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GDC-AWV70-001

MEASUREMENT OF RADIO FREQUENCY NOISE IN URBAN, SUBURBAN, AND RURAL AREAS

by

A. H. Mills

CONVAIR DIVISION OF GENERAL DYNAMICS

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA Lewis Research Center
Contract NAS3-11531
G. Anzic, Project Manager

GENERAL DYNAMICS
Convair Division

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FINAL REPORT

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P.O. Box 1128
San Diego, California 92112

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December 1970

Contract NAS3-11531

NASA Lewis Research Center
Cleveland, Ohio
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CONVAIR DIVISION OF GENERAL DYNAMICS
San Diego, California

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MEASUREMENT OF RADIO FREQUENCY NOISE IN URBAN, SUBURBAN, AND RURAL AREAS

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A. H. Mills

ABSTRACT

Measurements of radio frequency noise were made in the urban, suburban, and rural areas of Akron, Ohio at ground level and from the air. Characteristics of 300-MHz, 1-GHz, and 3-GHz noise data were recorded using specialized instrumentation systems developed for this application. The measurements were during various time periods of the day and at various locations about the city of Akron.

SUMMARY

The objectives of this contract were to characterize the indigenous radio frequency (RF) noise in a city as a function of several parameters (including time of day, location within the city, population density, and RF frequency) and to find a correlation between the noise measured from the air and that measured at the ground level. Measurements of RF noise were made in urban, suburban, and rural areas about the city of Akron, Ohio using special instrumentation systems. Noise-measuring systems assembled under a previous contract were modified for use in this survey. The systems consist of low-noise, wide-bandwidth receivers operating at 300 MHz, 1 GHz, and 3 GHz integrated with a data and recording system that processes the received interference. Detailed descriptions of the antenna and receiving subsystem, the logic and data processing subsystem, the monitoring subsystem, and the data recording subsystem are included in this report.

Following system modifications, calibration and testing were accomplished to evaluate system performance. The survey was planned and field tests were conducted in San Diego prior to the measurements in Akron. During the Akron survey, interference was measured at five ground locations as well as from the air. Airborne measurements were made using a DC-3 aircraft flying at 2500 feet (0.76 km) above the surface with directional antennas mounted beneath the fuselage. Measurements were made during the heavy traffic period of the day, during midday, and during the early evening.

The measurements were made at Akron in June 1970. Data was recorded on magnetic tapes, which were delivered to the NASA Lewis Research Center for post-measurement analysis, reduction, and presentation. Preliminary results of the data analysis are included in this report.

SECTION 1

INTRODUCTION

Increased utilization of electrical and electronic devices for man's well being and security has also increased the amount of undesired electromagnetic energy in the airways. This radio frequency (RF) interference is characteristically impulsive in form and random in occurrence and originates from such common sources as automobile ignition systems, high voltage transmission lines, electrical power generating stations, and electrical appliances and machinery. Other not-so-common sources of indigenous noise include gaseous discharge devices, ac heating equipment, and switching devices.

Noise in the signal channel of any communication system is a significant problem. The cost of decreasing noise effects in a system can be enormous since the noise affects the required effective radiated power of the transmitter, the sensitivity of the receiver, and the gain of the receiving antenna. Parameters affecting a system's output signal-to-noise ratio can be accurately and precisely specified except for the indigenous noise contributions to the antenna temperature.

Adequate data is not available to characterize the indigenous electromagnetic noise environment of a city. Considerable data has been collected over the past 50 years; however, it is of very limited value. The data on RF noise levels comes from spotty measurements widely separated in frequency, time, and place. Often questions are left unanswered concerning the measurement bandwidth, the antennas used, and the location and operation of the measurement equipment.

The type of measurement to be made depends on how the data is to be used. For indigenous RF noise, the data is needed in assessing the susceptibility of communication systems to RF noise and in designing new systems. Standard electromagnetic interference (EMI) meters, often used to collect noise data by measuring the root mean square (RMS), peak, or quasipeak value of the interference, do not provide sufficient data to adequately characterize the noise. Indigenous noise can be better characterized by providing a statistical description. A measurement of the RMS value, the amplitude-probability distribution, and the amplitude frequency-of-occurrence distribution characterize the noise to an extent that the data is more useful.

Under Contract NAS3-9714, "Measurement and Analysis of Radio Frequency Noise in Urban, Suburban, and Rural Areas," Convair engaged in a program to measure indigenous noise during 1967 and 1968. Two instrumentation systems were assembled and a survey was planned and conducted in Phoenix, Arizona. Noise measurements were made from the air and from the ground. The data recorded on magnetic tape was reduced and analyzed at the Lewis Research Center. Report NASA CR-72490 (GDC-AWV68-001), Measurement and Analysis of Radio Frequency Noise in Urban, Suburban, and Rural Areas, dated 1 February 1969 describes this program and presents the initial results of the data analyzed. This program showed that the quantity of data recorded was far greater than could be used or was needed. In several areas, the quality of the data required upgrading. Increasing the measuring system capability in some areas was also needed to conduct a more meaningful survey.

Attempts were made to correct the shortcomings of the Phoenix survey in this effort under Contract NAS3-11531. Modifications and additions were made to the measuring systems to ensure higher quality of data. The systems were calibrated and tested prior to performing the survey to ensure that the instrumentation was functioning properly. The survey was conducted during June 1970 in Akron, Ohio. Since Akron is a different type of city than Phoenix, a different type of RF noise environment was expected. Phoenix is a relatively new city, quite spread out and with light industry. Akron is a much older city with heavy industry.

The emphasis of this report is on the tasks that were accomplished and a description of the noise measuring systems. Preliminary results of the data analysis performed at Lewis Research Center are included.

SECTION 2

PROGRAM OBJECTIVES

The objectives of this contract and of the overall program to measure and analyze indigenous electromagnetic noise in urban, suburban, and rural areas are:

a. Ascertain noise levels in the VHF and UHF frequency bands in urban, suburban, and rural areas as a function of geographical size, population density, location, ground antenna pointing angle, and radio frequency. The noise levels are to be determined with sufficient accuracy to enable the establishment of field strengths necessary for satellite-to-ground television and voice radio reception.

b. Determine the correlation between air and ground surveys and other available data.

c. Establish a method for determining RF received noise from air survey results.

Data has now been collected in Cleveland, Phoenix, and Akron to find differences in the noise environment of different types of cities. Since it is much faster and more economical to collect the data in an air survey, a primary goal of the program has been to find the information necessary to predict ground noise characteristics from air survey results.

The program to accomplish the objectives has encompassed several phases. Personnel at Lewis Research Center made some preliminary measurements and analysis of noise in the Cleveland area prior to letting Contract NAS3-9714. Data on the Phoenix noise environment measured by Convair was analyzed at Lewis Research Center prior to commencing work under Contract NAS3-11531. In the latter contract, Convair was responsible for collecting data in Akron and delivering it to Lewis Research Center for analysis and presentation.

SECTION 3

TASK DESCRIPTION

This section describes the tasks to be accomplished under Contract NAS3-11531. The four major areas of work included:

a. System modification.

b. Calibration and testing.

c. San Diego field tests.

d. The general survey.

These tasks were accomplished in sequence and the completion of each was essential in fulfilling the contractural requirement of collecting data on the characteristics of the RF noise environment in Akron. Each task is described in detail in the following paragraphs.

3.1 SYSTEM MODIFICATIONS

Two RF noise measuring instrumentation systems were assembled under Contract NAS3-9714 and were used to measure RF noise characteristics in Phoenix, Arizona in May 1968. One system was installed in a DC-3 aircraft for measurements from the air while flying over the city. The second system was installed in a truck-mounted shielded enclosure. Experience from the Phoenix survey indicated several changes to improve the quality of the data.

The three linearly polarized receiving antennas on the ground RF noise measuring equipment were removed from the system. Since Contract NAS3-9714 results indicate that further information about the polarization of incoming noise signals is not needed, the airborne and ground systems require only circularly polarized antennas. The ground antenna assembly was also modified to permit varying only the azimuthal direction of the antennas and to fix the elevation pointing angle on the horizon.

Four-pole coaxial switches were installed in the front end of each system. These switches permit the input of each receiving-system channel to be connected to the antennas, a calibrated signal source, or a 50-Ω termination.

The parametric amplifiers, which provide low-noise preamplification of the 1 GHz and 3 GHz signals, were retuned to improve their stability. Ten-turn tuning potentiometers were installed in the ground system parametric amplifier control chassis.

Additional shielding and filtering were incorporated into each system to ensure that signals outside the receiving system passbands did not influence the data being measured. In each system, a shield braid was installed around the power and control cables between the parametric amplifiers and their power supplies. In the ground system, a shield braid was installed around all of the power and control leads that went to the RF box at the top of the antenna tower. Heliax RF transmission line was used in the ground system between the antennas and the RF box, as the 3-GHz local oscillator line, and to carry the 60-MHz IF signal from the RF box to the shielded enclosure. A new RF box was constructed to provide additional shielding of the receiving system's front end.

Five-section, 3-db bandwidth bandpass filters were installed in front of the 60-MHz IF amplifier to sharpen the skirts on the passband. This decreases the effect of high-level signals just outside of the passband on the detector output. New IF amplifiers to permit gain control of each frequency channel were installed. These amplifiers incorporated a linear detector.

There were three areas of modification in the data handling portion of the system. First, logging amplifiers were installed following the average envelope and RMS amplifiers. These amplifiers permit better resolution of low-level detector outputs by providing a linear variation in their output with a logarithmic variation in input power. Second, the number of level comparators and associated integrators were reduced from 10 to 6. Modifications were incorporated to permit automatic switching of the comparator reference voltages when the system is switched from one RF band to another. Finally, the integrators, which sum the amount of time and the number of times the comparators are turned on, were modified to permit more accurate zero and drift adjustments.

Code generators were incorporated into each system to permit visual position identification on the data tapes. In the ground system, the position code identifies the number of the ground site at which measurements are being made and the time the aircraft passes overhead (on simultaneous air and ground measurements). In the airborne system, the position code identifies the number of the flight path, the start and end times of each flight path, and the time the aircraft passes over preselected landmarks.

Both systems were modified to permit real-time monitoring of system performance and the outputs. A patch panel permits connecting the monitoring devices to any of the 19 data output lines. Signals can be monitored with an oscilloscope, a 2-channel pen recorder, or with a 12-channel oscillographic recorder. An electronic counter was also provided to measure the frequency of repetitive data signals and VCO outputs.

Each system was modified to include a time code generator. This provides a clock signal for system timing and an IRIG-B time code for recording on the data tape. New voltage-controlled oscillators were installed in each system.

Distance measuring equipment (DME) was installed as part of the airborne system to measure the distance from the aircraft to a local VORTAC station. Integrating the DME into the noise measuring system requires converting a pulse (whose width is proportional to the range) to a serial binary code output for recording. Circuit block diagrams of the system were prepared. Section 4 presents a detailed description of the modified systems.

3.2 CALIBRATION AND TESTING

After the RF noise measuring systems were modified, specific measurements were made to evaluate their performance. Procedures to follow in conducting these tests were required. The radiation patterns of each of the three antennas of the ground system and the gains relative to isotropic radiators were to be measured.

Noise figure measurements were required on each of the three RF channels of each system. The video detector output voltage and the RMS and average voltage-controlled oscillator (VCO) output frequencies were to be measured as functions of the input power levels.

The response of the system to a noise source was required so the proper ranges could be set up for the data integrators. An automotive ignition system was used as the noise source, with the antenna positioned to pick up the interference. Section 5.1 presents the results of these measurements.

3.3 SAN DIEGO FIELD TESTS

The third major task under this contract required conducting measurements of RF indigenous noise with both measuring systems in the San Diego area. The purpose of these tests was to evaluate the performance of the system while actually collecting data on the noise environment. Procedures were required for these tests. Section 5.2 describes these tests in more detail.

3.4 GENERAL SURVEY

The general survey was to be conducted in Akron, Ohio. Measurements of indigenous RF noise were to be made from the air as well as from the ground. Procedures and checklists were required to be prepared for this survey.

Prior to starting the general survey, preliminary checks and calibration of the systems were performed in Akron. The purpose was to check the systems to ensure that they had not been damaged or changed during shipment. A secondary purpose was to see if the gains and levels set during the field tests were applicable for the measurements in Akron and, if not, to make the necessary adjustments.

The general survey of indigenous electromagnetic noise in Akron required measurements while flying between 1000 and 4000 feet (0.3 and 1.2 km) above the surface over five survey paths. Three of the paths were parallel and two were at right angles to the other three. Two paths crossed over the major urban center and all paths were extended to the rural outskirts or sparsely populated surrounding regions. The flight duration, time of day, altitude, path, weather conditions, frequencies, ground temperature, cloud cover, and ground visibility and conditions were recorded during each flight along with photographs of the area being surveyed.

The general ground survey required measurements at five ground locations along the center flight path and the path normal to it. Three ground locations were selected before the survey, while the last two were selected after results of the first air survey measurements were reviewed. It was required that the measurements be made with the antennas pointing at the horizon in the direction of the highest local noise and in the direction opposite to it. Antennas were raised 3 to 10 feet (0.9 to 3.0 meters) above the average roof height of the area with visible sighting from the antenna height for at least 1/8 mile (0.2 km) except at the city center. Required records included time of day, cloud cover, visibility, and ground conditions. Near-field noise sources were avoided where possible.

Ground and air measurements were required during the traffic rush period (0630 to 0830 and/or 1600 to 1800) and during the midday period (any two-hour period between 1000 and 1500). During these air measurements, simultaneous measurements were to be made from the ground. Air measurements were also made during the early evening period (2000 to 2200). Measurements were not made on Saturdays, Sundays, or holidays. It was required that during the measurements there be no precipatation, a minimum cloud cover of 2000 feet (0.6 km) above the flight altitude, and five miles (8.0 km) of visibility. Section 6 describes the general survey.

SECTION 4

SYSTEM DESCRIPTION

The noise measuring systems were designed to measure characteristics of the noise over a bandwidth of 2.5 MHz at or near 300 MHz, 1 GHz, and 3 GHz. Noise data and certain auxiliary information were recorded on magnetic tape for post-measurement computer data analysis. The systems consisted of an antenna and receiving subsystem, a logic and data processing subsystem, a monitoring subsystem, and a data recording subsystem. Figure 4-1 is a block diagram of the noise-measuring system; Figure 4-2 shows the flow of data and signals within the system.

The nearly identical systems were used to measure noise data. One system was installed in the vehicle for ground measurements, with the antennas mounted at the

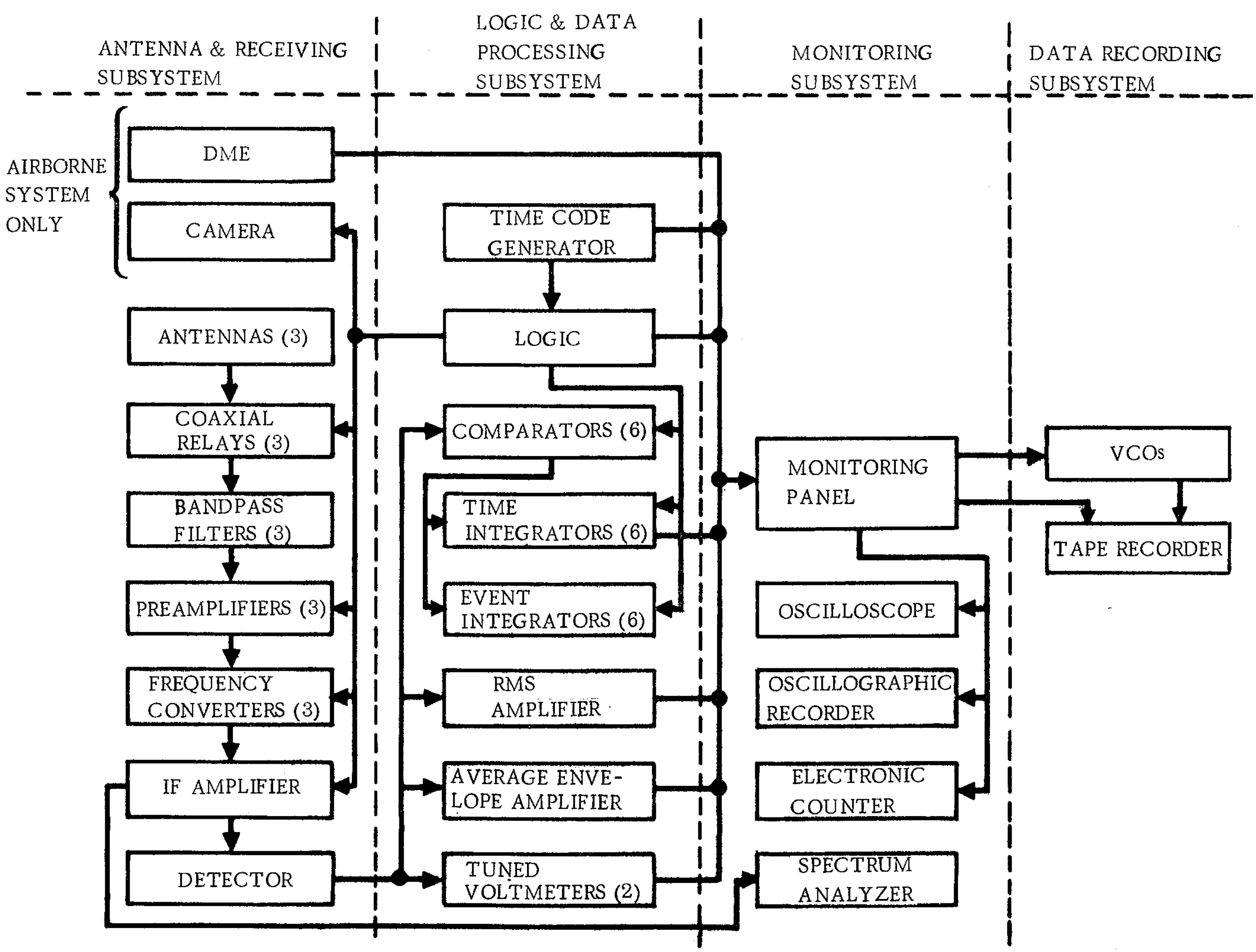


Figure 4-1. Noise-Measuring System

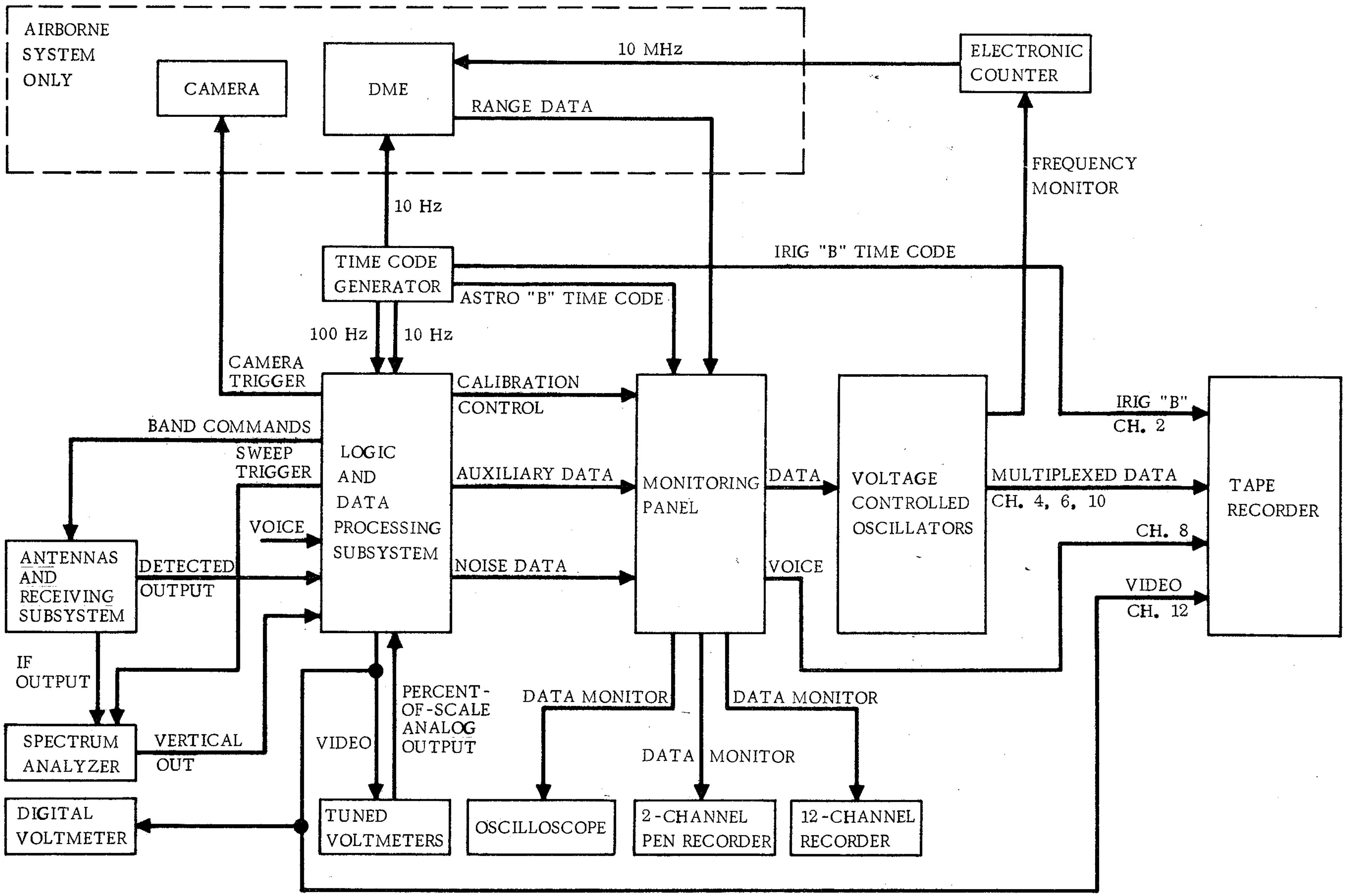


Figure 4-2. Data and Signal Flow within the System

top of a 40-foot (12.2-meter) tower as shown in Figure 4-3. The second system was installed in the DC-3 shown in Figure 4-4 for airborne measurements, with the antennas mounted beneath the fuselage. Except for the camera in the airborne system and the antennas on both systems, all equipment was rack-mounted. Figures 4-5 and 4-6 show equipment arrangement for the ground and airborne systems, respectively.

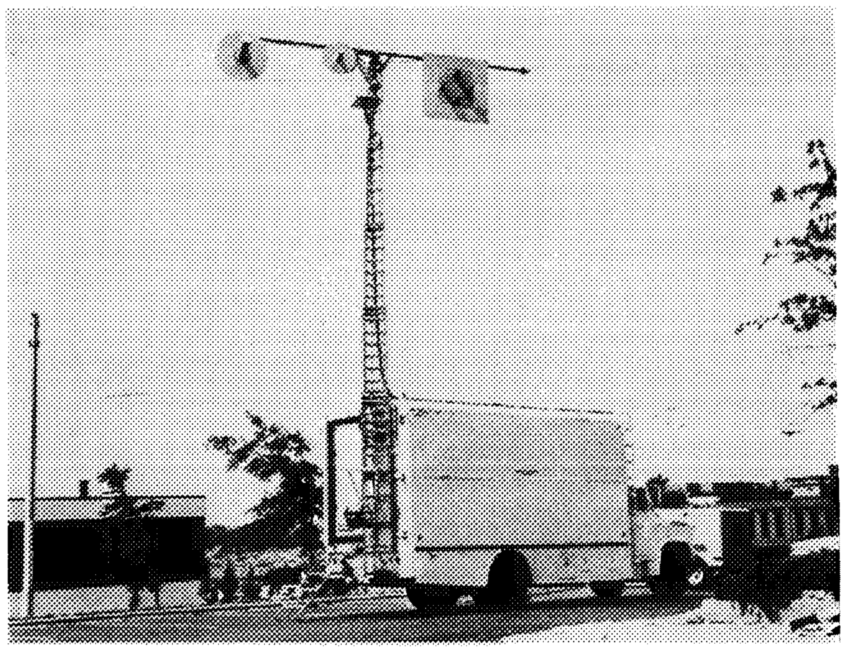


Figure 4-3. Ground Measuring System Installed in Truck-Mounted Shielded Enclosure

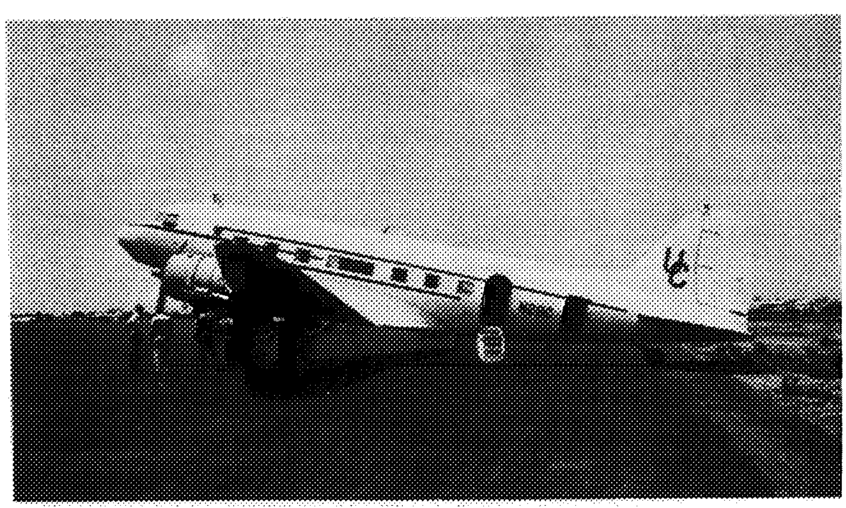


Figure 4-4. DC-3 Used for Airborne Noise Measurements

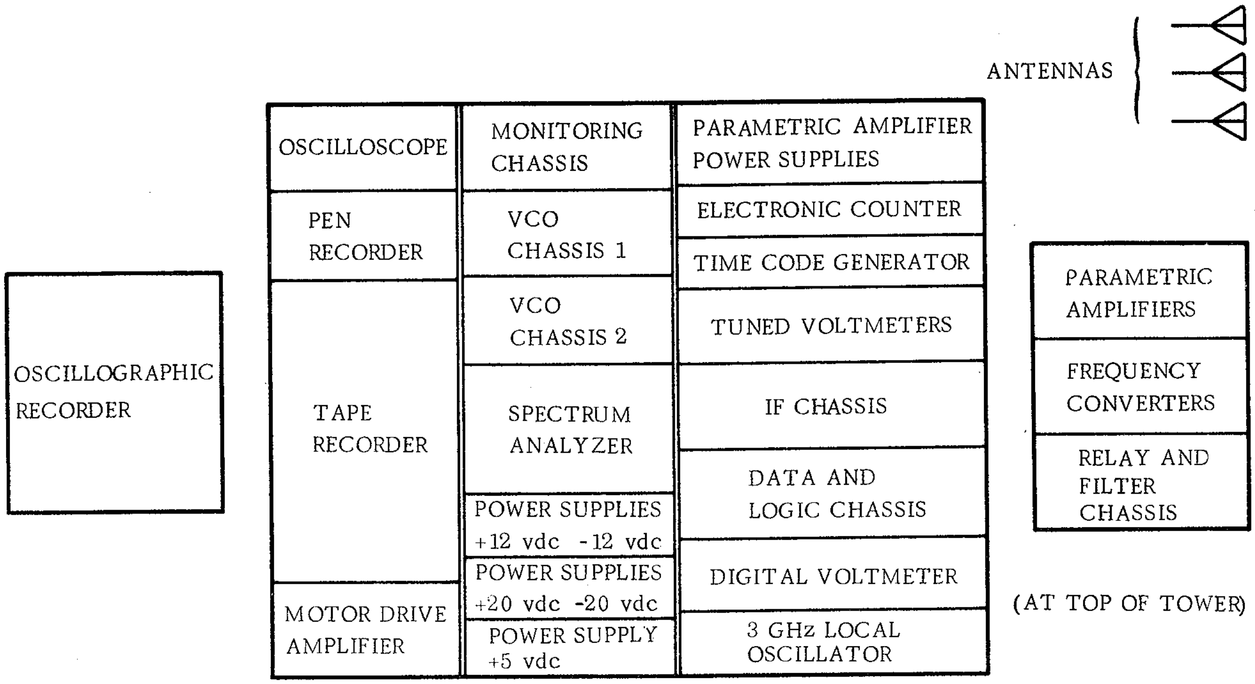


Figure 4-5. Equipment Arrangement in Racks (Ground System)

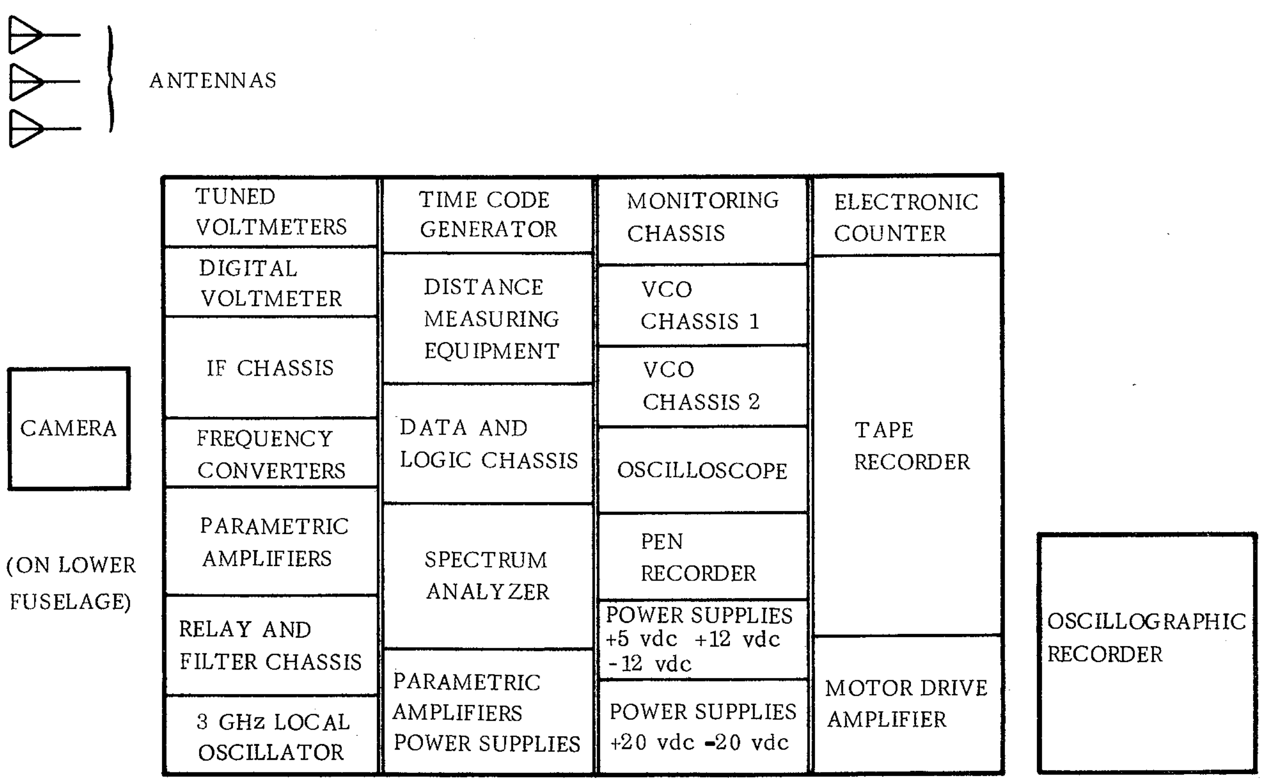


Figure 4-6. Equipment Arrangement in Racks (Airborne System)

4.1 GENERAL DESCRIPTION

Operation of the system is discussed briefly in the following paragraphs.

Noise signals are received by the three circularly polarized antennas. Three-pole coaxial relays permit connecting the input of each channel to the appropriate antenna, to a 50-Ω load for a calibrated noise source, or to a calibrated signal generator. Tunable bandpass filters with bandwidths of 5 percent of their center frequency reduce spurious responses and saturation of the preamplifiers from strong out-of-band signals.

A low-noise broadband transistorized preamplifier is used at 300 MHz, and tunable parametric amplifiers are used at 1 GHz and 3 GHz to obtain a system noise figure of approximately 3 db. The amplified RF signal at each frequency is converted to a 60-MHz IF. Since the system is designed with a single data and logic channel, the input to the 60-MHz IF amplifier is sequentially switched between the outputs of the three frequency converters. Channel gain and bandwidth control are provided in the IF amplifier. The amplified signal is then applied to a linear detector whose output goes to the data and logic subsystem.

The airborne antenna and receiving subsystem also includes DME and a 65-mm reconnaissance-type camera. The measured distance from the aircraft to a local VORTAC station is converted to a serial binary-coded output, which is applied to a VCO for recording on magnetic tape. The camera photographs the area below the aircraft when a command signal is received from the logic unit (10-second intervals).

The logic circuitry controls the sequence of operation of switching and data sampling. A time-code generator provides a 100-pulse-per-second clock signal for the logic. The logic circuitry provides these functions:

a. Switches the IF amplifier input from the three RF frequency converters.

b. Switches the reference voltages to the level comparators.

c. Resets the integrators, places them on "hold" at the end of the measurement interval, and samples the integrators.

d. Provides RF band identification and time or events-sampling identification signals to the monitoring and recording subsystems.

e. Generates a position identification signal.

f. In the airborne system, commands the camera to take a photograph and to advance the film.

The measurement interval (the time during which the system is measuring data at each frequency) is selectable at 2, 3, 5, or 10 seconds. The interval between camera commands is selectable at 5, 10, or 20 seconds.

A block diagram of the data processing circuitry is shown in Figure 4-7. The RMS amplifier squares the video signal, averages it over a 300-ms period, and takes the square root. The average noise envelope amplifier averages the video signal over a 100-ms period. Logging amplifiers following these circuits enhance resolution of low-level outputs. Tunable phase-lock voltmeters capable of measuring low-level repetitive signals obscured by noise or in the presence of other nonharmonically related signals are used to measure components of the noise at specific frequencies.

The percentage of time that the noise amplitude was above various levels and the number of times the noise amplitude exceeded each threshold level is evaluated by using a bank of six comparators, each of which is set to a different threshold. While the system is receiving noise data at 300 MHz, the reference voltages between adjacent comparators differ in 5 db steps. At 1 GHz, the reference voltages differ in 4 db steps, while at 3 GHz the voltages differ in 3 db steps. The noise amplitude probability distribution information is stored on a bank of integrators connected to the comparators. The output of each comparator is also applied to a unit-charge dispenser whose output is summed by an integrator to provide a count of the number of times the noise amplitude exceeds each threshold level. The output of both sets of integrators is sampled at the end of each measurement interval.

The monitoring subsystem permits real-time monitoring of the entire noise-measuring system. This subsystem includes a monitoring panel by which the various functions

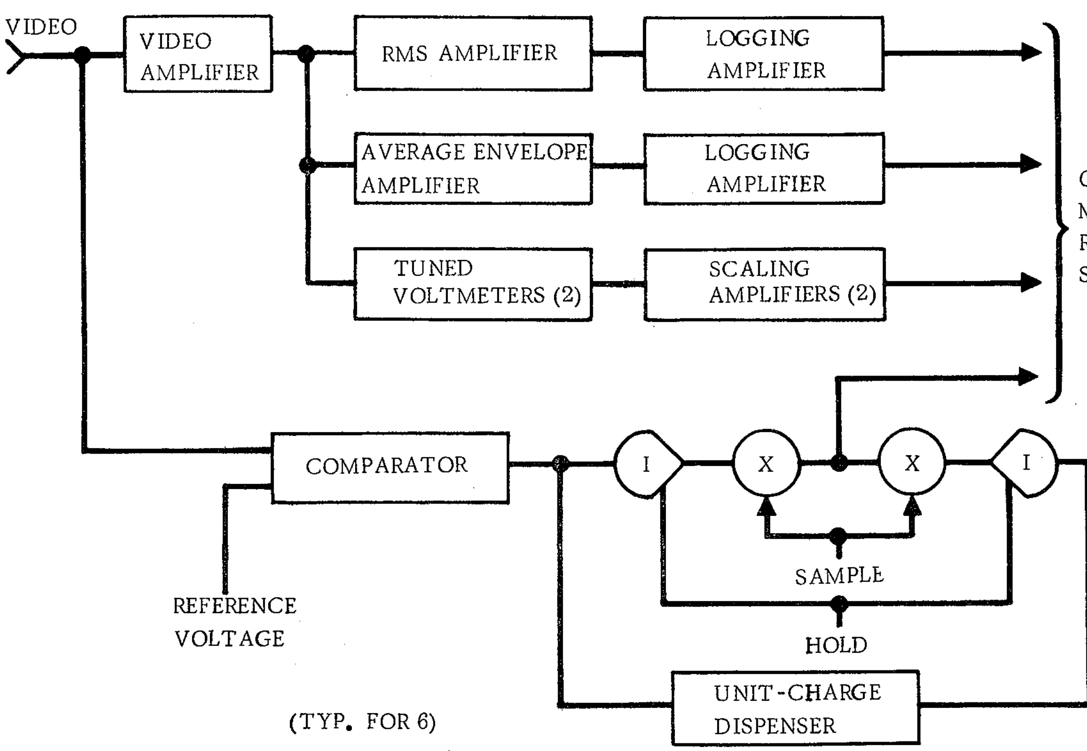


Figure 4-7. Data Processing Circuitry

can be applied to the monitoring devices. An oscilloscope, a 12-channel oscillographic recorder, and a 2-channel pen recorder are used to monitor data and auxiliary information before it is applied to the recording subsystem. An electronic counter is used to set up and monitor the frequency and deviation sensitivity of the VCOs. The IF bandwidth is swept by a spectrum analyzer several times during each measurement interval to give a visual display of the noise being received. Vertical deflection of the spectrum analyzer is recorded to provide additional information for post-measurement data analysis.

The outputs of the time and events integrators, the RMS and average amplifiers, the frequency selective voltmeters, and the vertical deflection of the spectrum analyzer are then applied to VCOs. The VCO outputs are summed and the multiplexed signal recorded on one track of a multitrack magnetic tape recorder. Auxiliary information (such as identification signals, DME position code, and visual position code) are also applied to VCOs whose outputs are summed and recorded. Other tracks of the tape recorder are used to record voice annotations, a wow-and-flutter reference, and a time-code signal. When all measurements are completed, the taped information is analyzed by a computer.

4.2 ANTENNA AND RECEIVING SUBSYSTEM

A block diagram of the antenna and receiving subsystem is shown in Figure 4-8. The antennas that receive the noise signal are shown in Figure 4-9 as they are mounted under the aircraft fuselage.

The 300-MHz antenna is a group of four crossed dipoles in front of a ground plane fed by a coaxial phasing harness. Polarization is circular, and gain is measured as 8 db over an isotropic antenna. The receiver is a low-noise wideband transistorized preamplifier feeding the Band 1 portion of a tunable frequency converter which translates the noise signals to the 60-MHz IF frequency. A coaxial relay switches the receiver to the antenna, a 50-Ω coaxial termination, or to a signal generator for calibration. A five-section tunable bandpass filter in front of the preamplifier provides additional front-end rejection of unwanted frequencies.

The 1-GHz antenna is an axial-mode helix mounted on a ground plane. Polarization is circular and gain is measured as 11 db over an isotropic antenna. A similar coaxial relay switches the receiver between the antenna, a 50-Ω coaxial termination, or a signal generator. The coaxial relay feeds a tunable bandpass filter followed by the 1 GHz section of a parametric amplifier. The signal is then converted to the 60-MHz IF by the Band 2 portion of the tunable converter.

The 3-GHz antenna is also an axial-mode helix in front of a ground plane, with 13 db gain (measured over an isotropic antenna), and circular polarization. It feeds a similar coaxial relay that switches the receiver between the antenna, a 50-Ω load, or a signal generator. The input relay is followed by a tunable bandpass filter, which feeds

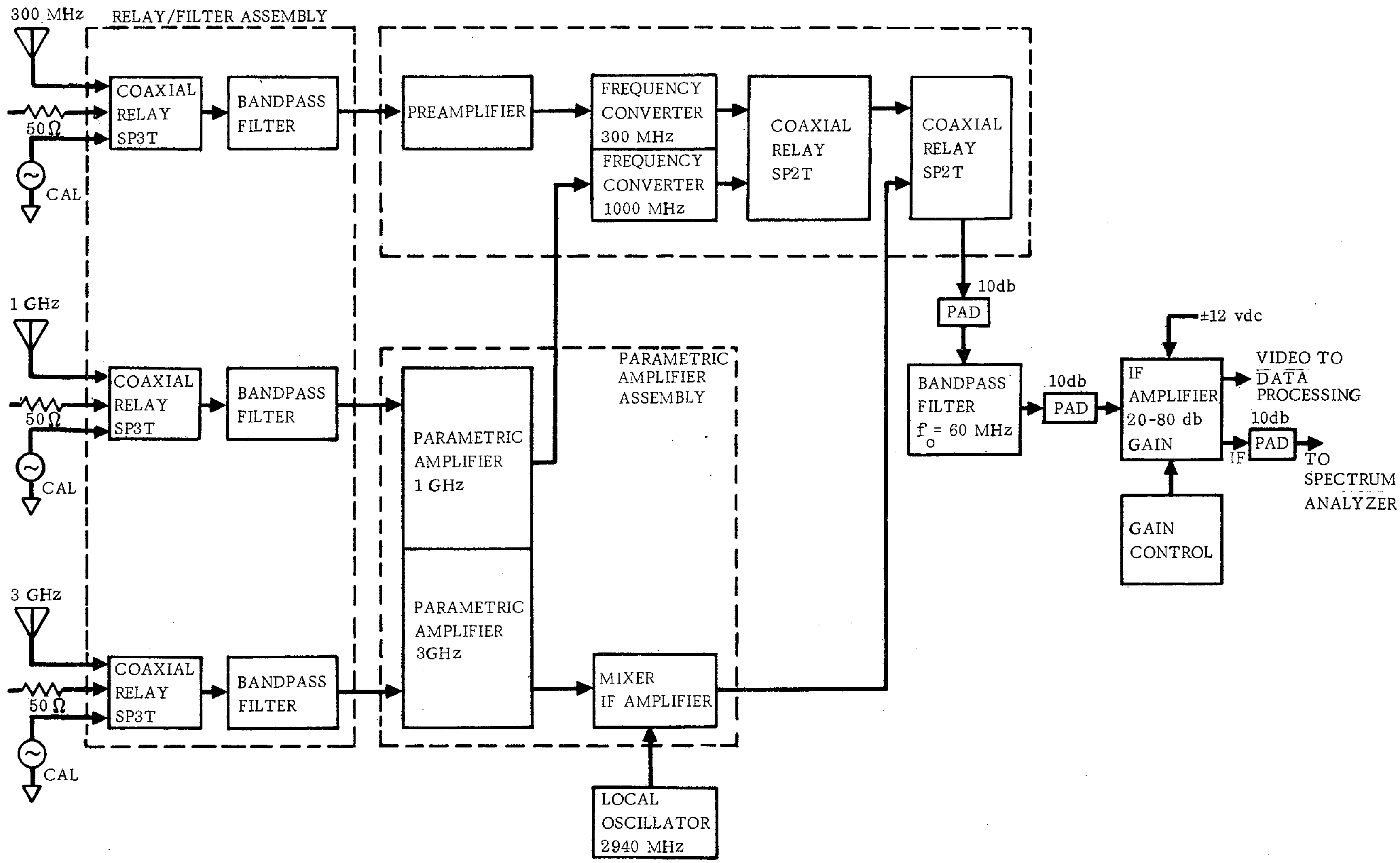


Figure 4-8. Antenna and Receiving Subsystem

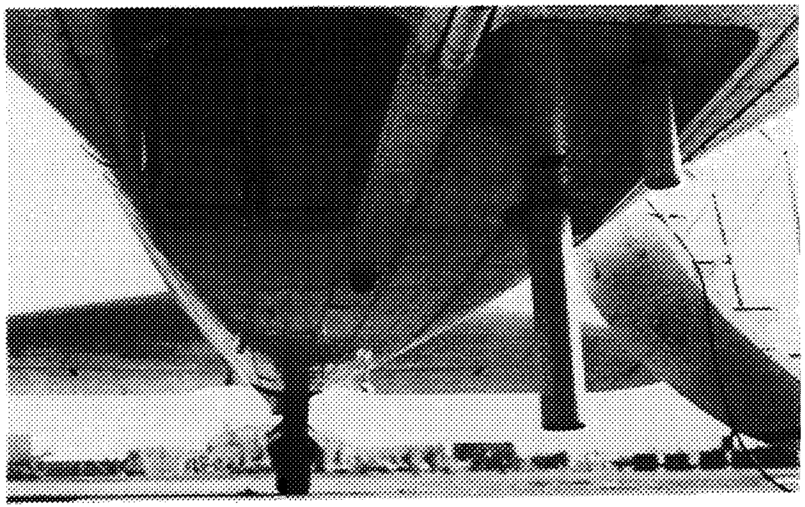


Figure 4-9. Circularly Polarized Antennas Mounted Beneath Aircraft Fuselage

the 3-GHz section of the parametric amplifier. The 3-GHz RF is then converted directly to 60 MHz in a mixer-IF amplifier mounted on the parametric amplifier chassis. A local oscillator signal 60 MHz below the desired RF frequency is supplied externally by a signal generator. Figure 4-10 is a schematic of the RF and IF switching relays. A pair of coaxial relays mounted inside the tunable frequency converter are used to select the IF signal to be routed through the IF amplifier. A second pair of coaxial relays located in the RF filter chassis are used in the opposite fashion to route calibration signals from the "CAL" coax to any of the three front-end coax relays. These relays are all operated by +28 vdc band commands from the IF amplifier chassis. The parametric amplifier power supply and the frequency converter are both powered by 115 vac, 400 Hz. The preamplifier receives its power from the frequency converter circuitry. The 3-GHz mixer IF amplifier is supplied by the +12 vdc and -12 vdc power supplies, which also feed the data handling and logic circuitry. All coaxial relays are shunted by diodes to damp out voltage transients that occur when the relays are de-energized.

The IF amplifier and detector unit is mounted in a separate chassis along with a 60-MHz bandpass filter. This chassis, shown schematically in Figure 4-11, is pictured in Figure 4-12. The filter establishes the video and IF bandwidths of the entire system. Ten-db attenuators are placed before and after the filter to prevent oscillations in the 3-GHz mixer-IF amplifier and in the 60-MHz IF amplifier. Integrated circuit voltage regulation is used to generate a stable reference voltage for controlling the IF amplifier gain. Separate IF gain adjustments for the 3 RF bands are made by potentiometers on the front panel. Relay logic circuitry is included to override the automatic band commands from the sequence logic unit and to substitute a band command selected on the front panel of the IF amplifier chassis. Raw video from the detector is then fed to the data processing subsystem, and a high-level 60-MHz IF signal is available at the front panel for spectrum analyzer display or automatic noise figure measurement.

NOTES:

1. COAXIAL CABLES AND CONNECTORS NOT NECESSARILY SHOWN.
2. ALL DIODES 1N914A.
3. ALL RELAYS COAXIAL.
4. RELAYS ILLUSTRATED AS NOT ENERGIZED.

