1</td>
<td>VC03-ALL</td>
<td>34-37</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>IFBW-ALL</td>
<td>38-42</td>
<td>Send control data to A6 to select IFBW. Light appropriate lamp on C2 and A6.</td>
</tr>
<tr>
<td>1</td>
<td>NORMAL</td>
<td>28</td>
<td>Send control data to A6 to select Loop Type. Light appropriate lamp on C2 and A6.</td>
</tr>
<tr>
<td>1</td>
<td>SQUARE</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GAP</td>
<td>00</td>
<td>Specify appropriate frequency plan and light the lamp on C2.</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>01</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>02</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>C</td>
<td>03</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>04</td>
<td>Not used.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>05</td>
<td>Not used.</td>
</tr>
<tr>
<td>3</td>
<td>CHAN</td>
<td>06</td>
<td>Specifies that subsequent numerical entry will be a channel number to be used with selected frequency plan. Light 'Entry Req'd' on C2.</td>
</tr>
<tr>
<td>3</td>
<td>CTR FREQ</td>
<td>07</td>
<td>Specifies that subsequent numerical entry will be a frequency in MHz. Light 'Entry Req'd' on C2.</td>
</tr>
<tr>
<td>3</td>
<td>MODE</td>
<td>08</td>
<td>Specifies that subsequent numerical entry will designate a preset mode of operation. Light 'Entry Req'd' on C2.</td>
</tr>
</tbody>
</table>

56
<table>
<thead>
<tr>
<th>Group</th>
<th>Name</th>
<th>Number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>All numbers</td>
<td>09-12</td>
<td>Load the value of the button in a register.</td>
</tr>
<tr>
<td></td>
<td>letters and decimal</td>
<td>17-23</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-31</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CLEAR ENTRY</td>
<td>32</td>
<td>Load zeros in the number register.</td>
</tr>
<tr>
<td>4</td>
<td>ENTER</td>
<td>33</td>
<td>Based on which Data Entry was pushed, act accordingly on the contents of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>the numerical entry register.</td>
</tr>
<tr>
<td>5</td>
<td>PANEL ON</td>
<td>43</td>
<td>Enable control panel C2. Light the lamp on C2.</td>
</tr>
<tr>
<td>5</td>
<td>PANEL OFF</td>
<td>44</td>
<td>Disable control panel C2. Light the lamp on C2.</td>
</tr>
<tr>
<td>5</td>
<td>VCO RESET</td>
<td>45</td>
<td>Send control data to A6 to short the VCO integrating capacitor.</td>
</tr>
<tr>
<td>6</td>
<td>ENTRY REQ'D</td>
<td>NA</td>
<td>Prompt operator that further entries are needed.</td>
</tr>
<tr>
<td>6</td>
<td>IN</td>
<td>NA</td>
<td>A6 locked on signal.</td>
</tr>
<tr>
<td>6</td>
<td>OUT</td>
<td>NA</td>
<td>A6 not locked on signal.</td>
</tr>
<tr>
<td>6</td>
<td>REMOTE</td>
<td>NA</td>
<td>A6 control at C2.</td>
</tr>
<tr>
<td>6</td>
<td>LOCAL</td>
<td>NA</td>
<td>A6 control at A6.</td>
</tr>
<tr>
<td>6</td>
<td>NORMAL</td>
<td>NA</td>
<td>Indicates source of input to AN/WSC-3.</td>
</tr>
<tr>
<td>6</td>
<td>OFFSET</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>
the signal must be converted to a usable frequency. This conversion is accomplished by the Primary Receiver local oscillator. Thus, in the "OFFSET" case, the received signal goes from antenna to RF group to down converter to up converter (receiver A6) to WSC-3. The properly converted signal can now be demodulated by the AN/WSC-3. Figure 23 shows a simplified block diagram of this system. Note that the WSC-3 OFFSET mode and normal operation of the Primary Receiver cannot occur simultaneously.

E. CONTROL PANEL TESTING

The Matrix Board generation of switch addresses, status, and interrupt signals was tested with satisfactory results. Future tests for proper operation should check the following: (1) Proper address (see Figure 21) for the depressed button is generated at IC3 and 4; (2) Status pulse is generated at IC16 pin 8 each time a button is pushed; (3) SATNO interrupt pulse is generated at IC16 pin 11 each time a button is pushed. Failure of any one of the above indicates improper operation of the Matrix Board and reference should be made to the troubleshooting guide in Table XII.

The Control Bus Test Panel (bottom of equipment rack 15) was used to test the Light Board. The test panel provided simulated computer data to the Light Board and all lighting tested satisfactory. Future tests using the Control Bus Test Panel should proceed as follows: (1) Strobe (up/down)
SCLRO; (2) Set in the address of the Light Board on data out switches; (3) Strobe ADRSO; (4) Set data out switches to 0100 0000; (5) Strobe CMD; (6) Use data out switches to set up lights (data out 0 corresponds to Light Board column 1) and DAO to clock the data to C2. In case of improper operation refer to troubleshooting guide Table XIII.

On completion of these tests, the project proceeded to step three, interfacing of equipment.
\[ F_{\text{out}} = F_{\text{rf}} - 180 + F_{\text{lo}} \]

\[ F_{\text{lo}} = 405.00 - F_{\text{rf}} \quad \text{(IF WSC-3 SET AT 225 MHz)} \]

Figure 23 - AN/WSC-3 OFFSET MODE
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address lines L-T not sweeping.</td>
<td>1. Button depressed.</td>
</tr>
<tr>
<td></td>
<td>2. Shorted switch or wiring.</td>
</tr>
<tr>
<td></td>
<td>3. Clock (IC14) stopped.</td>
</tr>
<tr>
<td></td>
<td>4. Check IC13p6. If clocking then problem limited to IC2, 3, 4. If not clocking check IC6, 7, 8, 9, 10, 11, 13.</td>
</tr>
<tr>
<td></td>
<td>5. +5 supply.</td>
</tr>
<tr>
<td>High order lines (R-T) not sweeping, but low order (L-P) OK.</td>
<td>IC1 and 3.</td>
</tr>
<tr>
<td>Low order lines (L-P) not sweeping, but high order (R-T) OK.</td>
<td>IC2 and 4.</td>
</tr>
<tr>
<td>No pulse generated at IC16p8 when button depressed.</td>
<td>1. IC9 and 16.</td>
</tr>
<tr>
<td></td>
<td>2. CMD 070 state must be low.</td>
</tr>
<tr>
<td></td>
<td>3. Address generating circuits.</td>
</tr>
<tr>
<td>No pulse generated at IC16p11 when button depressed.</td>
<td>1. IC8, 9, 12, 15, 16.</td>
</tr>
<tr>
<td></td>
<td>2. CMD 070 state must be low.</td>
</tr>
<tr>
<td></td>
<td>3. Address generating circuits.</td>
</tr>
<tr>
<td>Improper address being generated.</td>
<td>1. If high order error check IC1, 3, 5, 6.</td>
</tr>
<tr>
<td></td>
<td>2. If low order error check IC2, 4, 5, 6.</td>
</tr>
<tr>
<td>Depress button doesn't stop sweeping of address lines (L-T)</td>
<td>IC5, 6, 9, 10, 11, 13.</td>
</tr>
<tr>
<td>No clock pulse.</td>
<td>1. Loss of +5v</td>
</tr>
<tr>
<td></td>
<td>2. IC14.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Check</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>Lamp test inoperative.</td>
<td>Loss of 28 v supply.</td>
</tr>
<tr>
<td>Any single light out.</td>
<td>Lamp test for bad bulb.</td>
</tr>
<tr>
<td>One or more of the following lights out:</td>
<td></td>
</tr>
<tr>
<td>GAP, VC01-1.3, VC02-3, VC03-10, 0.2, PNLOM, NORM.</td>
<td>IC1, 2, 3, 4, 12</td>
</tr>
<tr>
<td>A, VC01-1, VC02-10, VC03-30, 1, PNLOFF, SQUARE.</td>
<td>IC1, 2, 3, 5, 13.</td>
</tr>
<tr>
<td>B, VC03-100, 3, VCO RESET.</td>
<td>IC1, 2, 3, 6, 14.</td>
</tr>
<tr>
<td>C, VC01-10, VC02-100, VC03-300, 10, ENTRY REQ'D.</td>
<td>IC1, 2, 3, 7, 15.</td>
</tr>
<tr>
<td>AUX 1, 30.</td>
<td>IC1, 2, 3, 8, 16.</td>
</tr>
<tr>
<td>AUX 2.</td>
<td>IC1, 2, 3, 9, 17.</td>
</tr>
<tr>
<td>All lights on.</td>
<td>+28 v to drivers grounded.</td>
</tr>
<tr>
<td>All lights off.</td>
<td>1. IC1, 2, 3, .</td>
</tr>
<tr>
<td></td>
<td>2. Loss of +5 v.</td>
</tr>
</tbody>
</table>
IV. SYSTEM INTEGRATION