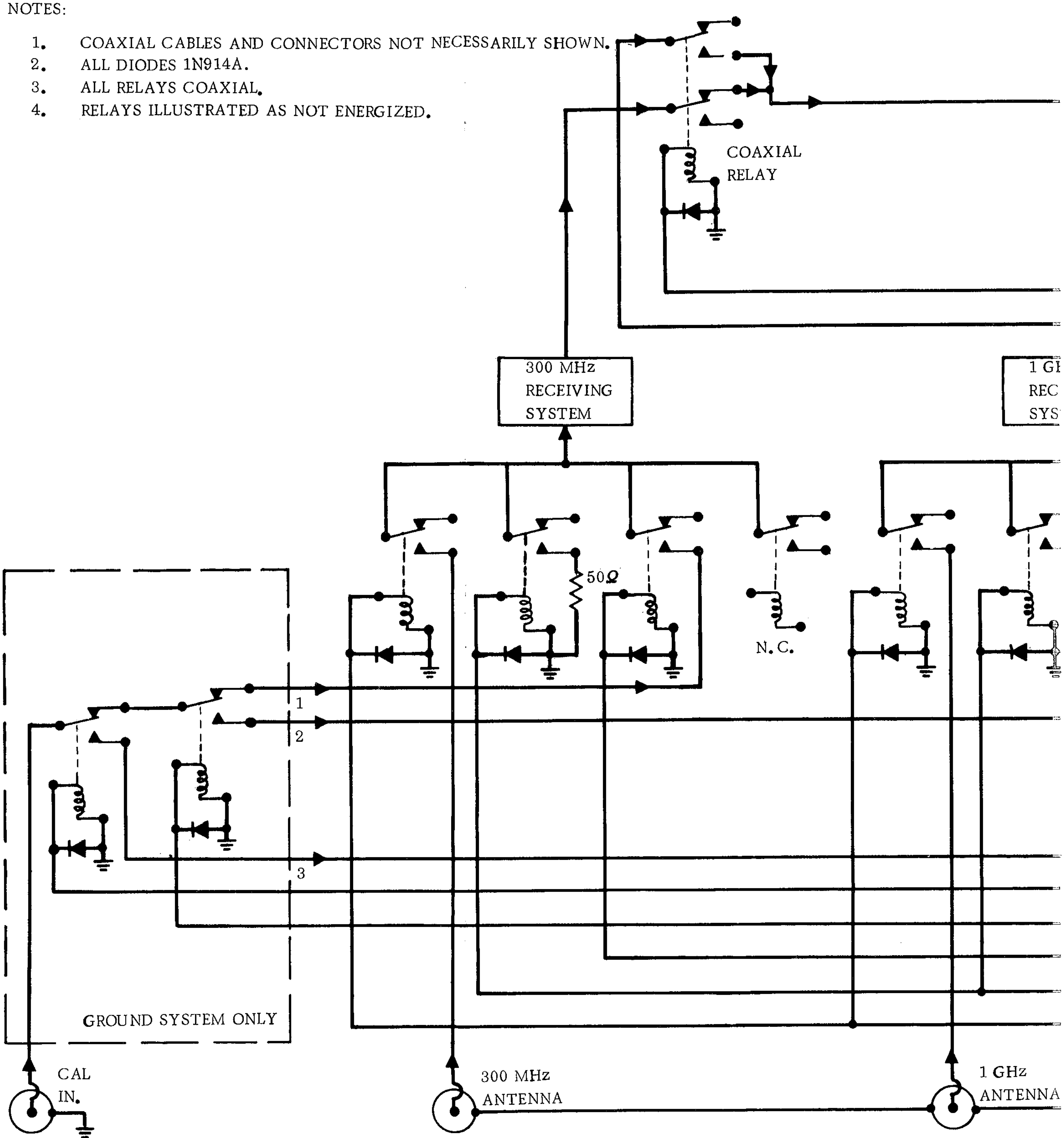
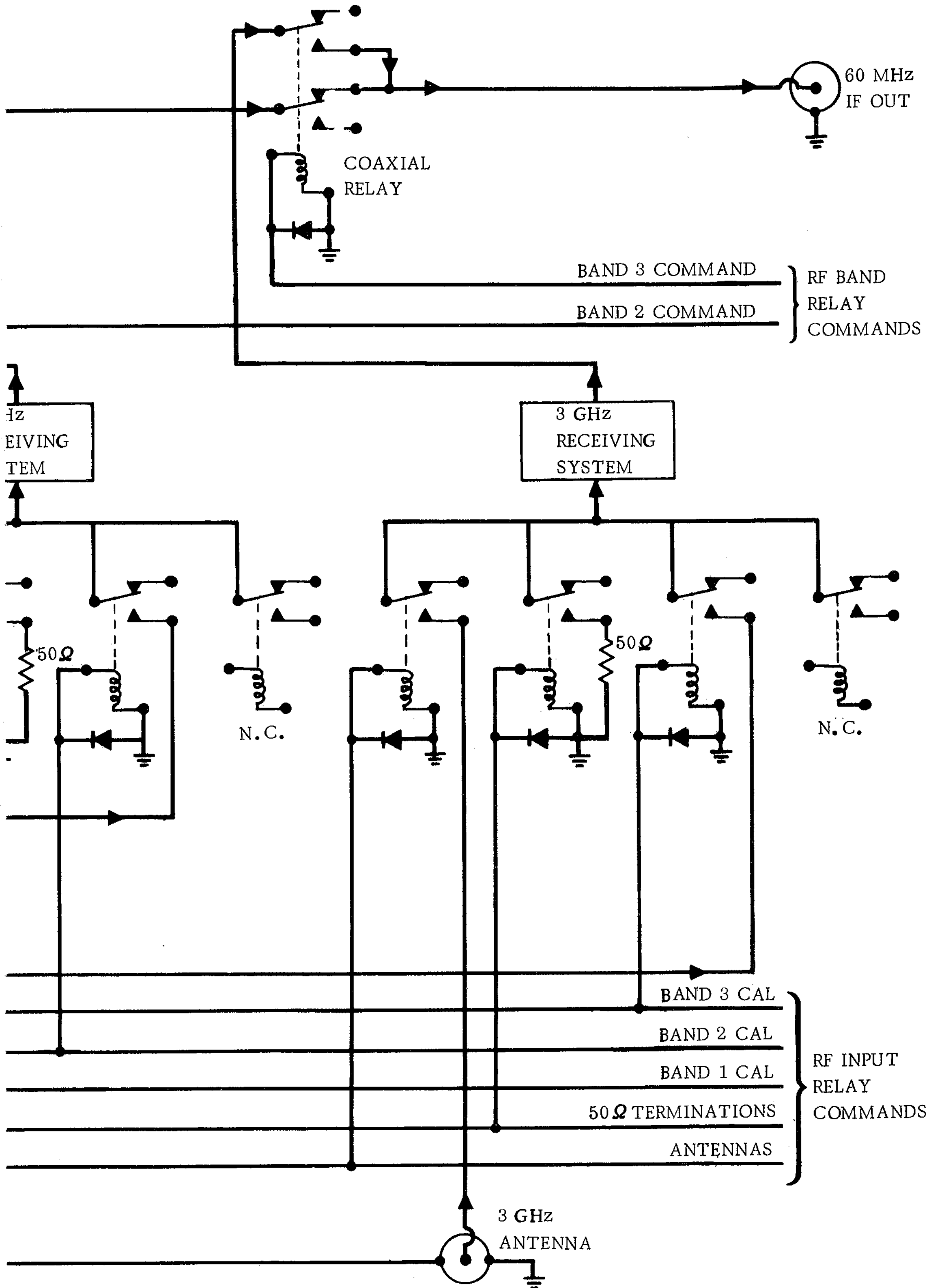


Figure 4-10. RF and IF Switching Relays



60 MHz
IF OUT
COAXIAL
RELAY
BAND 3 COMMAND
BAND 2 COMMAND
RF BAND
RELAY
COMMANDS
Iz
EIVING
TEM
3 GHz
RECEIVING
SYSTEM
50Ω
N.C.
50Ω
N.C.
BAND 3 CAL
BAND 2 CAL
BAND 1 CAL
50Ω TERMINATIONS
ANTENNAS
RF INPUT
RELAY
COMMANDS
3 GHz
ANTENNA

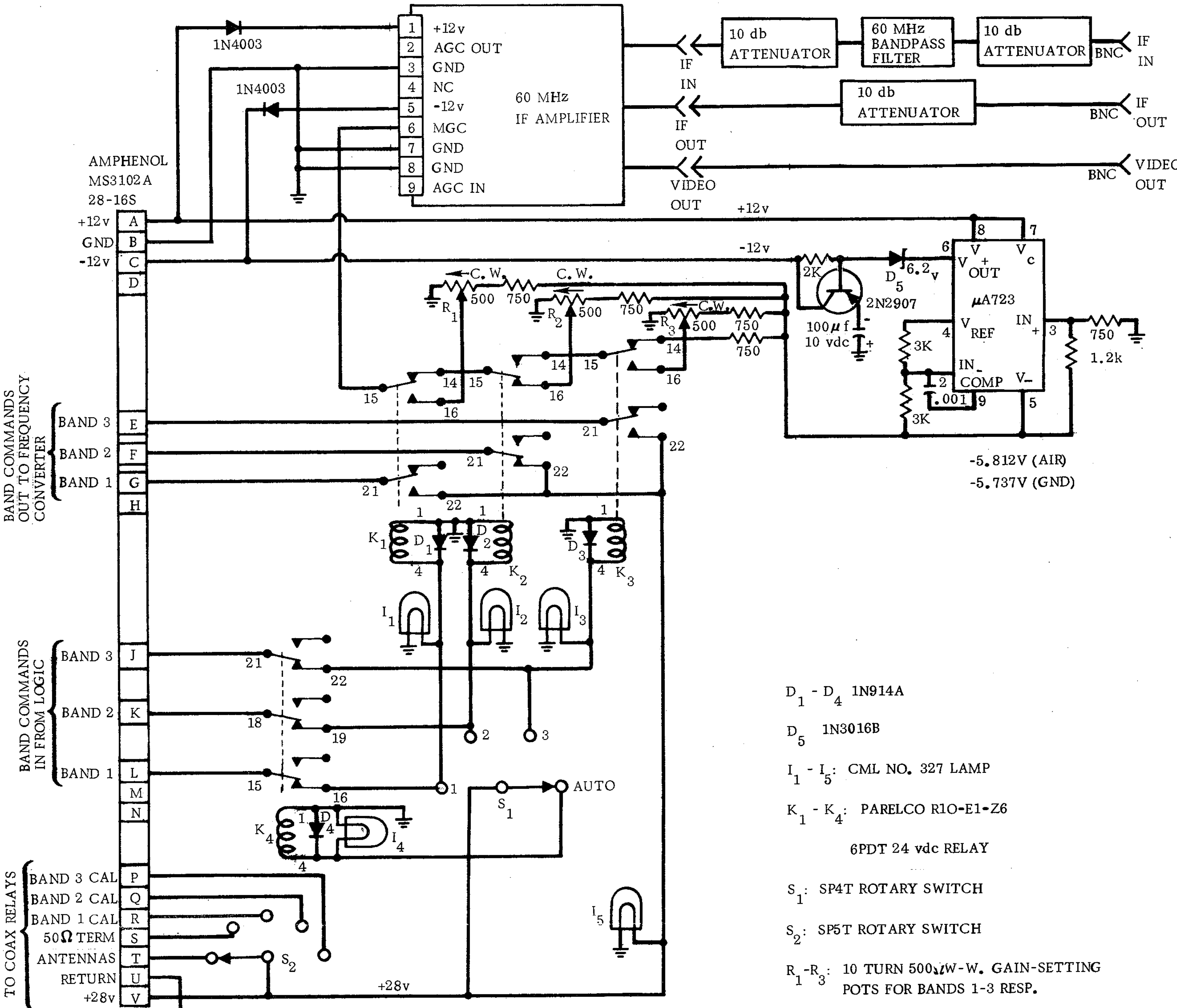
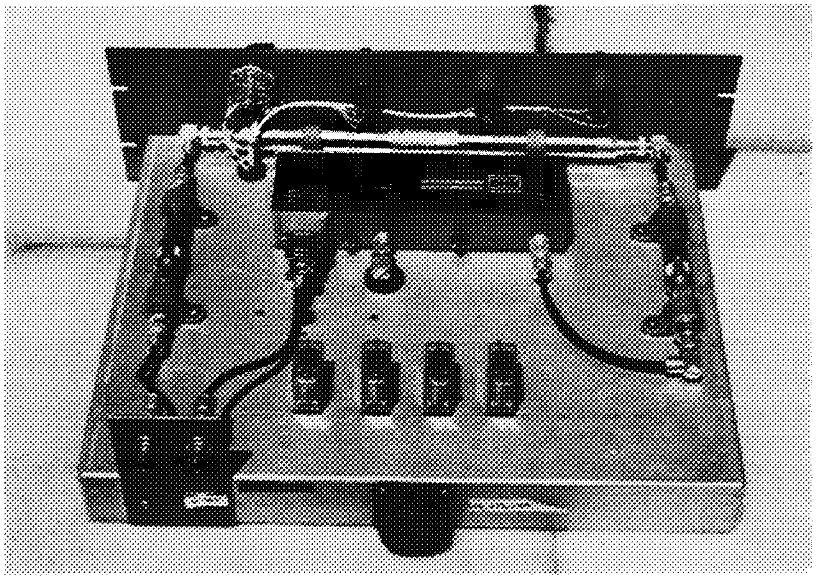


Figure 4-11. IF Chassis



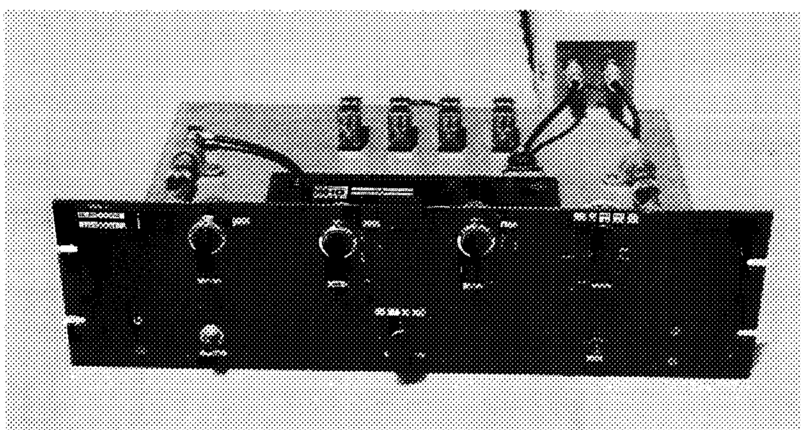


Figure 4-12. Front and Back Views of the IF Chassis

The air and ground systems differ primarily in the location of units of the RF system. The airborne-system antennas are mounted on two large detachable aluminum panels fastened to the bottom of the fuselage. Since lead lengths are minimal, the RF units are rack-mounted along with the rest of the system. Standard RG-9/U coaxial cable leads connect the antennas to the front-end coaxial relays. The ground-system antennas are mounted on separate reflectors on the mast-mounted antenna boom. Semiflexible low-loss coaxial cable connect the antennas to a shielded equipment box clamped to the boom. The box contains the parametric amplifier, frequency converter, 3-GHz mixer-IF amplifier, and the combined front-end filter and coaxial relay chassis. Semiflexible coax is also used to carry the IF signal down the tower to the IF amplifier and to carry the 3-GHz local oscillator signal up.

iews of the
assis

9C operational amplifier. The
change in integrator contents
HOLD line. The voltage
istor are such that +5v from
off voltage when the hold line
ent flows into the integrator.

ed by a standard circuit.
3-kΩ series resistor on the
rent is supplied to the sum-
ers. Integrator No. 1, the
drift then integrators 2

ITRY. A block diagram of the data processing
in Figure 4-13. Video data from the detector is
processed data is applied to VCOs for recording.
the data are discussed in the following paragraphs.
a and logic chassis except for the two logging ampli-
erage amplifiers. These logging amplifiers are built
Figure 4-14 shows front and rear views of the data

ical comparator shown in Figure 4-15 uses a μA710C
r circuit. A hysteresis resistor R_{hyst} was added to
ge for positive-going voltages, much like a Schmitt
resistor prevents oscillations when the video signal
ge applied to pin 3 of the comparator. The input resistor
ing on the gain of the particular integrated circuit (IC).

s limit the differential input voltage to a safe value.
the three lines by the auxiliary band relays selects the
. Band 3 threshold is adjusted first, then Band 2.
he Band 3 threshold potentiometer also affects Bands
ntiometer also affects Band 1. Adjustment of the thresh-
is facilitated by keeping the Band 3 potentiometer wiper
as possible.

tegrators. The output of each voltage comparator is
t-of-time integrator, whose schematic is shown in Fig-
ltage is below threshold, the voltage comparator if OFF,
saturated. With its collector at -0.3v, the diode is not
rrent flows into the integrator summing point (the junction
30 transistor), and the integrator output voltage is steady.
ltage increases above threshold, the voltage comparator
l the EN2907 transistor is biased OFF. Its collector volt-
gative for the diode to conduct, and current flows into the
The integrator output increases steadily at the rate
otentiometer.

e needed to raise the summing point impedance. A zener
dback capacitor prevents overheating the μA709C opera-
ntegrator is not cleared for long periods of time. The
t transistor (FET) is normally biased OFF by -12v applied
AR line is grounded, the drain resistance drops to a few
grator is cleared within 25 ms. The 180-pf capacitor and
nd 0.0047-μf capacitor are standard high frequency com-

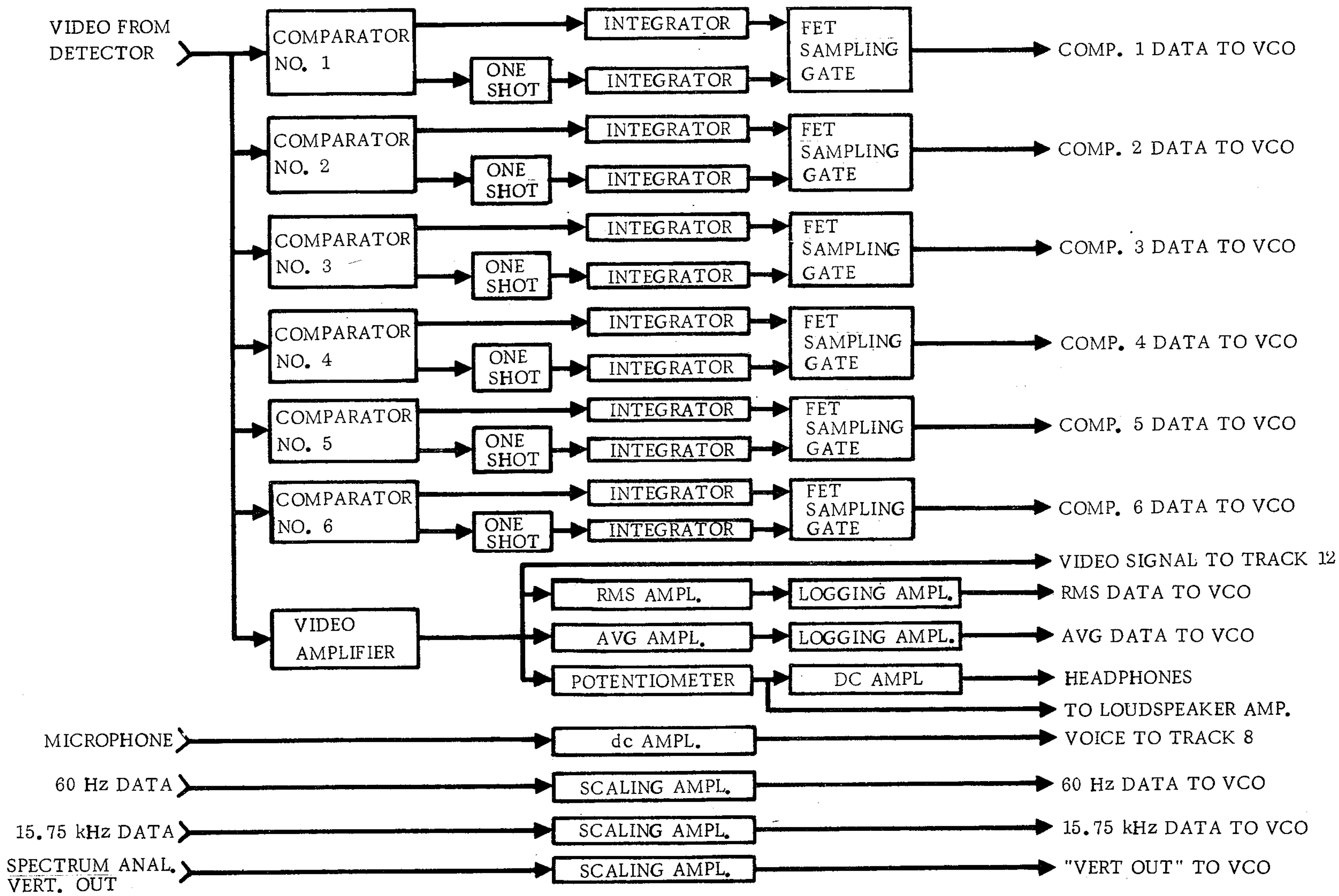


Figure 4-13. Data Processing Subsystem

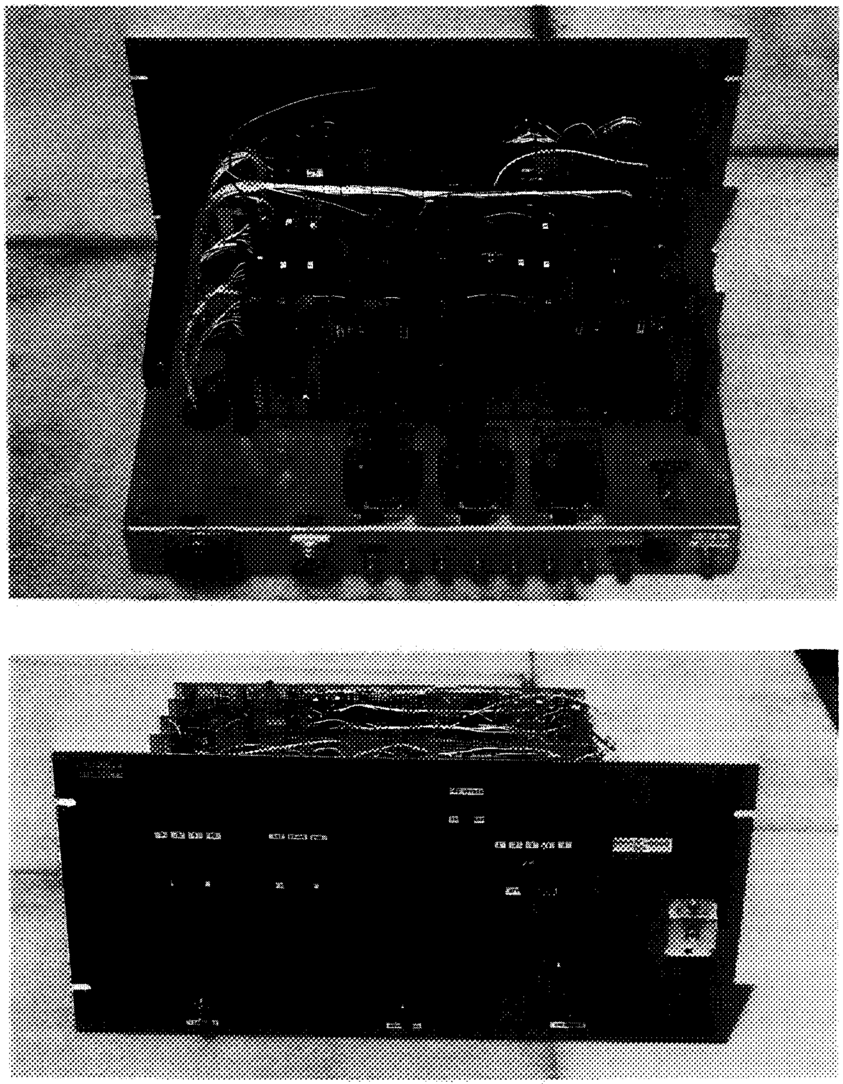


Figure 4-14. Front and Rear Views of the Data and Logic Chassis

pensation components that ensure stability of the μA709C operational amplifier. The integrators are placed in a HOLD condition (no further change in integrator contents regardless of the video voltage) by applying -12v to the HOLD line. The voltage divider constants in the base circuit of the EN2907 transistor are such that +5v from the comparator can not raise the transistor's base to cutoff voltage when the hold line is at -12v. The transistor is thus saturated and no current flows into the integrator.

Offset zeroing of the operational amplifier is accomplished by a standard circuit. The emitter followers on the amplifier inputs require a 43-kΩ series resistor on the arm of the 10-kΩ potentiometers. A small amount of current is supplied to the summing junction through 500-Ω drift-cancelling potentiometers. Integrator No. 1, the most sensitive, requires slightly more current to cancel drift then integrators 2 through 6.

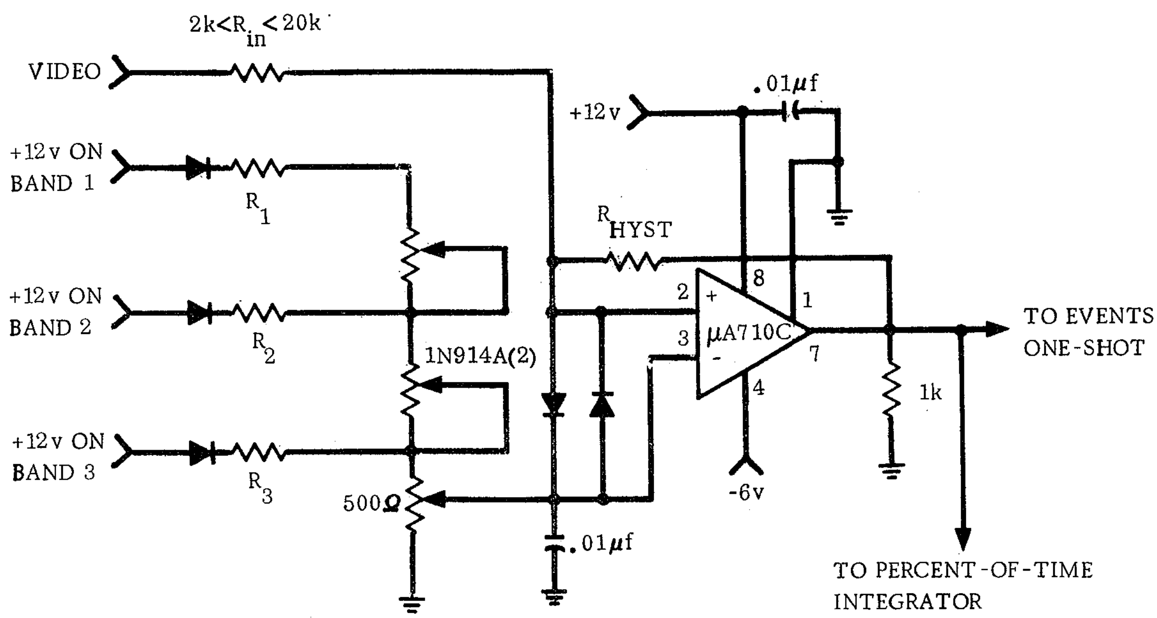


Figure 4-15. Voltage Comparator

4.3.1.3 Number-of-Events Integrator. The output of each comparator is also applied to an extremely fast one-shot multivibrator (Figure 4-17). The output of the multivibrator is summed by the number-of-events integrator (Figure 4-18). This integrator is identical to the percent-of-time integrator except that the HOLD line is not connected. The hold function is performed by grounding pin 4 of the one-shot multivibrator, which disables it. Each time the video voltage exceeds the threshold voltage, the positive-going transition of the μA710C comparator fires the one-shot multivibrator and the integrator output increases at a rate determined by the 100-kΩ SCALE potentiometer for the duration of the one-shot pulse. The duration is determined by the value of C_3. The integrator output increases by a fixed increment for each pulse of the one-shot multivibrator, so the output of the integrator thus represents the number of times the comparator threshold has been exceeded.

4.3.1.4 Integrator Sampling Gates. A 3N128 insulated-gate chopper FET is connected to the output of each of the 12 data integrators of each system. Figure 4-19 shows a schematic of the sampling gate. With -5v on the gates, the FETs are OFF and the data line to the VCO is at ground potential. At the end of the integration period, the integrators are placed in hold, and +5v appears on the SAMPLE TIME line. The upper 3N128 FET is then biased ON. Since no gate current flows, the FET is turned on without disturbing the voltage at its source. A low-drain resistance then connects the percent-of-time integrator to the data line, and the integrator contents appear at the output data line to the VCO. After 300 ms, the SAMPLE TIME line returns to -5v and the SAMPLE EVENTS line goes to +5v for 300 ms. Thus the percent-of-time and number-of-events integrators are successively connected to their data lines, and at the end of the sample period the data lines to the VCOs drop back to zero volts.

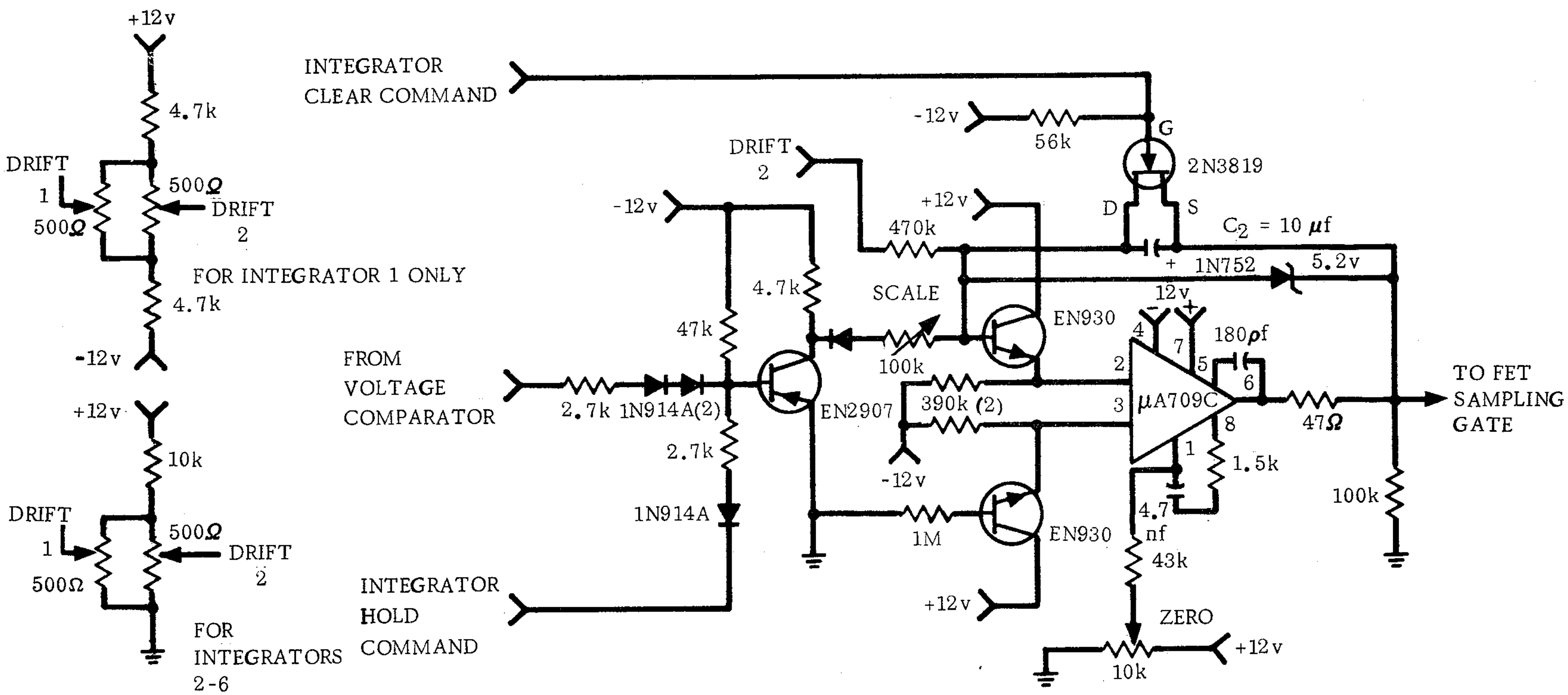


Figure 4-16. Percent-of-Time Integrator

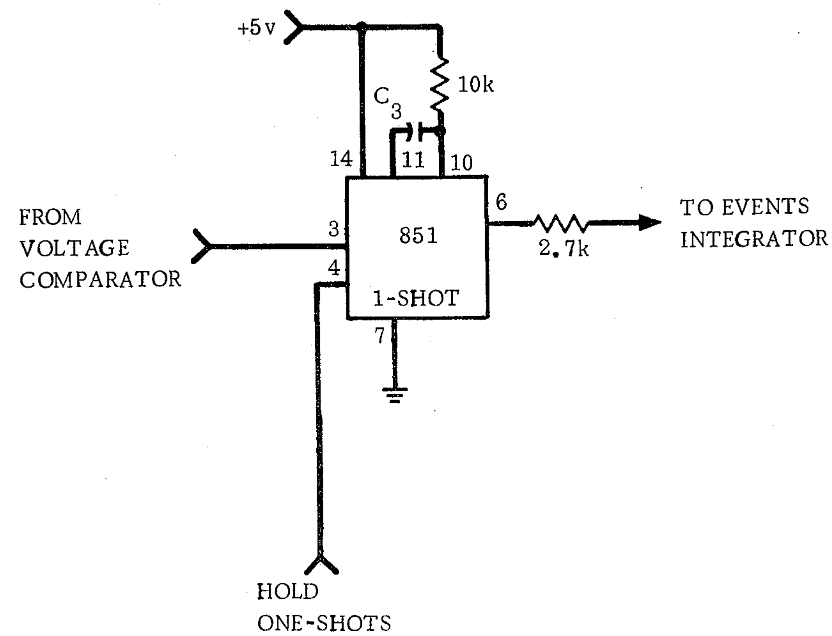


Figure 4-17. Events One-Shot Multivibrator

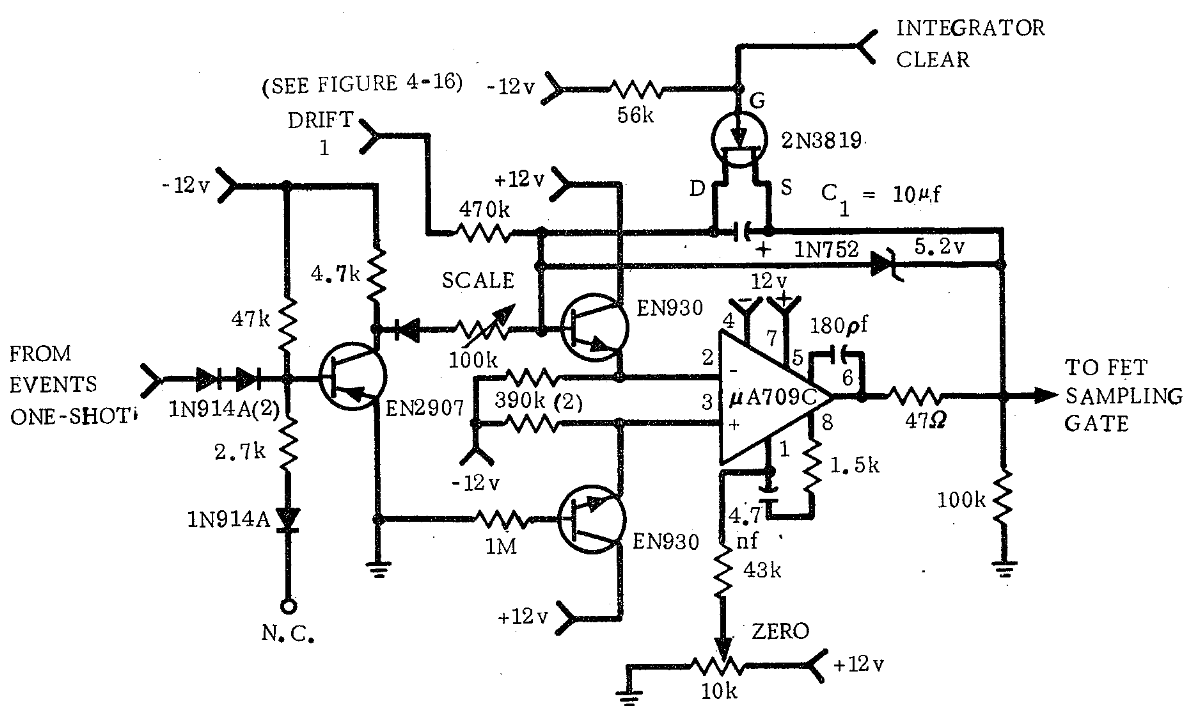


Figure 4-18. Number-of-Events Integrator

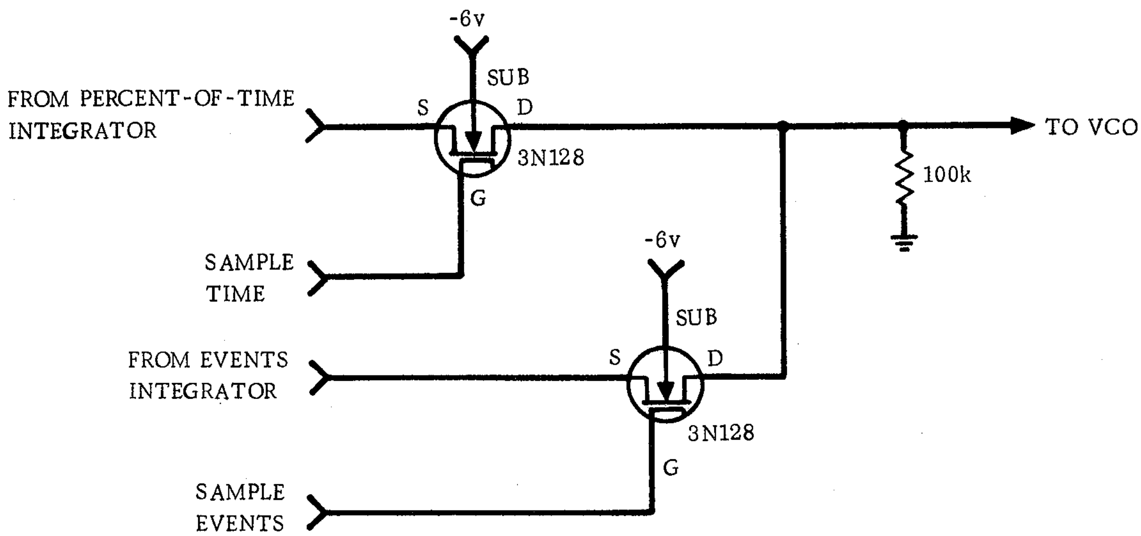


Figure 4-19. Integrator Sampling Gate

4.3.1.5 <u>Video Amplifier</u>. The video amplifier (Figure 4-20) is physically located on the front board in the data and logic chassis. Two high-performance operational amplifiers form a positive gain amplifier with a high slewing-rate capability. Video gain is independently adjustable for the three RF bands. An adjustable positive dc voltage can be added to the video signal. The video signal is totally blanked for the first 100 ms after the band-change sequence is started.

Three lines from the RF band counter carry band information to the video amplifier. Two lines are low (0 v), while the third is higher (+5 v). When band change is initiated, the 1-0 transition on the STEP line (also from the RF band counter) fires the one-shot multivibrator, which places a logical 0 on the SN7400N (quad 2-input nand gate) inputs. After the 100-ms one-shot duration, the one-shot output goes to logical 1, and the output of the gate for the band in use goes low. This saturates the EN2907 transistor inverter connected to it while the others remain OFF, except the offset gate (pin 11). The offset gate is ON at all times except during the 100-ms one-shot interval. The saturated EN2907 inverters turn on the 3N139 FET gates connected to them, which in turn connects the video signal through the appropriate input resistor and the offset signal through its input resistor. The 91-Ω resistor establishes the proper operating load for the video detector.

4.3.1.6 <u>RMS Amplifier</u>. A schematic of the RMS amplifier is shown in Figure 4-21. The first μA709C operational amplifier approximates a voltage-squared transfer function by using several input resistors which raise the amplifier gain at progressively higher input voltages. An RC filter follows, deriving the average value of the squared input voltage. Then a second operational amplifier approximates the square root of that average voltage by a similar series of break points that lower the stage gain at higher input voltages. A 20-kΩ SCALE potentiometer is used to obtain a 5-v RMS signal for the maximum expected video input signal.

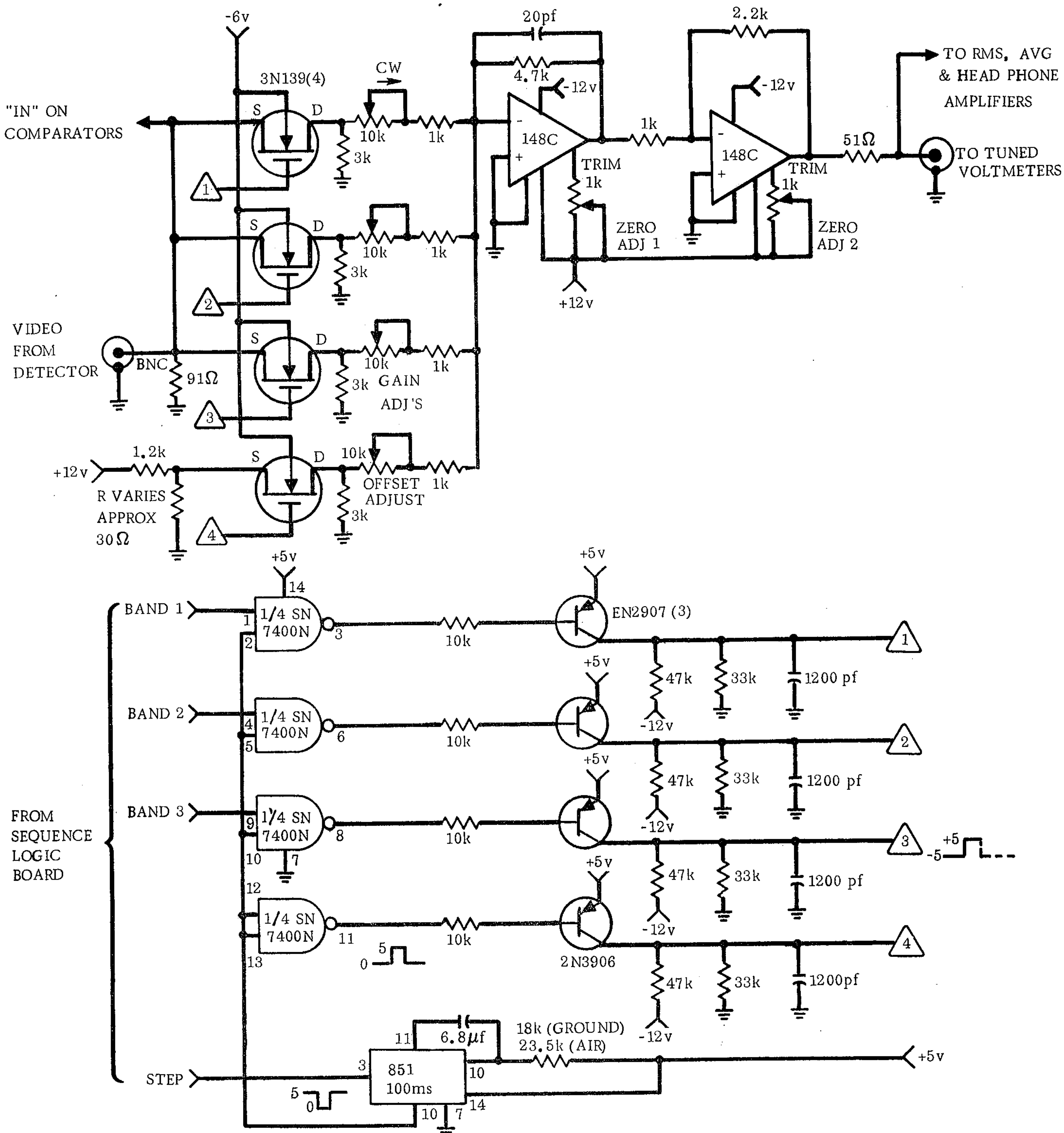


Figure 4-20. Video Amplifier

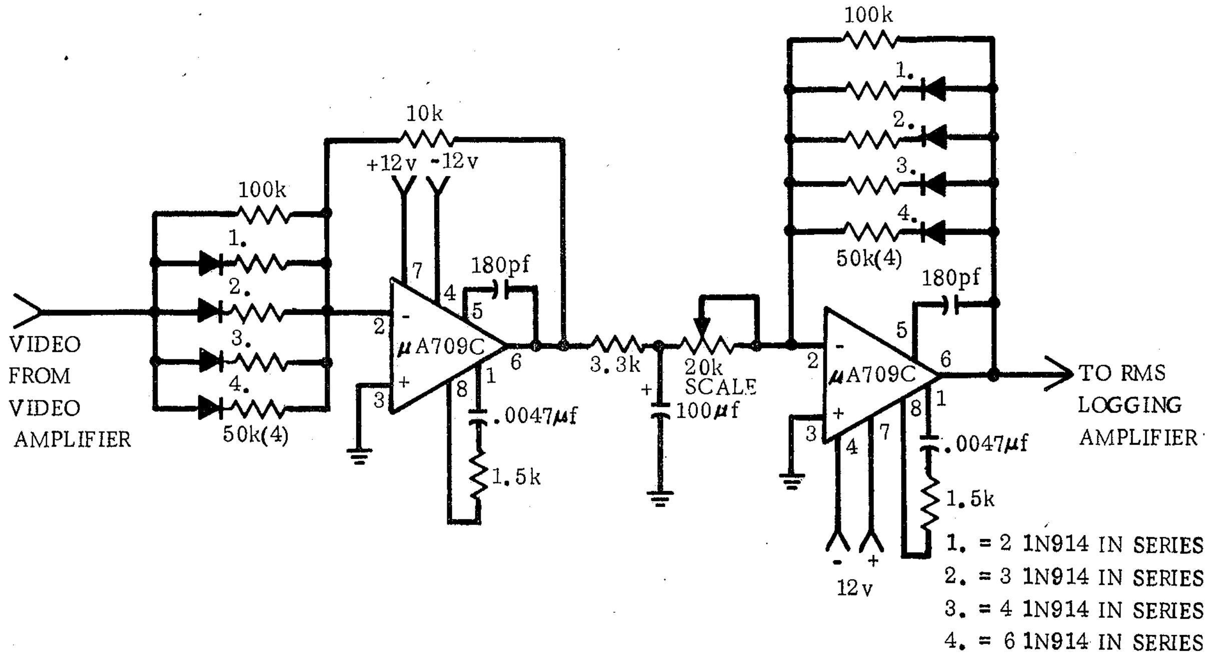


Figure 4-21. RMS Amplifier

4.3.1.7 <u>AVG Amplifier</u>. A schematic of the average envelope (AVG) amplifier is shown in Figure 4-22. Video from the video amplifier is passed through an RC low-pass filter to approximate the average value of the video noise. The filter is followed by a unity gain μA709C operational amplifier which prevents loading of the filter network. The 6.8v zener prevents latch-up of the amplifier.