A. GENERAL

With the Primary Receiver (A6), Control Panel (C2), and the associated cabling and hardware interfacing complete, the next step was to develop the necessary software to cause these units to work together through the INTERDATA 7/32 Computer.

The main concern of this report was the creation of the Control Panel Operating Program. This program was developed in FORTRAN and is contained in Appendix A of this report. The individual driver programs for each piece of equipment (Primary Receiver, Control Panel, and Local Oscillator) were developed separately and will therefore not be covered in detail in this report.

B. CONTROL PANEL TO COMPUTER

The Control Panel to Computer interface is handled by the driver program, PANELll, contained in reference 15. This driver performs two major functions. First, when a button on the control panel is pushed the driver reads the address generated by the Matrix Board. It then translates that address from its hexadecimal coded form (see Figure 21) to a decimal number to be used by the Control Panel Operating Program. Second, it performs the necessary logic to light the appropriate lamp on the control panel. The logic takes two forms: (1) if light X is on then light Y must be off,
and (2) only one light in rows A, B, and C can be on at any
given time. These steps set and clear the appropriate bits
in the lamp matrix (see Figure 22) and then the status of all
lamps is updated simultaneously. A simplified block diagram
of this is shown in Figure 24.

C. PRIMARY RECEIVER TO COMPUTER

The Primary Receiver to Computer interface is handled by
the driver programs PRCVRll and FLUKEll contained in reference
14.

The receiver driver (PRCVRll) supplies control data to
the receiver to determine selection of VCO and LFBW, IFBW,
Normal or Squaring Loop, and VCO Reset. The control data
pertaining to selection of these items is detailed in Table
XIV. Note that DATA OUT bits 1, 3, 5, and 7 apply to the VCO
and LFBW; bits 0, 2, and 4 apply to IFBW; bit 6 applies to
Normal or Squaring Loop. Additionally, this driver provides
status information to the computer about the receiver. It
provides status on "IN" or "OUT" of lock and "LOCAL" or
"REMOTE" operation for use by the Control Panel Operating
Program.

The local oscillator driver (FLUKEll) provides control
data to the receiver local oscillator (Fluke 6160B) to estab-
lish its frequency of operation.

A simplified block diagram of the Primary Receiver to
Computer information flow is shown in Figure 25.
Figure 24 - Control Panel to Computer Information Flow
<table>
<thead>
<tr>
<th>Select</th>
<th>Data Out Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>010</td>
</tr>
<tr>
<td>VC01</td>
<td>.3</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>VC02</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>VC03</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>300</td>
</tr>
</tbody>
</table>
### TABLE XIV - PRIMARY RECEIVER CONTROL DATA (con't)

#### IF BANDWIDTH

<table>
<thead>
<tr>
<th>Select</th>
<th>Data Out Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>000</td>
<td>020</td>
</tr>
<tr>
<td>.2 KHz</td>
<td>H</td>
</tr>
<tr>
<td>1 KHz</td>
<td>H</td>
</tr>
<tr>
<td>3 KHz</td>
<td>L</td>
</tr>
<tr>
<td>10 KHz</td>
<td>L</td>
</tr>
<tr>
<td>30 KHz</td>
<td>L</td>
</tr>
</tbody>
</table>

#### NORMAL/SQUARING LOOP

<table>
<thead>
<tr>
<th>Select</th>
<th>Data Out Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>060</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>L</td>
</tr>
<tr>
<td>Squaring</td>
<td>H</td>
</tr>
</tbody>
</table>

#### VCO RESET

Pulse Command Line 070
Figure 25 - Computer to Receiver Information Flow
D. CONTROL PANEL TO PRIMARY RECEIVER

The Control Panel to Receiver interface is handled by the Control Panel Operating Program (C20P) and the previously discussed equipment drivers (PANEL11, PRCVR11, and FLUKE11). This program was broken into two major sections. The first section was to provide a manual or "Mode 0" method of operation where the control panel duplicates the receiver front panel. The second section was to provide for multiple automatic modes of operation which preselect the receiver set-up, acquisition scheme, and method of data handling. These two sections were approached with the thought that an operable manual system could then be used to provide the preselected receiver set-up for the automatic modes. Thus, the basic program was created for the manual mode with provisions included for subsequent addition of the automatic modes as necessary.

The fundamental concept used in developing the program was that the control panel buttons could be categorized into the six groups listed in Table XI and a separate routine written to handle each of the groups. This idea is outlined in the simplified flow chart shown in Figure 26. Detailed flow charts for the entire program are shown in Figures 27-35. Each of the six main subsections as well as other aspects of the Control Panel Operating Program are discussed in detail below.
1. **Program Initialization and Access**

Initially there was only one means of accessing the C20P program; that was by pushing a button on C2. With the acquisition scheme added, there will be a second means of access, the IN/OUT of lock status of the receiver. For either of these to access the program, the receiver must be in the REMOTE mode of operation. The control panel button means of access (NBUT) must first pass a test for valid entry, and is then used in a computed GO TO statement to trigger the appropriate routine. The second method, the IN/OUT of lock status of the receiver, is used to access the acquisition scheme. This will be covered in more detail in a later section.

When the program is initialized, all flags are cleared and all lights turned off with the exception of the PANEL OFF light. Thus, the control panel is initialized in the OFF or LOCKED-OUT condition. The only button which can be used initially is the PANEL ON button.

2. **First Computer GO TO Statement**

Once initialized and running, the program can be accessed by any control panel button which passes the valid entry tests (see Figure 26). This button entry (NBUT) is then processed by the computed GO TO statement which determines the routine applicable to that button.

3. **Frequency Plan Routine**

Entry of one of the frequency plan buttons specifies
a column in the data matrix known as IFREQ. This button, used in conjunction with a channel number entry, will select a unique frequency (see Tables IX and X) in the IFREQ matrix. In addition to selecting the matrix column, this routine also lights the appropriate control panel lamp. See Figure 27.

4. **Receiver Action Button Routine**

These buttons pertain to selection of VCO, LFBW, and NORM/SQ loop. On entry of one of these buttons this routine will cause the appropriate control bit stream (from data array IDOT) to be sent to the Primary Receiver to cause a configuration change. A receiver action button entry is only allowed when in the Manual or Mode 0 condition. This routine also lights the appropriate lamp on control panel C2. See Figure 28.