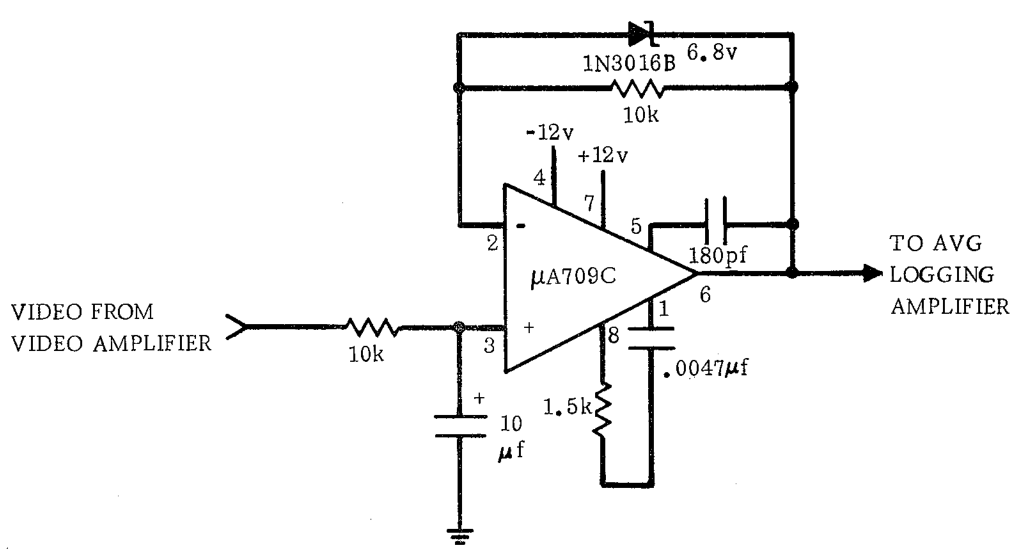


Figure 4-22. Average (AVG) Amplifier

4.3.1.8 Logging Amplifier. The RMS and AVG signals are passed through amplifiers with logarithmic transfer functions before they are applied to the VCOs in the recording subsystem. The logging amplifiers (Figure 4-23), consisting of a logging module followed by an inverting and scaling amplifier, are located on the upper side of the data monitoring chassis. The logging module has a logarithmic response to input currents (at pin 5) between +1 nanoampere and +1 milliampere. Input currents outside of this range produce invalid outputs. Pin 5 of the modules is a virtual ground, so the input current range is determined by the input resistor and the input voltage range.

The scaling amplifiers that follow the modules have variable offset (zero) and gain (full scale) adjustments. These amplifiers also have diodes in their feedback networks to truncate the output at zero volts. That is, the output is locked at zero volts for inputs that would have otherwise produced a negative output. This function can be disabled by a push switch on the circuit board to facilitate setting the zero adjustment.

4.3.1.9 Tuned-Voltmeter Scaling Amplifiers. In each system, the tuned voltmeters measure the amplitude of the 60-Hz and 15.75-kHz components in the video. Analog signals proportional to voltmeter deflections are sent through positive-gain scaling amplifiers located on the second circuit board from the front in the data and logic chassis. The output of the amplifiers is passed through the calibration relays and the monitoring subsystem before being applied to the VCOs in the recording subsystem. Figure 4-24 is a schematic of the 60-Hz scaling amplifier. The amplifier for the 15.75-kHz data is identical to this. Each amplifier has variable gain, and truncates its outputs at zero volts like the logging amplifiers.

The 22-kΩ input resistors are used to prevent overheating of the amplifiers when no output is connected. Diodes in the feedback networks produce zero output for negative inputs, while with positive inputs the circuits operate in the usual fashion. The amplifier outputs are loaded by 1-kΩ resistors to aid the truncating circuits when the signal is negative and in the low millivolt range.

4.3.1.10 Microphone Amplifiers. The microphone amplifiers (Figure 4-25) amplify the signal from the ceramic microphone to the proper level for the tape recorder. The circuitry is located on the underside of the data and logic chassis. The amplifier has a fixed positive gain of 11.

4.3.1.11 Headphone Amplifier. Video from the video amplifier is made available at the headphone jack on the data and logic chassis to aid in identifying noise signals. A conventional amplifier (Figure 4-26) has a gain of 6 at dc and rolls-off to a gain of 1 at 13 kHz. The video signal on the wiper of the 5-kΩ gain potentiometer is available at the BNC connector on the rear of the chassis for driving an optional loudspeaker amplifier. The headphone amplifier is located on the bottom of the data and logic chassis.

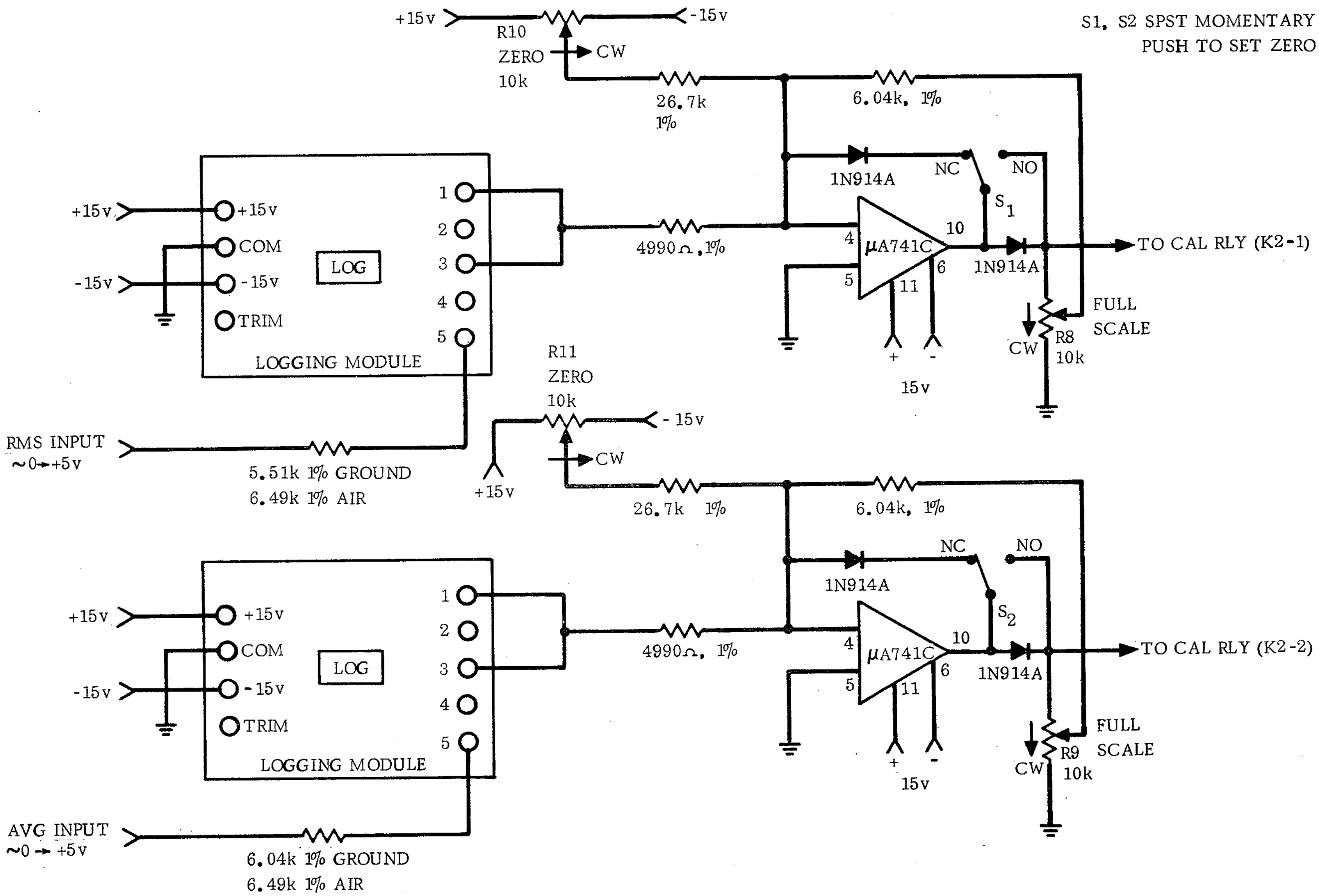


Figure 4-23. Logging Amplifiers

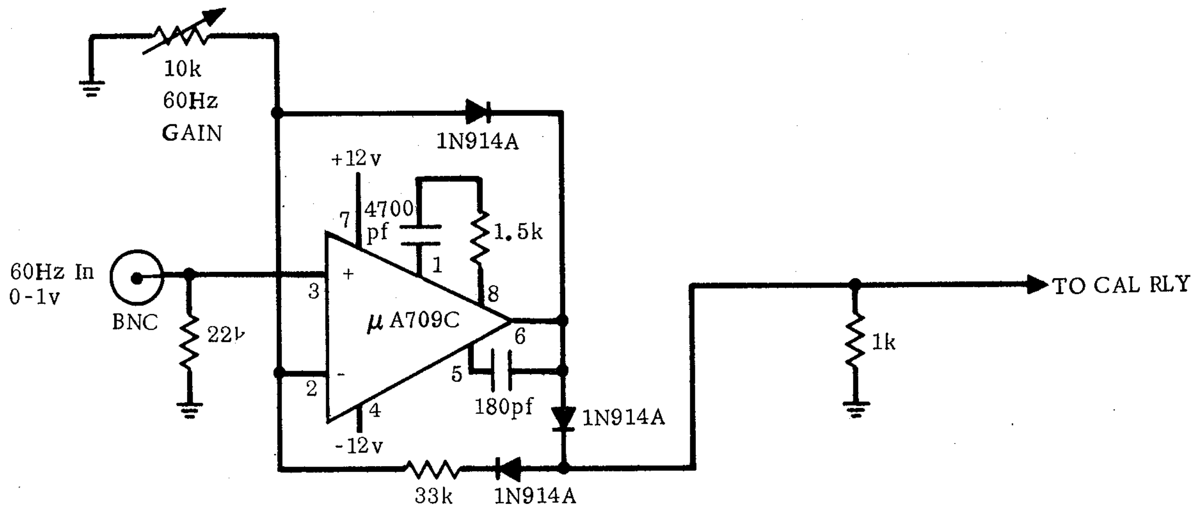


Figure 4-24. Tuned Voltmeter Scaling Amplifier

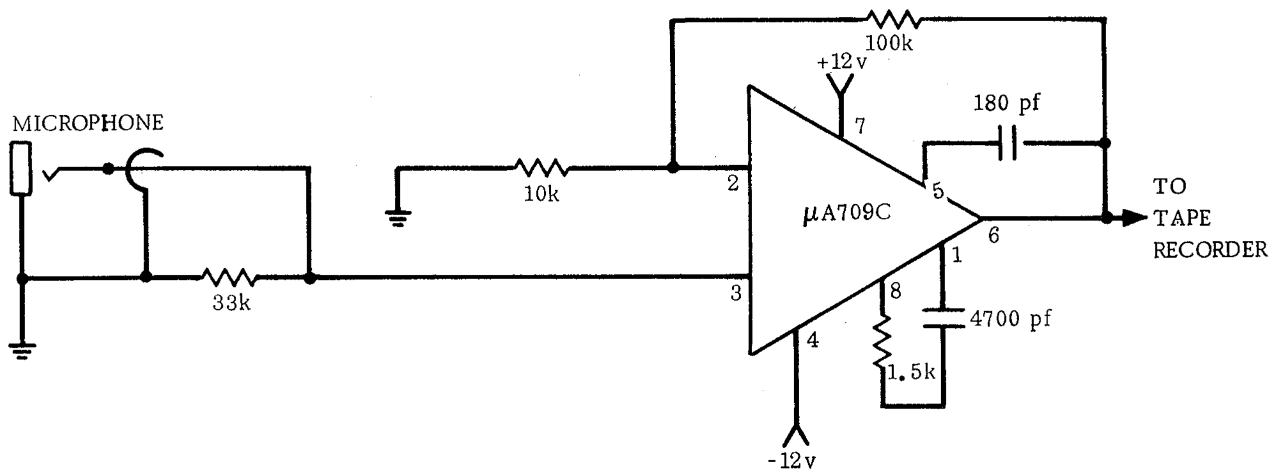


Figure 4-25. Microphone Amplifier

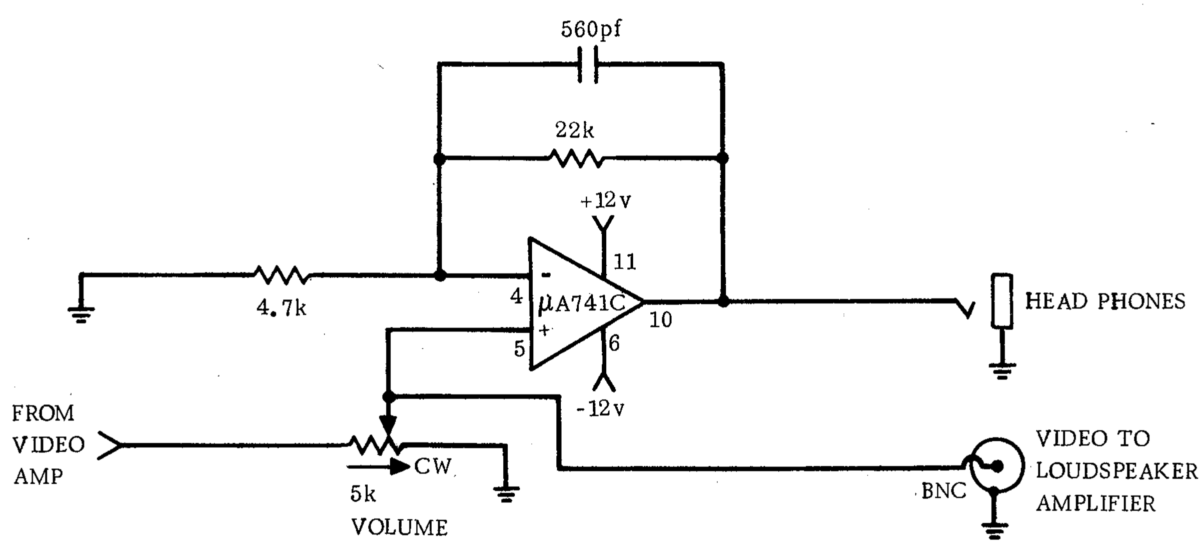


Figure 4-26. Headphone Amplifier

4.3.1.12 Spectrum Analyzer Scaling Amplifier. The vertical deflection signal from the spectrum analyzer is inverted and scaled by the amplifier shown schematically in Figure 4-27. This amplifier is located on the second board in the data and logic chassis. The amplifier gain was set by a fixed feedback resistor to give 5 volts out with full-scale deflection of the analyzer.

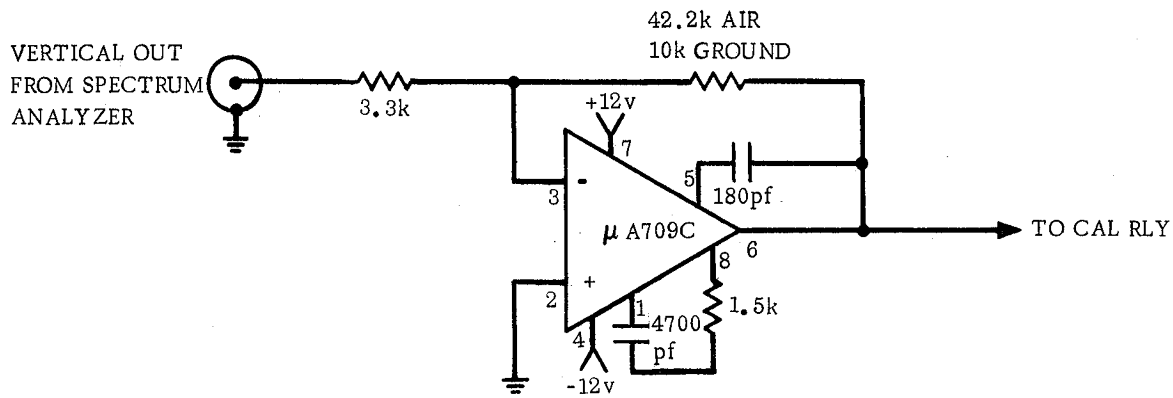


Figure 4-27. Spectrum Analyzer Scaling Amplifier

4.3.2 LOGIC CIRCUITRY. The logic portion of the logic and data processing subsystem is shown in Figure 4-28. A time-code generator provides the 100-Hz clock signal for the logic circuitry, which controls the sequence of operation of switching and data handling of the noise-measuring system. A 10-Hz signal provides the clock for the visual position serial code generator. A timing diagram for the system's logic is shown in Figure 4-29. The circuits used for logic control are discussed in the following paragraphs.

4.3.2.1 Serial Code Generators. A serial code generator in each noise-measuring system generates an identification code to indicate the visually observed position of the measuring system. A schematic of the ground system serial code generator is shown in Figure 4-30. This circuitry generates a self-clocked binary serial code that indicates the number of the ground site at which the measurements are made and tells when the aircraft passed overhead (on simultaneous air and ground measurements).

The code is repeated every 6.4 seconds and is continuously recorded on tape through a VCO. Two SN7495N parallel-in serial-out integrated shift registers are cascaded to provide a six-bit capacity. The code is parallel-loaded into the registers by a front panel rotary switch and a push switch. The loading and shifting are timed by a chain of flip-flops that divide the 10-Hz time base from the time code generator. The binary serial code is converted to a three-level self-clocked binary form by a μA741C operational amplifier and one section of G_1 (a quad 2-input nand gate). Figure 4-31 illustrates the sequence of events.

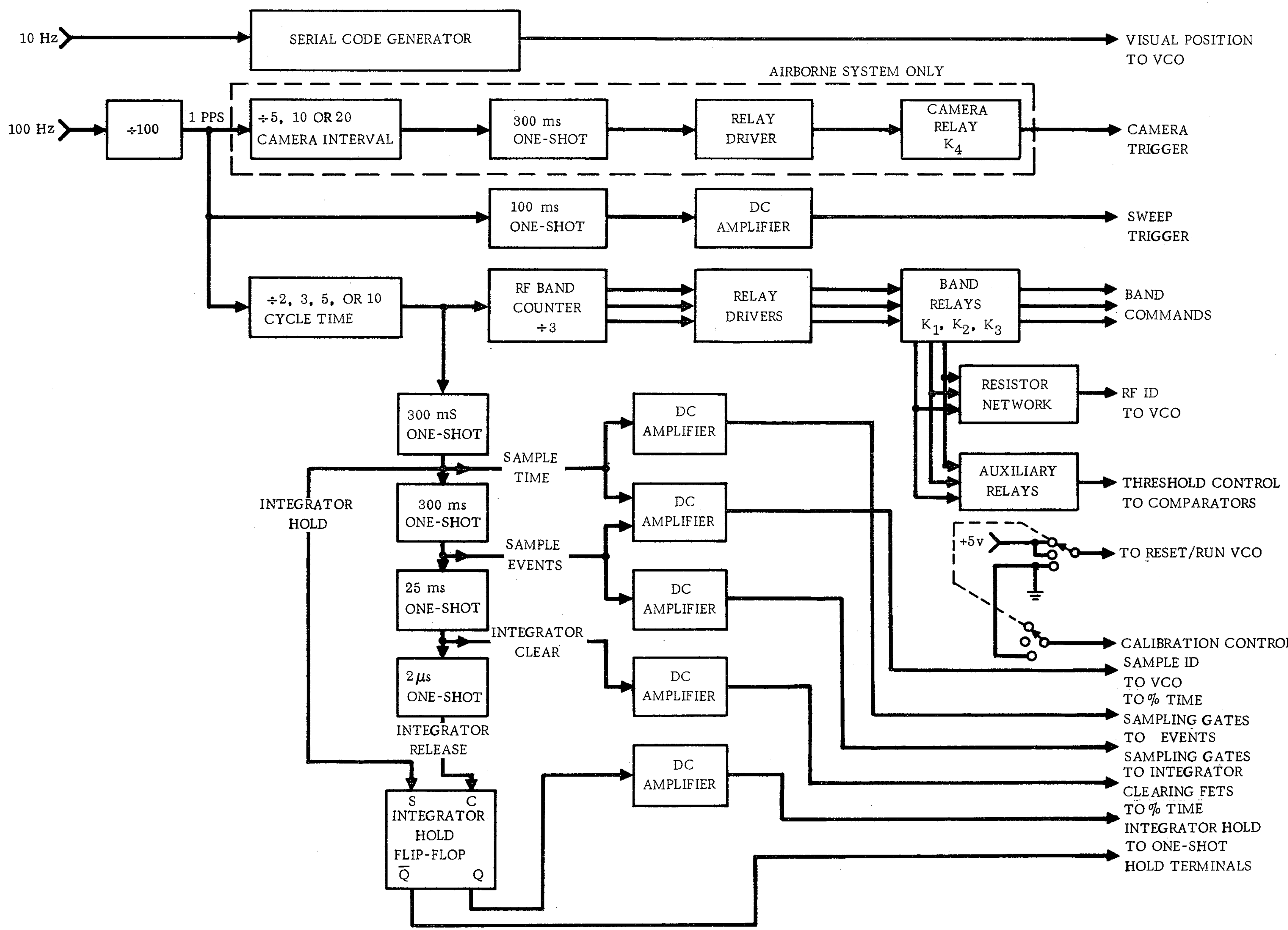


Figure 4-28. Logic Control Subsystem

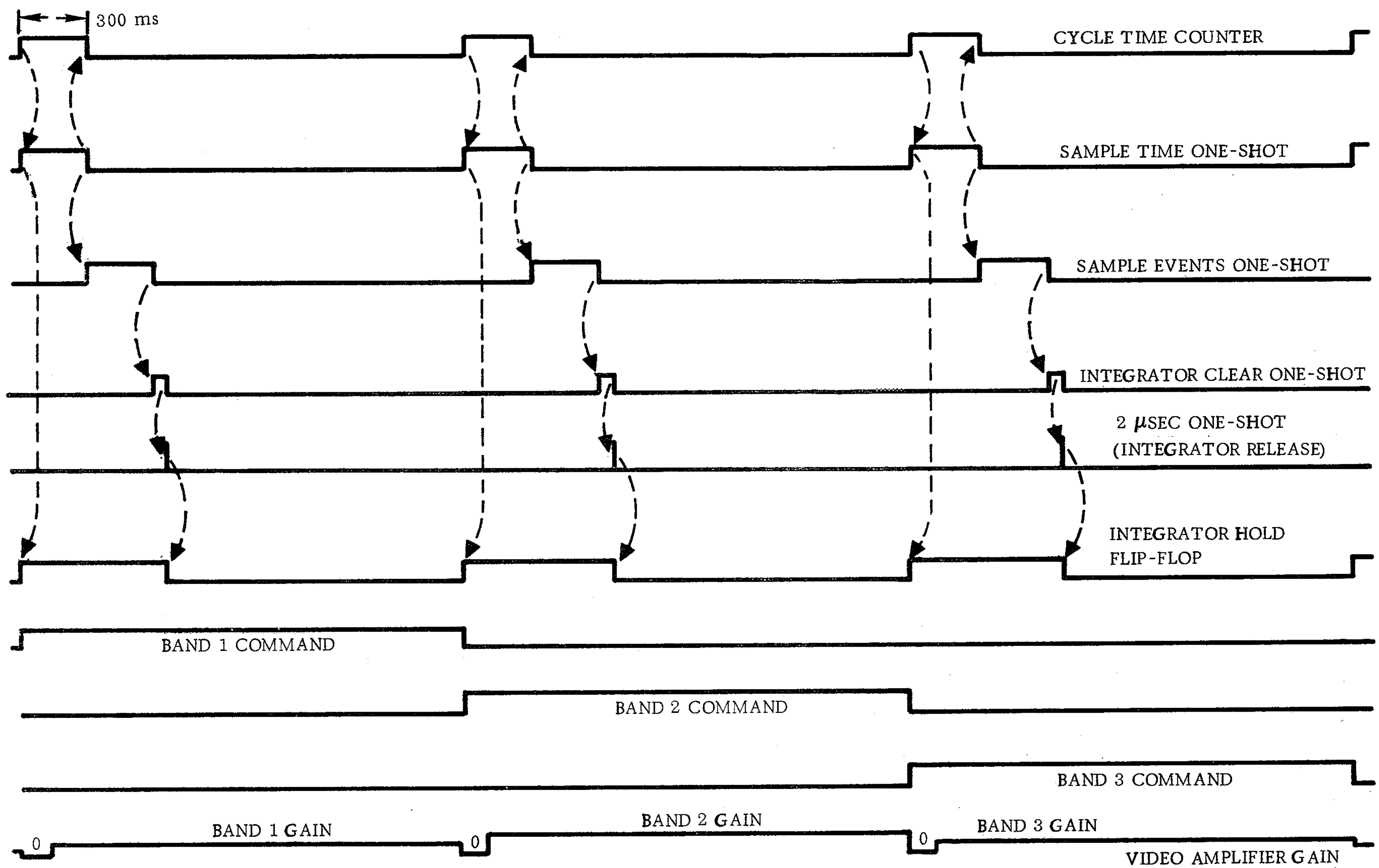
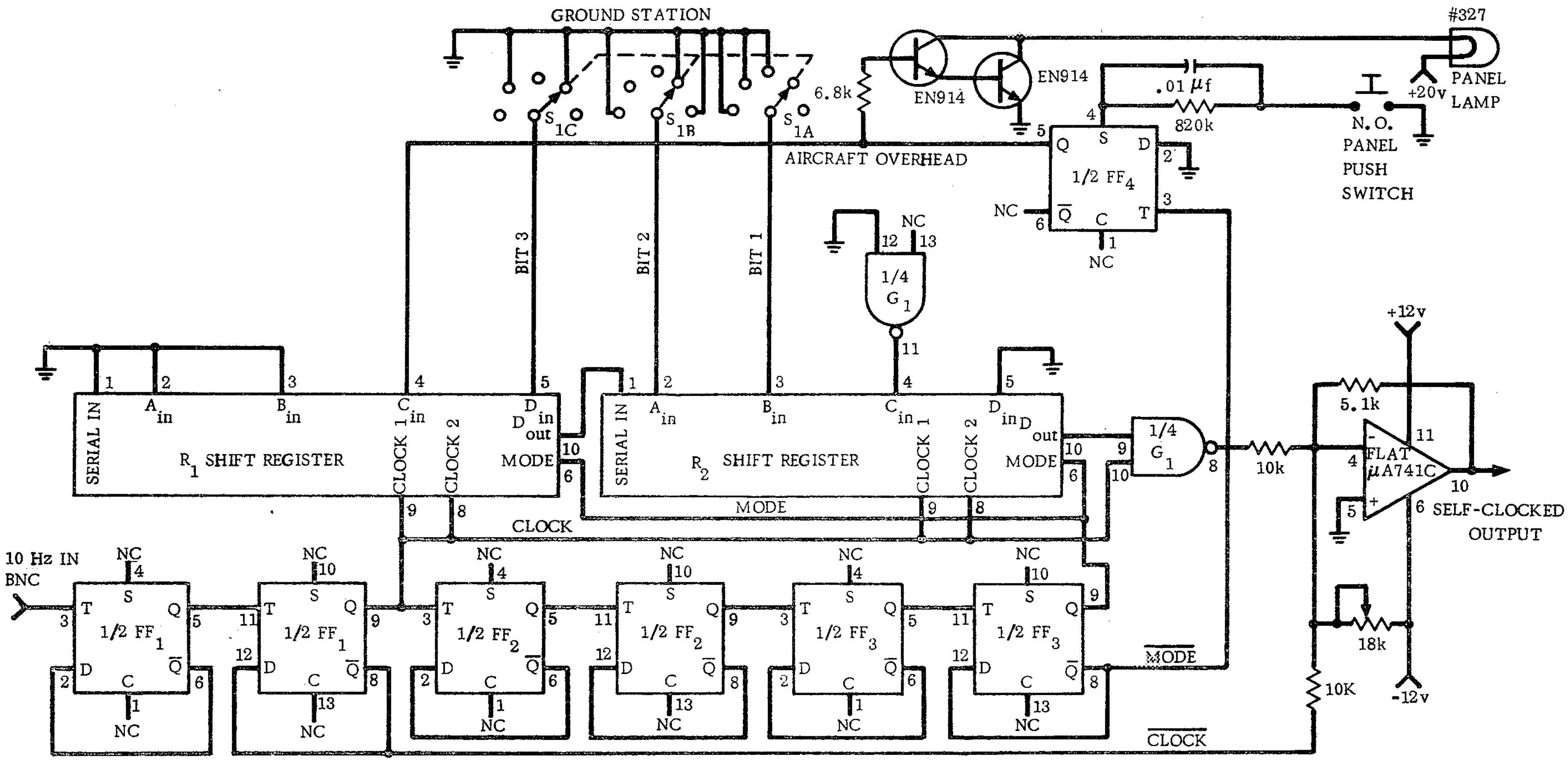


Figure 4-29. Timing Diagram for Logic Control Subsystem



G_1: SN7400N QUAD 2 INPUT NAND GATE

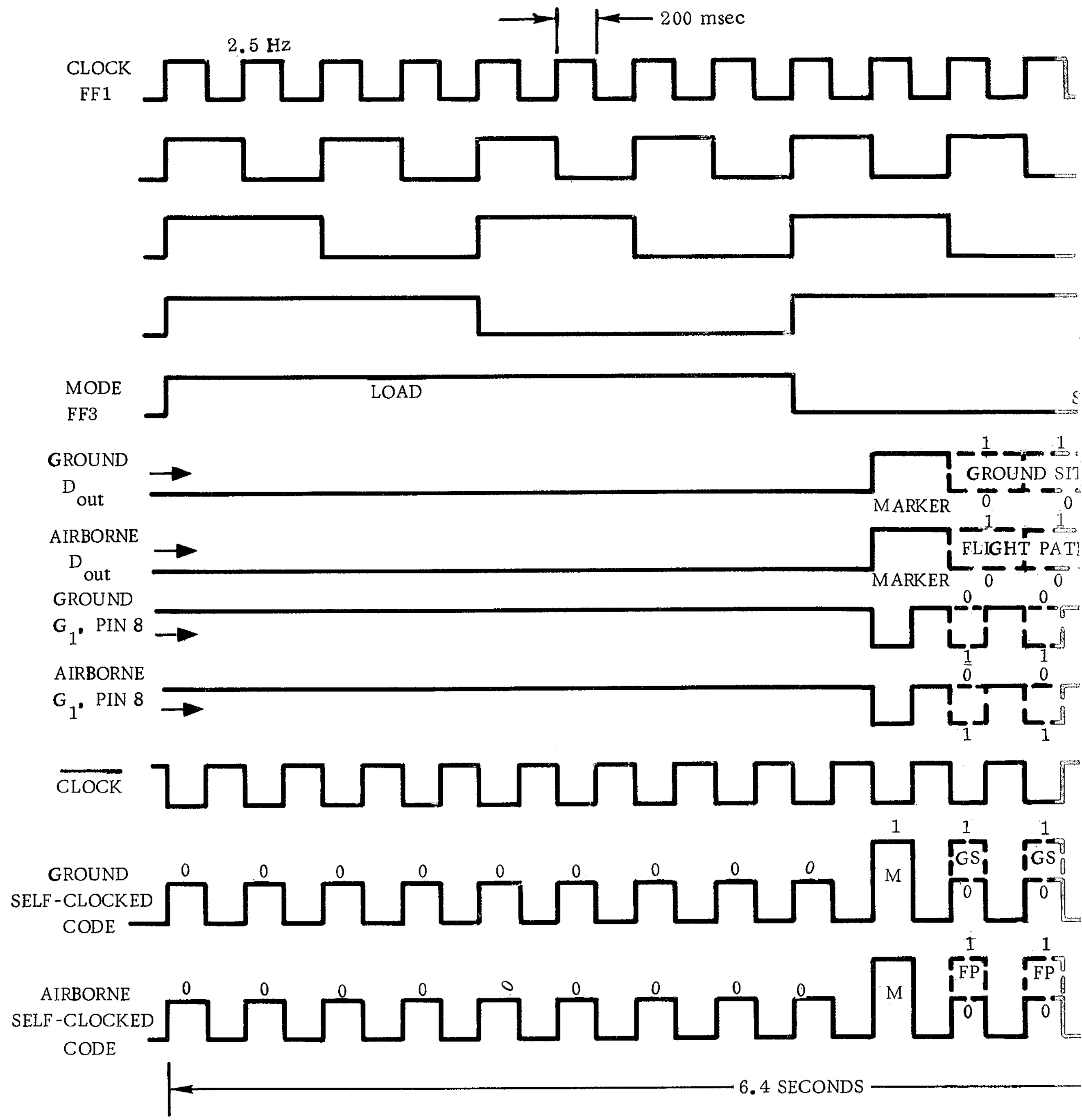
FF_1 - FF_4: SN7474N DUAL TYPE "D" FLIP-FLOP

R_1 - R_2: SN7495N 4-BIT SHIFT REGISTER

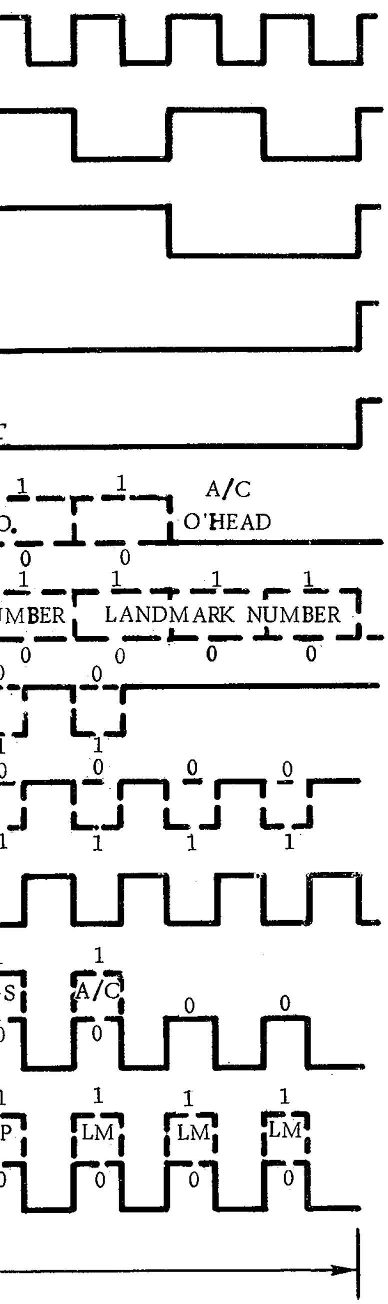
POWER CONNECTIONS:

SN7400N, ALL SN7474N, SN7495N GROUND PIN 7, APPLY +5 vdc TO PIN 14. OPERATIONAL AMPLIFIER μA741C CONNECTIONS AS SHOWN.

Figure 4-30. Ground System Serial Code Generator



200 msec
2.5 Hz
CLOCK
FF1
MODE
FF3
LOAD
GROUND
D out
GROUND SI
MARKER
AIRBORNE
D out
FLIGHT PAT
MARKER
GROUND
G 1, PIN 8
AIRBORNE
G 1, PIN 8
CLOCK
GROUND
SELF-CLOCKED
CODE
M
GS
AIRBORNE
SELF-CLOCKED
CODE
M
FP
6.4 SECONDS



AIRBORNE CODING

BIT NO. 1 2 3	EXPLANATION
0 0 0	NEVER OCCURS
0 0 1	FLIGHT PATH NO. 1
0 1 0	FLIGHT PATH NO. 2
0 1 1	FLIGHT PATH NO. 3
1 0 0	FLIGHT PATH NO. 4
1 0 1	FLIGHT PATH NO. 5
1 1 0	NEVER OCCURS
1 1 1	NEVER OCCURS

BIT NO. 4 5 6	EXPLANATION
0 0 0	NOT OVER ANY LANDMARK
0 0 1	OVER START OF FLT. PATH
0 1 0	OVER LANDMARK NO. 1
0 1 1	OVER LANDMARK NO. 2
1 0 0	OVER LANDMARK NO. 3
1 0 1	OVER LANDMARK NO. 4
1 1 0	OVER LANDMARK NO. 5
1 1 1	OVER END OF FLT. PATH

GROUND CODING

BIT NO. 1 2 3	EXPLANATION
0 0 0	NEVER OCCURS
0 0 1	AT GROUND SITE NO. 1
0 1 0	AT GROUND SITE NO. 2
0 1 1	AT GROUND SITE NO. 3
1 0 0	AT GROUND SITE NO. 4
1 0 1	AT GROUND SITE NO. 5
1 1 0	NEVER OCCURS
1 1 1	NEVER OCCURS

BIT NO. 4	EXPLANATION
0	AIRCRAFT NOT OVERHEAD
1	AIRCRAFT OVERHEAD

Figure 4-31. Timing Diagram of Serial Code Generators and Explanation of Code

The registers are loaded while the MODE line is at a high level. A high-level input on one of the parallel inputs (pins 2 through 5) loads a 1 into that bit section. Conversely, a low-level input loads a binary 0. An open circuit is equivalent to a binary 1. If the push switch for aircraft overhead has been pushed previously (since the last loading interval), FF_4 is high and the aircraft-overhead bit is loaded into the register. The first and second bits are always 0 and 1, respectively. The second bit is a marker bit that always preceeds the position code. Since the first bit is an extra 0, the register does not produce a string of 1s during parallel loading.

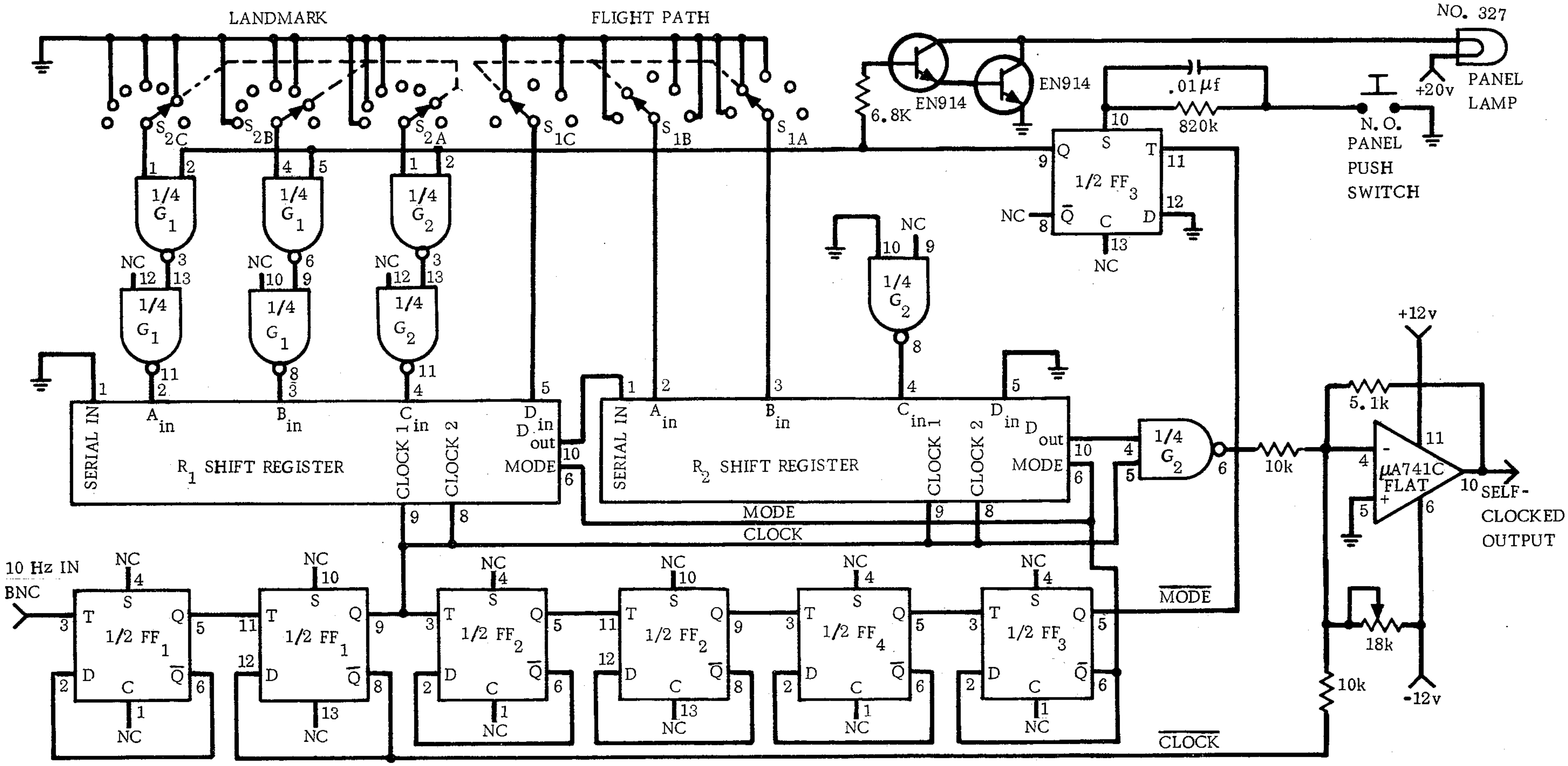
At the end of the load interval, the MODE line goes from a high to a low level, disconnecting the registers from their parallel inputs. The simultaneous transition of the $\overline{\text{MODE}}$ line resets the aircraft-overhead flip-flop. Succeeding 0-1 transitions of the CLOCK line transfer the register contents one step to the right at a time. As the code is shifted to the right out of the D_{out} terminal of R_2, the registers left vacant are filled from the left with zeros from the SERIAL IN terminal of R_1. At the end of the shift interval, both registers are full of zeros and the MODE line goes high, starting another parallel load interval.

The serial code from D_{out} of R_2 is combined with the clock pulses by NAND gate G_1 (pin 8), which chops the second half of each bit and inverts the resultant. The code is then combined with the clock complement, $\overline{\text{CLOCK}}$, and the dc voltage by the μA741C operational amplifier. The re-inverted output is the self-clocked code shown in Figure 4-31, which is then routed to a VCO via the patch panel.

A schematic of the airborne system serial code generator is shown in Figure 4-32. This circuitry generates a self-clocked binary serial code that indicates the number of the flight path on which measurements are being made and shows when the aircraft passes over preselected landmarks (including the start and end of each flight path). This code is repeated every 6.4 seconds and is recorded on tape through a VCO. Figure 4-31 indicates the sequence of events for this generator.

The circuit operation is very similar to that of the ground unit. The main difference is the substitution of a three-bit landmark code for the single-bit aircraft-overhead marker. Referring to Figure 4-32, the landmark code is determined by the front panel switch S_2. The landmark code, however, is prevented from reaching the shift register by a low output from pin 9 of FF_3. The normal landmark code thus produced is 000. When the push switch on the panel is pressed, FF_3 goes to a high output until the end of the next load interval. This connects the landmark code to the parallel load inputs of R_1 (pins 2-4), and thus sends out the landmark code only once. The self-clocked output is shown in Figure 4-31.

4.3.2.2 Divide-by-100 Counter. The 100 pps time base signal from the time code generator is divided to 1 pps by two cascaded CμL 9958 decade counters (Figure 4-33). The counters are stopped and set to zero when the system mode switch is in either the CAL or RESET position.



G_1 - G_2:	SN7400N QUAD 2 INPUT NAND GATE
FF_1 - FF_4:	SN7474N DUAL TYPE "D" FLIP-FLOP
R_1 - R_2:	SN7495N 4-BIT SHIFT REGISTER

POWER CONNECTIONS:

ALL SN7400N, SN7494N, SN7494N. GROUND PIN 7, APPLY +5 vdc TO PIN 14. OPERATIONAL AMPLIFIER μA741C CONNECTIONS AS SHOWN.

Figure 4-32. Airborne System Serial Code Generator

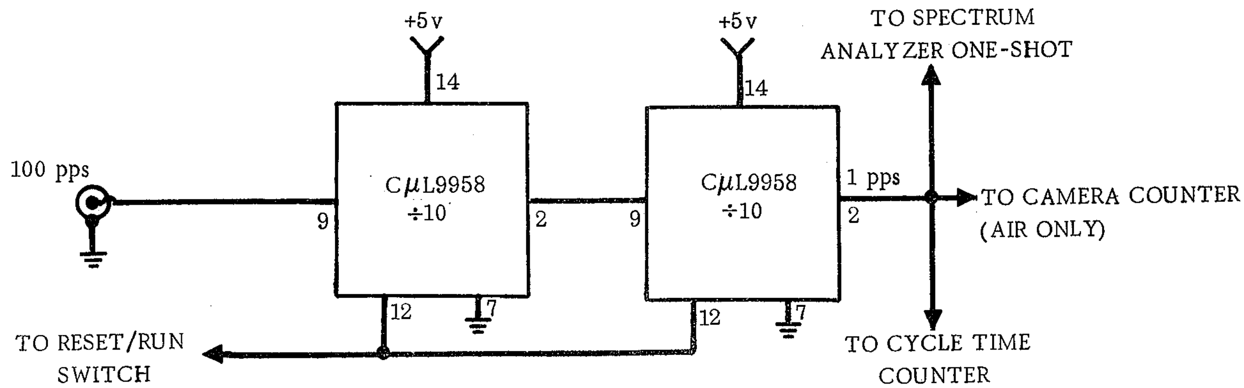


Figure 4-33. Divide-by-100 Counter

4.3.2.3 Spectrum Analyzer Sweep Trigger. A schematic of the circuitry used to trigger the spectrum analyzer's sweep is shown in Figure 4-34. A 100-ms one-shot multivibrator is triggered once each second by the 1 pps signal from the divide-by-100 counter. The output of the one-shot multivibrator is applied to a μA709C operational amplifier with a gain of two. A diode is used in a dc-restoring circuit at the output to the spectrum analyzer. The circuit triggers the spectrum analyzer's horizontal sweep once per second and the trigger occurs 100 milliseconds after the band change begins. This avoids displaying the IF passband while most of the switching transients are in the system.

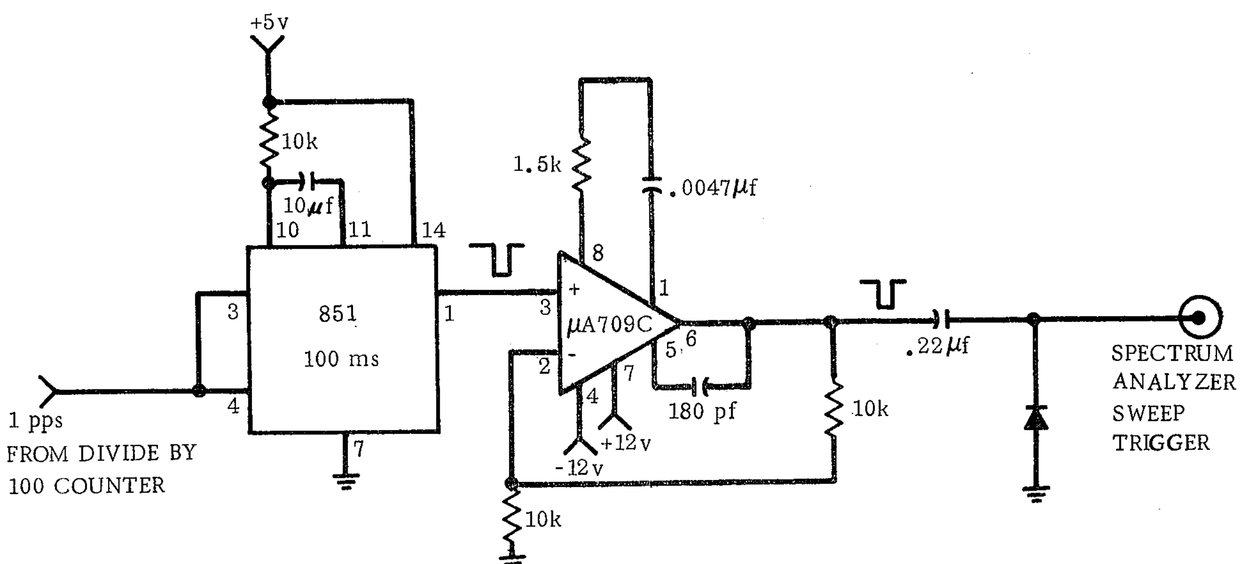


Figure 4-34. Spectrum Analyzer Sweep Trigger

4.3.2.4 Camera Trigger. The camera trigger circuit (Figure 4-35) is used in the airborne system only. The circuit produces a 300-ms-wide, +28 volt pulse to trigger the camera shutter and film transport. The trigger occurs every 5, 10, or 20 seconds as selected on the front panel.