5. **Data Entry Type Routine**

An entry of this type (CHAN, CTR FREQ, MODE) is used to SET/CLEAR flags and clear counters in preparation for handling the subsequent numerical entry. This routine also lights the ENTRY REQ'D lamp to remind the operator that a numerical entry is required. See Figure 29.

6. **Numerical Entry Routine**

These entries are used in conjunction with the DATA ENTRY TYPE buttons to specify the actual data to be entered. The actual data is stored in NMBR. NMBR can be a channel number, a frequency in megahertz, or a mode designation. This routine is also used to clear or zero NMBR (clear entry)
and to increment the decimal point counter (N) if a decimal entry is made. Numerical entries are only valid when preceded by a DATA ENTRY TYPE. Otherwise, they are ignored. There are no lights operated by this routine. See Figure 30.

7. Enter Routine

This routine is the heart of all data entries. The previously made entries to specify data type and numerical value can be thought of as "setting-up" for use of the ENTER button. This routine determines what type of data has been entered, exactly what the data value is, and what to do with the data. In the case of a channel or frequency entry the data is sent to the local oscillator driver. A mode entry is used to select the routine for the desired automatic mode by means of a computer GO TO. Additionally, if a channel or frequency entry is being made, and the system is in one of the automatic modes, this routine will be used to activate the appropriate acquisition scheme.

When in an automatic mode, entry of a channel number or frequency turns off the control panel when the routine has been completed. Since this is normally the last entry made at the control panel, this is done to prevent any subsequent accidental entries which might disrupt an operation in progress. More details on the automatic modes and acquisition are covered in a later section. The flow chart for this routine is shown in Figures 31, 32 and 33.
8. **Option Button Routines**

Each of the four option buttons has a separate routine. The PANEL ON routine merely turns off the PANEL OFF light and turns on the PANEL ON light. It also sets the PNLON flag. Likewise, the PANEL OFF routine clears the PNLON flag and handles the lights appropriately. The VCO RESET routine does two things. It sends a control data stream to the Primary Receiver to reset (zero) the VCO control voltage and it blinks the VCO RESET lamp on the control panel. The ENTRY REQ'D button is used as an indicator only. Pushing the button causes no noticeable action. The flowcharts for these routines are shown in Figure 34.

The routines detailed above completed the steps necessary to duplicate the receiver front panel operation at the control panel. Details concerning the automatic modes of operation and signal acquisition are covered in the following section.

E. **AUTOMATIC MODES AND SIGNAL ACQUISITION**

Selection of an automatic mode (a mode other than 0) causes the signal acquisition scheme to be brought into use also; therefore, these routines will be covered together.

1. As previously discussed in Section IV-D, the program allows for selection of various modes of operation. The term MODE, as used here, specifies a preset receiver operating set-up and a particular signal acquisition scheme. The number
of possible modes is unlimited; however, only three (modes 1, 2, and 33) have been included for demonstration purposes. See Table XV.

As shown in Figure 33, if Mode 1 or 2 (or any future value) is selected it is handled by a computed GO TO statement which initiates the appropriate routine. The preset routine will set the receiver steady-state VCO and LFBW, IFBW, Normal or Squaring Loop, and satellite frequency plan as well as lighting the appropriate lamps on the control panel. It also sets values for acquisition parameters pertaining to step-size (ISTEP), step-rate (IDLAY), and loop bandwidth. The operator must then enter the desired channel number or frequency at which time the acquisition routine will be initiated.

If Mode 33 is selected, the entry is handled by the Mode 33 routine. This routine turns off all control panel lamps associated with the Primary Receiver as it is no longer in use. The routine also sets a flag (Mode 33) in insure proper calculation of the local oscillator frequency for use with the AN/WSC-3.

It is anticipated that further automatic modes will be needed in the future. Their inclusion in the program requires only the following minor modifications: (1) Expand the "2ND Computer GO TO" to include the additional mode; and (2) Modify the test for illegal modes so that it will now allow the new mode. The routine for the new mode can now be inserted as a
## TABLE XV - AUTOMATIC MODES

<table>
<thead>
<tr>
<th>Mode No.</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VCO - 1</td>
</tr>
<tr>
<td></td>
<td>S/S LFBW - 3 Hz</td>
</tr>
<tr>
<td></td>
<td>ACQ. LFBW - 10 Hz</td>
</tr>
<tr>
<td></td>
<td>IFBW - 3 kHz</td>
</tr>
<tr>
<td></td>
<td>IDLAY - 2000</td>
</tr>
<tr>
<td></td>
<td>N/SQ - Squaring</td>
</tr>
<tr>
<td></td>
<td>Freq. Plan - GAP</td>
</tr>
<tr>
<td></td>
<td>ISTEP - 5 Hz</td>
</tr>
<tr>
<td>2</td>
<td>VCO - 2</td>
</tr>
<tr>
<td></td>
<td>S/S LFBW - 10 Hz</td>
</tr>
<tr>
<td></td>
<td>ACQ. LFBW - 100 Hz</td>
</tr>
<tr>
<td></td>
<td>IFBW - 1 kHz</td>
</tr>
<tr>
<td></td>
<td>IDLAY - 3000</td>
</tr>
<tr>
<td></td>
<td>N/SQ - Squaring</td>
</tr>
<tr>
<td></td>
<td>Freq. Plan - FLTSAT B</td>
</tr>
<tr>
<td></td>
<td>ISTEP - 50 Hz</td>
</tr>
<tr>
<td>33</td>
<td>Set LO for AN/WSC-3 use</td>
</tr>
<tr>
<td></td>
<td>Control Lights</td>
</tr>
<tr>
<td>99</td>
<td>Stop Program</td>
</tr>
</tbody>
</table>

**NOTE:**

S/S LFBW—Steady-state loop bandwidth  
VCO--------Voltage controlled oscillator  
ACQ. LFBW--Loop bandwidth during acquisition  
IFBW------Intermediate frequency bandwidth  
N/SQ-------Normal or squaring loop operation  
ISTEP------LO step size during acquisition  
IDLAY------Delay(MSEC) between steps during acquisition
block following the previously last automatic mode routine.

Future probable additional functions of the automatic mode will be to preset the data taking or count interval and local oscillator step rate when in acquisition. The automatic mode routine can also be used to select whether to plot data, store data, or both.

2. Signal Acquisition Routine

The purpose of this routine is to cause the receiver to search for a signal whenever one of the following conditions occurs: (1) A new channel number is selected; (2) A new center frequency is selected; (3) A previously "LOCKED-ON" signal is lost. This search is accomplished by first setting the receiver to a wider LFBW and then stepping the local oscillator through a given range around the selected frequency. Throughout the search, periodic sampling of the receiver IN/OUT status (ISTAT) is done to note when acquisition occurs.

If the search is completed without acquisition, the routine will cause the 'ENTRY REQD' light to blink five times, thereby notifying the operator. During the acquisition routine, the local oscillator will be stepped through the given range of searched frequencies ten times or until stopped either by locking on a signal or by operator interaction. The operator may cancel this search and end acquisition at anytime by making any button entry at the control panel. At this time, acquisition will not be restarted except through
the normal sequence of entries (i.e. a new channel number or center frequency is entered). If acquisition does occur, this routine will then cause the receiver to return to the desired steady-state LFBW for the selected mode.

A flowchart for the acquisition routine is shown in Figure 35. The step size (ISTEP) and step rate (IDLAY) used in the program were chosen for test purposes only and can be adjusted to suit operational conditions as necessary. The currently selected step size is 5 Hz for Mode 1 and 50 Hz for Mode 2. In the program these step sizes are specified in tenths of Hertz as are all of the local oscillator frequencies. The step rate (delay time between steps) currently in use is 2 seconds for Mode 1 and 3 seconds for Mode 2.

The search routine first increases the local oscillator frequency by going through 5 step-up and delay increments, then decreases the frequency by going through 10 step-down and delay increments, and then back up by 5 again returning to the original frequency. Thus, one search cycle requires 40-60 seconds. In operational use, search times will be much shorter.
Figure 26 - C2 Operating Program Flowchart
Figure 27 - Frequency Plan Routine
COMPUTED TO GO

MODE=0

SEND CNTRL DATA TO RCVR

LIGHT APPROPRIATE LAMP

A

Figure 28 - Receiver Action Routine
Figure 29 - Data Entry Routine
COMPUTED
GO TO

DATA
ENTRY SET

NO

A

SET
NMBR=0

A

SET
DECIMAL
FLAG

N = N + 1

A

CLEAR
ENTRY

NO

DECIMAL

NO

DECIMAL
FLAG SET

NO

GET BUTTON
VALUE
FROM DATA

LOAD VALUE
IN NMBR

A

Figure 30 - Number Entry Routine
COMPUTED GO TO

-chan

-mode 33

-get l.o. value from freq matrix

-l.o. to l.o. driver and stat

-95

-mode 0

-update flags and lights

Figure 31 - Enter Button Routine (CHAN)
Figure 32 - Enter Button Routine (CTR FREQ)
Figure 34 - Option Button Routines
GET IN/OUT
STATUS
FROM RCVR

LOCKED

SET
RCVR TO
ACQ. STATUS

LOCKED

SET
RCVR TO
S/S STATUS

DO L.O.
STEP-UP
LOOP

LO=LO+STEP

DELAY

LOCKED

INCREMENT
COUNTER(L)

BLINK ENTRY REQD LIGHT

DO L.O.
STEP-DOWN
LOOP

LO=LO-STEP

DELAY

L=10

Figure 35 - Acquisition Routine
V. DATA

A. GENERAL

In the future, the C20P program will also include a data
taking capability. That is, the ability to read the HP fre-
quency counter (A7) and transfer this data to either a dis-
play or storage device. Presently, when the program has com-
pleted handling an interrupt from either the receiver or con-
trol panel, it goes into a "wait" (Call KTLWAT) or dormant
state until the next interrupt occurs. When data taking is
added to the program, instead of returning to a dormant con-
dition on completion of handling an interrupt, the program
will go into a data taking loop. On subsequent interrupts,
it will discontinue data taking, handle the interrupt, and
return to data taking. The statements needed to accomplish
this sort of loop are already included in the C20P program as
comments (Call A6DATA and GO to 6).

B. DATA PROGRAMS

Appendix B of this report contains a copy of a subroutine
(A6DATA), currently being tested to handle the data taking
capability of the program, and a copy of the stand alone pro-
gram from which it was condensed (A6DAT). The called sub-
routines and the HP 9830A DATA LINK program are also in-
cluded in Appendix B. The DATA LINK program and subroutines
HPCMD and HPDATA are covered in reference 14.

The A6DATA subroutine requires interfacing the INTERDATA
7/32 computer with a Hewlett Packard model 9830A calculator. Timing problems were experienced in attempting to get these equipments to operate together. These timing problems, at present, preclude the possibility of adding the data taking feature to C20P. The HP 9830A is presently used to manage the IEEE 488 data bus through which the frequency counter provides its data. A modification to the INTERDATA 7/32, to be made in the near future, will allow it direct control of the IEEE 488 bus and eliminate the need for the HP calculator. Therefore, further efforts toward eliminating the current timing problems are considered inappropriate. However, when the appropriate subroutine is developed, it may be added to C20P by merely deleting the Call KTLWAT statement and adding the Call A6DATA and GO TO 6 statements.

Figure 35 shows a flowchart for the subroutine A6DATA.
GET DATA FROM FREQ COUNTER VIA HP 9830A

UPDATE STATUS DISPLAY

GET TIME VIA HP 9830A

UPDATE STATUS DISPLAY

RETURN TO C20P

Figure 35 - Data Taking Subroutine
VI. CONCLUSION

The necessary circuit modifications and additions to the Primary Receiver have been installed and tested and the receiver is operating as designed. The Primary Receiver Control Panel installation has been completed and a computer program developed to allow receiver operation from this control panel. The control panel operating program has been tested, debugged, and operationally demonstrated.

With the exception of the data taking capability, the integration of the Primary Receiver into the NAVPGSCOL SATCOM Signal Analyzer is complete.
APPENDIX A - C2 OPERATING PROGRAM (C20P)

********* C2 OPERATING PROGRAM *********

THIS PROGRAM INTERFACES THE C2 CONTROL PANEL WITH
THE A6 RECEIVER AND ITS L.O.

ADDRESS INTRPT
LOGICAL PNLO:N, DATENT, MODE0, DPT, MODE33
DIMENSION IDOT(32), NVAL(31), IFREQ(24, 4)
DATA IDOT/X'240', X'241', X'244', X'245', 7*X'000', X'210' ,
C X'211', X'214', X'215', X'300', X'302', 4*X'000', X'200',
C X'201', X'204', X'205', X'120', X'123', X'180', X'188',
C X'1A0', X'4C6', X'433'/
DATA NVAL/9*0, 7, 8, 9, 22, 4*0, 4, 5, 6, 23, 1, 2, 3, 7*7/
DATA IFREQ /988250000, 988500000, 988750000, 989300000,
C989250000, 989500000, 989750000, 990000000, 990250000,
C990500000, 990750000, 991000000, 991250000, 991500000,
C991750000, 992000000, 992250000, 992500000, 992750000,
C993000000, 993250000, 993500000, 1041500000, 1075500000,
C0, 1004500000, 1019500000, 1036500000, 1053500000,
C1069500000, 1034500000, 1153500000, 1168500000, 1182500000,
C1197500000, 939450000, 939550000, 939600000, 939650000,
C939700000, 939750000, 939800000, 939850000, 939900000,
C939950000, 940000000, 940100000, 1105000000, 0,
C1005500000, 1020500000, 1037500000, 1054500000, 1070500000,
C1085500000, 1154500000, 1169500000, 1183500000, 1198500000,
C940450000, 940550000, 940600000, 940650000, 940700000,
C940750000, 940800000, 940850000, 940900000, 940950000,
C941000000, 941100000, 1117000000, 0,
C1100500000, 1021500000, 1038500000, 1055500000,
C1107500000, 1036500000, 1155500000, 1170500000, 1184500000,
C1199500000, 941450000, 941500000, 941600000, 941650000,
C941700000, 941750000, 941800000, 941850000, 941900000,
C941950000, 942000000, 942100000, 1123000000/

ESTABLISH INITIAL CONDITIONS AND BRING PANEL UP
IN THE 'PANEL OFF' STATE.

INTRPT=A'1100'
CALL CNTSET
DEFAULTS ARE:
JFREQ=1
PNLO:N=.FALSE.
DATENT=.FALSE.
MODE0=.TRUE.
DPT=.FALSE.
NTYPE=0
MODE33=.FALSE.