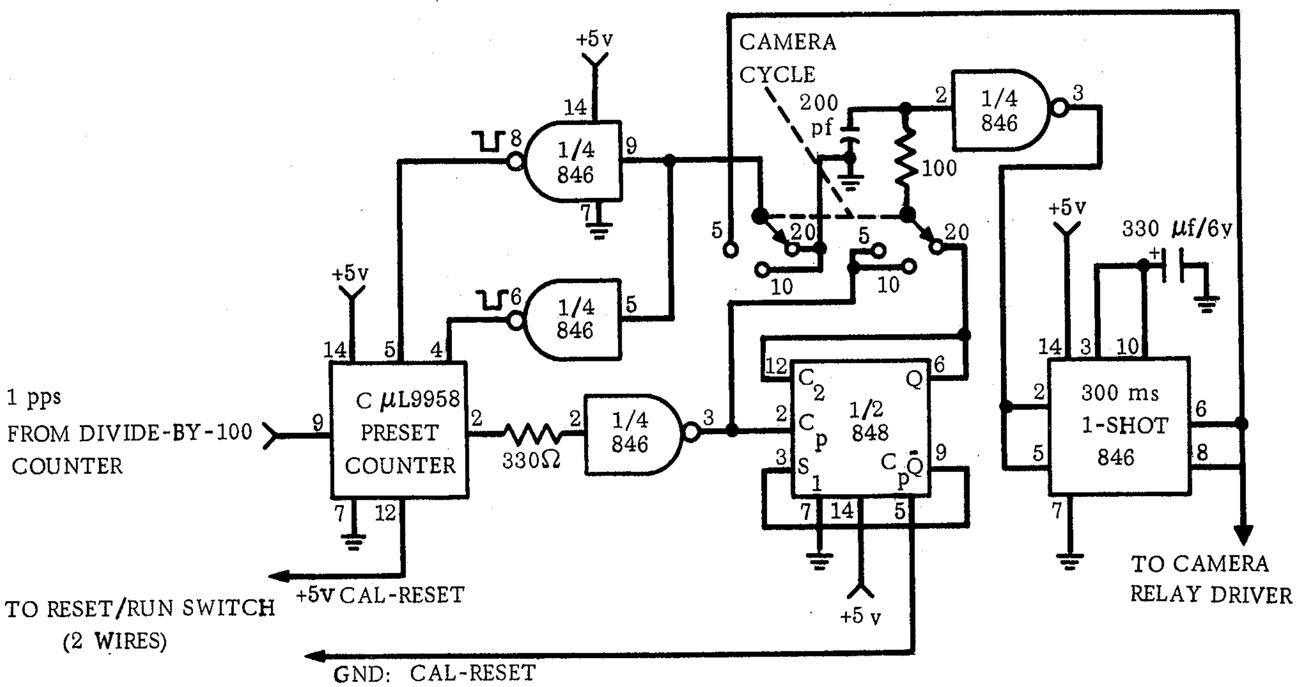


Figure 4-35. Camera Trigger

To produce a 5-second camera cycle, the 1 pps from the divide-by-100 circuit is counted by a CμL9958 decade counter. At the count of 8, there is a 1-0 transition at the counter output, which is inverted by one section of an 846 quad 2-input nand gate and reinverted by a second section of the gate. The resulting 1-0 transition triggers a 300-ms 846 one-shot multivibrator. The +5 volt pulse from this multivibrator is inverted by two parallel inverters, therefore grounding pins 4 and 5 of the decade counter for 300 ms. This presets the counter to a count of 3. When the one-shot pulse ends, the grounds are removed from pins 4 and 5 and the counter functions normally. The counter then counts to 8 and repeats the cycle every 5 seconds.

A 10-second camera cycle is formed by eliminating the feedback around the CμL9958 counter. The inputs to the feedback pins of the counter are the true (1) outputs of the 846 gates, which do not affect counter operation. Without feedback, the counter recycles after a full count of 10. The 1-0 transition at the counter output at the count of 8 is inverted twice and triggers the 300-ms one shot multivibrator. The 846 feedback gate inputs are grounded by the cycle-time switch. The counter proceeds to the count of 10 before recycling to zero.

The 20-second camera cycle is attained by adding a toggling flip-flop after the inverter on the decade counter output. The 0.1 pps signal at the CμL9958 counter output is then divided by two, triggering the one-shot multivibrator every 20 seconds. The 28 volt camera pulse is formed by camera relay K_4 (Figure 4-28) with its associated relay driver. Five volts from the one-shot multivibrator saturates the EN914 transistor. The 1N914A diode in the emitter lead ensures that the transistor is OFF when 0.8 volt (logical 0) is applied to it.

The counter and the flip-flop are both reset to zero when the mode switch is in CAL or RESET. A toggle switch at the rear of the logic chassis disconnects the camera trigger and driver circuits from the relay, allowing manual camera control.

4.3.2.5 Cycle Time, Divide by 2, 3, 5, or 10. The cycle-time counter is a slightly more complicated version of the camera interval counter. As shown in Figure 4-36, 1 pps is applied to the counter input. Feedback is used on all four preset inputs (pins 2, 3, 4, and 5), including the counter output itself. The 10-second cycle is formed by using no feedback at all. The cycle time switch opens the feedback to pin 2 and grounds the three 846 gate inputs, allowing the counter to cycle normally. The 1-0 transition on output pin 2 at the count of 8 triggers the one-shot chain for sampling and the RF band counter.

The 5-second cycle time is attained by presetting the counter to the count of 5 immediately after it reaches 10. When 10 is reached, pin 2 of the counter goes high and the first 300-ms one-shot multivibrator is triggered. The one-shot output (pins 6 and 8) goes high and the two inverter gates go low (pins 3 and 8), grounding the first and third flip-flops in the CμL9958 counter (pins 3 and 5). This changes the count from 0 to 5. The one-shot pulse ends and the feedback is removed before another pulse arrives at the counter input.

The 3-second cycle is formed similarly, except that feedback after the 10th count uses all three feedback gates and grounds counter pins 3, 4, and 5, which preset the counter to the count of 7. The 2-second cycle is formed by presetting the counter to 8. The three feedback gates are not used (i.e., inputs are grounded); the negative-going pulse of the second one-shot grounds pin 2 (the counter output) 300 ms after the count of 10 is reached. The ground is removed when the one-shot pulse is over, 600 ms after the 10th count was reached.

4.3.2.6 RF Band Counter. Pulses from the output of the cycle time counter are fed through an RC low-pass filter and inverter to the RF band counter. A schematic of this counter is shown in Figure 4-37. The filter prevents double-advance of the band counter. Two SN7473N dual J-K flip-flops and one section of an 846 gate form a scale-of-three counter. The flip-flops count like a normal binary counter until the count of 3 (binary 11) is reached. Then both inputs to the gate are high and its output goes low and grounds the C_D (clear) terminals of both flip-flops, resetting the count to 00 almost instantaneously.

The band commands are formed here at a 5-volt level. The diodes and resistor form a NAND gate that sends a band 1 command when both flip-flops are low (count 00). Band 2 is sensed when the first flip-flop is high (count 01), and Band 3 is sensed when the second flip-flop is high (count 10). The count 11 sends band commands to Band 2 and Band 3 relay drivers, but the 11 state disappears long before the band relays close. The video amplifier is blanked during this transient state. A 5-volt signal on one of these three lines sets the video amplifier gain and saturates the appropriate relay driver, closing the appropriate band relay.

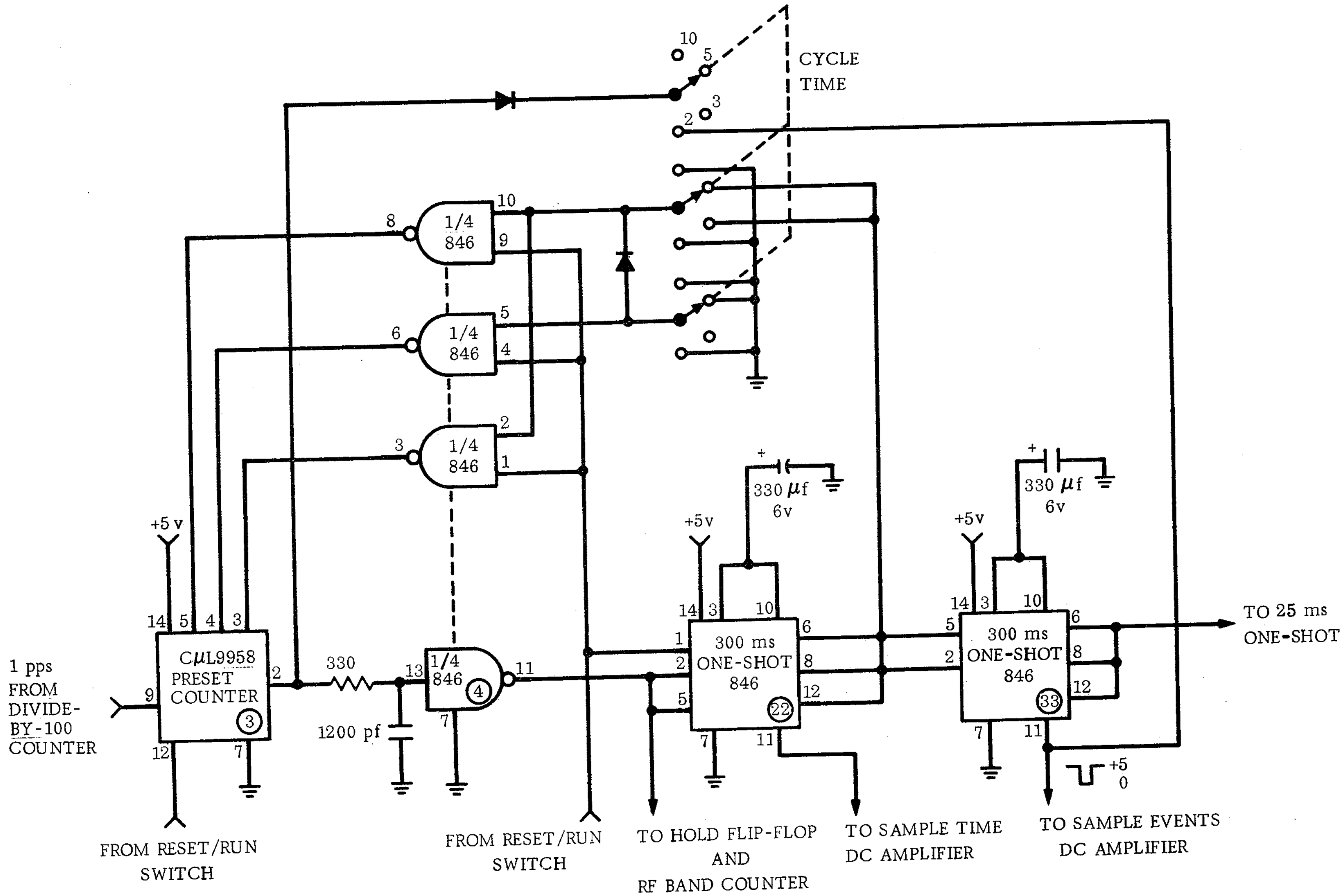


Figure 4-36. Cycle Time Counter

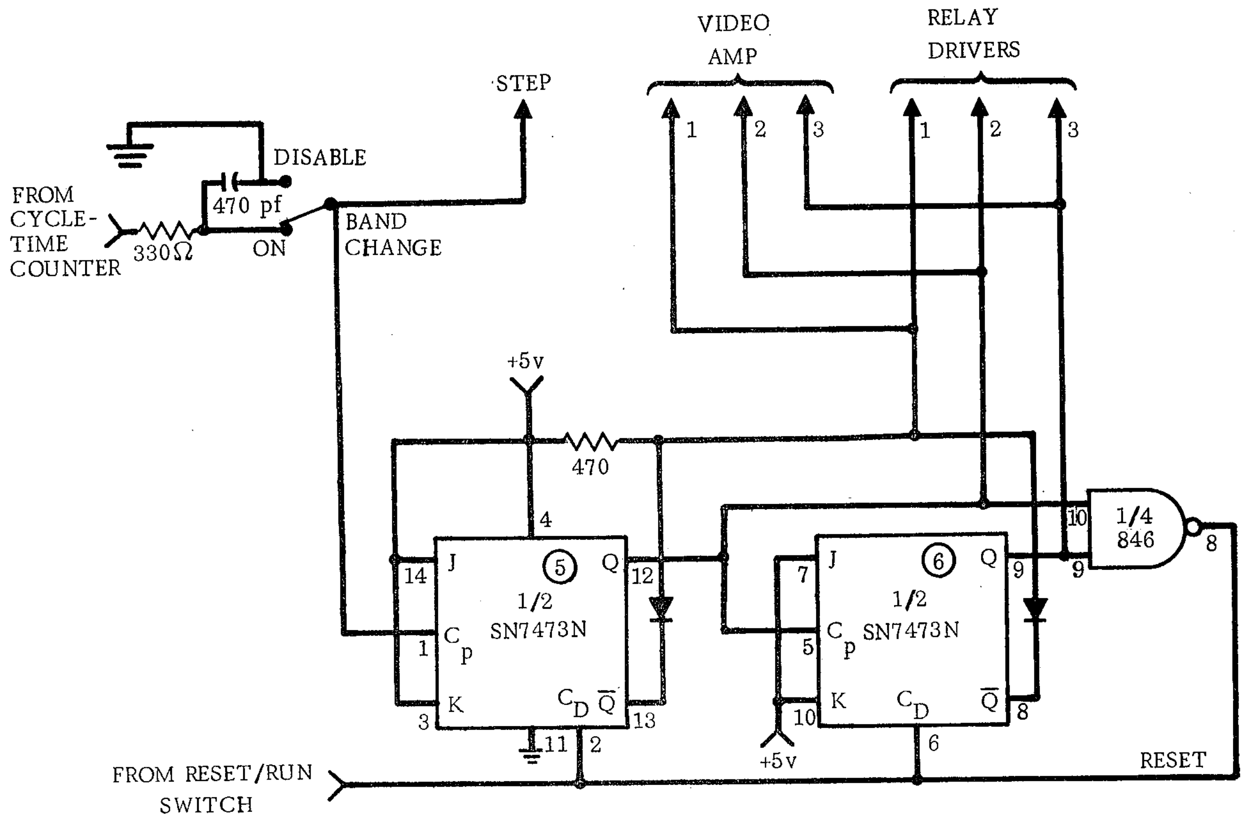


Figure 4-37. RF Band Counter

4.3.2.7 Relay Drivers. Each of the four 28 vdc relays is closed by saturating an EN914 transistor switch in the ground return lead from the relay coil. Figure 4-38 is a schematic of the relay drivers. The relay coils are all shunted by damping diodes to prevent high negative voltage transients at the transistor collectors. The diode in series with each of the emitter leads ensure the transistors are OFF with a logical 0 input (0.4 volt maximum).

4.3.2.8 RF Identification. One set of contacts on each of the three RF band relays is used in developing an analog signal to encode the RF band information. The relay contacts connect the VCO input to one of three taps on a voltage divider, as shown in Figure 4-39. The voltage tap is at 0 volts on Band 3, +2.4 volts on Band 2, and +4.8 volts on Band 1 (3 GHz, 1 GHz, and 300 MHz, respectively).

4.3.2.9 Comparator Threshold Control. A special 12-volt band command appearing on one of three lines sets the voltage comparator threshold levels to the correct value for that RF band. Two miniature 28v relays (K_5, K_6) located beneath the logic chassis generate these band commands, as indicated by Figure 4-40. Voltage from the main 12v supply is switched by these relays to one of the three voltage comparator threshold control lines.

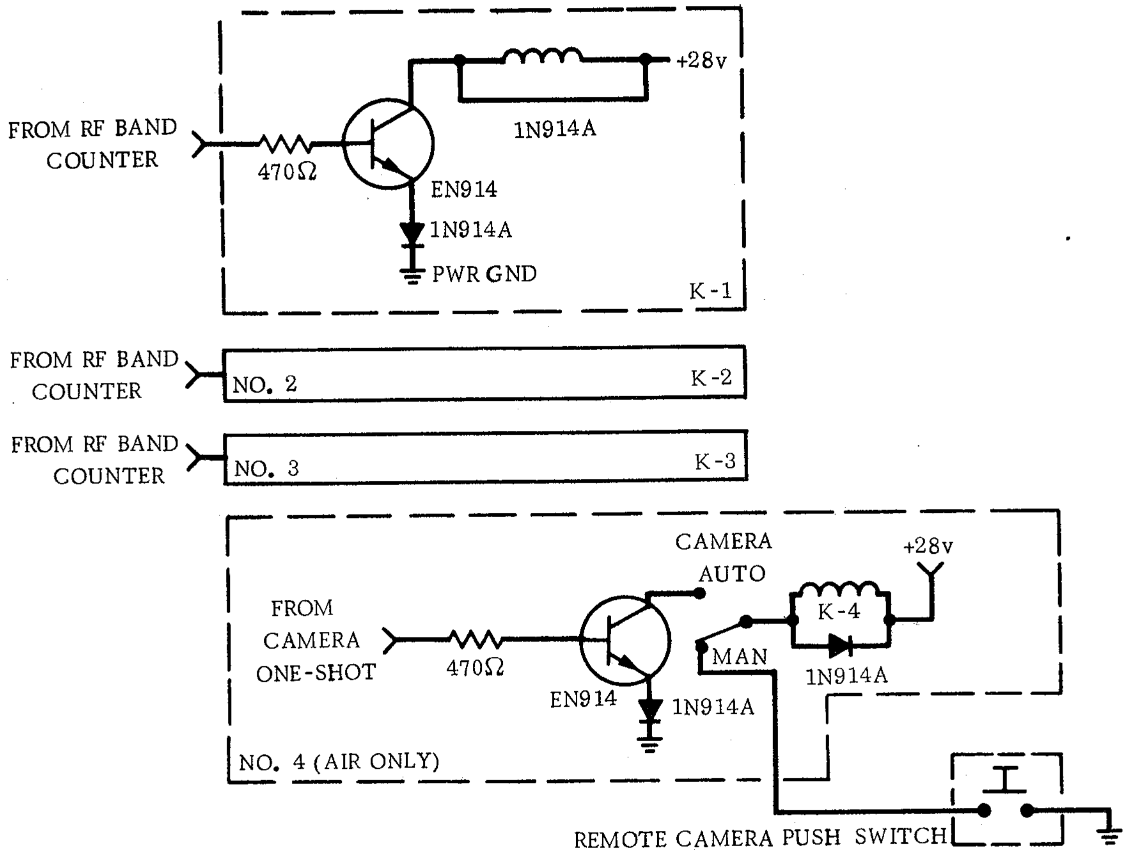


Figure 4-38. Relay Drivers

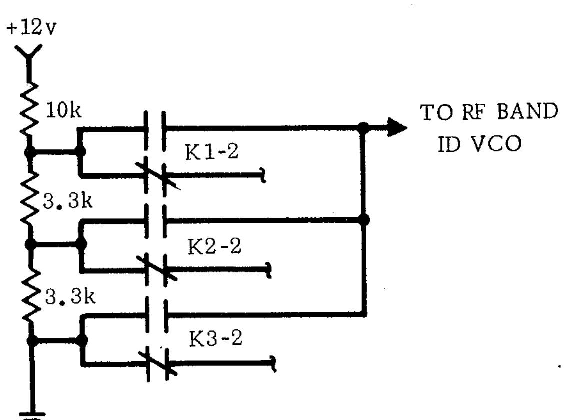


Figure 4-39. RF Band ID Voltage Divider

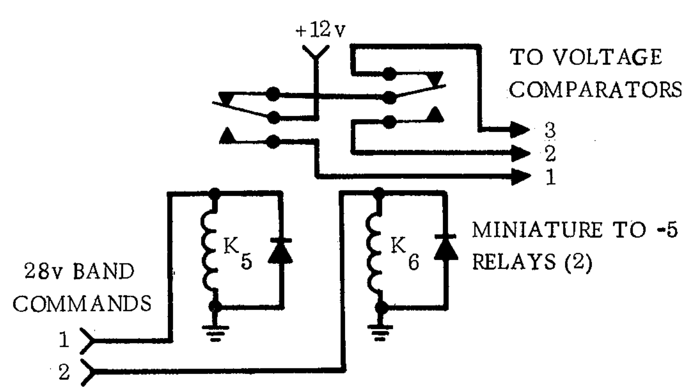


Figure 4-40. Comparator Threshold Control Circuitry

4.3.2.10 Data Sampling Control. At the end of each measurement interval, all integrators are held at a constant value while being sampled, then reset to zero. The string of four one-shot multivibrators shown in the logic control block diagram (Figure 4-28) controls the sequence of these actions. The sequence logic timing diagram (Figure 4-29) details the chain of events at each band-change transition.

The 0-1 transition at the end of a measurement interval at the cycle-time preset output (pin 2) is inverted by one section of an 846 quad 2-input nand gate, applying a 1-0 transition to the RF band counter, the first 300-ms one-shot multivibrator and to the integrator hold flip-flop (848). Immediately, the RF band counter advances by one, the integrator hold flip-flop goes to a "true" state, and the sample-events one-shot multibrator fires. The positive-going pulse output of this multivibrator is connected to the second 300-ms one-shot multivibrator, and the 1-0 transition at the end of the first 300-ms pulse fires the second multivibrator. Similarly, the 25-ms and 2-μsec one-shot multivibrators are fired successively. This is illustrated in the timing diagram of Figure 4-29.

The 12 time-and-events integrators are prevented from filling further during the sampling intervals by the integrator-hold flip-flop, shown schematically in Figure 4-41. When the first one-shot multivibrator fires at the end of the measurement interval, the 1-0 trigger applied to the SET and CLOCK terminals of the 848 set that flip-flop to a 1 output. The 0 complementary output at terminal $\overline{Q}$ disables the six event one-shot multivibrators. The percent-of-time integrators are sampled and cleared (625 ms later), and the negative-going pulse from the 2-μsec one-shot multivibrator grounds the dc clear (C_D) terminal of the flip-flop, causing it to revert to a 0 state. The integrators are thus released and begin filling again.

Two insulated-gate FETs and an operational amplifier form a three-level signal, which is sent to a VCO to identify the sample that is present simultaneously on the six comparator data lines. Figure 4-42 is a schematic of the circuitry that forms this identification signal. When no sample is being taken, the sample-time and sample-events lines are both at -5 volts. The FETs are OFF and the μA709C amplifier output is 2.5 volts. While the percent-of-time sample is being taken, the lower FET is ON and the amplifier output is limited to approximately +5 volts by the back-to-back feedback zener diodes. Without these diodes, the output would be +8 volts. While the number-of-events sample is being taken, the upper FET is ON and the amplifier output is limited to 0 volts by the 1N914 feedback diode. Without this diode, the amplifier output would then be -3 volts.

The negative-going outputs of the 300-ms sample time and events one-shot multivibrators pass through identical dc amplifiers before being applied to the sampling FETs. Figure 4-43 is a schematic of these dc amplifiers. In the quiescent state, the one-shot outputs are +5 volts, the EN2907 transistors are OFF, and the sample line voltages are determined by the resistive voltage dividers. The value becomes -5 volts. In the transient (one-shot) state, the one-shot outputs are 0 volts, the transistors are saturated, and the sample lines are at +5 volts.

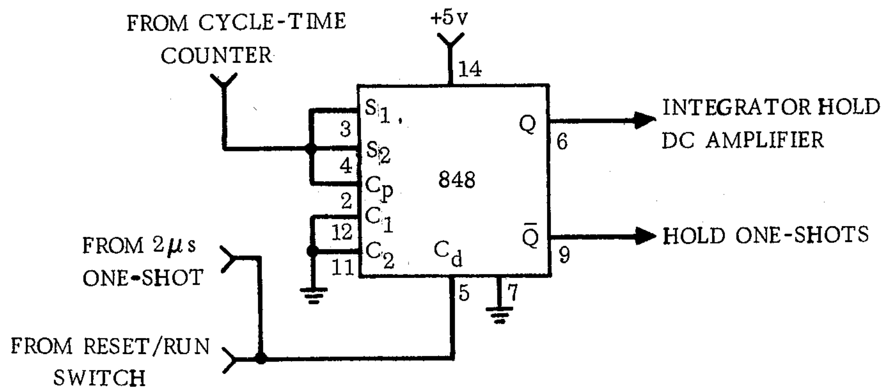


Figure 4-41. Integrator Flip-Flop

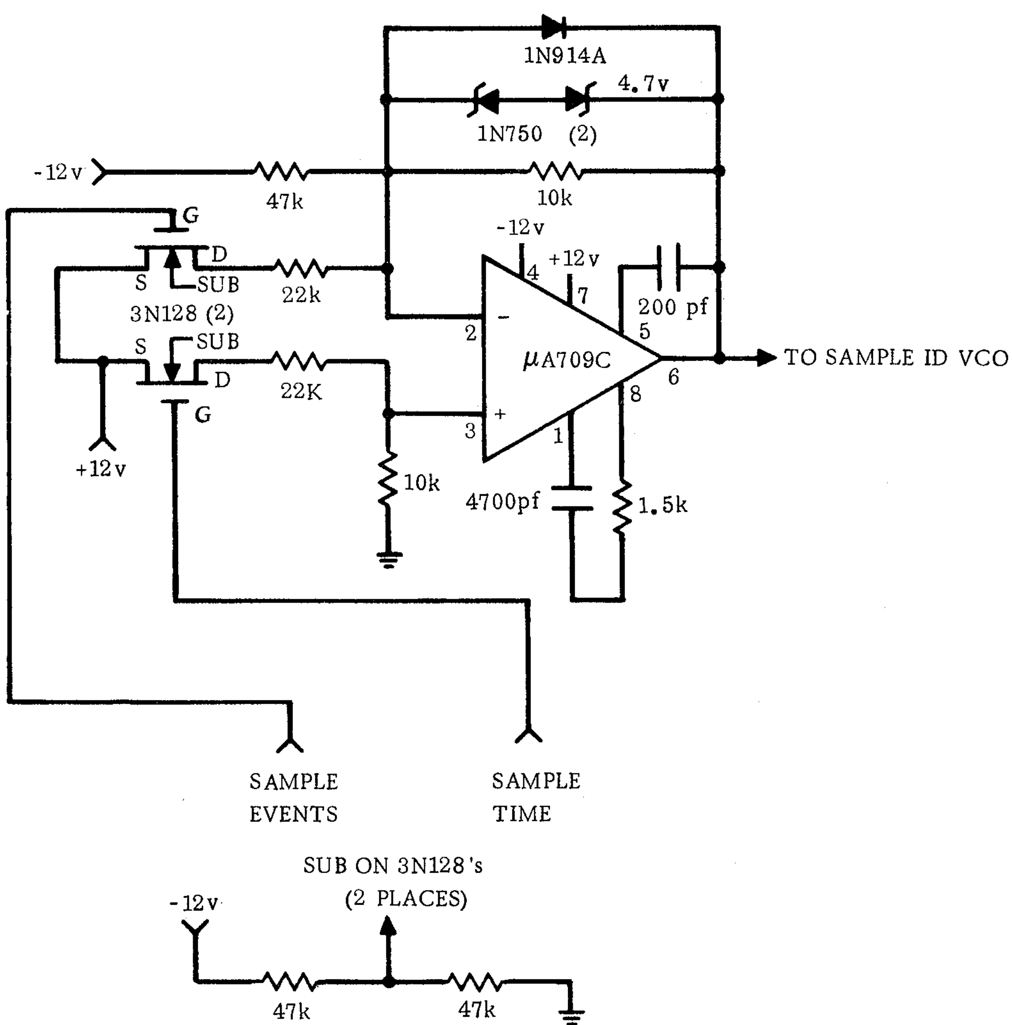


Figure 4-42. Sample ID Circuitry

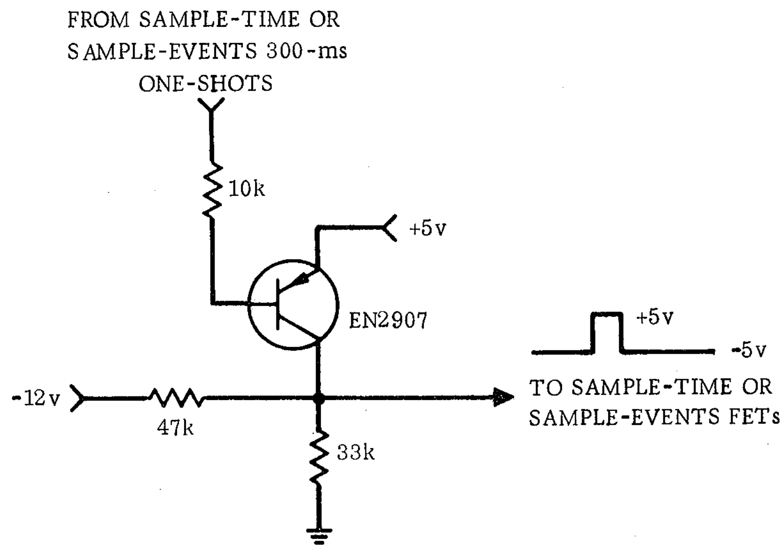


Figure 4-43. Sample-Time or Sample-Events dc Amplifier

The output of the 25-ms integrator-clear one-shot multibrator is connected to an EN2907 dc amplifier, shown schematically in Figure 4-44. In the quiescent state, the one-shot output is +5 volts, the transistor base is raised to 3.6 volts, and the transistor is cut OFF, leaving the integrator-clear line at -12 volts. In the transient (one-shot) state, the one-shot output is zero and the transistor is saturated by base current from the 22-kΩ resistor. The integrator-clear line is then at -0.3 volt, clearing the integrators.

While the integrators are being filled, the integrator-hold flip-flop is in the 0 state. The first transistor of the following dc amplifier (Figure 4-45) is saturated and the second transistor is biased OFF, so no current is drawn from the integrator-clear line. During the integrator-hold period, the flip-flop is in the 1 state, the first transistor is OFF, and the second transistor is ON. The integrator-hold line is then at -12 volts, disabling the percent-of-time integrators.

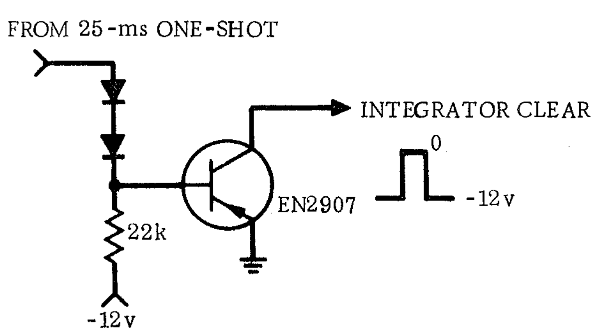


Figure 4-44. Integrator-Clear dc Amplifier

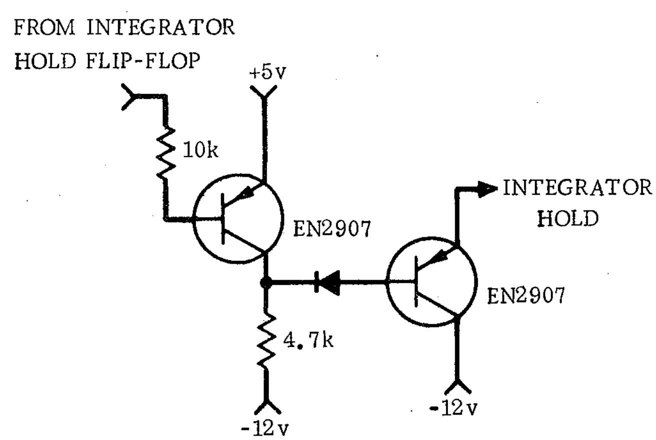


Figure 4-45. Integrator-Hold dc Amplifier

4.3.2.11 Calibrate/Reset/Run Control. A front panel switch (Figure 4-46) is used to reset most of the system logic while calibrating the VCOs. In the RESET position, the divide-by-100 counter, the RF-cycle-time preset counter, the camera-cycle-time counter and flip-flop, and the RF band counter are all set to the count of 0. The system is thus placed in Band 1 (300 MHz), the integrators are allowed to fill, and camera shutter pulses or spectrum analyzer sweep trigger pulses are not generated. This is accomplished by grounding the reset inputs of the band counter and camera flip-flop while placing +5 volts on the reset inputs of the divide-by-100 counter, cycle-time counter, and the CμL 9958 preset counter in the camera section. At the same time, the RESET/RUN (normally grounded) line to the VCO has +5 volts placed on it. In the CAL position, all these functions are the same as in the RESET position, while the ground returns from the CAL relays in the monitoring chassis are grounded, thus pulling in the calibration relays.

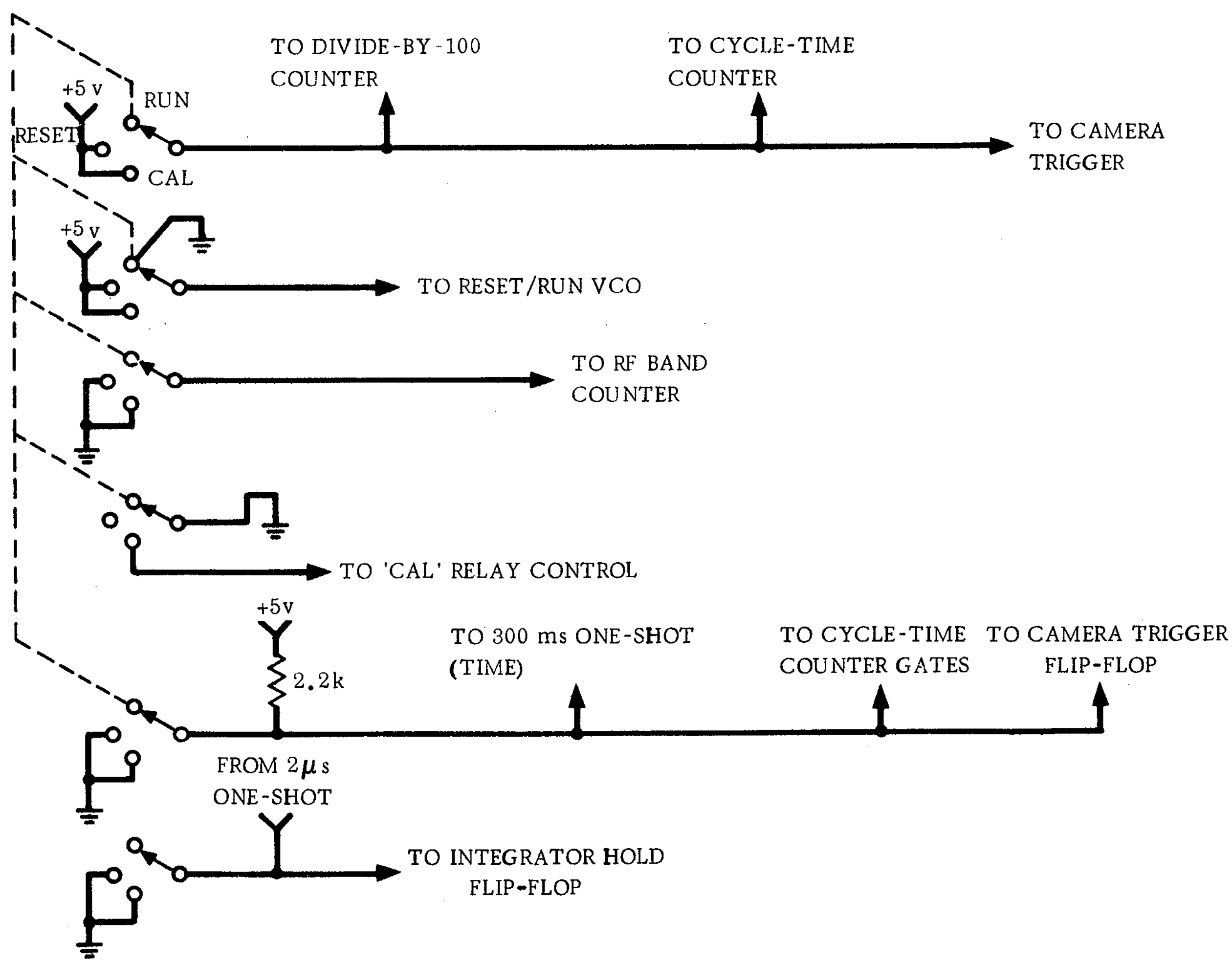


Figure 4-46. Calibrate/Reset/Run Switch

4.3.3 AUXILIARY CIRCUIT DETAILS

4.3.3.1 DME Interface Circuitry. DME was included in the airborne noise-measuring system so that the distance from the aircraft to a local VORTAC station could be measured continuously. The DME consists of a receiver/interrogator, a servo indicator, and an antenna mounted forward beneath the fuselage. The antenna is fed by a 50-Ω RG-9/U coaxial cable running through the aircraft's drift sight well. The receiver/interrogator unit was modified by adding a wire from test point TP7 inside the unit to output pin 32 of the unit. This wire makes accessible a pulse whose width is proportional to the distance measured by the DME. A special pulse-width to binary-code converter provides a serial binary code range output for recording. Figure 4-47 is a schematic of the DME control circuitry.

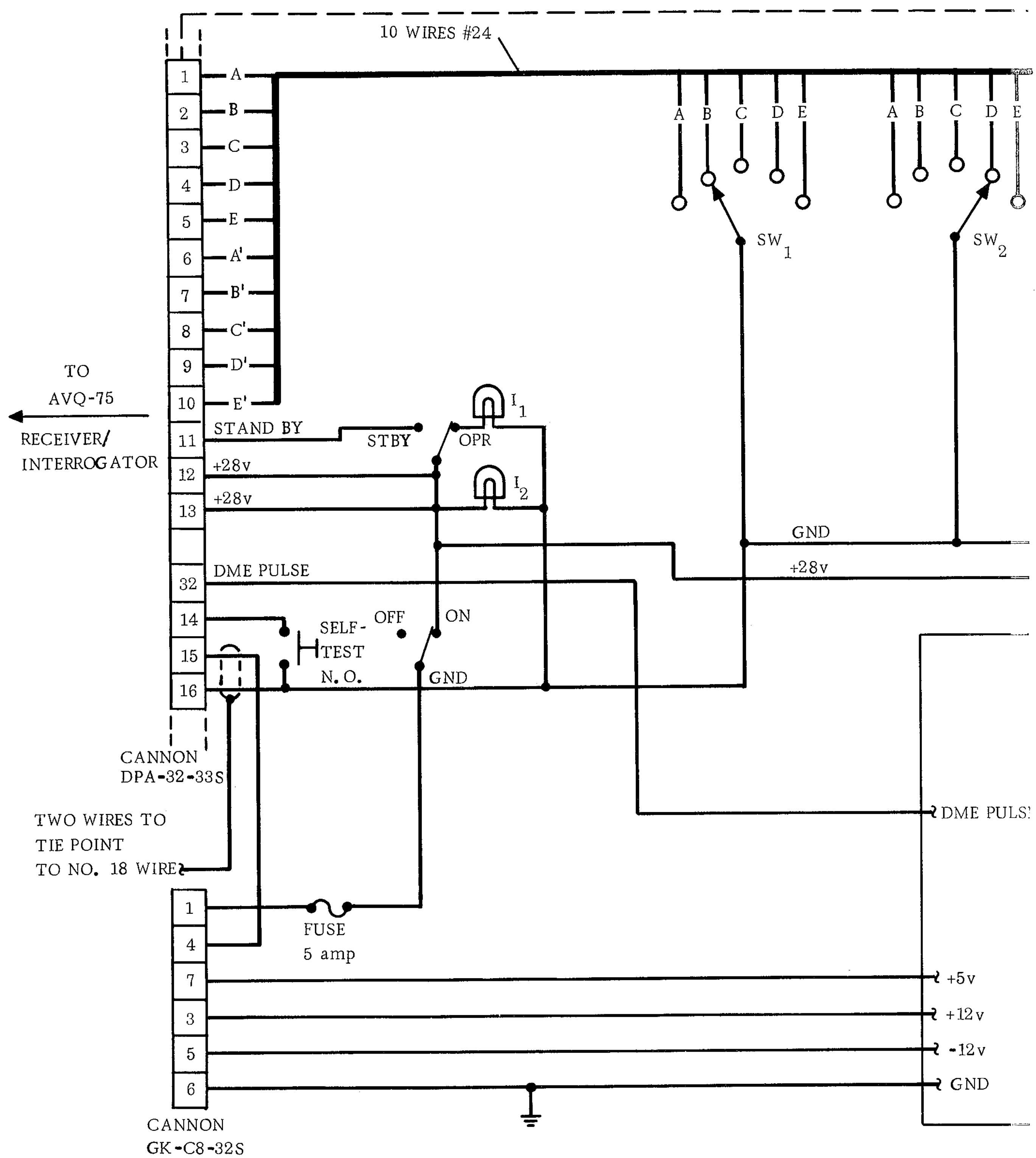
The DME range pulse is converted to a three-level self-clocked binary code by the interface circuit shown in Figure 4-48. The DME code format is explained in Figure 4-49. A 10-MHz FAST CLOCK signal is gated into a counter for the duration of the DME range pulse. The counter is isolated from the 10 MHz signal after the range pulse is over, and the count is transferred to a shift register. The binary count is then shifted out of the register (becoming the serial code output) and the counter is reset to zero, enabling the FAST CLOCK gate. The next DME range pulse opens the FAST CLOCK gate briefly, and the cycle of operation starts over. Figure 4-50 is a timing diagram of the entire chain of events.

The DME interface operation is completely halted if the DME interrogator loses its ground station. The single discrete EN914 transistor then disables both sections of counter C_5 (10 MHz and 10 Hz) by disconnecting their reset pins from ground. The resulting DME CODE output is steady dc at 0 or +2.5 volts, depending on where FF_{1B} stops and on the last bit in register R_3.

Amplifier A_2 develops an extremely high input impedance. The DME range pulse source impedance is many megohms, and loading TP7 produces non-linear distortion of the waveform. The 16-megohm impedance developed was high enough to avoid this problem.

The level of the 10-MHz time base from the frequency counter is too low to trigger the TTL logic used. It is first amplified by A_1, which is a μA710C comparator being operated as a Schmitt trigger. A 10-MHz signal is then divided by six so that a 50-n.mi. (92.6-kilometer) range pulse (614 μsec wide) gates through 1023 pulses, exactly filling the 10-bit binary counter. Thus, a 50-n.mi. range corresponds to the DME code 1111111111.