DO 5 I=1, 47

92
CALL KTLWR(2,-1)

CONTINUE
CALL KTLWR(2,45)
CALL KTLON(2,INTRPT)
CALL KTLWAIT

WHEN DATA TAKING IS ADDED TO THIS PROGRAM, THE
FOLLOWING TWO STATEMENTS WILL PUT THE PROGRAM
IN A LOOP TO TAKE DATA AND UPDATE THE STATUS
DISPLAY WHILE WAITING FOR AN INTERRUPT

6 CALL A6DATA
GO TO 6

INTERRUPT ROUTINE

1100 CALL KTLRD(IUNIT,IVALUE)
IF(IUNIT.EQ.2) GO TO 15
IF(IUNIT.EQ.6) GO TO 400
CALL KTLRET

GET A BUTTON # / CHECK VALID ENTRY / GO TO ROUTINE

15 CALL KTLFF (6,INRPRT)
NBUT=IVALUE
IF(NBUT.EQ.44)PNLON=.TRUE.
IF(.NOT.PNLON)GO TO 10
IF(NBUT.GT.47 OR.NBUT.LT.1)GO TO 10

1ST COMPUTED GO TO

GO TO (20,30,40,50,10,10,60,60,70,70,70,70,70,80,80,80,80,80,80,80,80,80,80,80,80,100,110,115,10),NBUT

ROUTINE FOR FREQ PLAN BUTTONS

20 JFREQ=1
GO TO 200
30 JFREQ=2
GO TO 200
40 JFREQ=3
GO TO 200
50 JFREQ=4
GO TO 200

ROUTINE FOR DATA ENTRY BUTTONS
60  DATENT=.TRUE.
    DPT=.FALSE.
    N=0
    CALL KTLWR(2,47)
    NM3R=0
    NTYPE=NUT
    IF(NTYPE.NE.9)GO TO 10
    MODEO=.FALSE.
    MODE33=.FALSE.
    GO TO 10

ROUTINE FOR NUMBER ENTRY BUTTONS

70  IF(.NOT.DATENT)GO TO 10
    IF(NBUT.EQ.33)GO TO 73
    IF(NBUT.EQ.32)GO TO 72
    IF(DPT) N=N+1
    IVAL=NVAL(N3UT)
    NM3R=NM3R*10+IVAL
    GO TO 10
    DPT=.TRUE.
    GO TO 10
72  NM3R=0
    GO TO 10

ROUTINE FOR RCVR ACTION BUTTONS

80  IF(.NOT.MODEO)GO TO 10
    CALL KTLWR(6,10T(NBUT-13))
    GO TO 200

ROUTINE FOR 'ENTER' BUTTON

WHICH DATA ENTRY BUTTON PUSHED

90  IF(NTYPE.EQ.7)GO TO 94
    IF(NTYPE.EQ.8)GO TO 96
    IF(NTYPE.NE.9)GO TO 10
    MODE=NM3R
    IF(MODE.LT.0.OR.MODE.GT.99)GO TO 10
    IP1='Y'OF000000' 
    IP2='Y'43000000' 
    IP3='Y'40000000'

94
WRITE(3,900)IP1,IP2,IP3,M0DE
900 FORMAT(3A1,'MODE=',I2)
C
C SELECT THE MODE
C
IF(MODE.EQ.0)GO TO 91
IF(MODE.NE.99)GO TO 120
CALL KTLOFF(2,JUNK)
CALL KTLOFF(6,JUNK)
STOP
91 MODEO=.TRUE.
GO TO 97
C
C SELECT THE CHANNEL NUMBER
C
94 IF(NMBR.GT.23)GO TO 10
IF(NMBR.LT.0)GO TO 10
IF(.NOT.MODE33) LO = (405000000-IFREQ(NMBR+1,JFREQ)/10-150000000)*10
IF(.NOT.MODE33) LO = IFREQ(NMBR+1,JFREQ)
CALL KTLWR(8,LO)
IF(MODE33)LNKD N = 405000000-LO/10
IF(.NOT.MODE33) LNKDN = 150000000+LO/10
LNK1ST=L NKDN/10**6
LNK2ND=LNKD N-LNK1ST*100000
IP1=Y'0FQ00000'
IP2=Y'4300U000'
IP3=Y'48000000'
WRITE(3,940)IP1,IP2,IP3,NMBR,LNK1ST,LNK2ND
940 FORMAT(3A1,'CHAN='/I2,'CFREQ='/I3,'+',/I6)
95 IF(MODEO)GO TO 97
IF (MODE33) GO TO 951
C
C ***************ACQR******************************
C THIS ROUTINE IS TO CAUSE THE A6 RCVR TO GO INTO AN
C ACQUISITION LOOP WHENEVER CHAN/FREQ CHANGES ARE
C MADE OR THE SYSTEM DROPS OUT OF LOCK.
C
NOTE: KTLST(6,JUNK) HAS THE FOLLOWING VALUES
-1 ---- LOCAL/UNLOCKED
 4 ---- REMOTE/UNLOCKED
-1 ---- LOCAL/LOCKED
 0 ---- REMOTE/LOCKED
-1 INDICATES A6 NOT AVAIL. FOR AUTO MODES
C
BEGIN ACQ. SCHEME BY GOING TO APPROPRIATE ACQ. BW
C
$TRCE
IF (ISTAT.EQ.0) GO TO 565
CONTINUE
IF (M.EQ.1) GO TO 625
M=1
DO 620 K=1,10
CALL KTLWR (6,0)
CALL WAITMS(IDLAY)
ISTAT=KTLST(6,JUNK)
LO=LO-ISTEP
CALL KTLPND(IDUMY,INTPND)
IF(INTPND.EQ.1)GO TO 97
CALL KTLWR (8,LO)
IF (ISTAT.EQ.0) GO TO 565
CONTINUE
GO TO 601
C
C BLINK THE 'ENTRY REQD' LIGHT TO INDICATE
C SEARCH COMPLETE BUT NO SIGNAL FOUND.
C
625 DO 670 K=1,5
CALL KTLWR (2,47)
C
SNTRE
CALL WAITMS(200)
CALL KTLWR (2,-47)
CALL WAITMS(200)
CONTINUE
IF(L.LT.10)GO TO 600
C *************** END ACQR ************************
951 PNLON=.FALSE.
CALL KTLWR(2,-44)
CALL KTLWR(2,45)
GO TO 97
C
C SELECT THE CTR FREQ
C
C THERE IS SOME ARITH. IN THIS ROUTINE TO
C PREVENT OVERFLOW DUE TO LARGE VALUES
C
96 IF(N.LT.0.OR.N.GT.6) GO TO 10
NEXP=6-N
IF(NEXP.EQ.0)GO TO 962
DO 961 I=1,NEXP
NMBR=NMBR*10
CONTINUE
961 NMBR=NMBR*10
962 IF(MODE33) LO=(405000000-NMBR)*10
IF(.NOT.MODE33) LO=(NMBR-150000000)*10
CALL KTLWR (8,LO)
LNK1ST=NMBR/10**6
LNK2ND=NMBR-LNK1ST*1000000
IP1=Y'00000000'
IP2=Y'43000000'

IP3=Y'48000000'
WRITE(3,960)IP1,IP2,IP3,LNK1ST,LNK2ND
960 FORMAT(3A1,'CHAN=NA CFREQ=',I3,'.',I6)
GO TO 95
97 CALL KTLWR(2,-47)
98 NTYPE=0
DATENT=.FALSE.
GO TO 10
C

ROUTINE FOR PANEL ON
C
100 CALL KTLWR(2,-45)
GO TO 200
C

ROUTINE FOR PANEL OFF
C
110 PNLO= .FALSE.
CALL KTLWR(2,-44)
CALL KTLWR(2,45)
IF (.NOT.MODEO) CALL KTLON(6,INTRPT)
GO TO 10
C

VCO RESET ROUTINE
C
115 CALL KTLWR(6,0)
CALL KTLWR(2,46)
CALL WAITMS(200)
CALL KTLWR(2,-46)
GO TO 10
C

ROUTINES FOR MODES OTHER THAN 0
C
120 IF(MODE.EQ.33)GO TO 333
IF(MODE.GT.2)GO TO 10
C

2ND COMPUTED GO TO
C
GO TO (130,140), MODE
C

**** MODE 1 ******** VC01-3 *** IFBW-3 *** SQ ***
C
130 JFREQ=1
CALL KTLWR(6,ID0T(31))
CALL KTLWR(2,1)
CALL KTLWR(2,16)
CALL KTLWR(2,41)
CALL KTLWR(2,30)
ISTEP = 50
IDLAY = 2000
GO TO 98
C

**** MODE 2 ******** VC02-10 *** IFBW-1 *** SQ ***
C 140 JFREQ=3
   CALL KTLWR(6, IDOT(32))
   CALL KTLWR(2,3)
   CALL KTLWR(2,26)
   CALL KTLWR(2,40)
   CALL KTLWR(2,30)
   ISTEP = 500
   IDLAY = 3000
   GO TO 98
C
C *************** ADD NEW AUTO MODES HERE ***************
C
C LIGHT A LAMP (N9UT)
C
200 CALL KTLWR(2,N9UT)
   GO TO 10
C
C MODE33 --- WSC 3 OFFSET MODE
C
333 DO 335 I=14,43
   CALL KTLWR(2,-I)
335 CONTINUE
   MODE33=.TRUE.
   GO TO 98
10 CALL KTLR(2,INTRPT)
   CALL KTLRET
   END

98
KTL  PROG  CONTROL BUS I/O (FORTRAN-CALLABLE) - CC 5-16-78

*  *
R0  EQU  0
R1  EQU  1
R2  EQU  2
R3  EQU  3
R4  EQU  4
R5  EQU  5
R6  EQU  6
R7  EQU  7
R8  EQU  8
SP  EQU  11
RC  EQU  12
RE  EQU  14
RF  EQU  15

*  STACK EQUATES:
STACK  STRUC
SAVE  DS  64  REGISTER SAVE AREA
FCN   DS  1  SVC11 PARAMETER BLOCK
PUN   DS  1
STATUS DS  1
DEVADD DS  1
DATA  DS  4
SIXBLK DS  8  SVC6 PARAMETER BLOCK
SIXFCN DS  4
SIXSTAT DS  2
DS  12
DEVMNEM DS  4
DS  16
ENDS

UDL.TSKQ EQU 16  ADDRESS OF TASK QUEUE
UDL.TSKO EQU 112  TQSI OLD TSW SAVE LOC.
UDL.TSKN EQU 120  TQSI NEW TSW LOC.

ENTRY KTLPUN,KTLWR,KTLST,KTLPND
ENTRY KTLON,KTLOFF,KTLWAT
ENTRY KTLRD,KTLSIM
ENTRY KTLRD,KTLRET

*  *
TITLE SUBROUTINE ENTRY AND EXIT PROCEDURES

*  *
ENTER EQU *

SHI  RC,STACK  BUMP R12 STACK POINTER
STM  RO,SAVE(RC)  SAVE CALLER'S.Amount

99
LR SP, RC
ENTER2
LIS R0, 6
CH R0, 0(RF)
BNZ 0

STACK POINTER TO R11
LOOK AT NO. OF PARAMETERS
IF 2*(N+1) NOT = 6, CRASH

* * *
THERE MAY OR MAY NOT BE A HALFWORD FILLER
FOLLOWING THE NO.-OF-PARAMETERS HALFWORD:

NHI RF, X'FFFFC'
L R6, 4(RF)
L R4, 0(R6)
L R7, 8(RF)
L R5, 0(R7)
BR RE

MASK TO NEXT LOWER FULLWD
R6 HAS 1ST ADDRESS PASSED
R4 HAS UNIT NUMBER
R7 HAS 2ND ADDRESS PASSED
R5 HAS VALUE
RETURN TO MAIN ROUTINE

* * *
EXIT EQU *

LOCAL SUBROUTINE

ST R0, 4*RE(SP)
LM R0, SAVE(SP)
AHI RC, STACK
EXIT2 AIS RF, 12
NHI RF, X'FFFFC'
BR RF

STATUS --> CALLER'S R14
LOAD CALLER'S REGISTERS
POP STACK POINTER
BUMP RETURN ADDRESS
MASK TO NEXT LOWER FULLWD
RETURN TO CALLER OF KTL...

* * *
TITLE MAIN KTL ROUTINES, NON-INTERRUPT

KTLpun EQU *

BAL RE, ENTER
LIS R0, 0
BAL R8, SVC11
LB R1, DEVADD(SP)
ST R1, 0(R6)
B EXIT

PUN FCN
DO THE SVC11
LOAD THE RETURNED NO.
RETURN IT AS UNIT NO.
RETURN TO CALLER

* * *
KTLwr EQU *

BAL RE, ENTER
LIS R0, 1
BAL R8, SVC11
B EXIT

WRITE FCN
DO THE SVC11
RETURN TO CALLER

* * *
Ktlst EQU *

BAL RE, ENTER
LIS R0, 2
BAL R8, SVC11

STATUS FCN
DO THE SVC11

100
L R1,DATA(SP)    LOAD RETURNED VALUE
CHI RO,3         LOOK AT STATUS
BNZ STAT1        SKIP IF NOT OFF-LINE
LCS RO,1         RETURN STATUS -1 AS KTLST
LCS R1,1         RETURN -1 AS VALUE
STAT1 ST R1,0(R7) STORE DATA IN VALUE
B EXIT          RETURN TO CALLER

* KTLPND EQU *
BAL RE,ENTER     FCN = NO OF ENTRIES QUEUED
LH RO,TASKQ+2    RETURN AS VALUE, TOO
LR R1,RO         RETURN

* * *

TITLE MAIN KTL ROUTINES, INTERRUPT-RELATED

* ALIGN 4

TASKQ DLIST 10   DEFINE A TASK QUEUE
TQEN DC Y'08008000' ENABLE TQ ENTRY AND TRAP
DAC 0            LOCAL. COUNTER, => RETURN

* KTLPND EQU *
BAL RE,ENTER     TURN ON CONNECTION TO A DEVICE
L R1,UDDL.TSKQ   LOAD ADDR OF TASK QUEUE
BNZ HAVEQ       SKIP IF HAVE A QUEUE
LI R2,TASKQ      ADDR OF QUEUE DEFINED HERE
ST R2,UDDL.TSKQ  STORE IT AT QUEUE POINTER
LI RO,Y'A0000'  SIZE OF QUEUE
ST RO,0(R2)     STORE IT IN QUEUE
LIS RO,0         NUMBER NOW ON QUEUE
ST RO,4(R1)     STORE IT IN QUEUE
LI R2,Y'8000'   NEW TSW: ENABLE TQ ENTRY
ST R2,UDDL.TSKN  STORE AS TSW DURING INT.