The 10 Hz from the time base is divided by four by C_{5A} and FF_{1B} to produce the 2.5-Hz SHIFT CLOCK signal for the self-clock circuitry (G_4, A_3) and the shift registers R_1 through R_3. The register shifts to the right and parallel loads at the 0-1 transition on its CLOCK inputs. Counter C_4, flip-flop FF_{1A}, and gates G_{1B}, G_2, and G_{3A} control the timing of the MODE and COUNTER INHIBIT (reset) lines. The 2.5-Hz SHIFT



10 WIRES #24
1 A
2 B
3 C
4 D
5 E
6 A'
7 B'
8 C'
9 D'
10 E'
A B C D E
A B C D E
SW1
SW2
TO
AVQ-75
RECEIVER/
INTERROGATOR
11 STAND BY
STBY
OPR
I1
12 +28v
I2
13 +28v
GND
32 DME PULSE
+28v
14
SELF-
TEST
N. O.
OFF
ON
15
16
GND
CANNON
DPA-32-33S
TWO WIRES TO
TIE POINT
TO NO. 18 WIRE
DME PULS
1
4
FUSE
5 amp
7 +5v
3 +12v
5 -12v
6 GND
CANNON
GK-C8-32S

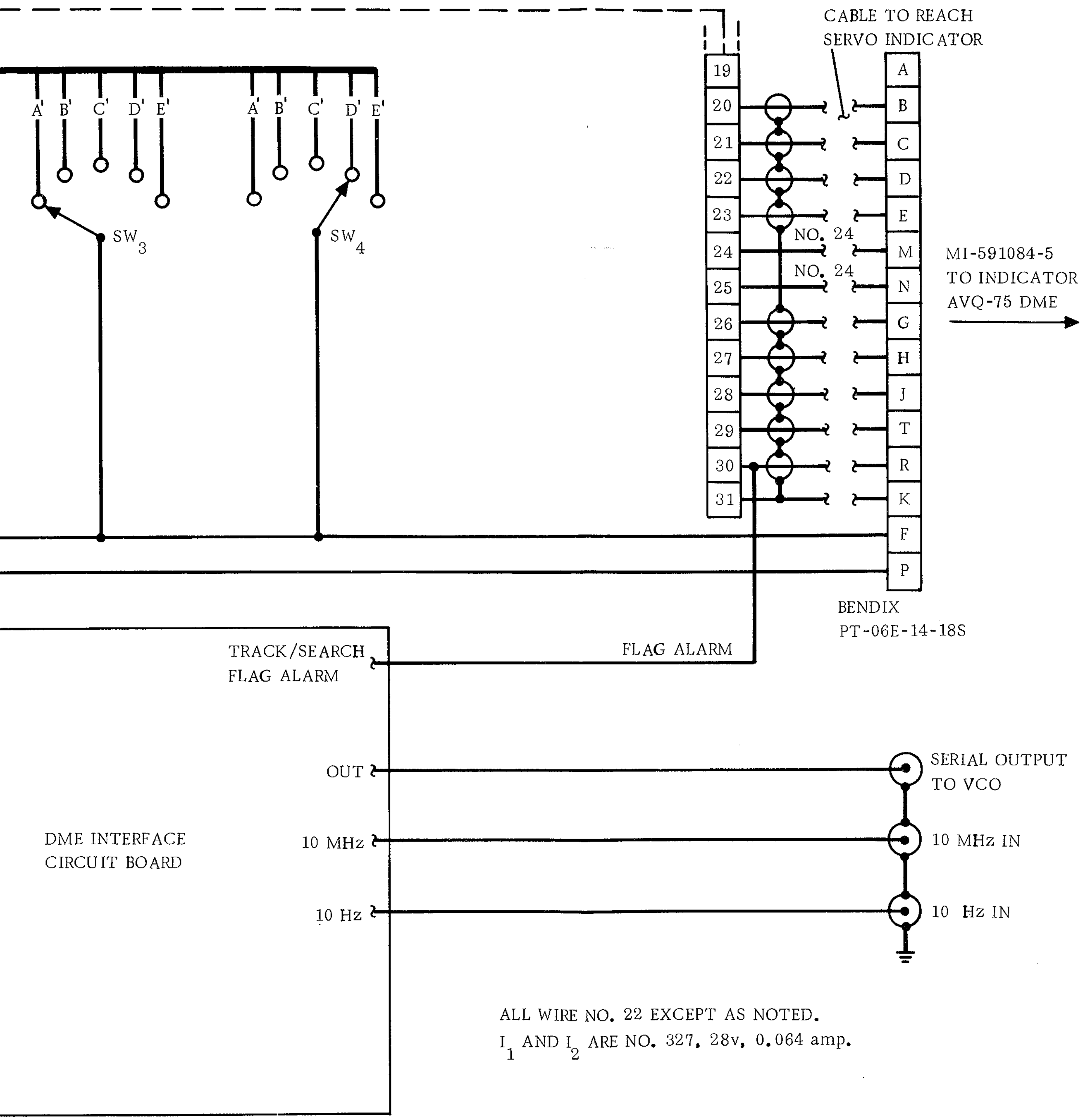
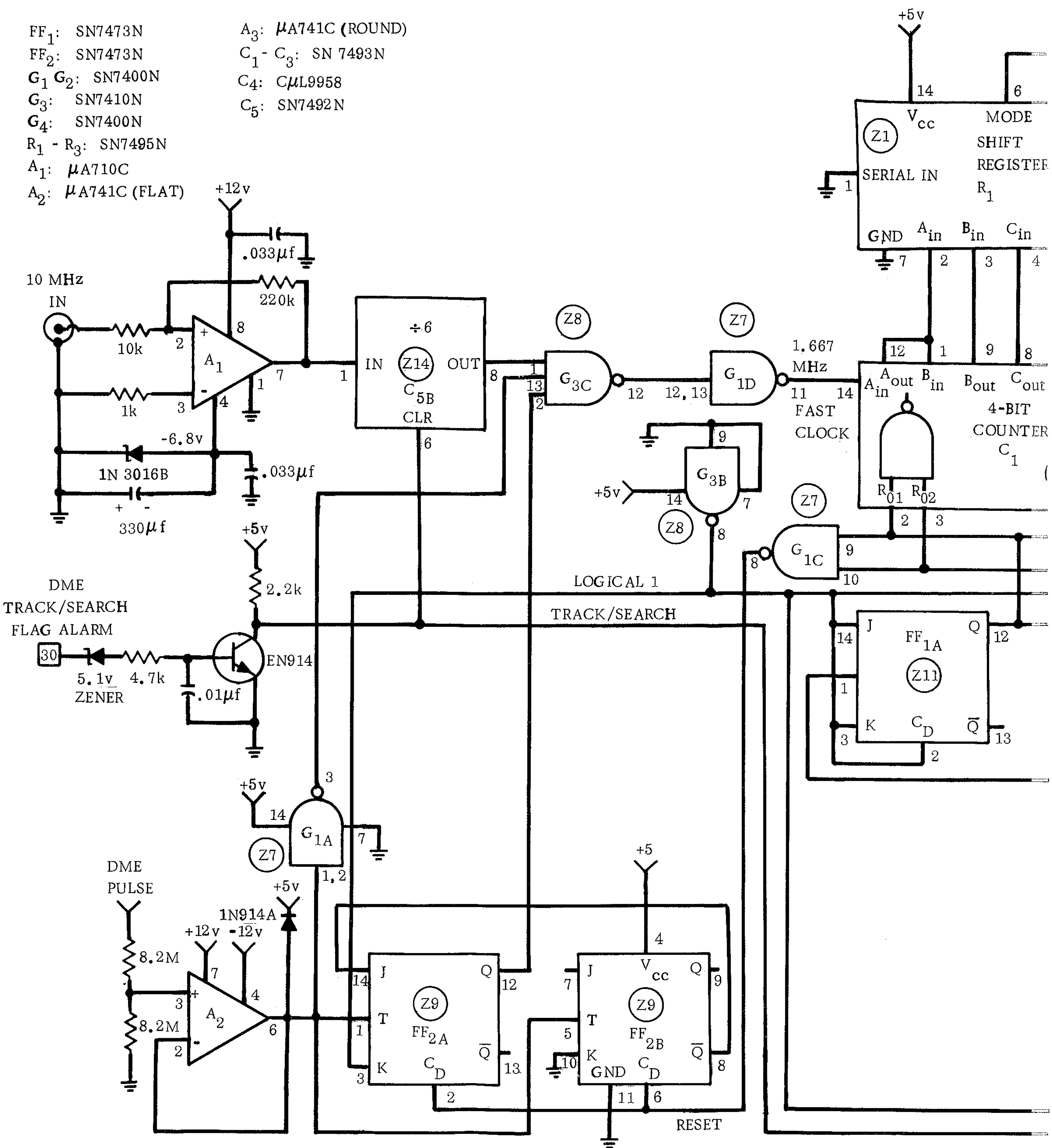


Figure 4-47. DME Control Circuitry


FF1: SN7473N
FF2: SN7473N
G1 G2: SN7400N
G3: SN7410N
G4: SN7400N
R1 - R3: SN7495N
A1: μA710C
A2: μA741C (FLAT)
A3: μA741C (ROUND)
C1 - C3: SN 7493N
C4: CμL9958
C5: SN7492N
+12v
.033μf
220k
10 MHz
IN
10k
1k
A1
-6.8v
1N 3016B
.033μf
330μf
÷6
IN
Z14
OUT
C5B
CLR
Z8
G3C
Z7
G1D
1.667
MHz
FAST
CLOCK
+5v
Z1
Vcc
MODE
SHIFT
REGISTER
R1
SERIAL IN
GND
Ain
Bin
Cin
Aout
Bout
Cout
4-BIT
COUNTER
C1
R01
R02
G3B
Z8
Z7
G1C
LOGICAL 1
TRACK/SEARCH
DME
TRACK/SEARCH
FLAG ALARM
30
2.2k
EN914
5.1v
ZENER
4.7k
.01μf
FF1A
Z11
J
Q
K
CD
Q̄
G1A
Z7
DME
PULSE
8.2M
8.2M
+12v
-12v
1N914A
A2
FF2A
Z9
T
+5
FF2B
GND
RESET

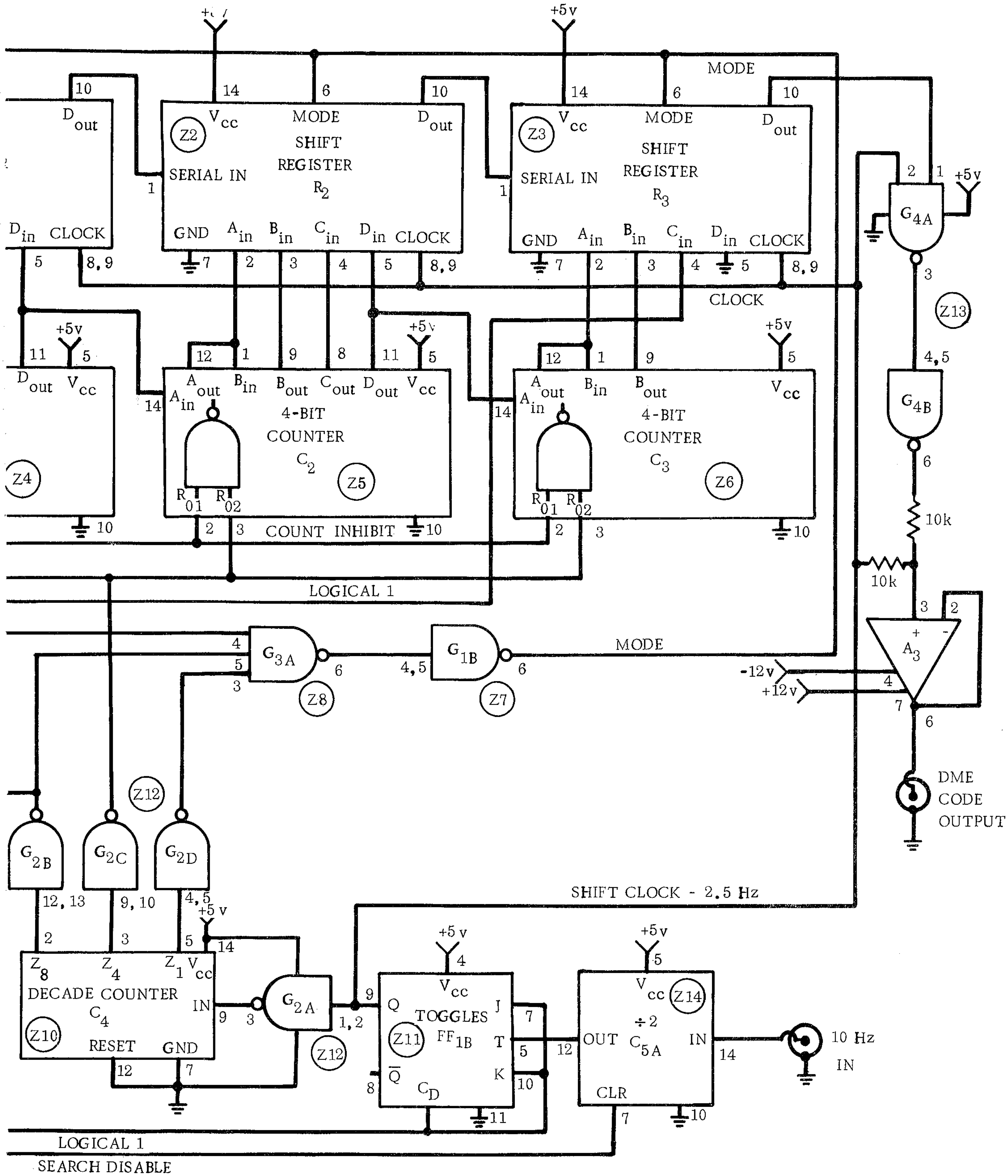


Figure 4-48. DME Interface Circuitry

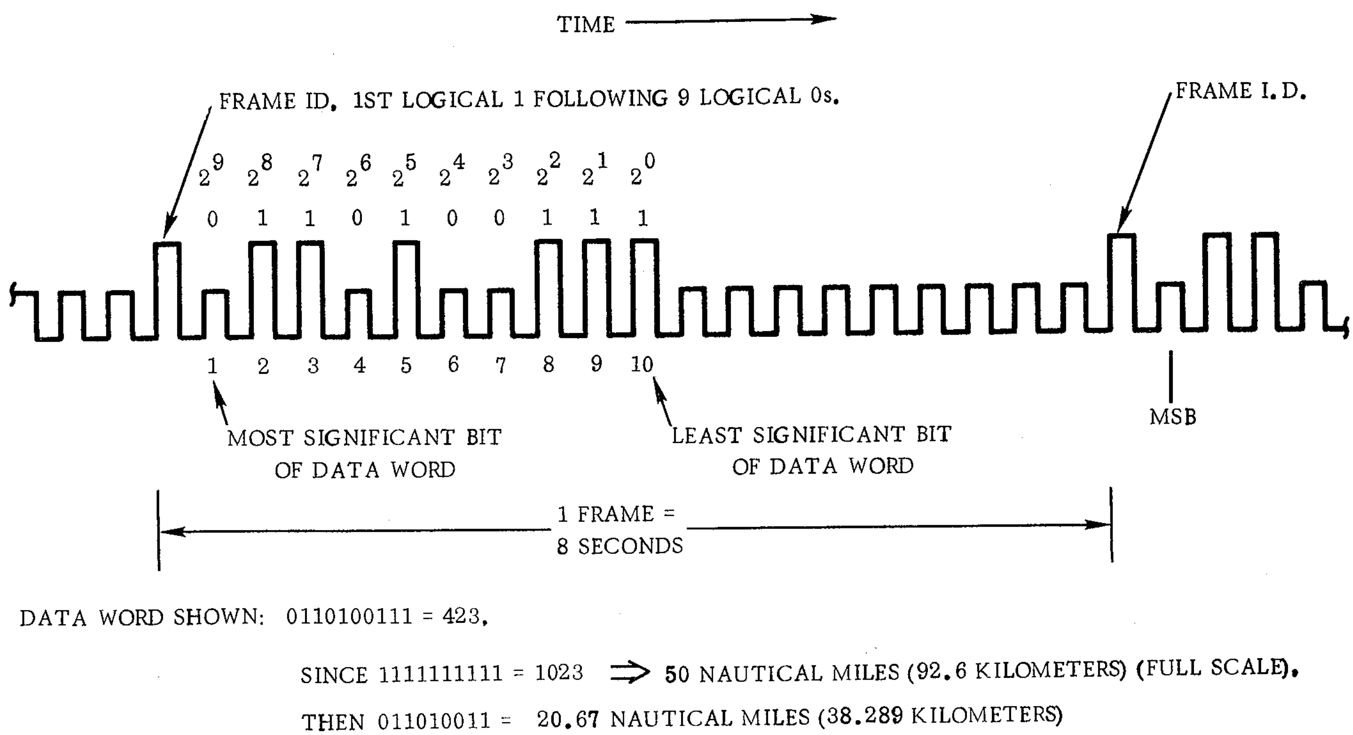


Figure 4-49. DME Range Data Code Format

CLOCK signal is divided by 20 to produce these signals. The MODE line is high (PARALLEL LOAD) only when FF_{1A} is high and the counter has $Z_8 = 0$ and $Z_1 = 0$. The counters are reset to zero when the COUNT INHIBIT lines are both high, which is when $FF_{1A} = 1$ and counter $Z_4 = 0$. At the same time, the DME pulse counter FF_2 is reset to zero.

As shown in the timing diagram in Figure 4-50, the fast clock is gated off after the DME pulse has passed. The MODE line then goes high, and the count is transferred to the registers at the next SHIFT CLOCK pulse. The MODE line then goes low, and the count is shifted to the right to the self-clock circuits (G_4). Nineteen SHIFT CLOCK pulses then fill the registers from the left with 0s. Between the 14th and 15th SHIFT CLOCK pulses, the counters are reset to zero and held there until after the 18th pulse. Then the counters are released (COUNTER ENABLE) and the first DME pulse in the next 600 ms opens the FAST CLOCK gate. Any succeeding DME pulses are blocked by FF_{2A} applying a 0 to gate G_{3C}.

4.3.3.2 Data Calibration Circuit. When the MODE switch on the data and logic chassis is set to the CAL position, relays in the monitoring chassis apply calibrating voltages from the CAL BUS to the analog data lines. Figure 4-51 is a schematic of the calibration control circuitry, and Figure 4-52 is a schematic of the calibration voltage supply. A high-precision dc amplifier using a μA727 temperature-compensated preamplifier and μA741C operational amplifier produce the CAL BUS voltages. A five-position switch on the front panel of the monitoring chassis allows selection of the amplifier feedback resistance, which sets the amplifier gain. The amplifier input is a stabilized

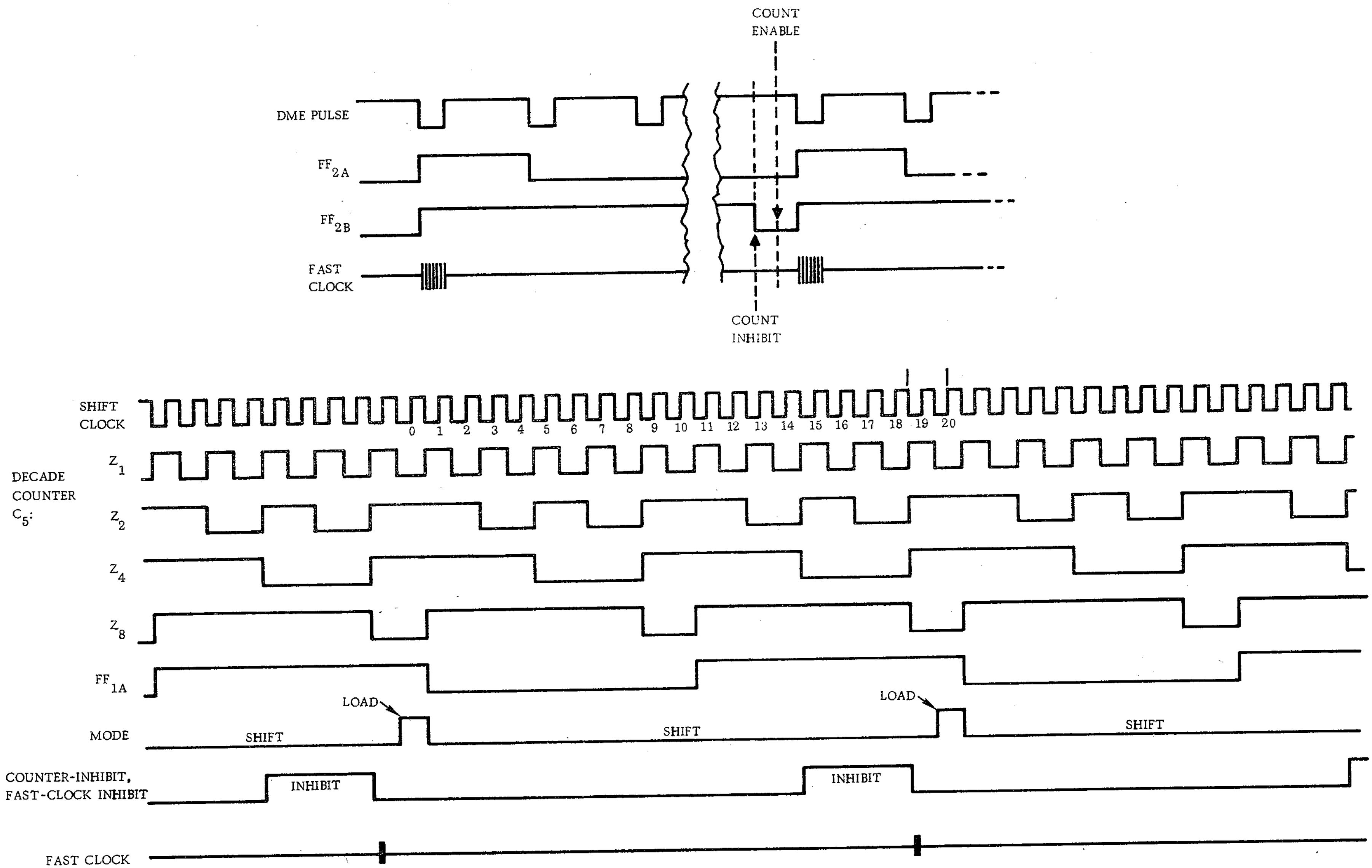
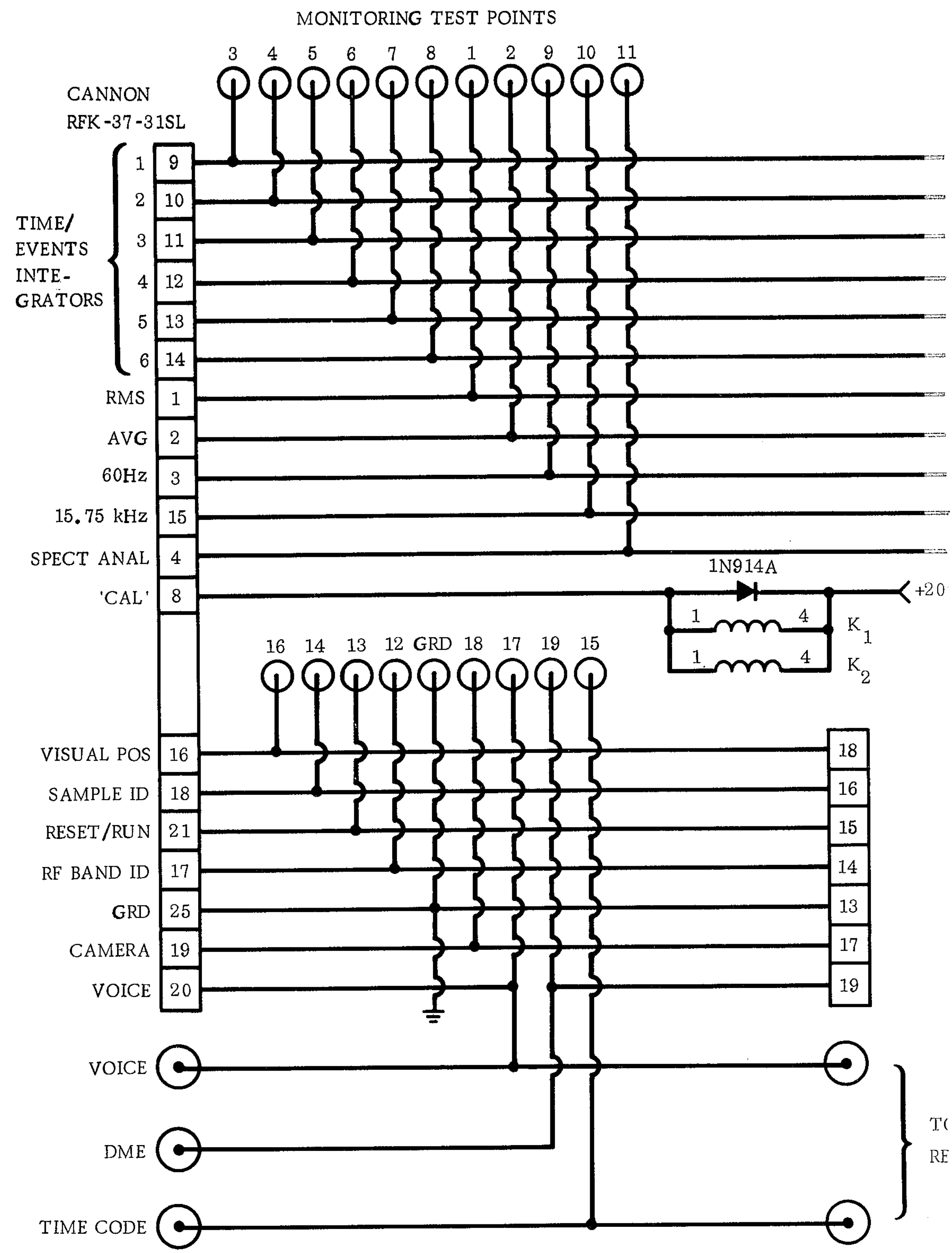


Figure 4-50. Timing Diagram for DME Range Data


MONITORING TEST POINTS
3 4 5 6 7 8 1 2 9 10 11
CANNON
RFK-37-31SL
TIME/
EVENTS
INTE-
GRATORS
1 2 3 4 5 6
9 10 11 12 13 14
RMS 1
AVG 2
60Hz 3
15.75 kHz 15
SPECT ANAL 4
'CAL' 8
1N914A
+20
K1
K2
16 14 13 12 GRD 18 17 19 15
VISUAL POS 16
SAMPLE ID 18
RESET/RUN 21
RF BAND ID 17
GRD 25
CAMERA 19
VOICE 20
18 16 15 14 13 17 19
VOICE
DME
TIME CODE

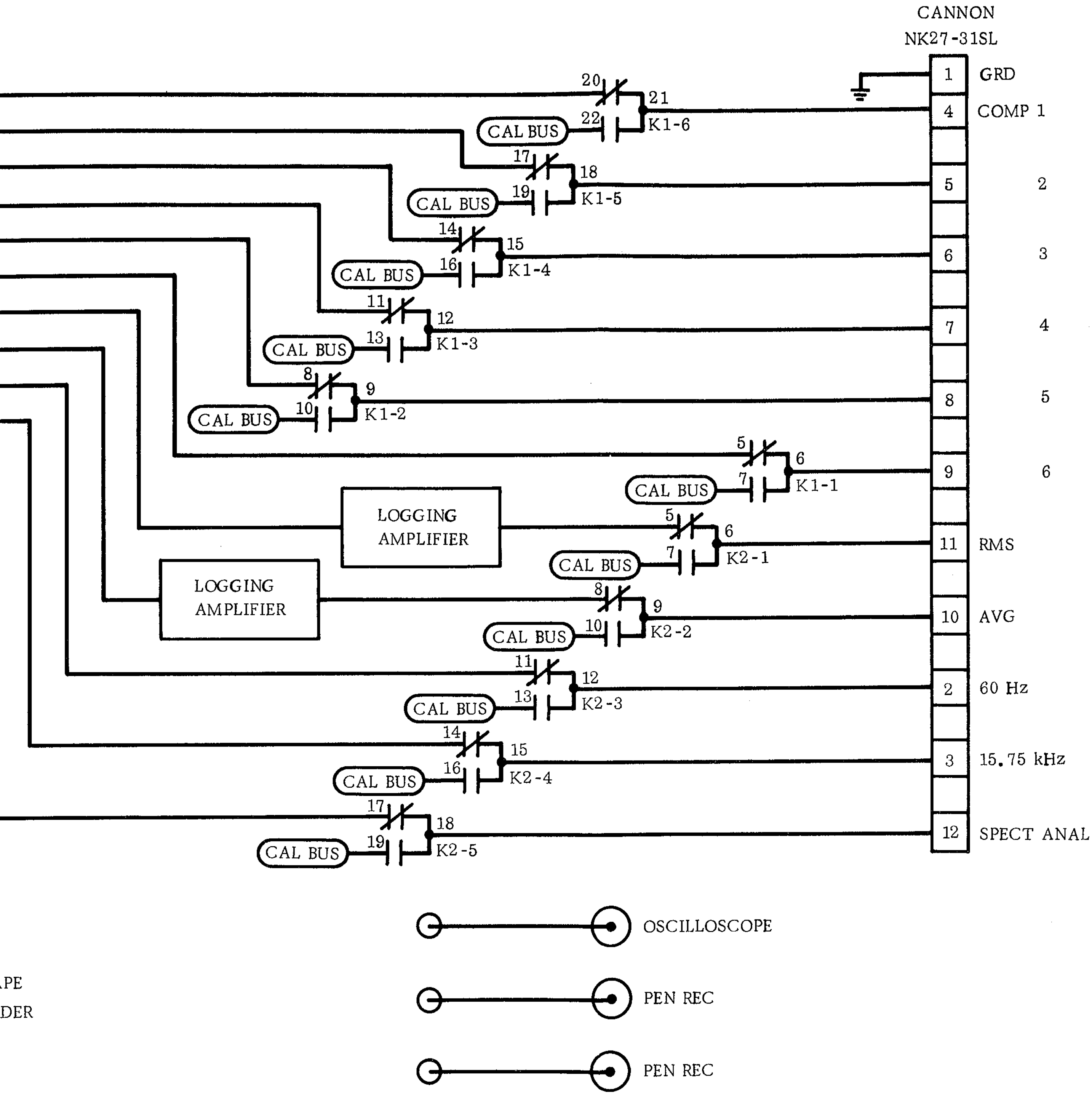


Figure 4-51. Calibration Control and Monitoring Circuitry

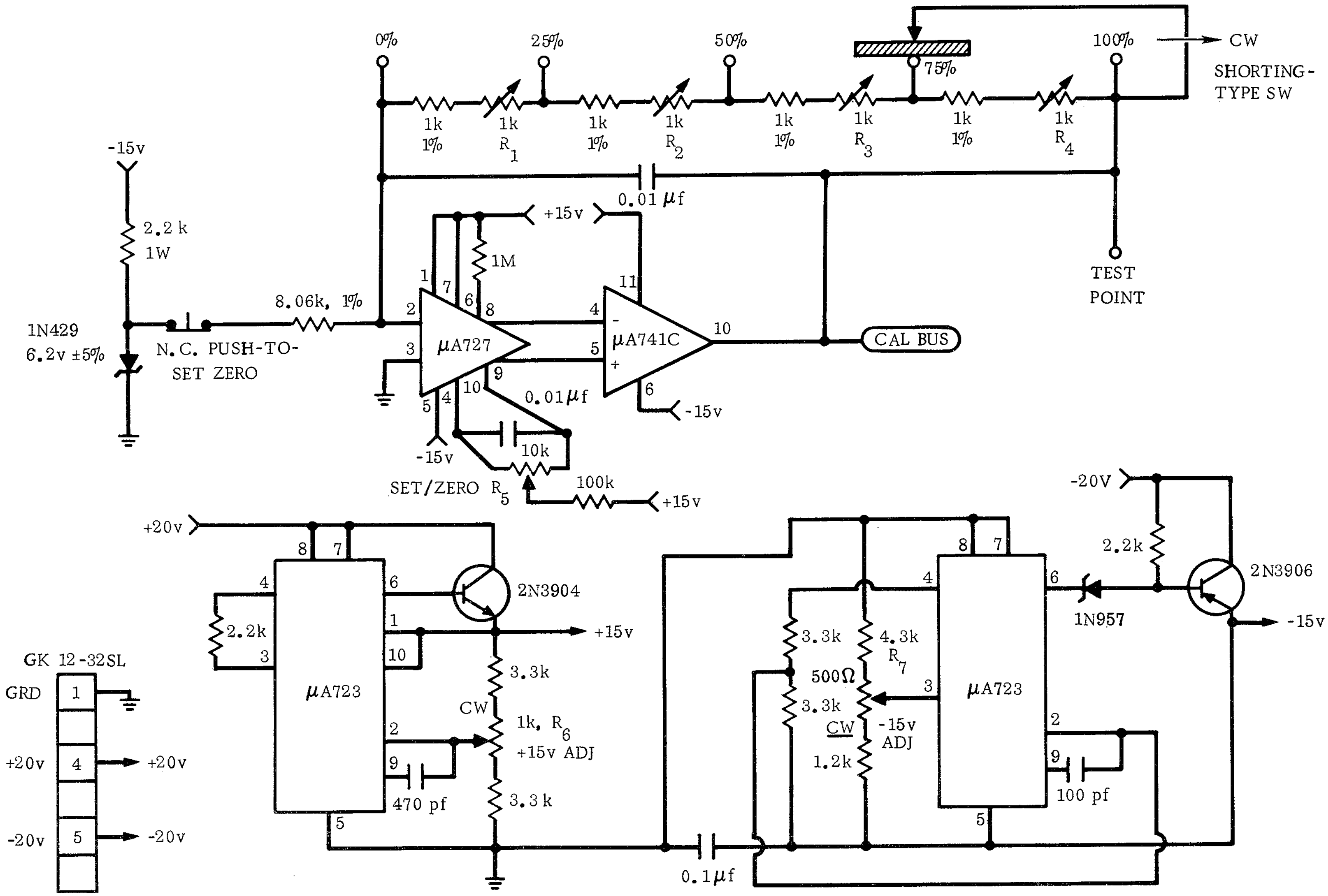


Figure 4-52. Calibration Voltage Supply

dc voltage (approximately -6v). The amplifier is set up by first setting the offset to zero and then adjusting the gains for 25, 50, 75, and 100 percent output levels. The CAL BUS voltages produced are nominally 0.00, 1.25, 2.50, 3.75, and 5.00 volts. The amplifier power is supplied by two conventional IC voltage regulator circuits for +15 and -15 volts.

4.3.3.3 Comparator/Integrator Calibration Unit. A calibrator designed and assembled for use in calibrating the video amplifier gain, comparator threshold, and integrator time constants is mounted separately in its own chassis (not rack mounted). Its dc power is obtained on the front panels of the +12 and -12 volt power supplies and the coaxial leads are connected to the logic chassis VIDEO IN, the digital voltmeter, and the frequency counter when in use. For comparator calibration, pulses are applied to the VIDEO IN connector from CAL EVENTS. The pulses are rectangular, with one level at zero volts and the other precisely variable by four cascaded potentiometers. The pulse height is adjustable from +0.06 to +5 volts, and is continuously displayed by the digital voltmeter. The pulse frequency is adjustable from 400 to 3600 Hz by a ten-turn coarse and a one-turn vernier potentiometer. The pulse frequency is continuously displayed by the frequency counter.

Figure 4-53 is a schematic of the calibrator. An astable multivibrator generates the basic pulse train. The frequency is varied by a variable-current source, and its collector resistors are split to improve the sharpness of the pulses. A signal derived at this point is used for monitoring by the frequency counter. The astable waveform is then dc-shifted and applied to an FET chopper. A zener diode and potentiometer string apply a finely adjustable dc voltage to the chopper FET source, where the voltage is monitored by a high-impedance digital voltmeter. A brute-force filter prevents spikes from the voltmeter from getting into the calibrator. A 3-Ω potentiometer mounted on the circuit board compensates for non-zero FET ON resistance. The FET chopper operates in the same way as the FET sampling gates used in the integrators of the data and logic subsystem. It impresses the astable frequency upon the dc voltage at its source, resulting in a rectangular waveform of precisely variable, calibrated height and frequency. An operational amplifier and booster transistor follow to prevent loading by the 91-Ω video impedance. Amplifier gain is unity.

The number-of-events integrators are calibrated by the same hook-up used for the comparators, and it is necessary only to ensure that the pulse height is sufficient to trigger all comparators. The percent-of-time integrators are calibrated by using the CAL PERCENT TIME output, which is a 6-volt pulse of fixed width and variable frequency. The pulse width is adjustable by changing a plug-in timing capacitor, C_X. A 40-μsec pulse width is appropriate for setting up full scale between 2.5 and 10 percent with a three-second cycle time. The 6-volt output is obtained by voltage divider action of the 91-Ω video resistor and the 100-Ω resistor at the emitter follower output. Since the output is loaded to less than 6 volts, the zener diode normally has no effect and is used only to limit the output voltage to a safe value when disconnected from the load (or if the video load resistor could become disconnected).

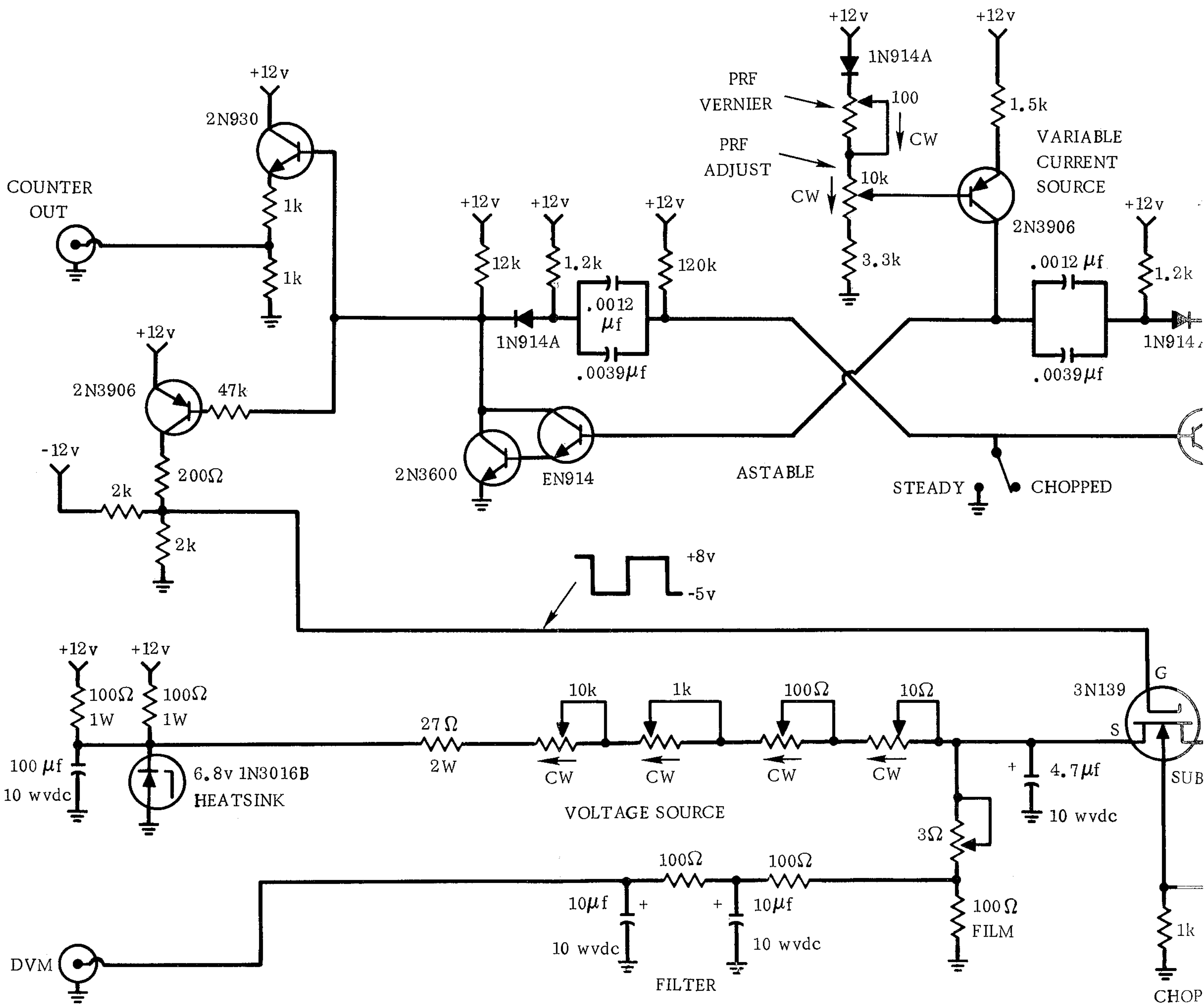
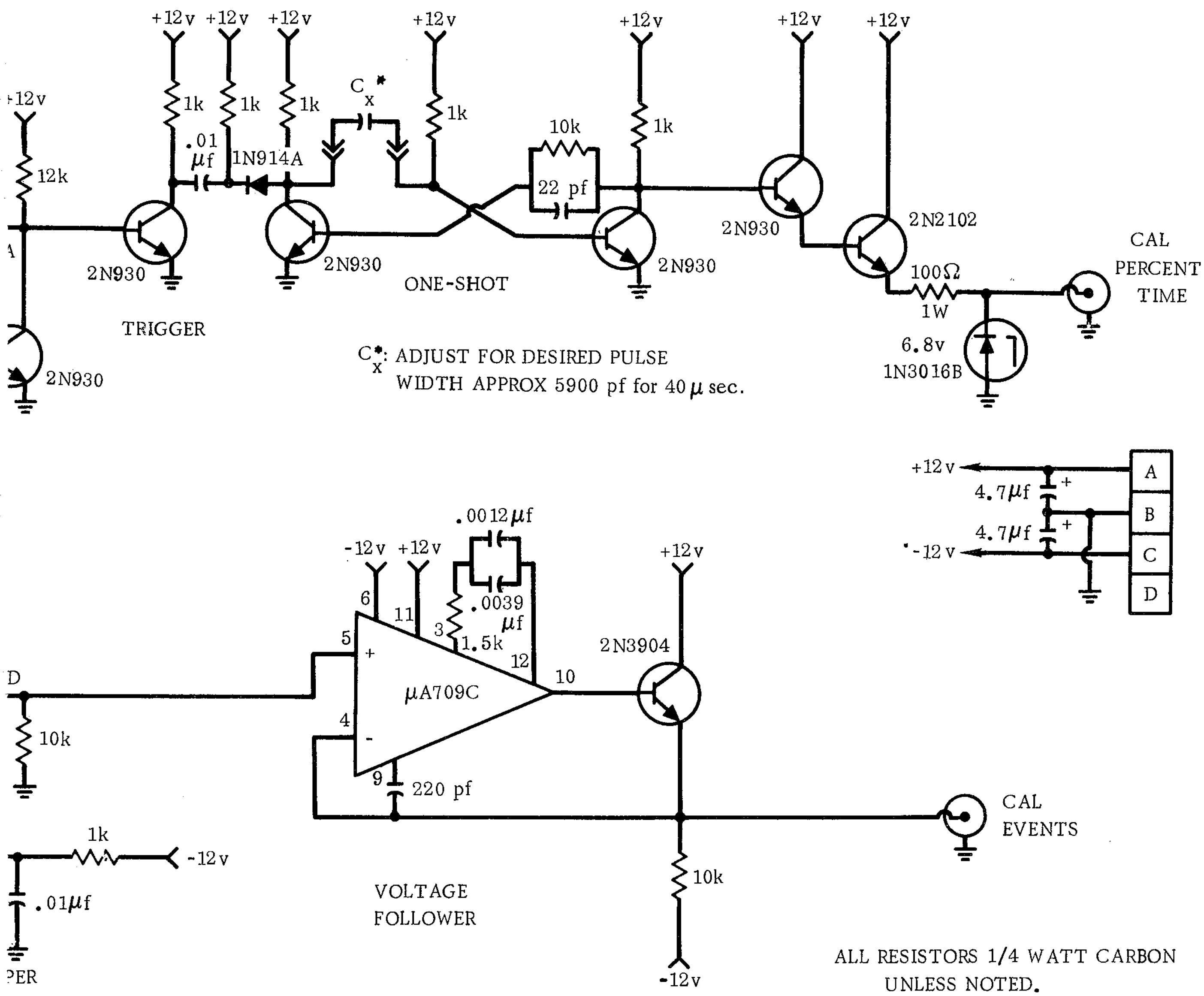


Figure 4-53. Calibrator Circuitry


+12v
12k
2N930
TRIGGER
1k
.01 μf
1N914A
2N930
C_x*
ONE-SHOT
10k
22 pf
2N930
2N2102
100Ω 1W
6.8v 1N3016B
CAL PERCENT TIME
C_x*: ADJUST FOR DESIRED PULSE WIDTH APPROX 5900 pf for 40 μ sec.
4.7μf
-12v
A
B
C
D
.0012μf
.0039 μf
1.5k
μA709C
220 pf
2N3904
10k
CAL EVENTS
1k
.01μf
VOLTAGE FOLLOWER
ALL RESISTORS 1/4 WATT CARBON UNLESS NOTED.

4.4 MONITORING SUBSYSTEM

The monitoring subsystem permits real-time monitoring of the data and auxiliary information as it is recorded. This subsystem consists of a patch panel, interconnecting cables, and the monitoring devices. The data and auxiliary information lines are routed through the monitoring chassis and brought out to test jacks on the front patch panel before they are connected to the inputs of the VCOs. The purpose of this subsystem is to allow verification of proper system operation during the measurements. Figure 4-51 shows the monitoring test points in the schematic of the calibration control and monitoring circuitry.

The monitoring chassis is shown in Figure 4-54, along with the front patch panel. Interconnecting cables permit connecting any of the data and auxiliary information lines to each monitoring device. Available monitoring devices consist of an oscilloscope, a 2-channel thermal oscillographic recorder, a 12-channel visicorder oscillograph, and an electronic counter.

The electronic counter is used to set up the frequencies and deviation sensitivities of the VCOs prior to the measurements and to calibrate the time constants of the number of-events integrators. Specific data and information lines are monitored with the recorders, and the oscilloscope is available for monitoring all the lines periodically. In addition to these monitoring devices, a pair of headphones and a speaker are available for listening to the video signal.

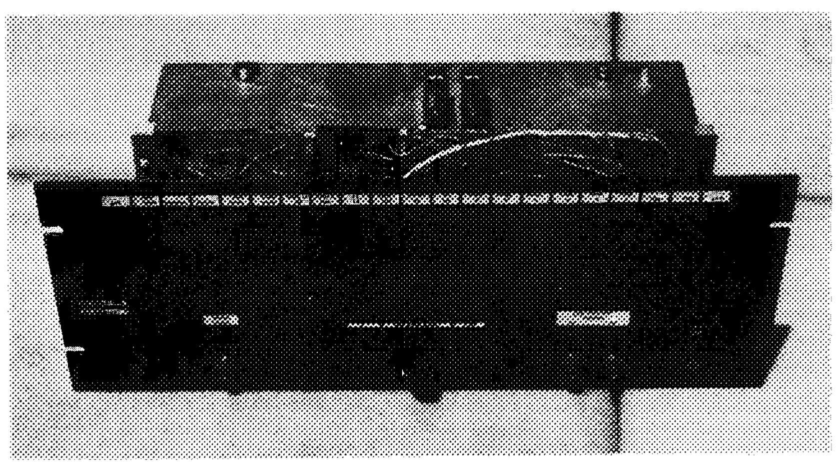


Figure 4-54. Monitoring Chassis

4.5 RECORDING SUBSYSTEM

The recording subsystem consists of the VCOs, their associated components, and the tape recorder. In both the airborne and ground noise measuring systems, the VCOs are arranged in two chassis. Each chassis contains a power supply and a summing amplifier. One chassis of each system contains 11 VCOs. The noise data is applied to the inputs of the VCOs. The VCO outputs are combined in the summing amplifier and the multiplexed output recorded on Track 4 of the tape recorder. The second chassis of each system contains a 50-kHz reference oscillator and some VCOs. There are 6 VCOs in the second chassis of the airborne system and 5 VCOs in the second chassis of the ground system. The auxiliary information is applied to the inputs of these VCOs, whose outputs are combined in the summing amplifier. This multiplexed output is recorded on Track 6 of the tape recorder. Figure 4-55 shows the two VCO chassis.

Table 4-1 lists the data and auxiliary information VCO channel and tape track assignments for each system. Voice annotations are recorded on Track 8, and the 50-kHz wow and flutter reference is recorded on Track 10. An IRIG Standard Time Code Format "B" from the time-code generator is recorded on Track 2, and the video signal is recorded on Track 12.

The tape recorder has a 14-track capability of which 6 tracks were used, and operates at a tape speed of 15 inches (0.381 meter) per second.

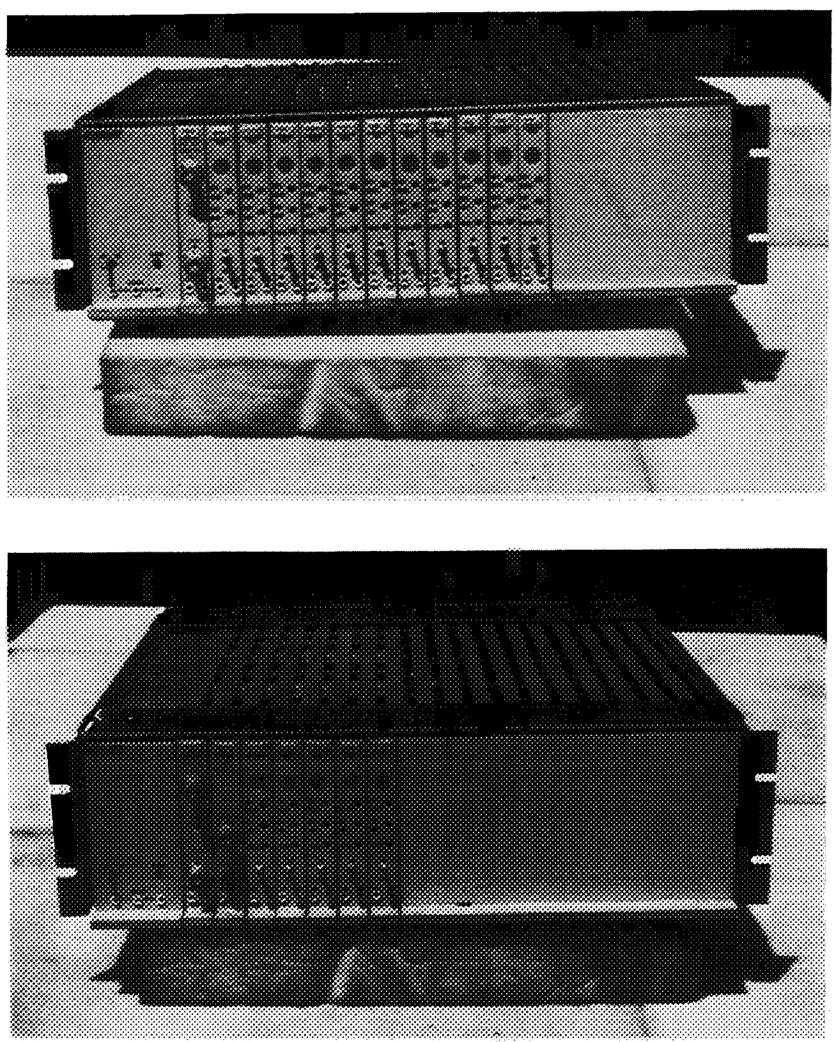


Figure 4-55. VCO Chassis

Table 4-1. Data and Auxiliary Information VCO Channel and Tape Track Assignments

Measurement	Ground System	Airborne System	IRIG Channel	Tape Track
1. 60-Hz Noise Level	X	X	5	4
2. 15.75-kHz Noise Level	X	X	6	4
3. Comparator No. 1	X	X	7	4
4. Comparator No. 2	X	X	8	4
5. Comparator No. 3	X	X	9	4
6. Comparator No. 4	X	X	10	4
7. Comparator No. 5	X	X	11	4
8. Comparator No. 6	X	X	12	4
9. Average Noise Level	X	X	13	4
10. RMS Noise Level	X	X	14	4
11. Spectrum Analyzer	X	X	15	4
12. RF Channel ID	X	X	2	6
13. Reset/Run ID	X	X	3	6
14. Time/Events ID	X	X	5	6
15. Azimuth	X		6	6
16. Camera Shutter		X	6	6
17. Position Indicator (DME)		X	7	6
18. Position Indicator (Visual)	X	X	8	6
19. Voice	X	X		8
20. Wow and Flutter Reference	X	X	50 kHz	10
21. Time Code	X	X		2
22. Video Signal	X	X		12

SECTION 5

SYSTEM PERFORMANCE

Measurements were made with the noise-measuring systems before starting the general air and ground surveys of RF noise in Akron, Ohio. Each system was calibrated and tested immediately after the modifications were completed. Field tests were conducted with the systems in the San Diego area. Preliminary checks and calibrations were performed in Akron, Ohio just prior to the start of the surveys.

These tests were performed to determine the characteristics of the assembled systems, to set up gains and time constants to the appropriate values, and to ensure that all parts of the systems were performing satisfactorily prior to shipping the systems to Akron and prior to commencing the general surveys. The tests were performed systematically following prepared procedures, with the successful completion of one being a prerequisite for initiation of the next. This section describes the tests performed and presents the results obtained.

5.1 CALIBRATION AND TESTING

During the calibration and testing phase, measurements were made on the assembled systems at the Convair Aerospace's Kearny Mesa plant in San Diego. These measurements were divided into four parts, with the first measurements made on the system antennas. The remaining tests included noise figure measurements, gain and sensitivity measurements, and system response tests.

5.1.1 ANTENNA MEASUREMENTS. Measurements were made on the three antennas of each system. Since the antennas of the airborne system were identical to those of the ground system, pattern measurements were made only on the ground-system antennas. It was felt that the difference between the ground-system and airborne-system ground planes on which the antennas were mounted would have relatively little effect on the patterns, since each antenna was made with a small integral ground plane. Gain measurements used the antennas from both systems.

Gain measurements were made using the two-identical-antennas technique. Figure 5-1 illustrates the test setup. Each pair of antenna was adjusted so that the main beam of the radiation pattern of the transmitting antenna was directed into the main beam of the radiation pattern of the receiving antenna. The antennas were placed 30 feet (9.15 meters) apart and were raised about 30 feet above the ground. The difference between the power delivered to the transmitting antenna and that directly to the measurement receiver (spectrum analyzer) to give the same level on the sprectrum analyzer was measured.

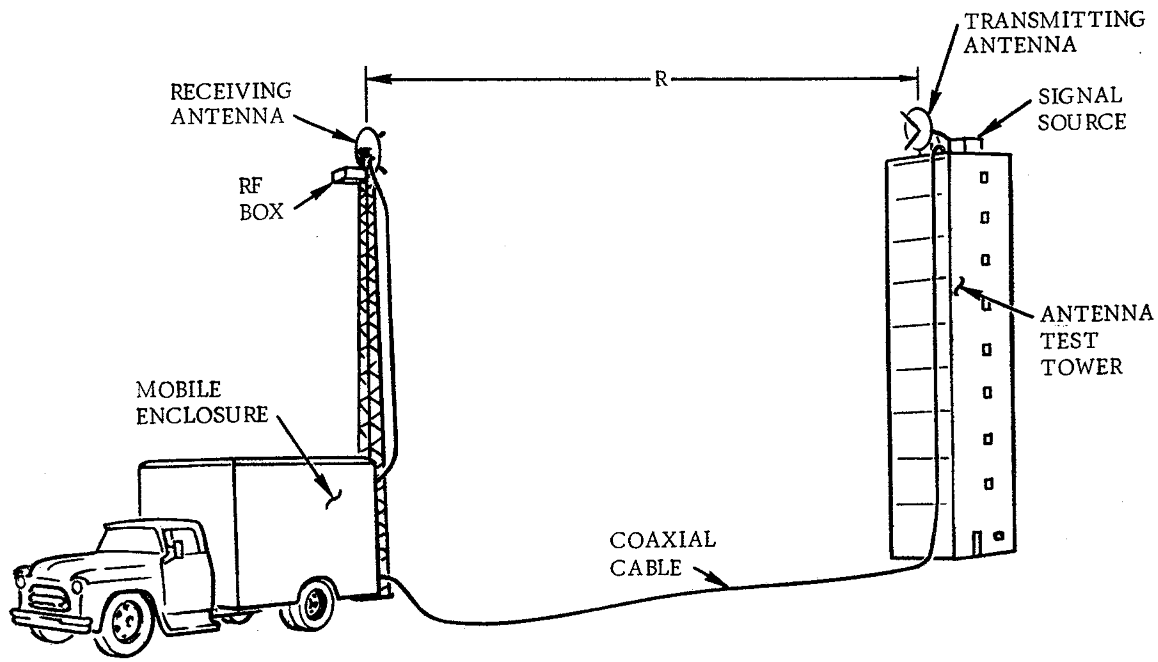


Figure 5-1. Setup for Antenna Gain Measurement
Using the Two-Antenna Technique

The relationship

$$G\ (\text{db}) = 10 \log_{10} \left[\frac{4\pi R}{\lambda} \sqrt{\frac{W_r}{W_t}} \right]$$

was used to give the gain of the antenna relative to that of an isotropic radiator, where R is the distance between the two identical antennas, λ is the wavelength of the measurement frequency, W_r is the power delivered directly to the spectrum analyzer, and W_t is the power delivered to the transmitting antenna for the same output. The measured gain of the crossed dipoles antennas at 300 MHz was 8.3 db. The gain of the 1 GHz helical antennas was 11.2 db, while the gain of the 3 GHz helical antennas was 13.1 db.

The radiation pattern of the three antennas of the ground noise-measuring system was measured by recording the spectrum analyzer's vertical deflection output as the ground-system antennas were rotated through 360 degrees in azimuth. A signal generator was connected to a transmitting antenna placed about 30 feet above the ground on the wooden test tower. The output of the ground-system antenna, which was about 30 feet above the ground and about 100 feet (30.5 meters) from the transmitting antenna, was connected to the spectrum analyzer's input.

Figure 5-2 shows recordings of the principal-plane radiation pattern of the crossed-dipole antenna mounted on the ground noise-measuring system at 300 MHz. Figure 5-2a is a linear plot of the pattern, with the upper trace showing the variation in azimuth. A logarithmic plot is shown in Figure 5-2b; the logarithmic calibration is shown in Figure 5-2c. The pattern shows a 3-db beamwidth of about 50 degrees and a front-to-back ratio of 16 db.

Recordings of the principal-plane radiation pattern of the 1-GHz helical antenna mounted on the ground noise-measuring system are shown in Figure 5-3. Figure 5-3a is a linear plot of the pattern, with the upper trace showing the variation in azimuth. A logarithmic plot is shown in Figure 5-3b; and the logarithmic calibration is shown in Figure 5-3c. The pattern shows a 3-db beamwidth of about 36 degrees and a front-to-back ratio of 19 db.

Figure 5-4 shows recordings of the principal-plane radiation pattern of the 3 GHz helical antenna mounted on the ground noise-measuring system. Figure 5-4a is a linear plot of the pattern, with the upper trace showing the variation in azimuth. A logarithmic plot is shown in Figure 5-4b; the logarithmic calibration is shown in Figure 5-4c. The pattern shows a 3-db beamwidth of about 32 degrees and a front-to-back ratio of 21 db.

5.1.2 NOISE FIGURE MEASUREMENTS. The system-noise figures of each RF channel in both the ground and airborne noise-measuring systems were measured. Measurements were performed with a noise-figure meter and a noise source. The output of the

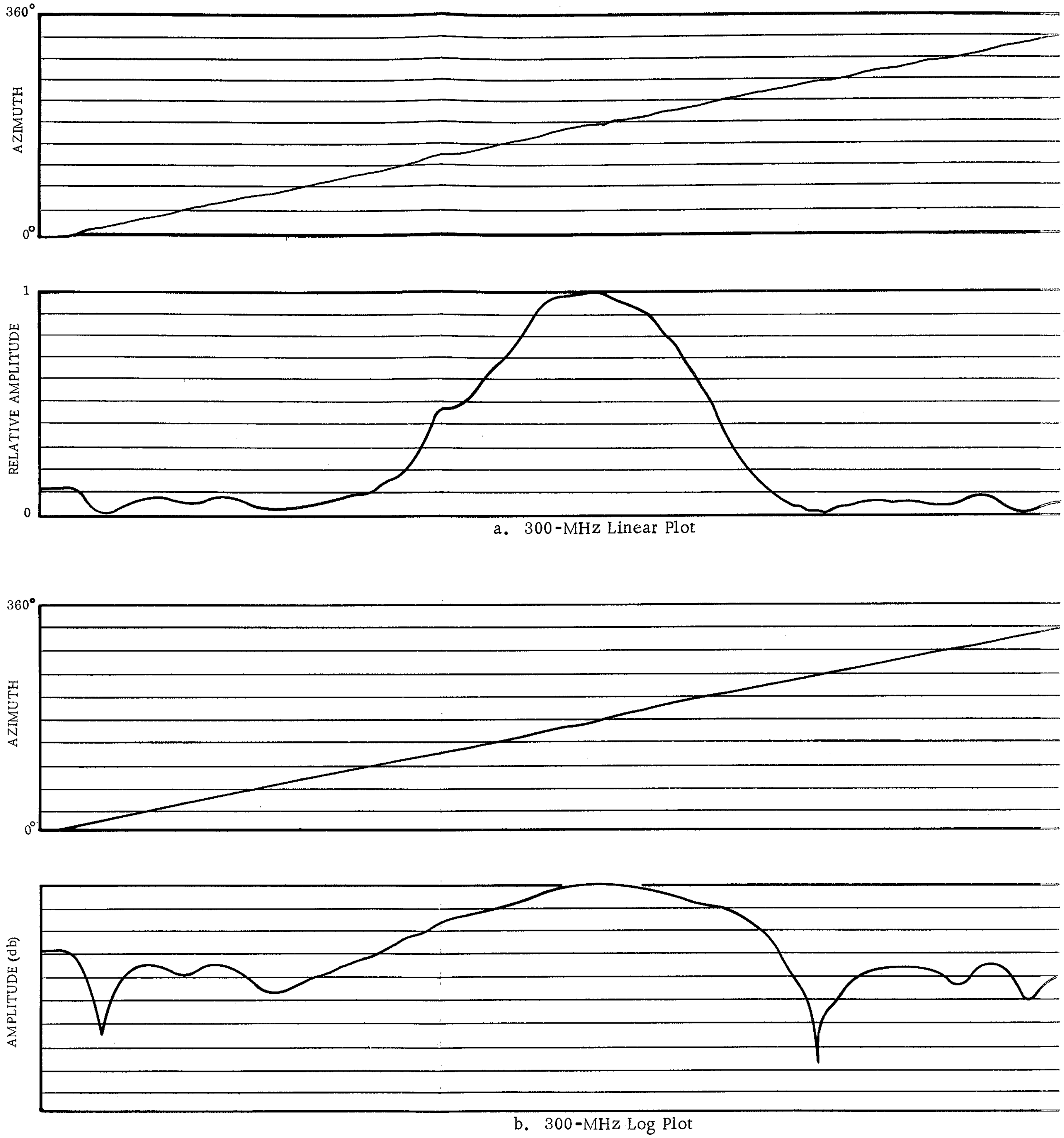
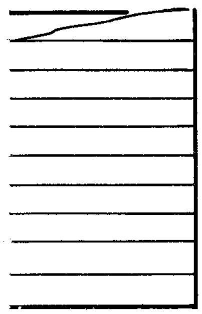
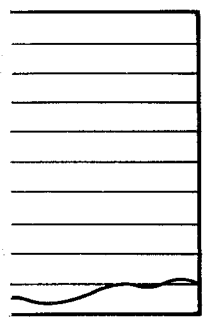
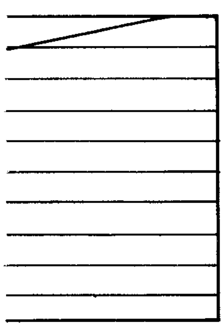
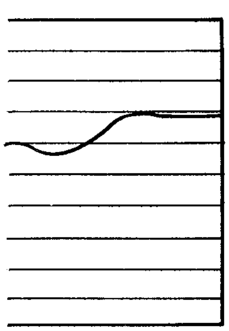


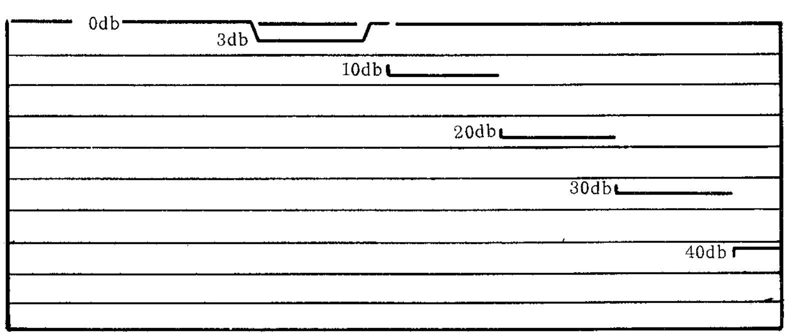
Figure 5-2. Principal-Plane Radiation Pattern of 300-MHz Antenna



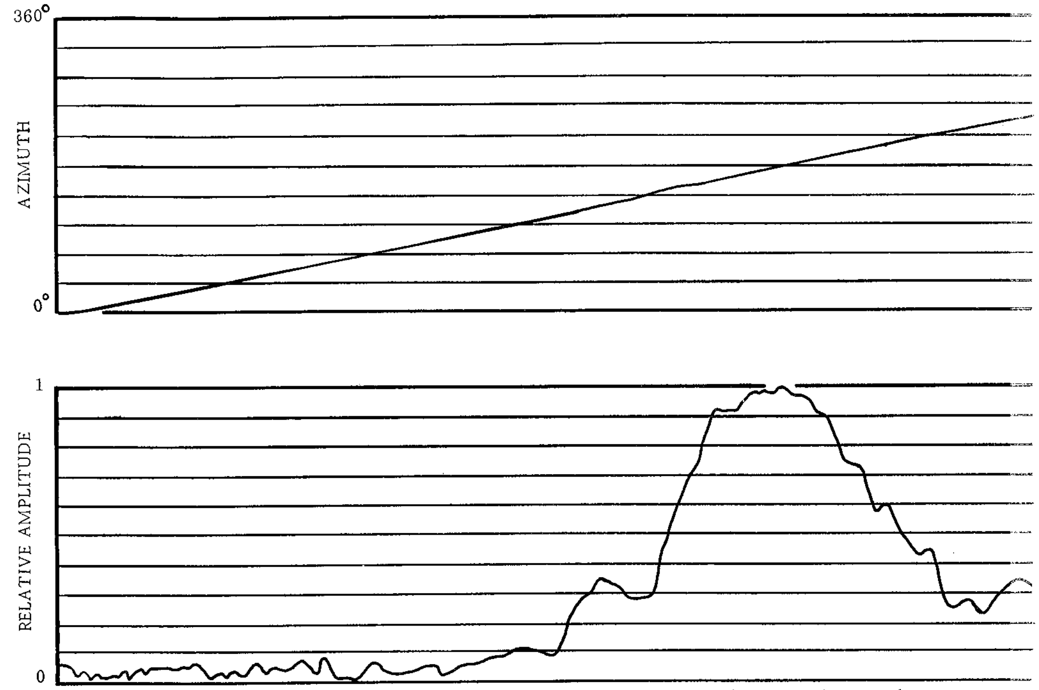




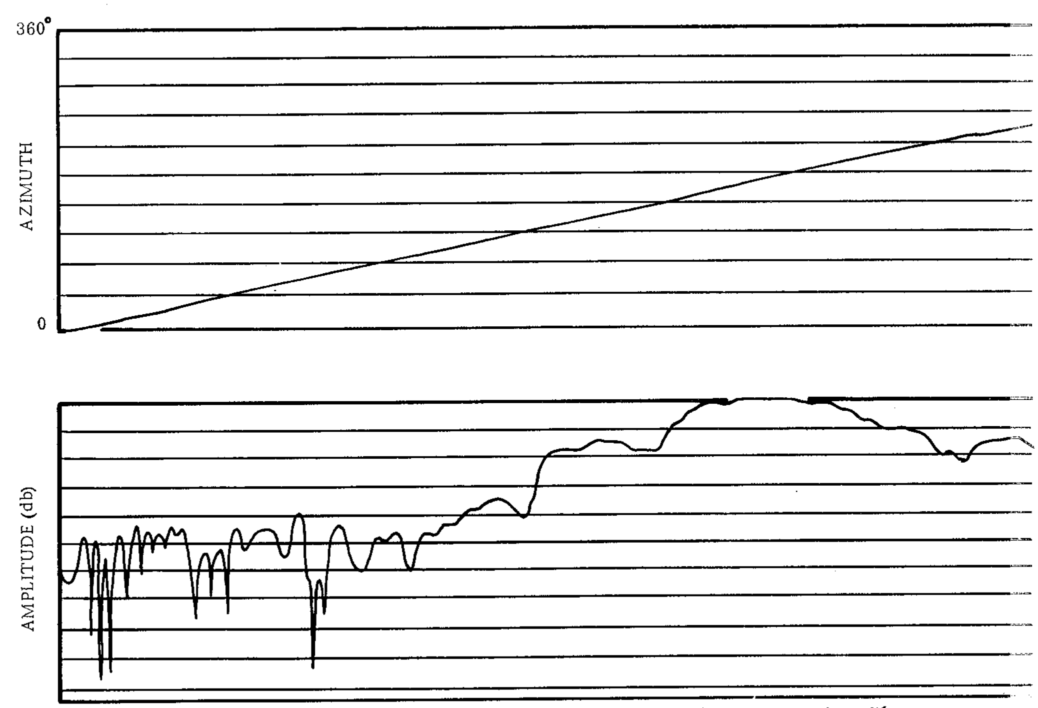




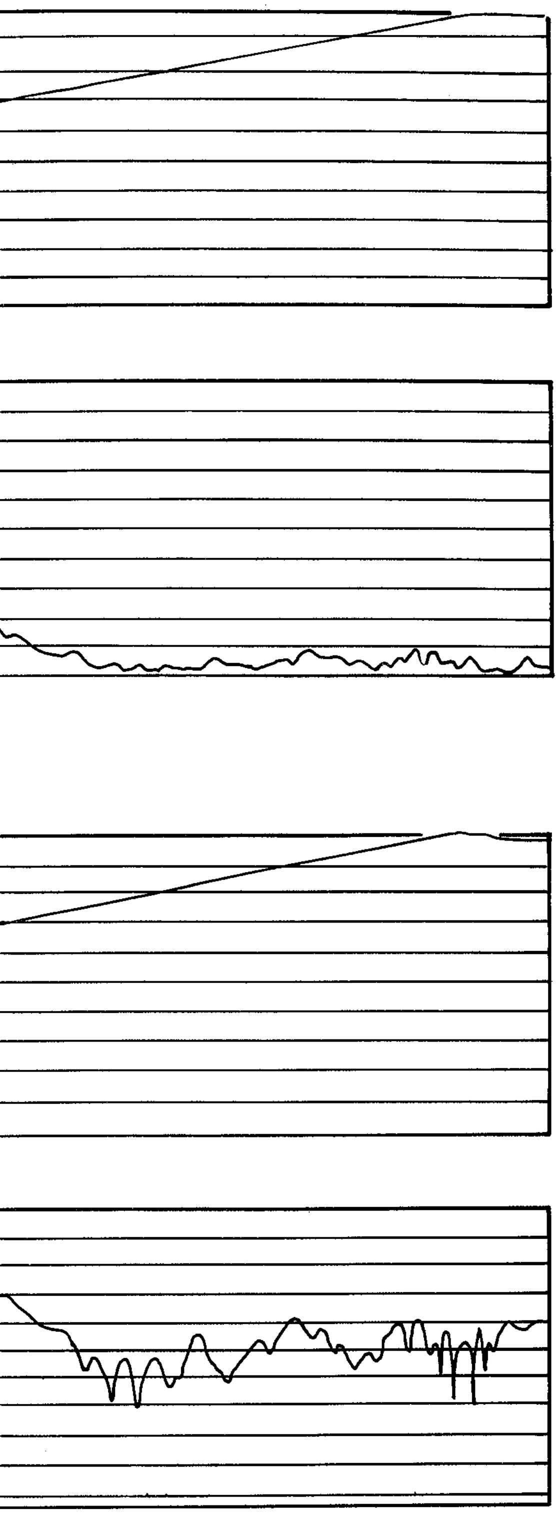
c. 300-MHz Log Calibration

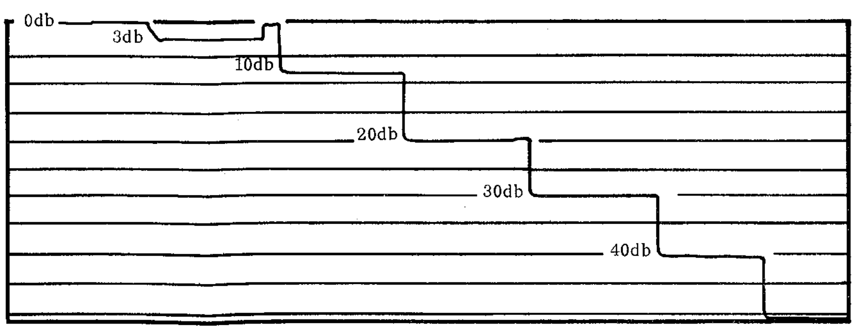


a. 1-GHz Linear Plot



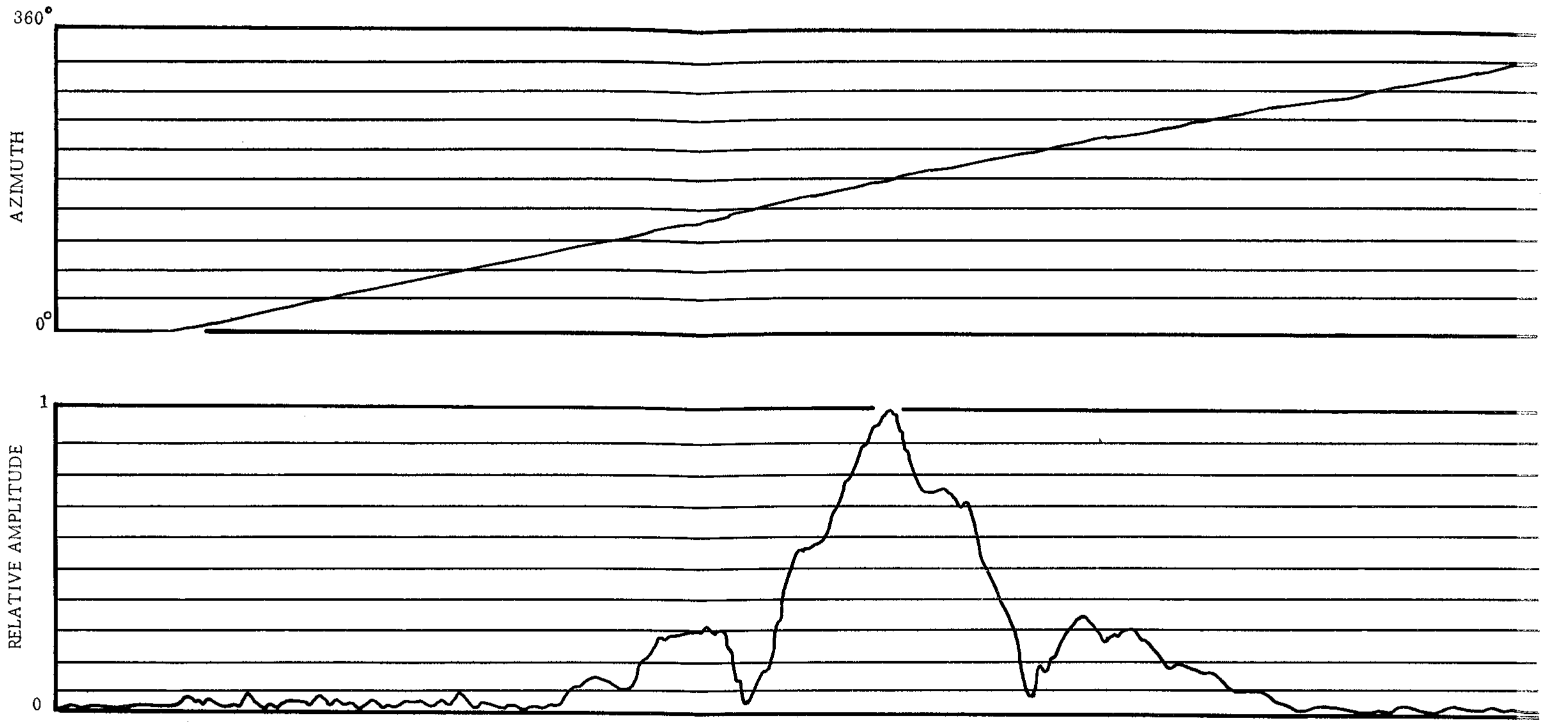
b. 1-GHz Log Plot



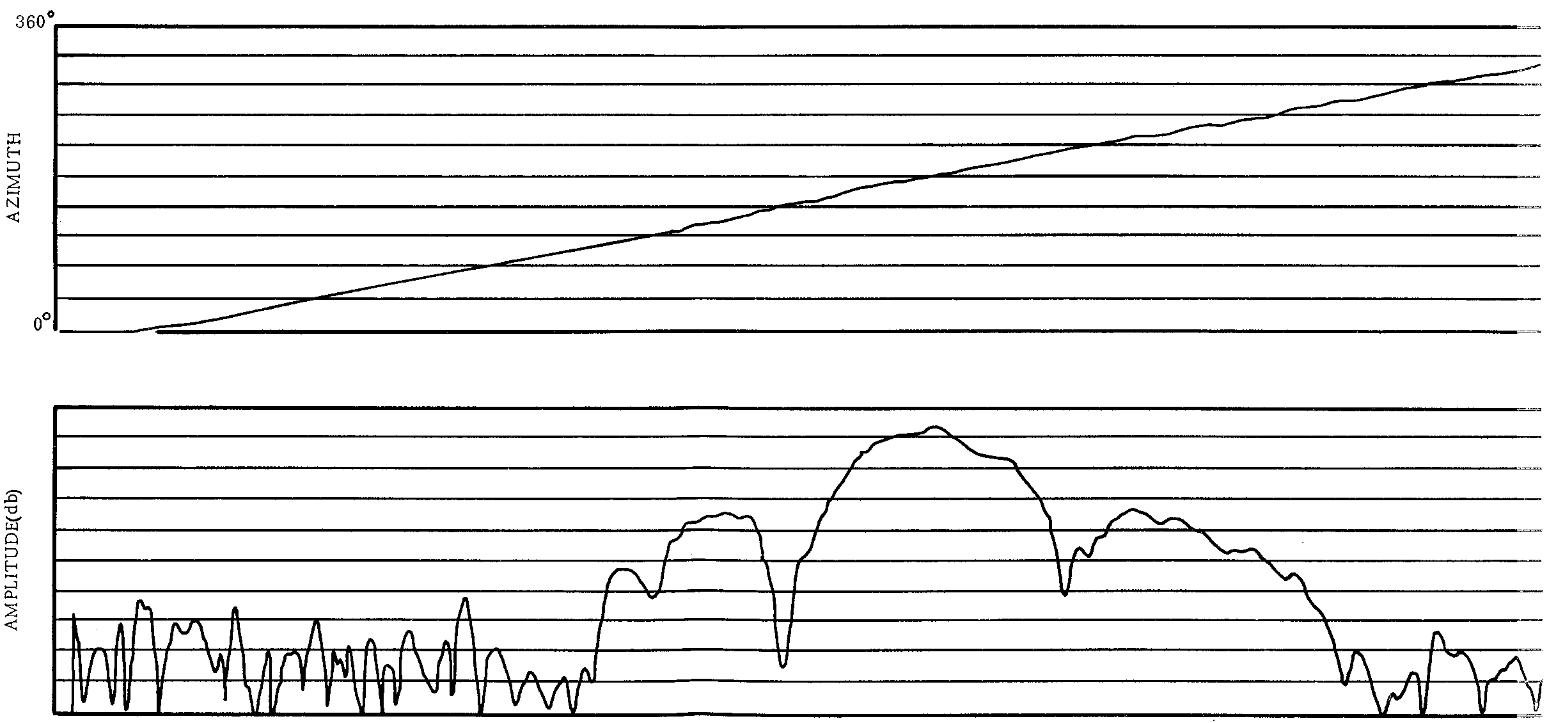


c. 1-GHz Log Calibration

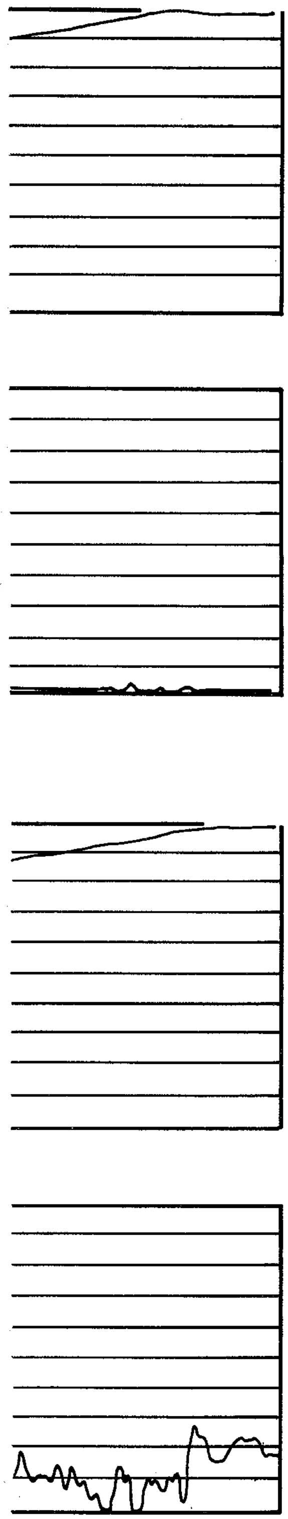
Figure 5-3. Principal-Plane Radiation Pattern of 1-GHz Antenna

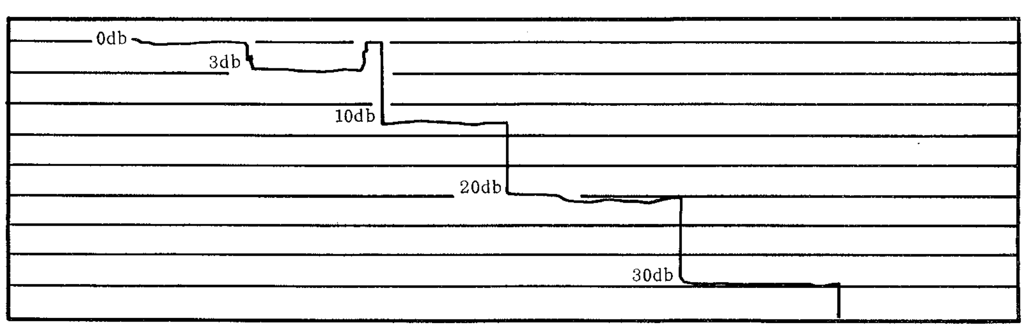


a. 3-GHz Linear Plot



b. 3-GHz Log Plot





c. 3-GHz Log Calibration

Figure 5-4. Principal-Plane Radiation Pattern of 3-GHz Antenna noise source was applied to the front end input of each channel and the 60-MHz output from the IF amplifier was connected back to the noise-figure meter. Corrections to the measured values were made for the attenuation of additional coaxial cables used in this measurement. The results are listed in Table 5-1. With the equipment used, a measurement accuracy of ±1 db was obtained. Subsequent noise-figure measurements performed at various times prior to the general survey gave about the same results.

Table 5-1. Results of System Noise Figure Measurements

Frequency	Airborne System (db)	Ground System (db)
300 MHz	3.3	3.4
1 GHz	2.4	3.0
3 GHz	3.8	4.0

5.1.3 SYSTEM GAIN AND SENSITIVITY MEASUREMENTS. Measurements were made on each noise-measuring system to determine the system gain and sensitivity. This was accomplished by measuring the video detector output and the RMS and AVG VCO frequencies as the level of the CW RF input to the system was varied from below threshold to saturation. This corresponded to from -120 dbm to approximately -70 dbm. The measurements were repeated at 300 MHz, 1 GHz, and 3 GHz for each system as the system was locked into Band 1, 2, and 3, respectively. Results of these measurements are not recorded here, since they were repeated during preliminary checks and calibrations in Akron. (See Section 5.3.) The Akron measurements differed slightly from those measured during this phase of testing because of gain adjustments and refinements in system tuning.

5.1.4 SYSTEM RESPONSE. The response of each system to various input stimuli was measured. The power levels of CW inputs to give RMS outputs of 25, 50, 75, and 100 percent of full scale were measured at each RF frequency. The response of the systems was measured with 50-Ω terminations placed on the antenna input of each channel. Results of these measurements are recorded in the tabulated values in Section 5.3, since these measurements were repeated just prior to the noise survey.

An automobile ignition system harness was used as a noise source in evaluating the response of each system to impulsive noise. An antenna was placed about 10 feet (3.05 meters) from the idling internal-combustion engine and was connected to the front end of the noise-measuring system. Results of this test helped in establishing the time constants of the number-of-events and the percent-of-time integrators. It was found that full scale on the event integrators should range from 3000 events per second on the lower level comparator to 1500 events per second on the high level comparator. Likewise, it was found that full scale on the time integrators should range from 10 percent on the lower level comparator to 2.5 percent on the high level comparator. Actual values used for comparator threshold setting and integrator scalings are recorded in Table 5-8 (Section 5.3).

5.2 SAN DIEGO FIELD TESTS

Field tests were conducted with each system in the San Diego area prior to moving the systems to Akron, Ohio. The purpose of the field tests was to verify that the systems were performing properly, to ensure that comparator threshold levels and integrator time constants were properly set, and to gain experience in operating the systems.

Four flight tests were conducted in the San Diego area between 21 and 26 April 1970. As a result of these measurements, several minor problems were corrected. On the last flight, a data tape was made and was forwarded to Lewis Research Center for reduction. Calibration of the DME serial code with the indicated range was not completed in San Diego because the aircraft was not available toward the end of the test period. This task was postponed until just prior to the general survey in Akron.

Field tests of the ground noise-measuring system were accomplished between 11 and 19 May 1970. The system was located southeast of Building 7 at Air Force Plant 19 in San Diego and was near both Pacific Coast Highway and Interstate 5. During the final test, a data tape was made and was forwarded to Lewis Research Center for processing.

5.3 PRELIMINARY CHECKS IN AKRON

Preliminary checks and calibrations were performed on each system between 2 and 13 June 1970 after the systems were moved from San Diego to Akron, Ohio. The purpose of the preliminary checks and calibrations in Akron was to verify that the systems had not been damaged or changed by shipment or movement and to ensure that the gains and levels set in the field tests were applicable to measurements in Akron. The preliminary checks and calibrations consisted of measuring system transfer functions, resetting comparator threshold levels and integrator time constants, and making a data tape for each system. The relationship between the DME-indicated range and the serial code output was determined during the preliminary air flight.

The frequencies of the AVG and RMS data VCOs and the output in volts of the video detector were measured as the RF input level was varied. Tables 5-2, 5-3, and 5-4 record the results for Bands 1, 2, and 3, respectively, of the airborne noise-measuring system. Tables 5-5, 5-6, and 5-7 record the results for Bands 1, 2, and 3, respectively, of the ground noise-measuring system. In each case, the RF input level is the value at the coaxial relay input to the system. Losses were accounted for in the coaxial cables between the calibrated signal source and the input coaxial relays.

The comparator thresholds and integrator time constants were adjusted for each system. Table 5-8 gives the values of these settings. The signal voltage at which each comparator

Table 5-2. Transfer Function — Airborne System - 300 MHz

RF CW Input (dbm)	AVG VCO Freq (Hz)	RMS VCO Freq (Hz)	Video DET (Volts)
50 Ω	15,590	23,641	-0.640
-120	15,590	23,640	-0.640
-117.5	15,590	23,641	-0.635
-115	15,590	23,640	-0.630
-112.5	15,590	23,640	-0.62
-110	15,590	23,640	-0.60
-107.5	15,513	23,486	-0.56
-105	15,395	23,273	-0.50
-102.5	15,248	23,024	-0.412
-100	15,070	22,750	-0.280
-97.5	14,888	22,487	-0.100
-95	14,797	22,296	+0.070
-92.5	14,695	22,155	+0.230
-90	14,653	22,138	+0.230
-87.5	14,562	21,999	+0.425
-85	14,466	21,863	+0.670
-82.5	14,353	21,704	+0.98
-80	14,250	21,557	+1.40
-77.5	14,119	21,370	+2.00
-75	13,990	21,181	+2.78
-72.5	13,879	20,958	+3.65
-70	13,623	20,700	+4.83
-67.5	13,573	20,661	+5.90
-65	13,575	20,663	+5.89

Table 5-3. Transfer Function — Airborne System - 1 GHz

RF CW Input (dbm)	AVG VCO Freq (Hz)	RMS VCO Freq (Hz)	Video DET (Volts)
50Ω	15,591	23,639	-0.640
-120	15,591	23,639	-0.640
-117.5	15,591	23,639	-0.637
-115	15,591	23,639	-0.640
-112.5	15,591	23,640	-0.638
-110	15,591	23,639	-0.625
-107.5	15,590	23,628	-0.595
-105	15,498	23,452	-0.560
-102.5	15,340	23,181	-0.480
-100	15,173	22,908	-0.370
-97.5	14,977	22,615	-0.200
-95	14,813	22,384	+0.000
-92.5	14,695	22,220	+0.160
-90	14,669	22,175	+0.220
-87.5	14,631	22,101	+0.320
-85	14,545	21,974	+0.540
-82.5	14,455	21,850	+0.830
-80	14,366	21,722	+1.16
-77.5	14,265	21,576	+1.71
-75	14,164	21,433	+2.39
-72.5	14,032	21,243	+3.30
-70	13,847	20,978	+4.20
-67.5	13,788	20,894	+5.72
-65	13,787	20,890	+5.88
-62.5	13,787	20,891	+5.88

Table 5-4. Transfer Functions — Airborne System - 3 GHz

RF CW Input (dbm)	AVG VCO Freq (Hz)	RMS VCO Freq (Hz)	Video DET (Volts)
50Ω	15,590	23,638	-0.645
-120	15,542	23,579	-0.630
-117.5	15,529	23,547	-0.625
-115	15,504	23,503	-0.610
-112.5	15,456	23,412	-0.600
-110	15,378	23,268	-0.575
-107.5	15,260	23,047	-0.515
-105	15,109	22,792	-0.435
-102.5	14,922	22,495	-0.295
-100	14,757	22,260	-0.135
-97.5	14,598	22,042	+0.060
-95	14,503	21,909	+0.210
-92.5	14,509	21,898	+0.220
-90	14,445	21,793	+0.380
-87.5	14,352	21,662	+0.630
-85	14,269	21,544	+0.925
-82.5	14,176	21,413	+1.30
-80	14,078	21,274	+1.82
-77.5	13,969	21,118	+2.58
-75	13,852	20,951	+3.33
-72.5	13,656	20,669	+4.40
-70	13,606	20,597	+5.85
-67.5	13,606	20,598	+5.87
-65	13,606	20,598	+5.87

Table 5-5. Transfer Functions — Ground System - 300 MHz

RF CW Input (dbm)	AVG VCO Freq (Hz)	RMS VCO Freq (Hz)	Video DET (Volts)
50Ω	15,584	23,647	-0.069
-120	15,582	23,647	-0.069
-117.5	15,582	23,641	-0.068
-115	15,577	23,628	-0.066
-112.5	15,567	23,611	-0.063
-110	15,543	23,574	-0.058
-107.5	15,506	23,516	-0.048
-105	15,441	23,416	-0.030
-102.5	15,363	23,296	-0.005
-100	15,262	23,140	+0.032
-97.5	15,140	22,953	+0.087
-95	15,019	22,771	+0.154
-92.5	14,915	22,617	+0.224
-70	14,814	22,467	+0.305
-87.5	14,720	22,325	+0.395
-85	14,611	22,158	+0.519
-82.5	14,505	21,994	+0.663
-80	14,357	21,763	+0.913
-77.5	14,233	21,566	+1.18
-75	14,099	21,358	+1.54
-72.5	13,955	21,141	+2.04
-70	13,802	20,916	+2.73
-67.5	13,644	20,685	+3.68
-65	13,519	20,499	+4.70
-62.5	13,421	20,315	+6.26
-60	13,422	20,321	+6.29

Table 5-6. Transfer Functions — Ground System - 1 GHz

RF CW Input (dbm)	AVG VCO Freq (Hz)	RMS VCO Freq (Hz)	Video DET (Volts)
50Ω	15,549	23,579	-0.058
-120	15,518	23,527	-0.051
-117.5	15,516	23,524	-0.050
-115	15,510	23,514	-0.048
-112.5	15,500	23,500	-0.046
-110	15,483	23,471	-0.041
-107.5	15,457	23,429	-0.033
-105	15,415	23,369	-0.021
-102.5	15,349	23,268	+0.000
-100	15,256	23,124	+0.035
-97.5	15,152	22,965	+0.081
-95	15,040	22,791	+0.141
-92.5	14,940	22,648	+0.206
-90	14,849	22,507	+0.275
-87.5	14,758	22,371	+0.360
-85	14,656	22,221	+0.463
-82.5	14,534	22,041	+0.610
-80	14,411	21,839	+0.818
-77.5	14,293	21,650	+1.05
-75	14,165	21,451	+1.37
-72.5	14,015	21,220	+1.82
-70	13,868	21,002	+2.42
-67.5	13,725	20,802	+3.15
-65	13,576	20,577	+4.25
-62.5	13,450	20,377	+5.60
-60	13,421	20,301	+6.31

Table 5-7. Transfer Functions — Ground System - 3 GHz

RF CW Input (dbm)	AVG VCO Freq (Hz)	RMS VCO Freq (Hz)	Video DET (Volts)
50Ω	15,554	23,579	-0.061
-120	15,545	23,570	-0.059
-117.5	15,541	23,561	-0.058
-115	15,531	23,548	-0.056
-112.5	15,518	23,525	-0.052
-110	15,493	23,488	-0.046
-107.5	15,455	23,431	-0.035
-105	15,401	23,346	-0.017
-102.5	15,317	23,216	+0.010
-100	15,214	23,056	+0.052
-97.5	15,094	22,876	+0.111
-95	14,988	22,716	+0.176
-92.5	14,886	22,568	+0.248
-90	14,802	22,442	+0.320
-87.5	14,703	22,291	+0.419
-85	14,599	22,130	+0.542
-82.5	14,476	21,940	+0.721
-80	14,358	21,751	+0.929
-77.5	14,224	21,543	+1.22
-75	14,092	21,339	+1.59
-72.5	13,945	21,115	+2.11
-70	13,797	20,900	+2.81
-67.5	13,658	20,693	+3.67
-65	13,511	20,478	+4.92
-62.5	13,446	20,243	+6.27
-60	13,346	20,234	+6.29

Table 5-8. Comparator — Integrator Settings

Comparator Number	Volts to Turn On Band 1	Band 2	Band 3	For Integrator Full Output (3 Seconds) Percent-of-Time	Number-of-Events
1	0.141	0.141	0.141	10.0	3000
2	0.251	0.224	0.200	10.0	2500
3	0.445	0.354	0.282	5.0	2000
4	0.792	0.562	0.398	5.0	1500
5	1.41	0.890	0.562	2.5*	1500
6	2.51	1.41	0.792	2.5*	1500

* Due to setup error, full output was set at 6.0 percent on airborne system for measurements made prior to 24 June 1970.

would turn on when the system was in each band is listed. The percentage of time each comparator is on and the number of events per second to give full integrator outputs with a three-second measurement interval are also listed.

The relationship between DME-indicated range and the serial code output recorded on the data tape was determined by flying on a line toward a local VORTAC station. Each time the serial-code "range" word appeared, the indicated range was read and noted. This was repeated as the range varied from 28 to 8 n.mi. These data points were plotted to give a linear relationship between indicated range and binary count. The resulting expression was

$$R = 0.0483 \quad N - 2.25$$

where R is range in n.mi. and N is the binary count.

SECTION 6

GENERAL SURVEYS

6.1 MEASUREMENT LOCATIONS

The general air and ground RF noise surveys were conducted in Akron, Ohio between 16 June and 1 July 1970. The air surveys were conducted while flying over five preselected flight paths at an altitude of 2500 feet (765 meters) at a speed of approximately 100 knots (185 km/hr). The ground surveys were conducted by making measurements at five locations in the city of Akron. Figure 6-1 shows the relationship between the flight paths and the ground measurement sites.