* HAVEQ EQU *
LI R2,INTVEC     NOW HAVE VALID TASK QUEUE
ST R2,UDDL.TSKN+4 ADDRSS OF INT. HANDLER
ST R5,USRINT    STORE PTR TO INT. ROUTINE
LI R3,Y'C0008000' SAVE USER ROUTINE ADDR
BAL R8,SVC6      CONNECT SELF SVC6 FUNCTION

* SVC 9,TQEN     CONNECT TASK TO DEVICE
LIS RO,3         ENABLE TASK INTERRUPTS
B D011           ENABLE-INT. SVC11 FUNCTION

DO SVC11 TO ENABLE INT.
* KTLOFF EQU * TURN OFF CONNECTION TO DEVICE
* BAL RE,ENTER
LI R3,'Y'00000800'
BAL R8,SVC6 DISCONNECT SELF SVC6 FCN
* LIS R0,4 DISCONNECT TASK FROM DEV.
* BAL R8,SVC11
LR R0,R3
B EXIT
* KTLWat EQU * WAIT FOR TASK TRAP
* SVC 9,TSWait LOAD A WAITING TASK STATUS
* ALIGN 4 TSWait DC 'Y'88008000' ENABLE DEVICE-GENERATED
* QUEUE ENTRIES, SERVICE TRAPS, & WAIT
* KTLSim EQU * TITLE SUBROUTINES TO DO SVC 6 AND 11 CALLS
* BAL RE,ENTER
LIS R0,5 SIMULATE-INTERRUPT FCN
BAL R8,SVC11 DO THE SVC11
B EXIT RETURN TO CALLER
* DUMNo EQU * TABLE OF DUMMY DC3 NO'S
DB 9,0,1,9 AS FUNCTION OF PUN
DB 2,9,3,9
DB 9,9,4,9
DB 4,9
* ALIGN 2 SVC6 EQU * LOCAL SUBROUTINE
* LB R0,DUMNo(R4) LOAD DUMMY NO.
AI R0,'C'DUMO' FORM DUMMY NAME
ST R0,DEVMNEM(SP) STORE IT IN PARAM BLOCK
ST R3,SIXFCN(SP) STORE FUNCTION
SVC 6,SIXRLK(SP) DO SVC6 CONNECT/DISCONNECT
LH R3,SIXSTAT(SP) LOAD SVC6 STATUS
BR R8 RETURN
*
SVC11 EQU * LOCAL SUBROUTINE
*
STB RO, FCN(SP) STORE REQUESTED FUNCTION
ST3 R4, PUN(SP) STORE DEVICE NO.
ST R5, DATA(SP) STORE DATA
SVC 11, FCN(SP) DO THE SVC 11
LB RO, STATUS(SP) LOAD THE STATUS RETURNED
BR R8 RETURN

TITLE ROUTINES CALLED BY INTERRUPT HANDLERS
*
ALIGN 4
RSAVE DS 16*4 REGISTER STORAGE AREA,
FPSAVE DS 16*4 DURING INTERRUPT ROUTINE
* (WHICH IS NON-INTERRUPTABLE)
USRINT DS 4 STORAGE FOR USER'S VECTOR
*
INTVEC EQU * OS VECTORS TO HERE ON INT.
*
STM RO, RSAVE SAVE INTERRUPTEE'S REG
STM E RO, FPSAVE
*
THESE REGISTERS WILL BE RESTORED BY KTLRET
L RO, USRINT ADDRESS OF USER'S ROUTINE
BR RO GO TO USER, WHO CALLS:
*
KTLRD EQU * RETURN INPUT DATA:
*
LI RC, OWN SWITCH TO OWN STACK
BAL RE, ENTER
RTL R5, TASKQ POP PARAMETER FROM QUEUE
LR R4, R5
EXHR R4, R4
NHI R4, X'FF' MASK TO LOW BYTE
ST R4, 0(R6) STORE UNIT NO.
NHI R5, X'FF' MASK TO LOW BYTE
ST R5, 0(R7) STORE VALUE READ IN
LIS RO, 0 LOAD OK STATUS
B EXIT RETURN TO CALLER
*
KTLEN EQU *
*
BAL RE, ENTER ENABLE-INTERRUPTS FCN
LIS P0, 3 DO THE SVC11
BAL R8, SVC11 RETURN TO CALLER
*
KTLRET EQU * CALLED LAST BY INT. ROUTINE!

103
LM    RO, RSAVE
LME   RO, FPSAVE
SVC   9, UDL, TSKO

RELOAD INTERRUPTEE'S REG
AND TASK STATUS WORD

ALIGN 4
DS    580
OWN   DS    4
END       LOCAL STACK
          TOP OF STACK
C subroutine to delay the caller

C waitms has one calling parameter, the length of time,
C in milliseconds, that the caller's task is to be
delayed.

C waitms uses svc 2 to generate a true timed delay.

C
subroutine waitms(ms)
in te g er ms

ic =ms

$assem
st 11,param
svc 2,block
bs done
align 4
block db 0,11
param dcf 0
done equ *

$fort
end
APPENDIX B - DATA PROGRAMS

*************** A6DAT ***************
THIS PROGRAM IS TO HANDLE DATA FOR THE PRIMARY RECEIVER.

DIMENSION CNTIME(6)
DATA CNTIME /'?U2@G2', '?U2@G1', '?U2@G0', '?U2@G', '?U2@G=', '/
CNTIMES ARE /100S, 10S, 1S, 100MS, 10MS, 1MS/

INITIALIZE BUS AND COUNTER

CALL HPCMD(?'U2@8E2)
CALL WAIT

ENTER THE NM3R FOR THE DESIRED CNTIME

WRITE(5,5)
5 FORMAT ('ENTER CNTIME 1,2,3,4,5, OR 6)
READ (5,10)L
10 FORMAT (I1)

SET COUNTER TO DESIRED CNTIME

CALL HPCMD (CNTIME(L))
CALL WAIT

READ THE COUNTER

20 CALL HPCMD(?'U?R)
CALL WAIT
CALL HPDATA (CNT)
CALL WAIT

USE COUNTER VALUE TO CALCULATE SIGNAL FREQ
AND DISPLAY RESULT ON STAT.

THIS CALC. WILL CHANGE FOR EACH CNTIME DUE
to the returned valuf number of sig. digits.
current calc. is a dummy
\[
RF = CNT \times 200 \\
IP1 = Y'0F000000' \\
IP2 = Y'45000000' \\
IP3 = Y'40000000' \\
\text{WRITE} \ (3, 500) \ IP1, IP2, IP3, RF \\
500 \text{ FORMAT} \ (3A1, 'SIGNAL = ', F11.7)
\]

C C
C C
C C
C C
C C
C

\text{DELAY THEN READ COUNTER AND UPDATE DISPLAY}

\text{DO 505 I=1,500000}

505 \text{ CONTINUE}

\text{GO TO 20}

\text{END}
THE PURPOSE OF THIS SUBROUTINE IS TO INITIALIZE THE MAIN RECEIVER COUNTER.

THE SUBROUTINE IS UNDER FILE NAME CNTSET.FTN.

SUBROUTINE CNTSET
INTEGER CODE(4)
CODE(1)='?U2, '
CODE(2)='E8E1 '
CODE(3)='E260 '
CODE(4)=' '
CALL HPCMD(CODE)
CALL WAIT
RETURN
END
THE PURPOSE OF THIS SUBROUTINE IS TO READ THE MAIN RECEIVER COUNTER.

IT IS UNDER FILE NAME CNTDATA.FTN

SUBROUTINE CNTDATA(CNT)
INTEGER CODE(4)
CODE(1) = 'R5'
CODE(2) = '
CODE(3) = '
CODE(4) = '
CALL HPCMD(CODE)
CALL WAIT
CALL HPDATA(CNT)
CALL WAIT
RETURN
END
THIS SUBROUTINE READS THE TIME

IT IS UNDER FILE NAME TIME.FTN

SUBROUTINE TIME(T)
INTEGER CODE(4)
CODE(1)='?J5'
CODE(2)=1
CODE(3)=1
CODE(4)=1
CALL HPCMD(CODE)
CALL WAIT
CALL HPDATA(T)
CALL WAIT
RETURN
END
The purpose of this subroutine is to write commands to the main receiver counter to cause it to go to the desired count period.