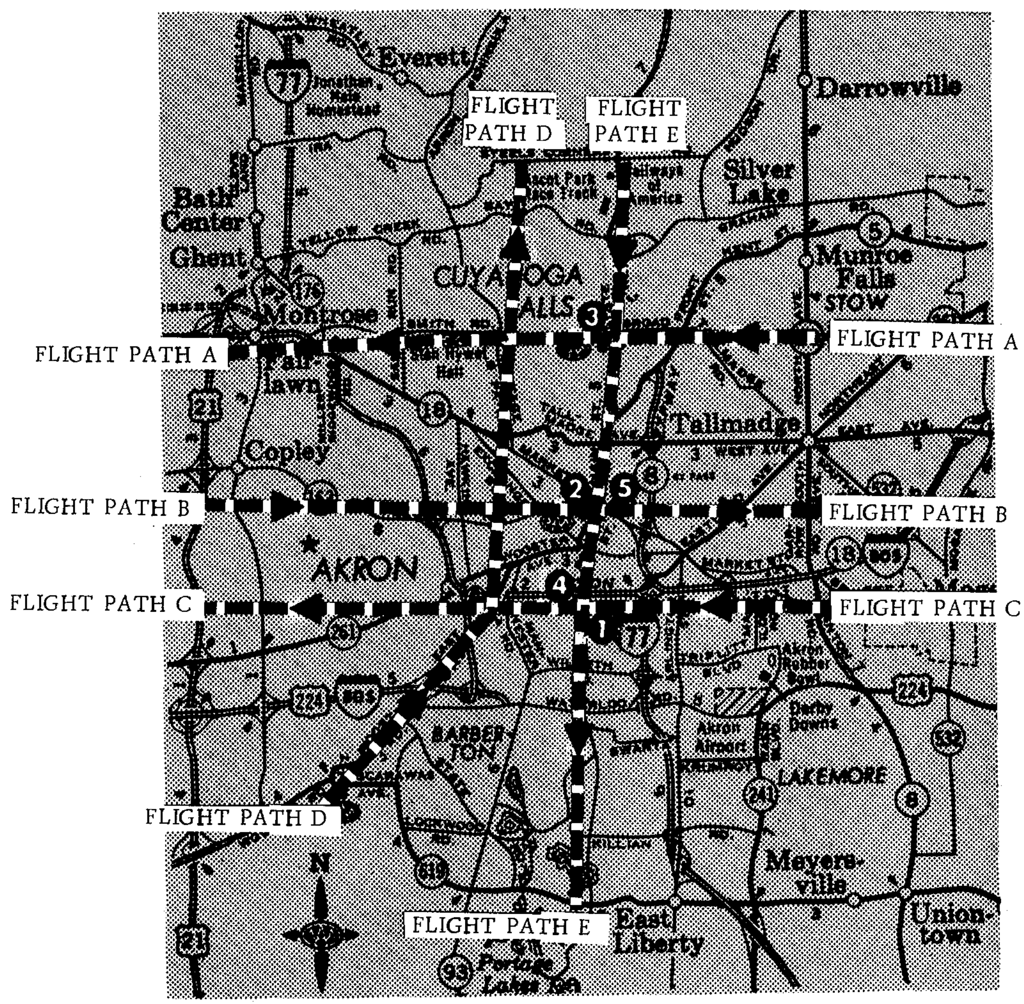


Figure 6-1. Relationship Between Flight Paths and Ground Sites

Flight Path A was flown from east to west starting at Main Street S in Munroe Falls 1/4 n.mi. south of Munroe Falls Road. The path continued west between E. Broadway and Curtis Avenue and between Fall Avenue and Broad Boulevard to the Green Cross General Hospital. The path then went west-southwest to the intersection of Shannabrook Drive and Carnette Road, and then west over Burlington Road, over Beaumont Drive, and ended at Highway 21. Flight Path B was flown from west to east. It started at Highway 21 about 3/8 n.mi. north of Miror Road, then went over Colon Drive, over White Pond, over Orrin Street, over the intersection of Exchange Street and Copley Road, over Grace Park, and 1/8 n.mi. south of Eastwood Avenue to Darrow Road, where it ended. Flight Path C, flown east to west, started at the intersection of Canton Road and Ardwell Avenue and went over Spade Avenue, over Twain Avenue, over Baird Street, over Paris Avenue, over Marie Avenue, and over Rockcliff Road. It continued west to 1/4 n.mi. north of Reimer Road, and ended at Highway 21. On airborne measurements made while the ground system was at Ground Site 4, Flight Path C was moved north approximately 1/2 n.mi. so that it passed over Ground Site 4 and was designated Flight Path C'.

Flight Path D started at Barberton and ran northeast to the intersection of East Avenue and Morse Street and then ran due north. The path started southwest of the Chemical Ponds in Barberton, ran northeast over the Tuscarawas River, over the west end of Prentiss Park, over East Avenue to Morse Street. It then turned north going over Packard Drive, over Vinita Avenue, over Castle Boulevard, and over the intersection of Shannabrook Drive and Carnette Road. From there it continued north and ended at West Steeles Corners Road.

Flight Path E, which was flown from north to south, started at West Steeles Corners Road approximately 1/8 mile west of Steeles Corners. The path went south over 24th Street, over Green Cross General Hospital, over Berwin Street, parallel but to the west of Main Street, and over the intersection of Main Street and Market Street. It turned a little west of south passing over Ground Site 1, over Moore Street, over Clairmont Avenue, over Holy Cross Pond, over East Reservoir, and ended at Turkey Foot Lake Road.

The ground measurement sites were located at various points along Flight Path E. The first three sites were selected prior to arriving in Akron, and the last two were selected after the data from the first airborne measurements was reviewed.

Ground Site 1 was a vacant lot on the north side of Miller Avenue between Sweitzer Avenue and Bellows Street. Figure 6-2 is a northerly view looking from the ground noise-measuring system at Site 1. There were industrial plants in the vicinity, with residential areas to the east and south.

Figure 6-3 is a view looking southeast over Ground Site 2. The site was a parking lot near the center of the urban section of Akron on the west side of South Main Street and

Figure 6-2. Northerly View from Ground System at Site 1

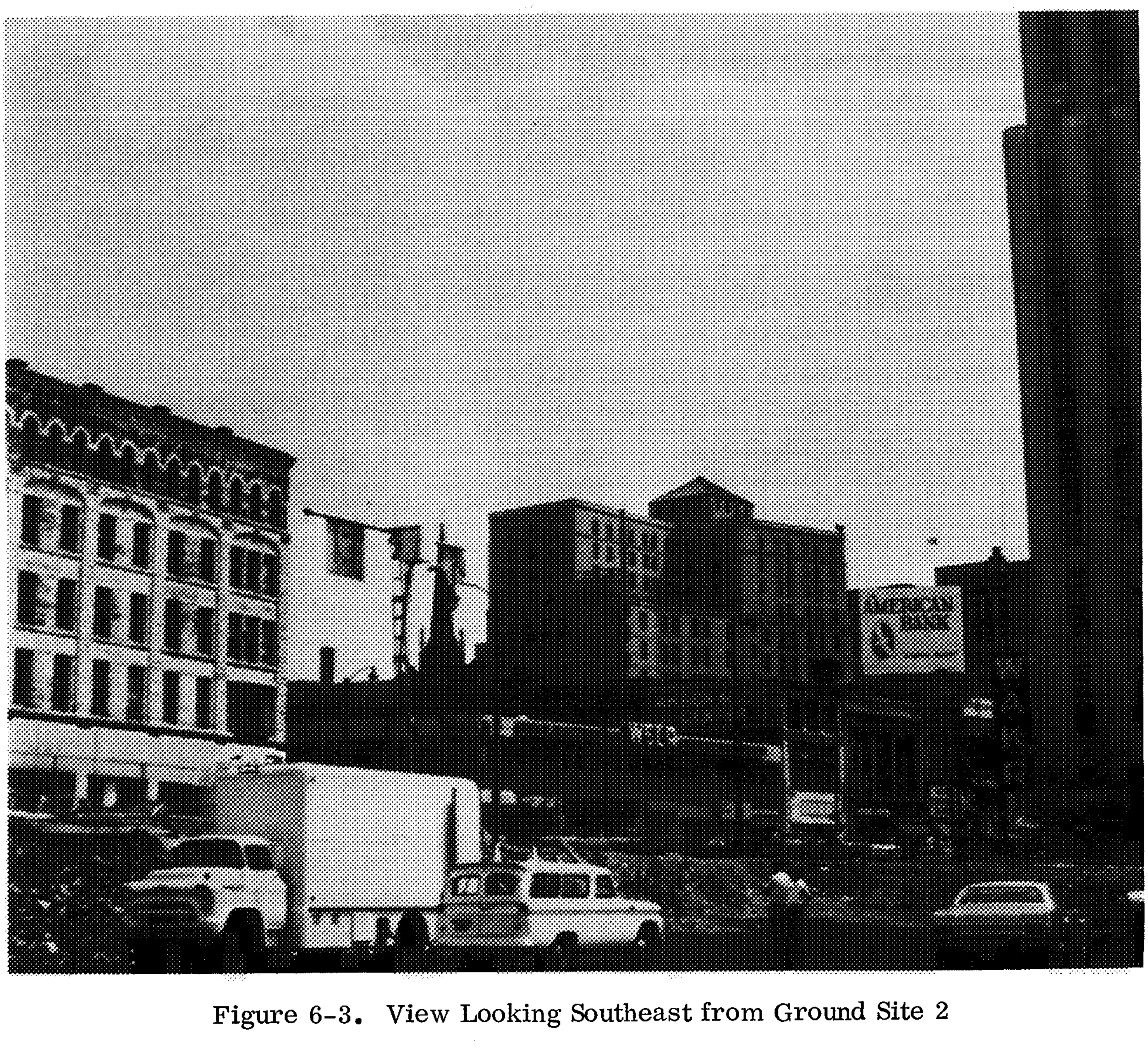


Figure 6-3. View Looking Southeast from Ground Site 2

one block south of Market Street. Office buildings and stores were to the east and south of the measurement site, and relatively heavy city traffic flowed on Main Street during the daytime period.

Ground Site 3 was located in a small parking lot near the intersection of Sackett Avenue and 23rd Street in Cuyahoga Falls. The parking lot was about 1/2 block west of State Road and 1/2 block from the Green Cross General Hospital. It was primarily a residential area except for resturants and service stations along State Road. Figure 6-4 is a view looking south from Ground Site 3.

Ground Site 4 was located in the parking lot of an abandoned service station near the intersection of Thornton Street and South Main Street. Figure 6-5 is a view looking east from this location. The area contained a mixture of small stores and old, multi-unit residences. Traffic was of medium volume on South Main Street throughout the day.

A parking lot on the east side of High Street was used as Ground Site 5. This site was near the center of the urban district. It was about 1/2 block south of Market Street. Figure 6-6 is a view to the west of the ground system at this site. Businesses and offices surrounded the area, and normal city urban traffic flowed on adjacent streets during the day.

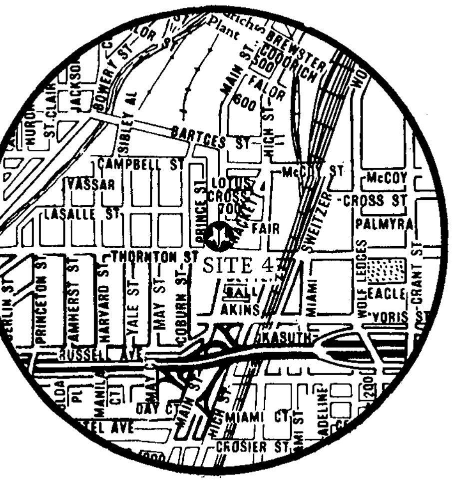
6.2 MEASUREMENT SUMMARY

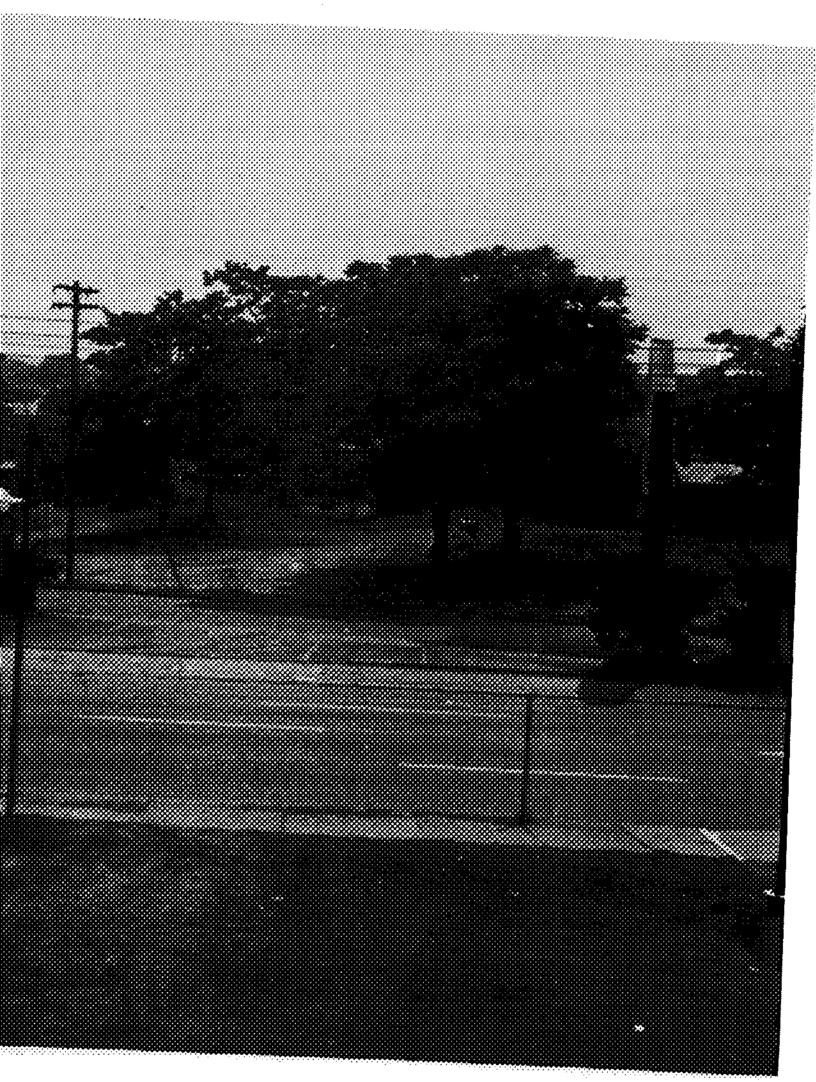
Measurements were made while flying over the flight paths and at the ground sites identified in the preceding section during various times of the day. Table 6-1 is a summary of these measurements showing the time, date, and location of the measurement and the identification of the data tape from that measurement. These tapes were picked up by the NASA program manager and were taken to Lewis Research Center for post-measurement reduction and analysis. Photographs were taken periodically of the area below the aircraft during the air surveys as well as of each ground measurement site. Log sheets were completed to record the measurement conditions during each step of the survey.

6.3 MEASUREMENT PROCEDURE

The surveys were conducted following the procedure contained in Appendix I. Included with this procedure are checklists that itemize the individual steps to be accomplished prior to and during the measurements.

The general procedure followed in making the airborne measurements started with applying electrical power to all components of the system immediately after becoming airborne. The local time was set up on the time code generator and the camera clock was synchronized with it. The DME was locked on to the VORTAC station in line with the upcoming flight path. The equipment was then allowed to warm up for 15 minutes





/iew Looking East from Ground Site 4

;tores were to the east and
/ traffic flowed on Main Street

;e intersection of Sackett Avenue
; about 1/2 block west of State
|ital. It was primarily a resi-
along State Road. Figure 6-4

loned service station near the
Figure 6-5 is a view looking
of small stores and old, multi-
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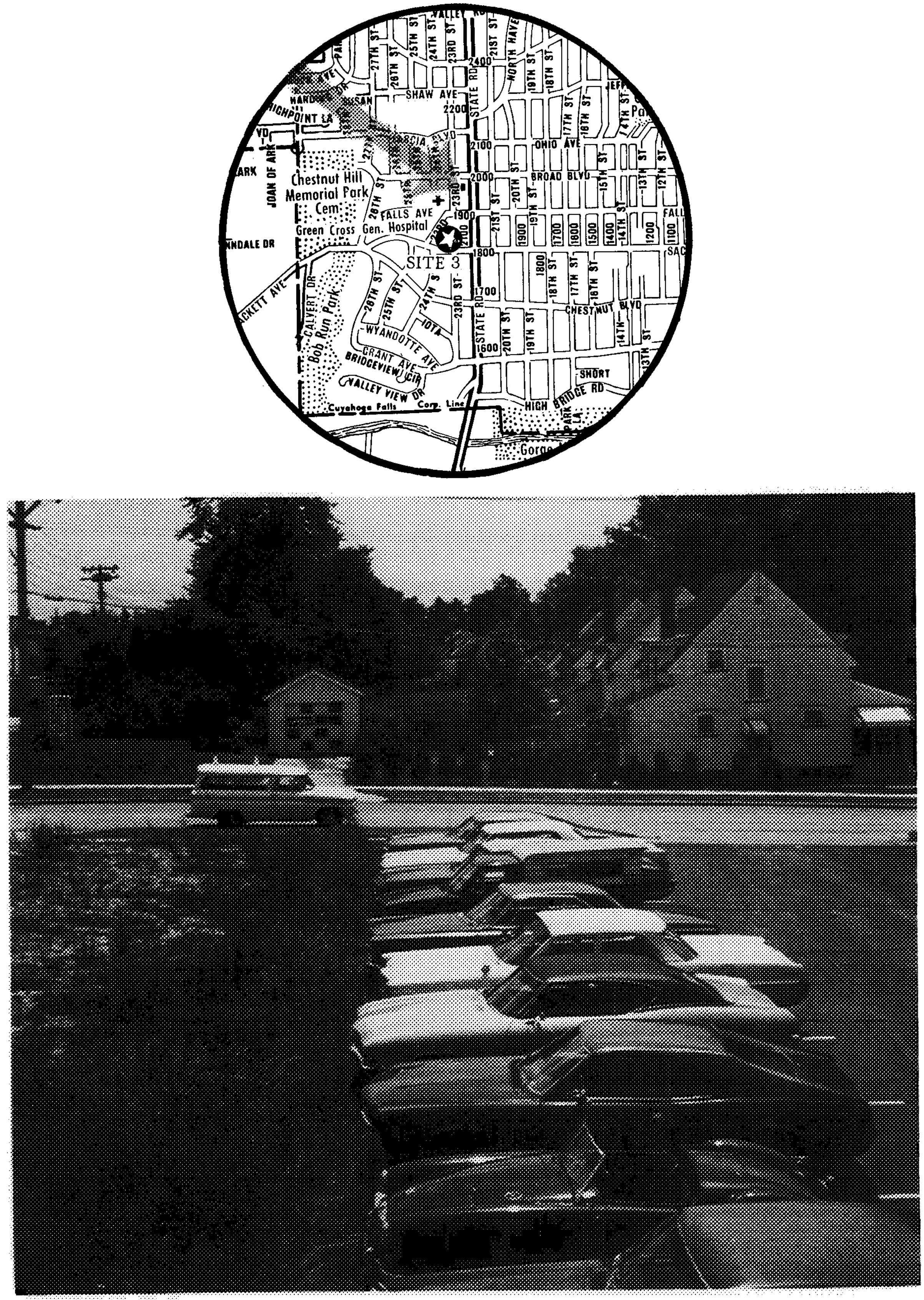


Figure 6-4. View Looking South from Ground Site 3

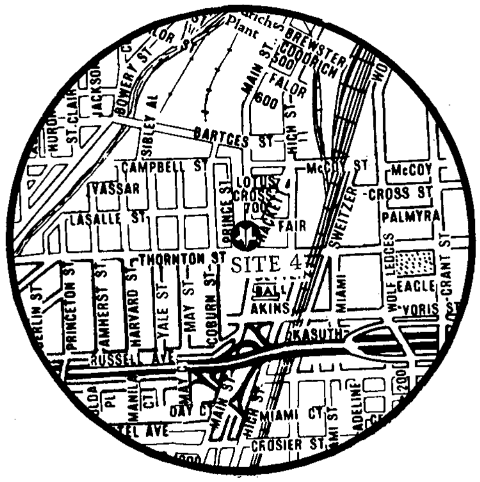
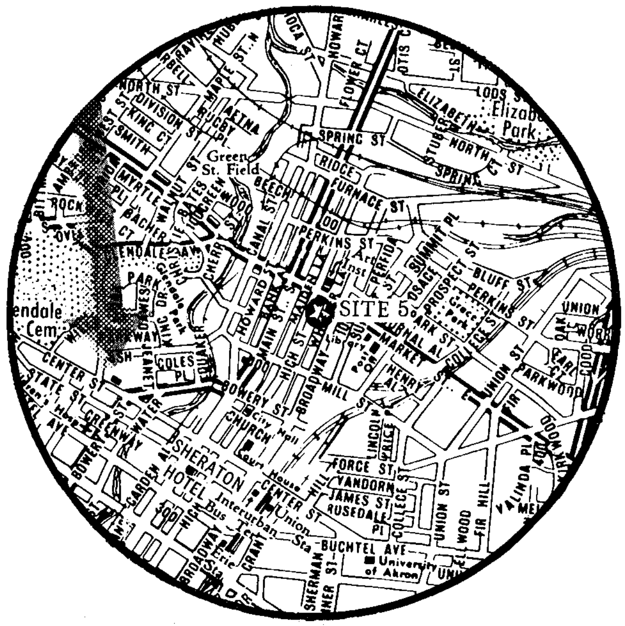


Figure 6-5. View Looking East from Ground Site 4



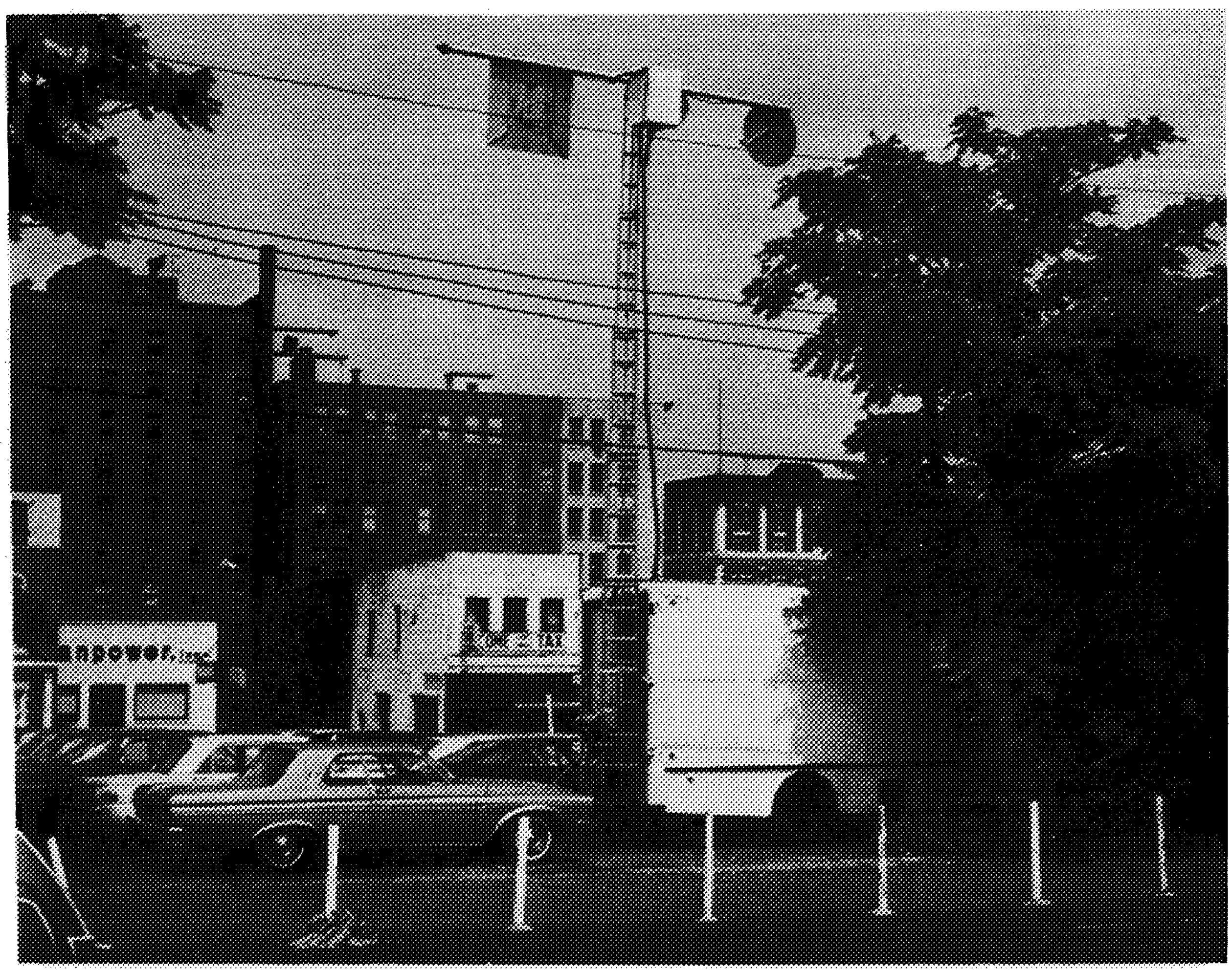


Figure 6-6. View Looking West from Ground Site 5

Table 6-1. Measurement Summary

Data Tape Identification	Date	Time Period	Air or Ground	Ground Site Number	Flight Paths Covered
G-06-16-1530	16 June	Afternoon Traffic	Ground	1	-
G-06-17-1330	17 June	Midday	Ground	1	-
G-06-18-1715	18 June	Afternoon Traffic	Ground	2	-
A-06-19-1000	19 June	Midday	Air	-	A, B, C, D, E
G-06-19-1030	19 June	Midday	Ground	2	-
G-06-22-1630	22 June	Afternoon Traffic	Ground	3	-
A-06-22-2000	22 June	Evening	Air	-	A, B, C, D, E
G-06-23-1100	23 June	Midday	Ground	3	-
A-06-23-1400	23 June	Midday	Air	-	Cleveland
G-06-25-0630	25 June	Morning Traffic	Ground	4	-
A-06-25-0700	25 June	Morning Traffic	Air	-	A, B, C', D, E, C
G-06-25-1600	25 June	Afternoon Traffic	Ground	4	-
A-06-25-1600	25 June	Afternoon Traffic	Air	-	A, B, C', D, E, C
G-06-25-2000	25 June	Evening	Ground	4	-
A-06-25-2000	25 June	Evening	Air	-	C', E
G-06-29-1200	29 June	Midday	Ground	4	-
G-06-30-1145	30 June	Midday	Ground	5	-
G-06-30-1600	30 June	Afternoon Traffic	Ground	5	-
G-07-01-0730	1 July	Morning Traffic	Ground	5	-
G-07-01-1100	1 July	Midday	Ground	5	-

while the aircraft circled near the start of Flight Path A. After warmup the IF gain for each RF channel was reduced to a minimum, the integrators zeroed, and drifts checked and adjusted if necessary. Next, the 50-ohm terminations were connected to the RF input of each channel and the video amplifier offset was adjusted to 100 millivolts. With the system cycling through three-second measurement intervals, the IF gains were adjusted to cause the lowest level event integrator to fill to 50 millivolts. The inputs to the RMS and AVG VCOs were zeroed.

Three minutes before starting the flight path, the system was placed in reset and the tape was identified on the voice track. The 12-channel recorder was started, the system was placed in calibration and a five-point calibration sequence was given. The system was placed in "run" condition with the 50-ohm terminations on the RF inputs for about 30 seconds, after which it was placed in "reset" and the tape recorder and 12-channel recorder were stopped. The position code was set up for Flight Path A and Start.

At 30 seconds before the aircraft was to pass over the start of the flight path, the RF inputs were switched to the antennas. The tape recorder, 12-channel recorder, and 2-channel recorder were started and the system was placed in the "run" condition. As the aircraft passed over the start of the flight path, the position code button was pressed, the time was noted and recorded, and the event was noted on the voice track of the tape. The camera operator recorded the frame number of the photograph and the time of this event. As each landmark and the end of the flight path were passed, the position code was operated and the time and photograph frame number were noted and recorded. At the end of the flight path, the recorders were stopped and the system was placed in "reset". Essentially, this same procedure was followed for each flight path.

The procedure for the ground measurements was similar to that followed in the airborne measurements. After the gain, zero, and drift adjustments were made, the antennas were rotated through 360 degrees in azimuth. The direction from which the highest noise level was coming was noted and the data was recorded for 15 minutes with the antennas pointing in this direction. The frequency of one VCO was adjusted to indicate this direction. After 15 minutes, the recorders were stopped, the antennas were rotated 180 degrees in azimuth, and the frequency of the azimuth VCO was readjusted. Data was then recorded for another 15-minute period.

SECTION 7

SURVEY RESULTS

7.1 INTRODUCTION

The data (magnetic tapes, photographs, log sheets, maps, etc.) obtained during the general survey of radio-frequency noise in Akron was sent to NASA, Lewis Research Center for reduction and analysis. At the Center, the data on magnetic tape was digitized, a program was prepared, and a computer was used to process and present the data. A small sample of the reduced data is contained in this section to show the results obtained. This data is primarily from the air-survey measurements made during the midday period on 19 June 1970. The reduced data illustrates the variation in noise level resulting from RF frequency, monitoring site location, and time of day. A rough comparison between airborne and ground noise levels is made. This comparison is based on the limited amount of reduced data available.

7.2 AIR SURVEY RESULTS

In reducing the data, each flight path was broken up into segments of rural area, suburban area, or urban area. Figure 7-1 shows a rough layout of the flight paths with the associated landmarks and an indication of the boundaries of the urban, suburban, and rural areas.

Table 7-1 is a summary of Tables 7-2 through 7-22, which contain the tabulated results of the airborne measurements made during the midday period on 19 June 1970 (Tape No. A-06-19-1000).

Tables 7-2 through 7-22 are identified by flight path and type of area (urban, suburban, or rural). Each table is divided into five basic parts:

a. The first part identifies start and stop test times, total time of test, samples per frequency, and computer-reduced DME range at start and completion of test.

b. The second part shows the average number of milliseconds that each level comparator was turned on for each frequency. If the value was within two percent of the full-scale value for that integrator, an asterisk (*) was placed after the number to indicate that the integrator was filled and the value may be as tabulated or greater. Each measurement period lasted approximately 2,380 milliseconds; thus, the average percent of time that a given level comparator was on is obtained by dividing the number tabulated by 2,380 and multiplying by 100.

c. The third part gives the average number of times the threshold of each comparator was exceeded for each frequency. Again, an asterisk indicates that the integrator was filled or within two percent of the full-scale value.

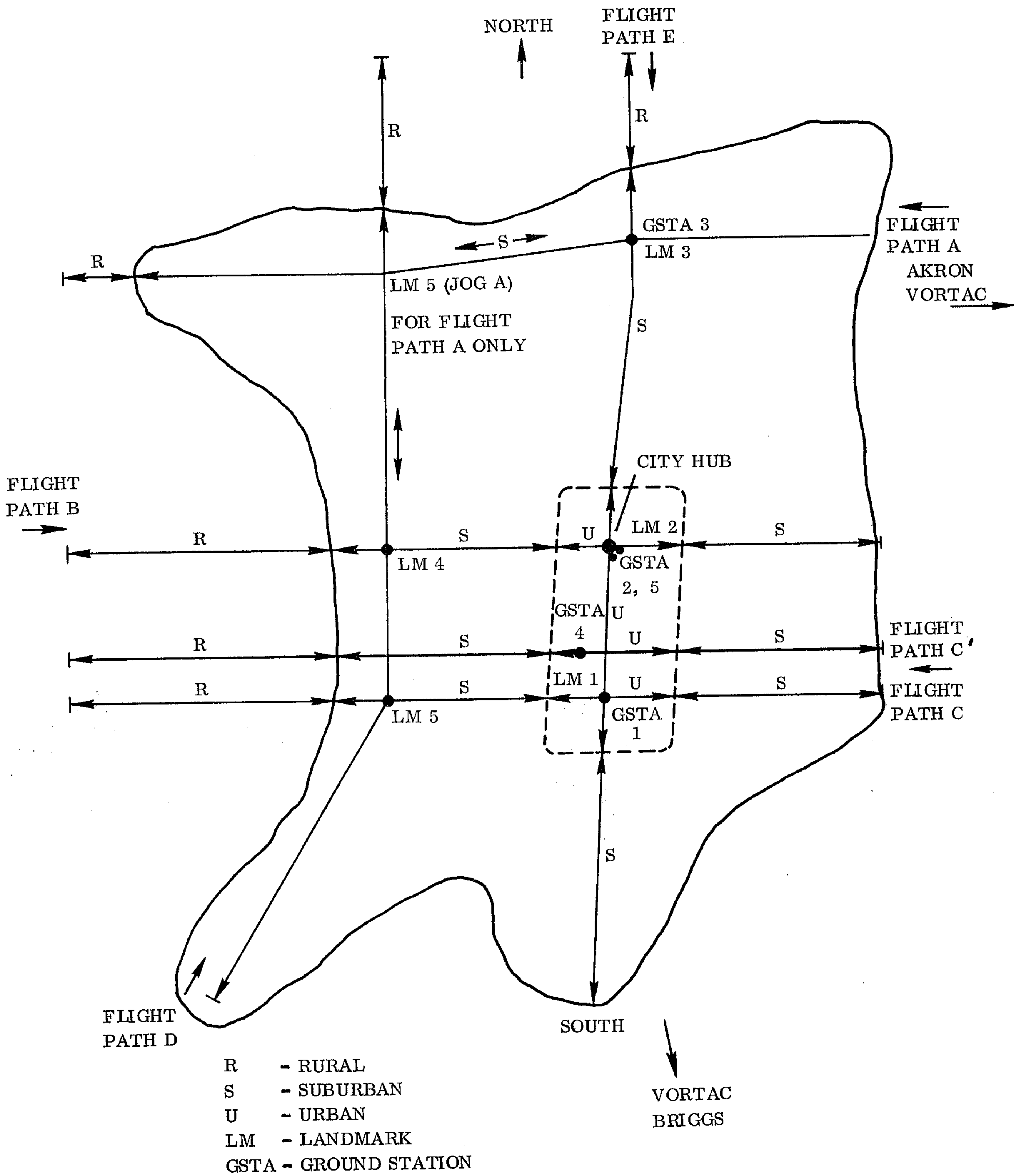


Figure 7-1. Boundaries of Rural, Suburban, and Urban Areas in Akron

d. The fourth part gives the average duration of the noise pulses that exceed each comparator threshold for each frequency.

e. The last part gives the average value at each frequency of the RMS noise level, the difference between the average and the RMS levels, and the values of the 60 Hz and 15.75 kHz components of the noise. The RMS value corresponds to that existing at the input to the receiving subsystem. The 60 Hz and 15.75 kHz values refer to the magnitude of these components in the detected signal.

The variation in the received RF noise levels at 300 MHz and at 1 GHz in db above KT_O for Flight Paths A, B, C, D, and E are shown in Figures 7-2, 7-3, 7-4, 7-5, and 7-6, respectively. The regions of each flight path and the times the landmarks were passed are shown in the figures. This data is from measurements made during the midday period on 19 June 1970.

Figures 7-7 through 7-10 show the effect of time of day on the variation of noise levels along two of the flight paths as measured from the air. Figure 7-7 shows the variation of the 300 MHz noise level as measured along Flight Path B for morning, midday, and evening traffic. Figure 7-8 shows corresponding variations of the 1 GHz noise data. Figures 7-9 and 7-10 show the variation of the 300 MHz and 1 GHz noise levels, respectively, as measured along Flight Path E for the three time periods.

Samples of the aerial photographs taken during the measurements are shown in Figures 7-11, 7-12, and 7-13 in which several overlapping photographs have been combined to give a view of a larger segment of the flight paths. Figure 7-11 shows combined aerial photographs of the west end of Flight Path C. This area was designated a rural region during the data reduction. Figure 7-12 shows combined aerial photographs of the urban portion of Flight Path C; ground site 4 is shown in this photograph. Figure 7-13 shows combined aerial photographs of part of the urban portion of Flight Path E; ground sites 2 and 5 are shown in this photograph.

7.3 GROUND SURVEY RESULTS

A small amount of the ground RF noise data was reduced at the time of this writing. Preliminary examination indicated that it was near the receiver threshold. Data samples of the RMS noise levels were available to compare results of the ground measurements with the airborne measurements. This comparison is shown in Table 7-23 with samples at each ground site at 300 MHz and 1.0 GHz. The aerial samples are the measured RMS noise levels at the times the aircraft was over the ground site. For example, the aircraft passed over Ground Site 1 on Flight Paths C and E. From the data, it can be concluded that the noise at 300 MHz measured from 2500 feet is on the order of 15 to 25 db above that measured from the ground. Because the 1 GHz RMS noise level was at or within a few db of the receiver threshold on both airborne and ground measurement, a valid comparison of this parameter is not possible.

Table 7-1. Summary of Airborne Data Tabulation
(from Tape A-06-19-1000)

Table	Flight Path	Region
7-2	A	Rural
7-3	A	Suburban
7-4	A	Rural and Suburban
7-5	B	Rural
7-6	B	Suburban
7-7	B	Urban
7-8	B	Suburban and Urban
7-9	B	Rural, Suburban
7-10	C	Rural
7-11	C	Suburban
7-12	C	Urban
7-13	C	Suburban and Urban
7-14	C	Rural, Suburban, and Urban
7-15	D	Rural
7-16	D	Suburban
7-17	D	Rural and Suburban
7-18	E	Rural
7-19	E	Suburban
7-20	E	Urban
7-21	E	Suburban and Urban
7-22	E	Rural, Suburban, and Urban

Table 7-2. RF Noise Survey, Flight Path A, Rural

Begin Time: 10:58:03 DME: 19.7 n.mi.

Stop Time: 10:58:26 DME: 20.4 n.mi.

Total Time: 24 sec

Samples Per Frequency: 3

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	94	54	24	12	8	4
1.00	3	1	<1	<1	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7086*	5925*	4750*	3550*	3550*	2892
1.00	5761	3713	2906	579	230	76
3.00	388	683	355	152	129	88

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0134	0.0092	0.0050	0.0032	0.0009	0.0013
1.00	0.0005	0.0003	0.0001	0.0001	0	0.0003
3.00	0.0000	0	0	0.0002	0	0.0005

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-98	-1	20	0
1.00	-107	0	2	0
3.00	<-107	0	0	0

* Integrator filled.

Table 7-3. RF Noise Survey, Flight Path A, Suburban

Begin Time: 10:52:33 DME: —

Stop Time: 10:58:01 DME: 19.7 n.mi.

Total Time: 329 sec

Samples Per Frequency: 36

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	234*	218	96	83	48	41
1.00	13	9	4	2	<1	1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7081*	5925*	4750*	3550*	3528*	3044
1.00	6813	5464	4420	1630	700	257
3.00	296	655	279	30	16	28

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0331	0.0367	0.0202	0.0234	0.0136	0.0135
1.00	0.0019	0.0016	0.0010	0.0013	0.0004	0.0027
3.00	0.0001	0.0001	0.0000	0.0010	0.0003	0.0038

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-83	-0	54	3
1.00	-107	0	2	0
3.00	<-107	0	0	0

* Integrator filled.

Table 7-4. RF Noise Survey, Flight Path A, Rural and Suburban

Begin Time: 10:52:33 DME: —

Stop Time: 10:58:26 DME: 20.4 n.mi.

Total Time: 354 sec

Samples Per Frequency: 39

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	224	205	90	77	44	38
1.00	12	8	4	2	<1	1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7082*	5925*	4750*	3550*	3530*	3034
1.00	6907	5469	4417	1591	682	250
3.00	301	657	283	36	22	31

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0316	0.0346	0.0190	0.0218	0.0125	0.0126
1.00	0.0018	0.0016	0.0009	0.0013	0.0003	0.0026
3.00	0.0001	0.0001	0.0001	0.0009	0.0002	0.0033

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-84	-0	51	2
1.00	-107	0	2	0
3.00	<-107	0	0	0

* Integrator filled.

Table 7-5. RF Noise Survey, Flight Path B, Rural

Begin Time: 11:04:17 DME: 20.6 n.mi.

Stop Time: 11:05:15 DME: 19.4 n.mi.

Total Time: 59 sec

Samples Per Frequency: 6

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	156	126	31	10	1	1
1.00	2	1	<1	<1	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7079*	5925*	4750*	3550*	3382	1964
1.00	5667	3448	2893	804	365	141
3.00	860	795	747	112	79	49

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0220	0.6212	0.0066	0.0028	0.0003	0.0006
1.00	0.0003	0.0002	0.0000	0.0001	0	0.0002
3.00	0	0	0	0	0.0001	0.0013

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-96	-0	28	0
1.00	-107	0	0	0
3.00	<-107	0	4	0

* Integrator filled.

Table 7-6. RF Noise Survey, Flight Path B, Suburban

Begin Time:	11:05:17 11:07:32	DME: 18.7 n.mi.	—
	and	and	
Stop Time:	11:06:30 11:09:00	DME: 17.0 n.mi.	—

Total Time: 163 sec

Samples Per Frequency: 18

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	232	176	80	52	13	9
1.00	15	11	4	2	<1	<1
3.00	26	25	13	12	6	2

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7076*	5925*	4750*	3550*	3550*	3212
1.00	5942	4532	3736	1690	842	363
3.00	711	859	498	143	88	52

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0328	0.0297	0.0169	0.0146	0.0036	0.0028
1.00	0.0025	0.0024	0.0011	0.0012	0.0003	0.0012
3.00	0.0366	0.0291	0.0266	0.0840	0.0883	0.0385

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-88	-1	44	0
1.00	-107	0	5	0
3.00	<-107	0	1	0

* Integrator filled.

Table 7-7. RF Noise Survey, Flight Path B, Urban

Begin Time: 11:06:32 DME: 15.8 n.mi.

Stop Time: 11:07:30 DME: 14.6 n.mi.

Total Time: 59 sec

Samples Per Frequency: 6

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	238*	238*	108	67	36	35
1.00	9	7	3	2	<1	1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7079*	5925*	4750*	3550*	3550*	3550*
1.00	7076*	5925*	4750*	3139	1909	853
3.00	569	901	429	118	85	52

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0336	0.0402	0.0228	0.0189	0.0101	0.0098
1.00	0.0013	0.0011	0.0007	0.0007	0.0002	0.0010
3.00	0.0001	0.0000	0.0000	0.0005	0.0001	0.0020

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-84	-1	60	0
1.00	-107	1	2	0
3.00	<-107	0	0	0

* Integrator filled.

Table 7-8. RF Noise Survey, Flight Path B, Suburban and Urban

Begin Time: 11:05:17 DME: 18.7 n.mi.

Stop Time: 11:09:00 DME: —

Total Time: 223 sec

Samples Per Frequency: 24

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	233*	182	82	53	15	11
1.00	14	10	4	2	<1	<1
3.00	23	23	11	11	5	2

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7076*	5925*	4750*	3550*	3550*	3245
1.00	6054	4669	3836	1833	948	411
3.00	706	878	498	143	89	52

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0329	0.0307	0.0174	0.0150	0.0042	0.0035
1.00	0.0023	0.0022	0.0010	0.0009	0.0002	0.0008
3.00	0.0331	0.0261	0.0227	0.0783	0.0563	0.0422

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-87	-1	38	0
1.00	-107	0	4	0
3.00	<-107	0	1	0

* Integrator filled.

Table 7-9. RF Noise Survey, Flight Path B, Rural, Suburban and Urban

Begin Time: 11:04:17 DME: 20.6 n.mi.

Stop Time: 11:09:00 DME: —

Total Time: 283 sec

Samples Per Frequency: 30

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	223	175	76	48	18	10
1.00	12	9	3	1	<1	<1
3.00	20	20	10	10	4	2

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7077*	5925*	4750*	3550*	3528*	3081
1.00	6004	4512	3715	1700	872	377
3.00	726	867	530	139	88	52

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0315	0.0295	0.0160	0.0134	0.0037	0.0032
1.00	0.0021	0.0020	0.0009	0.0008	0.0002	0.0008
3.00	0.0281	0.0230	0.0186	0.0702	0.0498	0.0372

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-89	-1	37	0
1.00	-107	0	3	0
3.00	<-107	0	1	0

* Integrator filled.

Table 7-10. RF Noise Survey, Flight Path C, Rural

Begin Time: 11:20:06 DME: 18.1 n.mi.

Stop Time: 11:22:14 DME: 21.3 n.mi.

Total Time: 129 sec

Samples Per Frequency: 14

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	92	65	31	9	2	2
1.00	1	<1	<1	<1	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7029*	5863*	4692*	3500*	3318	2015
1.00	6238	4054	3316	808	342	114
3.00	364	603	335	72	54	34

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0130	0.0111	0.0066	0.0026	0.0005	0.0008
1.00	0.0002	0.0001	0.0000	0.0001	0.0001	0.0003
3.00	0	0	0	0.0002	0.0003	0.0027

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-99	-1	29	0
1.00	-107	0	0	0
3.00	<-107	0	1	0

* Integrator filled.

Table 7-11. RF Noise Survey, Flight Path C, Suburban

Begin Time:	11:15:05	11:17:36	DME: 9.6 n.mi.	13.7 n.mi.
	and			and
Stop Time:	11:16:34	11:20:04	DME: —	17.4 n.mi.

Total Time: 238 sec

Samples Per Frequency: 25

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	166	140	61	29	12	12
1.00	7	5	2	1	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	6770	5633	4518	3306	3286	3137
1.00	6996*	5617	4592	2565	1312	558
3.00	260	705	258	71	46	25

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0245	0.0254	0.0135	0.0088	0.0037	0.0038
1.00	0.0010	0.0009	0.0004	0.0003	0.0001	0.0011
3.00	0.0000	0.0000	0	0.0004	0.0002	0.0082

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-95	0	36	0
1.00	-107	1	3	0
3.00	<-107	-1	2	0

* Integrator filled.

Table 7-12. RF Noise Survey, Flight Path C, Urban

Begin Time: 11:16:36 DME: 12.0 n.mi.

Stop Time: 11:17:34 DME: 12.8 n.mi.

Total Time: 59 sec

Samples Per Frequency: 6

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	238*	238*	115	87	74	75
1.00	5	3	2	2	1	1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7068*	5925*	4750*	3550*	3550*	3549*
1.00	7070*	5925*	4750*	2102	972	410
3.00	1177	1197	725	128	46	37

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0337	0.0402	0.0241	0.0245	0.0209	0.0210
1.00	0.0007	0.0006	0.0003	0.0007	0.0006	0.0033
3.00	0.0001	0.0000	0	0.0004	0.0001	0.0042

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-84	1	63	8
1.00	-107	1	2	0
3.00	<-107	1	0	0

* Integrator filled.

Table 7-13. RF Noise Survey, Flight Path C, Suburban and Urban

Begin Time: 11:15:05 DME: 9.6 n.mi.

Stop Time: 11:20:04 DME: 17.4 n.mi.

Total Time: 297 sec

Samples Per Frequency: 31

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	180	159	72	40	24	24
1.00	7	4	2	1	<1	1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	6828	5689	4563	3353	3338	3218
1.00	7010*	5676	4622	2475	1247	528
3.00	408	784	334	80	46	27

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0264	0.0280	0.0157	0.0121	0.0073	0.0075
1.00	0.0010	0.0008	0.0004	0.0005	0.0002	0.0011
3.00	0.0000	0.0000	0	0.0003	0.0002	0.0042

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-92	-0	23	2
1.00	-107	1	1	0
3.00	<-107	-0	1	0

* Integrator filled.

Table 7-14. RF Noise Survey, Flight Path C, Rural, Suburban and Urban

Begin Time: 11:15:05 DME: 9.6 n.mi.

Stop Time: 11:22:14 DME: 21.3 n.mi.

Total Time: 429 sec

Samples Per Frequency: 45

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	152	130	59	31	17	17
1.00	5	3	1	1	0	0
3.00	0	0	0	0	0	0

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	6890	5743	4603	3399	3332	2843
1.00	6909	5262	4290	1974	972	402
3.00	394	728	334	77	48	28

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0221	0.0226	0.0128	0.0090	0.0052	0.0060
1.00	0.0008	0.0006	0.0003	0.0005	0.0002	0.0010
3.00	0.0000	0.0000	0	0.0003	0.0003	0.0037

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-96	1	24	1
1.00	-107	1	1	0
3.00	<-107	-0	1	0

* Integrator filled.

Table 7-15. RF Noise Survey, Flight Path D, Rural

Begin Time: 11:36:01 DME: –

Stop Time: 11:37:14 DME: 26.7 n.mi.

Total Time: 74 sec

Samples Per Frequency: 8

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	89	30	5	2	<1	<1
1.00	<1	<1	<1	<1	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7055*	5925*	4750*	3297	1911	828
1.00	3119	2119	1574	427	165	42
3.00	1886	1454	1549	456	196	46

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0126	0.0051	0.0011	0.0007	0.0000	0.0003
1.00	0.0001	0	0	0.0000	0	0.0007
3.00	0.0000	0	0.0000	0.0000	0	0.0019

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-98	-0	21	0
1.00	-107	0	0	0
3.00	<-107	1	2	0

* Integrator filled.