The file name for this subroutine is CNTIME.FTN.

```
SUBROUTINE CNTIME(K)
INTEGER CODE(4)
CODE(1)='?U2,'
CODE(3)='
CODE(4)='
GO TO (10,20,30,40,50,60),K
GO TO 80
10 CODE(2)='G2'
GO TO 70
20 CODE(2)='G1'
GO TO 70
30 CODE(2)='G0'
GO TO 70
40 CODE(2)='G?'
GO TO 70
50 CODE(2)='G>'
GO TO 70
60 CODE(2)='G='
GO TO 70
70 CALL HPCMD(CODE)
CALL WAIT
80 RETURN
END
```
SUBROUTINE HPCMD TRANSFERS COMMANDS TO THE HP BUS THROUGH THE HP 9830.

SUBROUTINE HPCMD(CODE)
INTEGER CODE(4)
ITYPE='1'
100 WRITE(5,110) ITYPE, CODE
110 FORMAT(A1,4A4)
RETURN
END
SUBROUTINE HDATA READS DATA FROM THE BUS THROUGH THE HP 9830

SUBROUTINE HDATA(DATA)
INTEGER DATA(18)
ITYPE='3'
300 WRITE(5,310) ITYPE
310 FORMAT(A1)
320 READ(5,330) DATA
330 FORMAT(18A4)
RETURN
END
C
C
C
C
C
C

THIS SUBROUTINE CAUSES THE SYSTEM TO WAIT UNTIL THE HP 9830 HAS COMPLETED ITS TASK.

SUBROUTINE WAIT

40 READ(5,50) N
50 FORMAT(A1)

IF (N.EQ.'5') GO TO 70
GO TO 40

70 DO 100 I=1,5000
100 CONTINUE
RETURN
END
10 REM THE PURPOSE OF THIS PROGRAM IS TO ALLOW THE HP 9830
20 REM TO ACT AS A DATA LINK BETWEEN THE 7/32 AND THE IEEE
30 REM 488 BUS
40 REM DIMENSION THE STRING VARIABLES TO BE USED
50 DIM A$(72),B$(72),C$(72),D$(72),E$(72)
60 REM
70 REM SET UP THE SYSTEM FOR THE DATACOMM LINK
80 REM
90 SYSTEM 1,9600,8,NONE,ASY2,FD
100 EOT 15
110 TON 1
120 REM
130 REM INITIALIZE THE BUS
140 REM
150 CMD "?U.8*
160 FORMAT B
170 OUTPUT (13,160) 768;
180 CMD "?U"
190 FORMAT 3B
200 OUTPUT (13,190) 256,25,512;
210 REM
220 REM READ THE INTERDATA MT 7/32
230 REM
240 TREAD( 1,ASC)A$
250 REM
260 REM DETERMINE WHAT THE 7/32 WANTS TO DO
270 REM
280 B$=A$(1,1)
290 IF B$="1" THEN 360
300 IF B$="2" THEN 540
310 IF B$="3" THEN 620
320 GOTO 240
330 REM
340 REM ROUTINE FOR THE CMD
350 REM
360 A=POS(A$",",")
370 IF A=0 THEN 460
380 B=A-1
390 C$=A$(2,B)
400 C=A+1
410 S=LEN(A$)-1
420 D$=A$(0,S)
430 CMD C$,D$
440 TWRITE( 1,ASC)"5",15,
450 GOTO 240
460 S=LEN(A$)-1
470 C$=A$(2,S)
480 CMD C$
490 TWRITE(1,ASC)"5",15,
500 GOTO 240
510 REM
520 REM    ROUTINE TO CHECK THE BUS STATUS
530 REM
540 IF (STAT13=0) THEN 570
550 TWRITE(1,ASC)"0",15,
560 GOTO 240
570 TWRITE(1,ASC)"1",15,
580 GOTO 240
590 REM
600 REM    ROUTINE TO ENTER DATA FROM THE BUS
610 REM
620 ENTER (13,*)E$
630 WAIT 50
640 TWRITE(1,ASC)E$
645 WAIT 50
650 WAIT 50
660 TWRITE(1,ASC)"5"
670 GOTO 240
6-0 END
APPENDIX C - ACRONYMS AND MNEMONICS

This appendix contains a list of the acronyms and mnemonics used throughout this report and the appended programs.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>C2</td>
<td>Primary Receiver Control Panel</td>
</tr>
<tr>
<td>A6</td>
<td>Primary Receiver</td>
</tr>
<tr>
<td>A7</td>
<td>Frequency Counter</td>
</tr>
<tr>
<td>A8</td>
<td>Primary Receiver Local Oscillator</td>
</tr>
<tr>
<td>LFBW</td>
<td>Loop Filter Bandwidth</td>
</tr>
<tr>
<td>IFBW</td>
<td>Intermediate Frequency Bandwidth</td>
</tr>
<tr>
<td>VCO</td>
<td>Voltage Controlled Oscillator</td>
</tr>
<tr>
<td>S/S</td>
<td>Steady-State</td>
</tr>
<tr>
<td>N/SQ</td>
<td>Normal or Squaring</td>
</tr>
<tr>
<td>MGC</td>
<td>Manual Gain Control</td>
</tr>
<tr>
<td>PLL</td>
<td>Phase Locked Loop</td>
</tr>
<tr>
<td>C20P</td>
<td>Control Panel Operating Program</td>
</tr>
<tr>
<td>LO</td>
<td>Local Oscillator</td>
</tr>
<tr>
<td>PNLOON</td>
<td>Panel On</td>
</tr>
<tr>
<td>PNLOFF</td>
<td>Panel Off</td>
</tr>
<tr>
<td>DATENT</td>
<td>Data Entry</td>
</tr>
<tr>
<td>DPT</td>
<td>Decimal Point</td>
</tr>
<tr>
<td>IDOT</td>
<td>Program Data for Receiver Control</td>
</tr>
<tr>
<td>NVAL</td>
<td>Program Data for Numeral Button Values</td>
</tr>
<tr>
<td>IFREQ</td>
<td>Program Data for Satellite Frequencies</td>
</tr>
<tr>
<td>JFREQ</td>
<td>Variable to Specify a Satellite</td>
</tr>
<tr>
<td>NTYPE</td>
<td>Variable to Specify a Data Entry Button</td>
</tr>
<tr>
<td>NBUT</td>
<td>Variable to Specify a Button Number</td>
</tr>
<tr>
<td>NMBR</td>
<td>Variable to Specify a Number Entry</td>
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<td>CHAN</td>
<td>Channel</td>
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<tr>
<td>CFREQ</td>
<td>Center Frequency</td>
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<tr>
<td>ISTAT</td>
<td>Variable to Describe Receiver Status (IN/OUT of LOCK)</td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
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<td>--------------------------------------------------</td>
</tr>
<tr>
<td>ISTEP</td>
<td>Variable to Specify LO Step Size in Acquisition</td>
</tr>
<tr>
<td>IP1, IP2, IP3</td>
<td>Variables to Position Display on CRT</td>
</tr>
<tr>
<td>CNT</td>
<td>Variable for Frequency Counter Reading</td>
</tr>
<tr>
<td>T</td>
<td>Variable for Time</td>
</tr>
<tr>
<td>STAT</td>
<td>Display CRT at Operator's Console</td>
</tr>
<tr>
<td>CNTIME</td>
<td>Gating Time for Frequency Counter</td>
</tr>
<tr>
<td>CODE()</td>
<td>ASCII Variable to Control Frequency Counter</td>
</tr>
<tr>
<td>IDLAY</td>
<td>Variable to Specify LO Step Delays During</td>
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<tr>
<td></td>
<td>Acquisition</td>
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LIST OF REFERENCES


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<th>6. Professor John E. Ohlson</th>
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<td>Naval Security Group</td>
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<td>3810 Nebraska Avenue, N.W.</td>
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<tbody>
<tr>
<td>(Attn: Robert S. Trible, 0252)</td>
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<tr>
<td>Naval Electronic Systems Engineering Activity (NESEA)</td>
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