Table 7-16. RF Noise Survey, Flight Path D, Suburban

Begin Time:	11:31:01	DME: —
Stop Time:	11:35:59	DME: 24.5 n.mi.
Total Time:	299 sec	
Samples Per Frequency:	33	

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	200	174	73	54	20	14
1.00	11	7	3	2	1	1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	6927	5814*	4673*	3455	3367	3227
1.00	6943	5634	4522	1829	826	368
3.00	496	831	353	70	23	6

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0289	0.0300	0.0157	0.0156	0.0060	0.0044
1.00	0.0015	0.0012	0.0007	0.0010	0.0007	0.0016
3.00	0.0001	0.0000	0.0000	0.0003	0.0001	0.0233

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-89	-1	45	0
1.00	-107	1	3	0
3.00	<-107	1	0	0

* Integrator filled.

Table 7-17. RF Noise Survey, Flight Path D, Rural and Suburban

Begin Time: 11:31:01 DME: –

Stop Time: 11:37:14 DME: 26.7 n.mi.

Total Time: 374 sec

Samples Per Frequency: 41

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	179	146	60	44	16	12
1.00	9	6	3	<1	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	6952	5835	4688	3425	3083	2759
1.00	6197	4948	3946	1556	697	305
3.00	767	952	587	145	57	13

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0257	0.0251	0.0128	0.0128	0.0053	0.0042
1.00	0.0014	0.0011	0.0006	0.0010	0.0007	0.0016
3.00	0.0000	0.0000	0.0000	0.0001	0.0000	0.0088

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-92	-0	41	0
1.00	-107	1	2	0
3.00	<-107	1	0	0

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* Integrator filled.

Table 7-18. RF Noise Survey, Flight Path E, Rural

Begin Time: 11:40:50 DME: 26.4 n.mi.

Stop Time: 11:41:49 DME: 25.2 n.mi.

Total Time: 60 sec

Samples Per Frequency: 6

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	235*	178	68	22	6	7
1.00	4	3	1	1	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7057*	5925*	4750*	3550*	3484*	2895
1.00	6876	4748	3848	1306	607	248
3.00	112	525	297	24	11	1

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0333	0.0301	0.0143	0.0062	0.0017	0.0023
1.00	0.0006	0.0005	0.0003	0.0005	0.0000	0.0003
3.00	0.0001	0	0	0.0011	0.0016	0.0253

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-91	-0	42	0
1.00	-107	1	0	0
3.00	<-107	1	0	0

* Integrator filled.

Table 7-19. RF Noise Survey, Flight Path E, Suburban

Begin Time: 11:41:51 11:45:20 DME: 24.7 n.mi. 18.8 n.mi.
and and
Stop Time: 11:43:49 11:47:22 DME: 21.9 n.mi. 15.5 n.mi.

Total Time: 242 sec

Samples Per Frequency: 26

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	237*	226	101	55	11	10
1.00	7	5	2	2	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	6839	5738	4598	3434	3431	3342
1.00	7059*	5828*	4714*	2322	1148	502
3.00	172	676	193	48	22	6

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0347	0.0400	0.0220	0.0168	0.0032	0.0029
1.00	0.0010	0.0086	0.0004	0.0009	0.0001	0.0013
3.00	0.0000	0.0000	0	0.0011	0.0002	0.0304

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-86	-1	41	0
1.00	-107	1	1	0
3.00	<-107	1	0	0

* Integrator filled.

Table 7-20. RF Noise Survey, Flight Path E, Urban

Begin Time: 11:43:51 DME: 21.3 n.mi.

Stop Time: 11:45:18 DME: 19.6 n.mi.

Total Time: 88 sec

Samples Per Frequency: 10

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	238*	233*	107	69	17	15
1.00	40	37	19	12	1	1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	7052*	5925*	4750*	3550*	3550*	3549*
1.00	7059*	5925*	4750*	3538*	2384	1066
3.00	210	732	225	65	36	13

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0337	0.0393	0.0224	0.0196	0.0049	0.0043
1.00	0.0057	0.0062	0.0039	0.0034	0.0006	0.0007
3.00	0.0007	0.0002	0.0003	0.0021	0.0002	0.0066

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-87	-0	55	0
1.00	-104	0	7	0
3.00	< -107	1	1	0

* Integrator filled.

Table 7-21. RF Noise Survey, Flight Path E, Suburban and Urban

Begin Time: 11:41:51 DME: 24.7 n.mi.

Stop Time: 11:47:22 DME: 15.5 n.mi.

Total Time: 330 sec

Samples Per Frequency: 36

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	237*	227	102	57	12	10
1.00	11	9	4	3	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	6870	5765	4620	3451	3449	3372
1.00	7059*	5841*	4719*	2480	1309	575
3.00	180	694	200	51	24	7

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0345	0.0394	0.0220	0.0165	0.0035	0.0031
1.00	0.0016	0.0015	0.0009	0.0012	0.0002	0.0007
3.00	0.0001	0.0000	0.0001	0.0009	0.0001	0.0126

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-86	-1	35	0
1.00	-107	1	2	0
3.00	< -107	1	0	0

* Integrator filled.

Table 7-22. RF Noise Survey, Flight Path E, Rural, Suburban and Urban

Begin Time: 11:40:50 DME: 26.4 n.mi.

Stop Time: 11:47:22 DME: 15.5 n.mi.

Total Time: 393 sec

Samples Per Frequency: 42

Time Integrators (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	237*	219	96	51	11	10
1.00	10	8	4	3	<1	<1
3.00	<1	<1	<1	<1	<1	<1

Event Integrators (pulses)

Frequency (GHz)	1	2	3	4	5	6
0.30	6903	5794	4643	3468	3455	3287
1.00	7026*	5646	4563	2271	1184	517
3.00	168	664	218	46	22	6

Time/Events (milliseconds)

Frequency (GHz)	1	2	3	4	5	6
0.30	0.0343	0.0377	0.0206	0.0146	0.0036	0.0030
1.00	0.0014	0.0014	0.0008	0.0011	0.0002	0.0007
3.00	0.0001	0.0000	0.0000	0.0009	0.0003	0.0134

Frequency (GHz)	RMS (dbm)	Avg-RMS (db)	60 Hz (mv)	15.75 kHz (mv)
0.30	-87	-1	36	0
1.00	-107	1	1	0
3.00	<-107	1	0	0

* Integrator filled.

Table 7-23. Ground and Air Noise Level Comparisons

Site No.	Aerial Sample Time	Aerial Sample RMS Noise, db>KT_o 0.3 GHz	Aerial Sample RMS Noise, db>KT_o 1.0 GHz	Ground Sample Time	Ground Sample RMS Noise, db>KTo 0.3 GHz	Ground Sample RMS Noise, db>KTo 1.0 GHz
1	07 58 20	30	5	-		
	11 18 44	26	6	-		
	11 45 00	22	4	-		
	16 31 44	22	<4	-		
	16 45 19	22	5	16 15 00	<5	<4
	20 53 07	22	5	-		
	21 15 47	28	<4	-		
2	07 04 30	26	<4	-		
	07 42 00	26	7	-		
	11 07 13*	37	6	11 05 00	12	<5
	11 44 02*	26	7	11 44 10	<5	<4
	16 03 40	22	6			
	16 31 10	26	6	17 15 00	5	<4
	20 43 00	26	5			
	20 27 18	26	7			
	21 15 00	26	<4			
3	06 52 40	30	<4	-		
	07 40 10	30	<4	-		
	10 54 50	28	4	-		
	11 42 20	28	5	11 42 00	<5	<4
	15 54 19	28	6	-		
	16 29 40	31	4	16 25 00	<4	<4
	20 25 38	28	6	-		
	20 31 37	22	5	-		
	21 13 14	31	6	-		
4	07 11 10*	23	<4	07 11 10	<4	<4
	07 42 50*	23	7	07 42 50	<5	<4
	16 10 40*	19	6	16 10 40	5	<5
	20 11 40*	22	5	20 11 40	<5	<4
	20 28 02*	20	<4	20 28 02	<4	<4
5	07 04 30	26	<4	-		
	07 42 00	26	7	07 30 00	<5	<4
	11 07 13	37	6	12 12 00	<5	<4
	11 44 02	26	7	11 30 00	<5	<4
	16 03 40	22	6	16 05 00	<4	<4
	16 31 10	26	6	16 31 00	<5	<4
	20 27 18	26	7	-		
	20 43 00	26	5	-		
	21 15 00	26	<4	-		

*Simultaneous Air and Ground Survey.
All other ground samples are ±1 hour, different day.

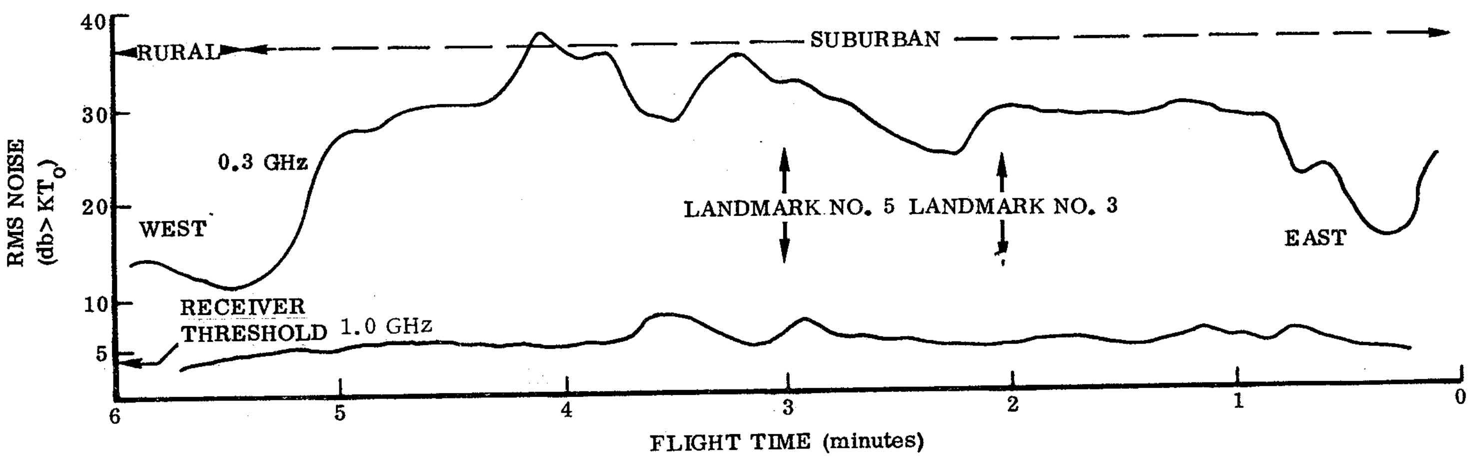


Figure 7-2. Noise Level Variation on Flight Path A

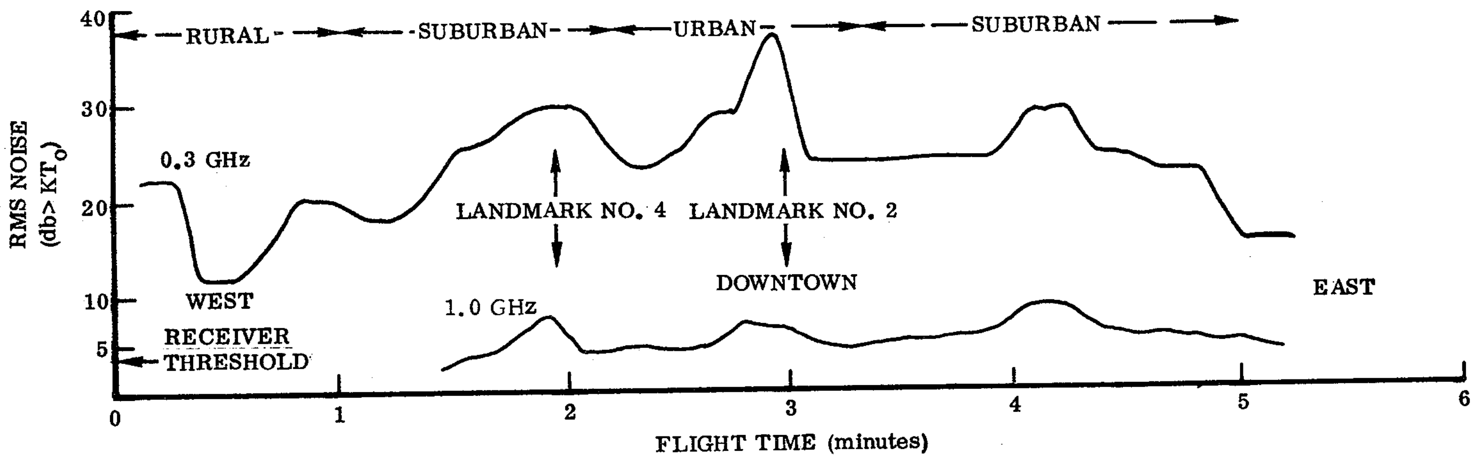


Figure 7-3. Noise Level Variations on Flight Path B

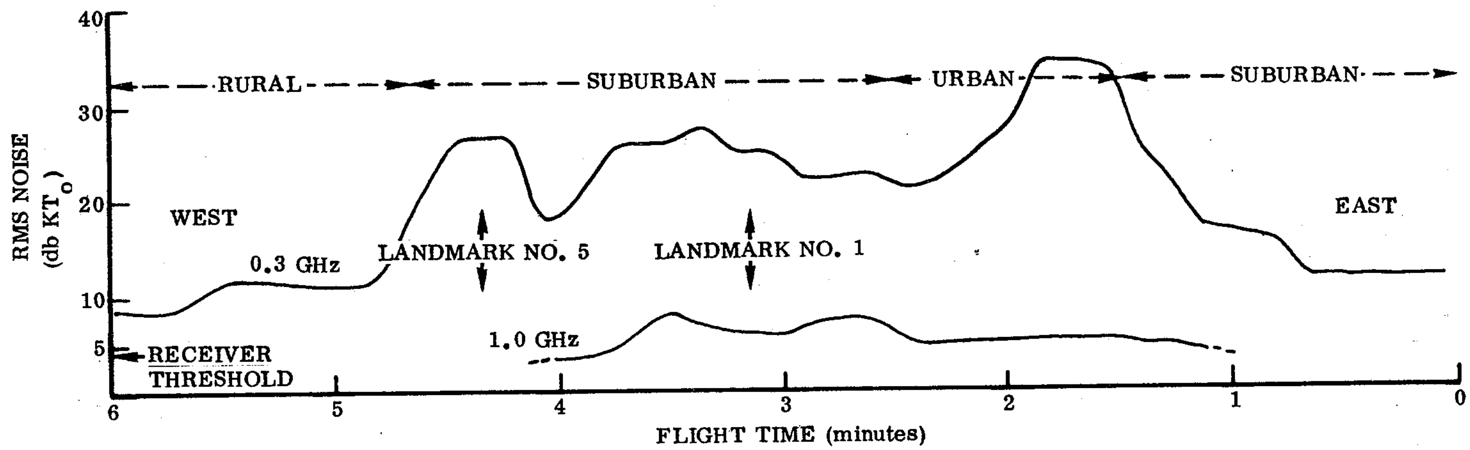


Figure 7-4. Noise Level Variations on Flight Path C

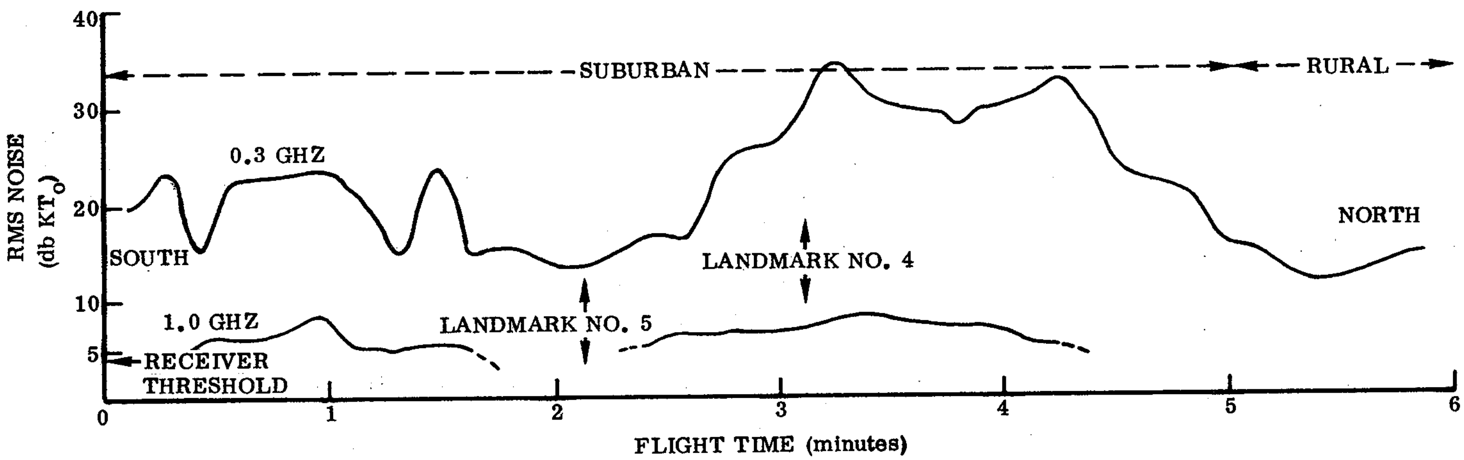
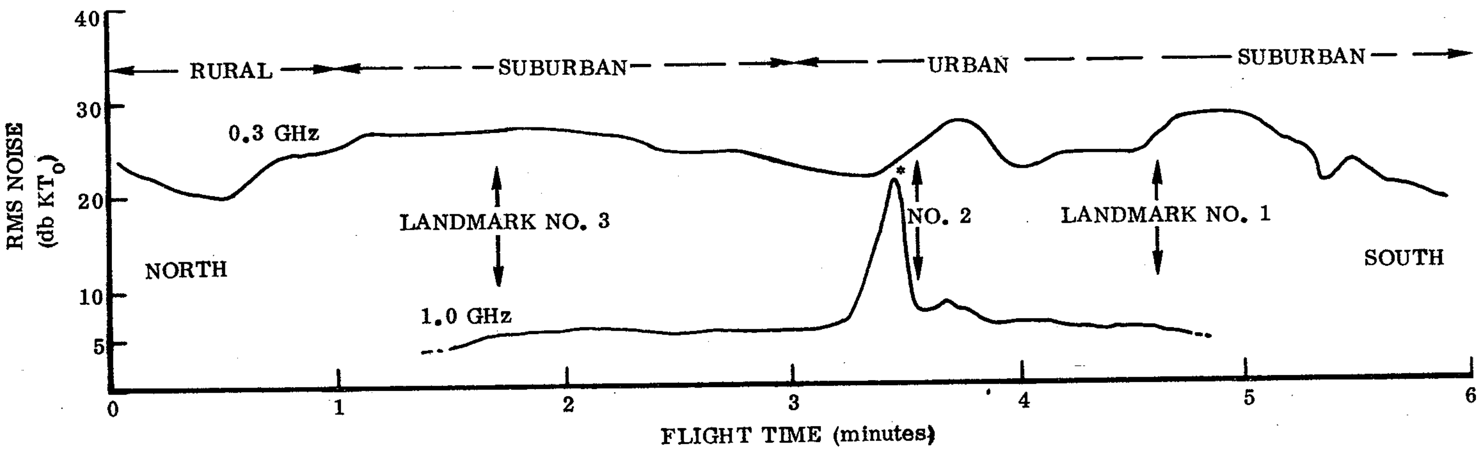


Figure 7-5. Noise Level Variations on Flight Path D



*Possible CW source.

Figure 7-6. Noise Level Variations on Flight Path E

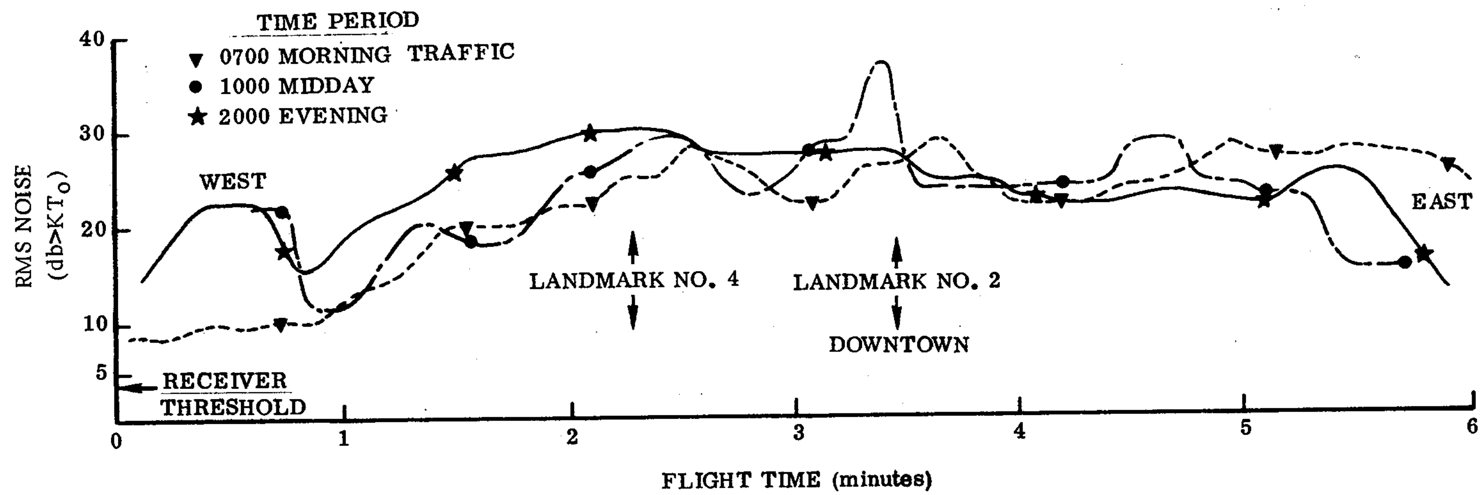


Figure 7-7. 300-MHz Noise Level Variations on Flight Path B for Three Time Periods

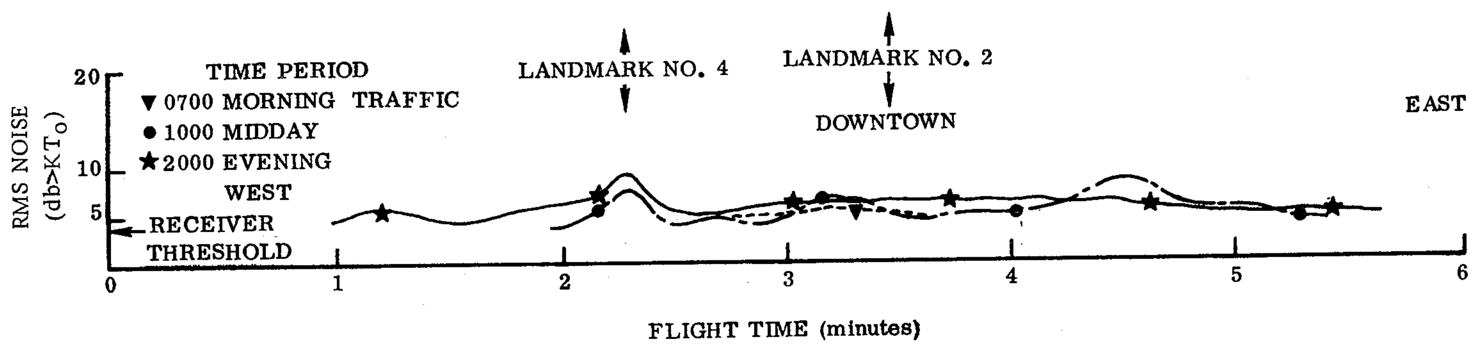


Figure 7-8. 1-GHz Noise Level Variations on Flight Path B for Three Time Periods

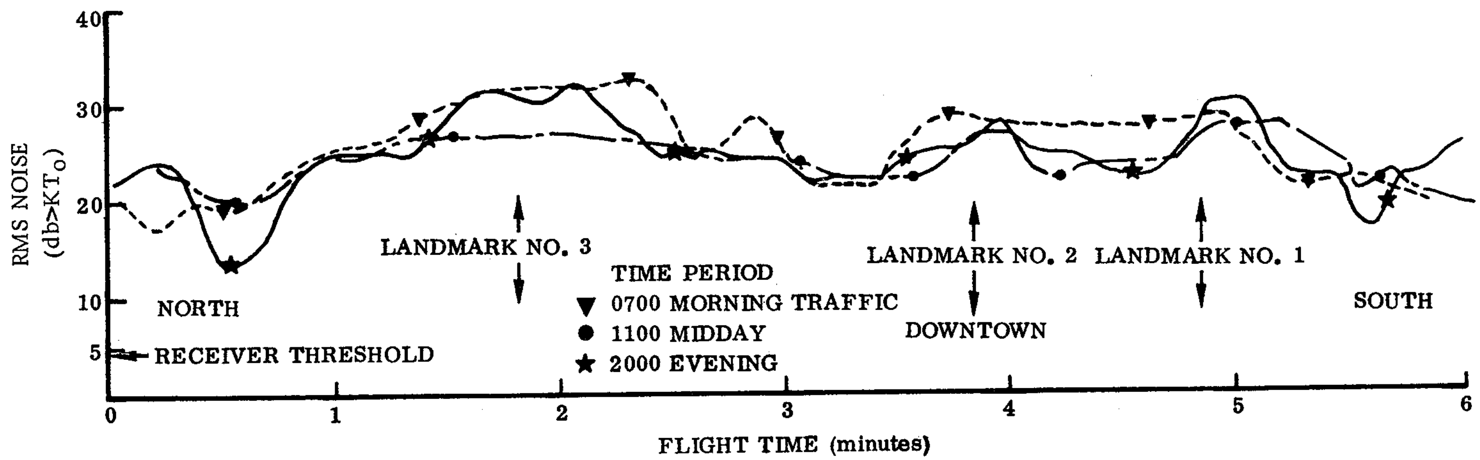
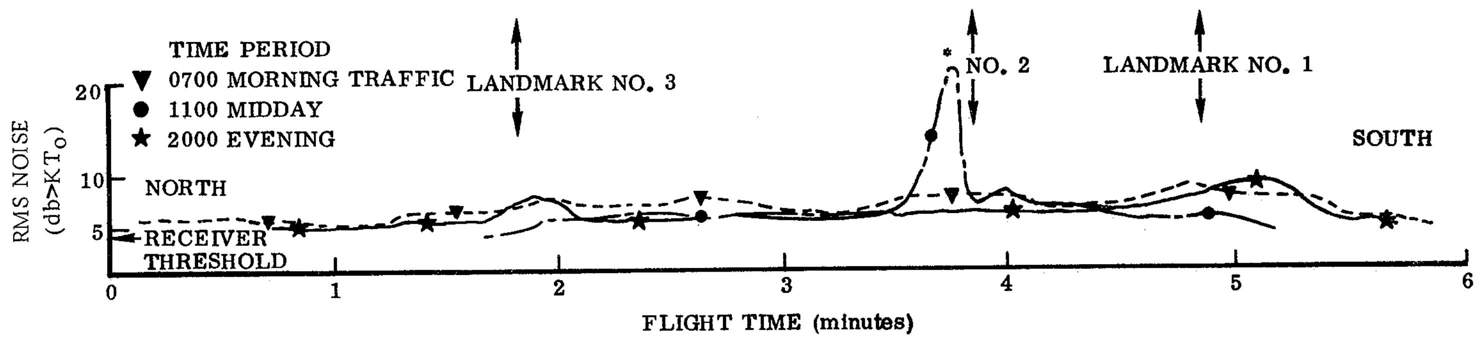


Figure 7-9. 300-MHz Noise Level Variations on Flight Path E for Three Time Periods



*Possible CW source

Figure 7-10. 1-GHz Noise Level Variations on Flight Path E for Three Time Periods

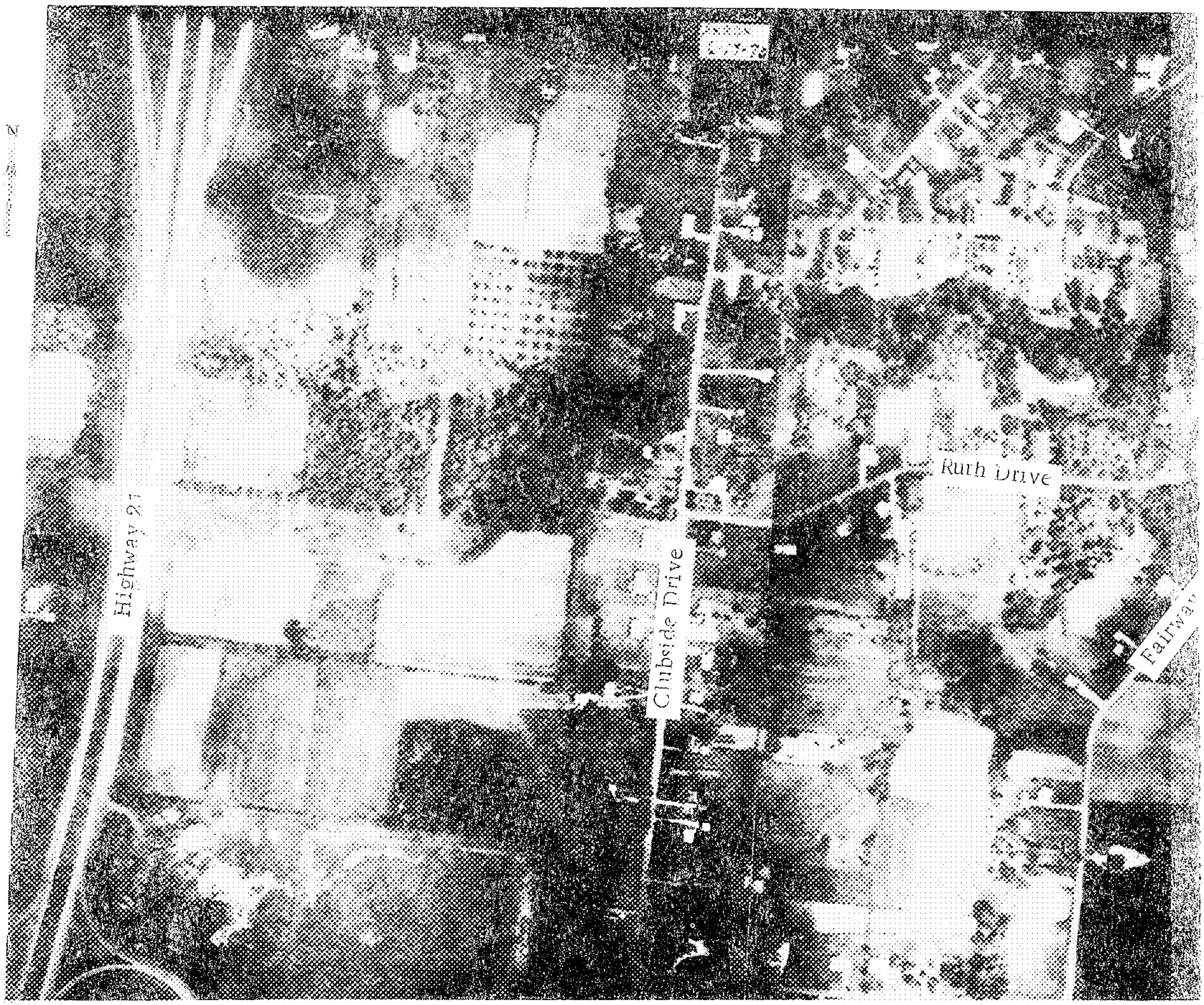
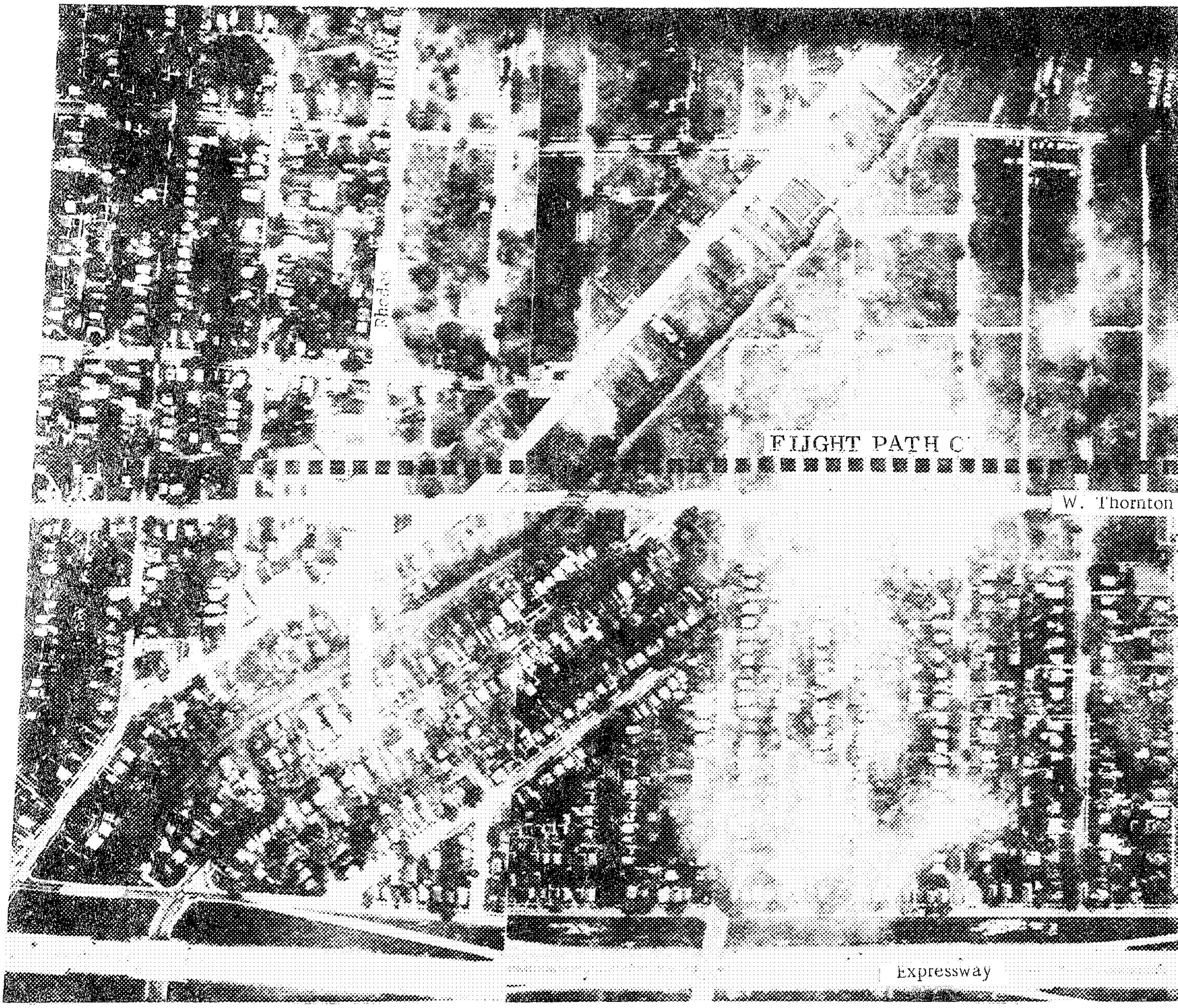


Figure 7-11. Aerial Photographs Along Rural Portion of Flight Path C


Drive
Driftwood Road
Cleveland Massillon Rd


Loyal Oak Dr
Kay Blvd
Brent Lane
Mark Lane
Houston Rd
Floraway Dr



Rhodes
FLIGHT PATH C
W. Thornton
Expressway

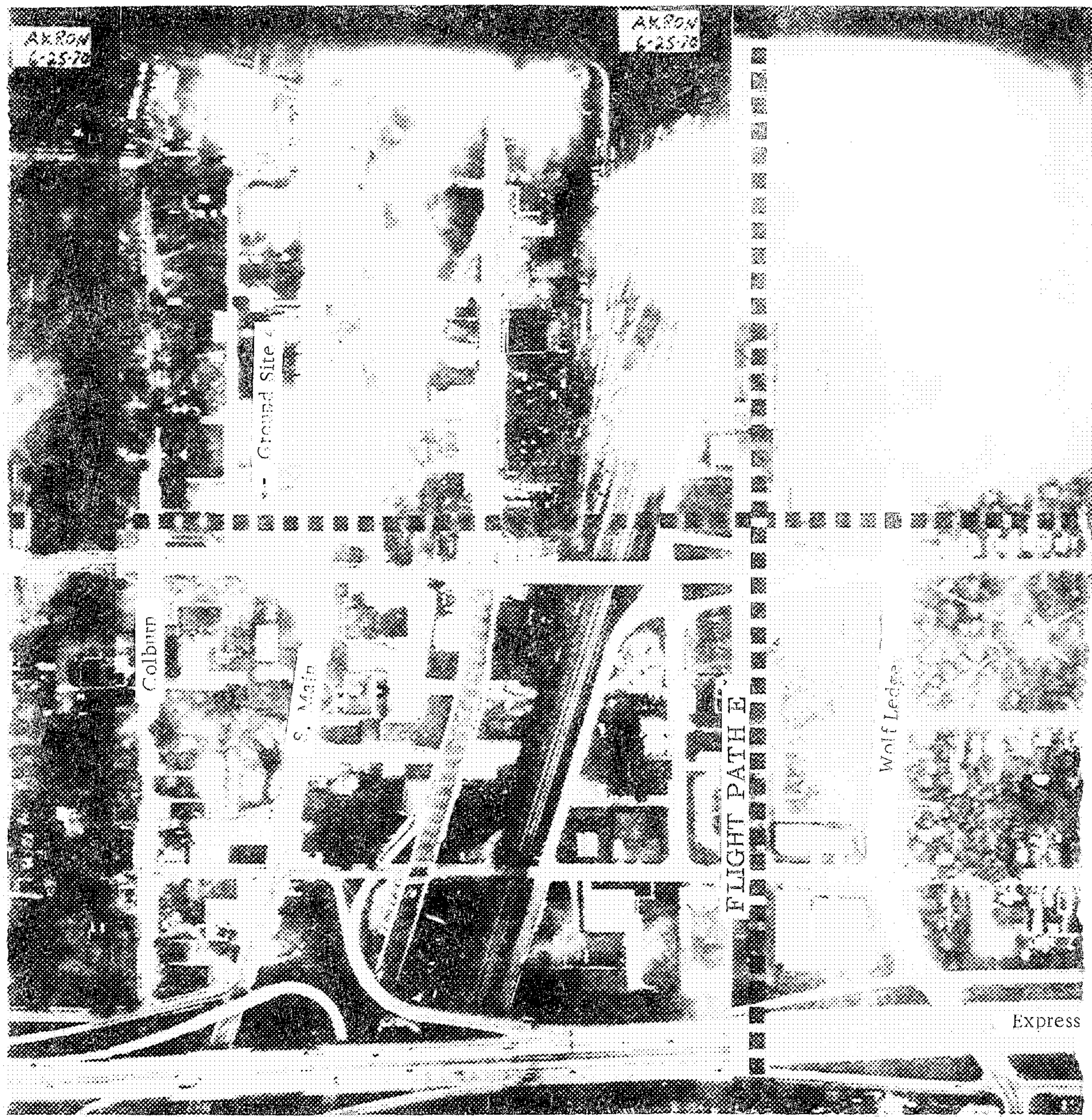
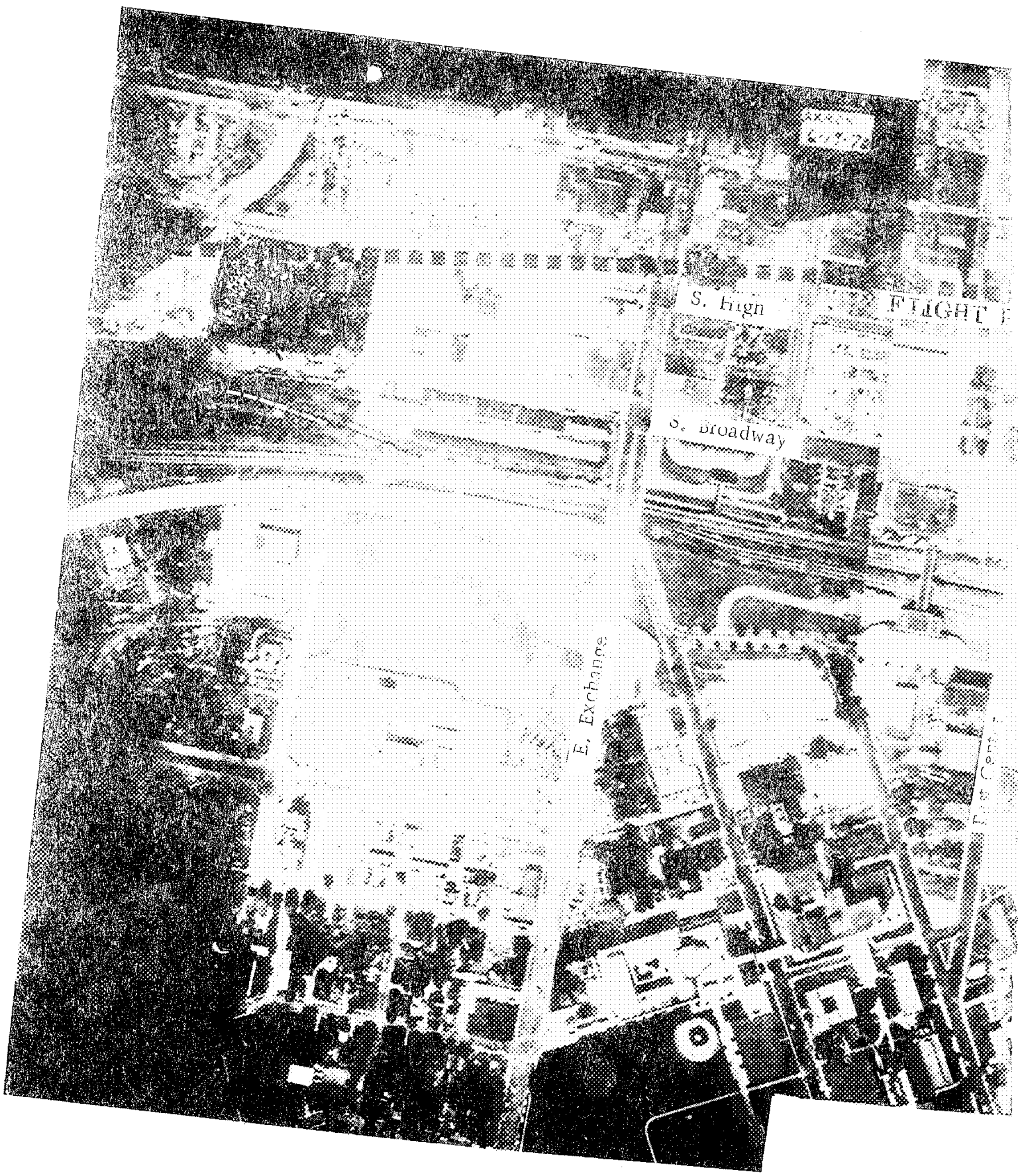
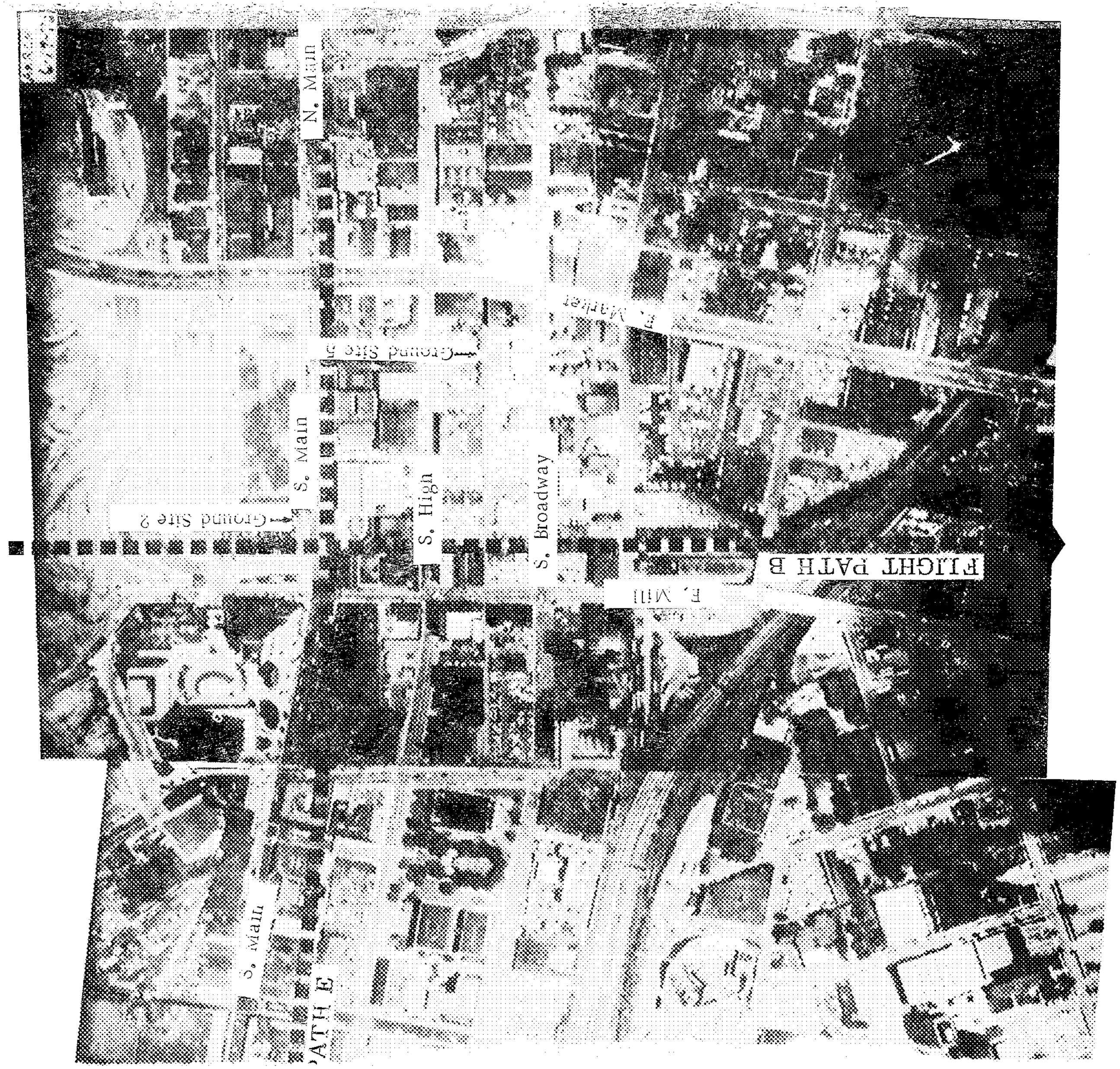

AKRON 6-25-70
AKRON 6-25-70
Ground Site
Colburn
S. Main
FLIGHT PATH E
Wolf Ledge
Express

Figure 7-

·12. Aerial Photographs Along Urban Portion of Flight Path C


S. High
FLIGHT
S. Broadway
E. Exchange



N. Main
Ground Site 5
E. Market
S. Main
S. High
S. Broadway
Ground Site 2
FLIGHT PATH B
E. Mill
S. Main
PATH E

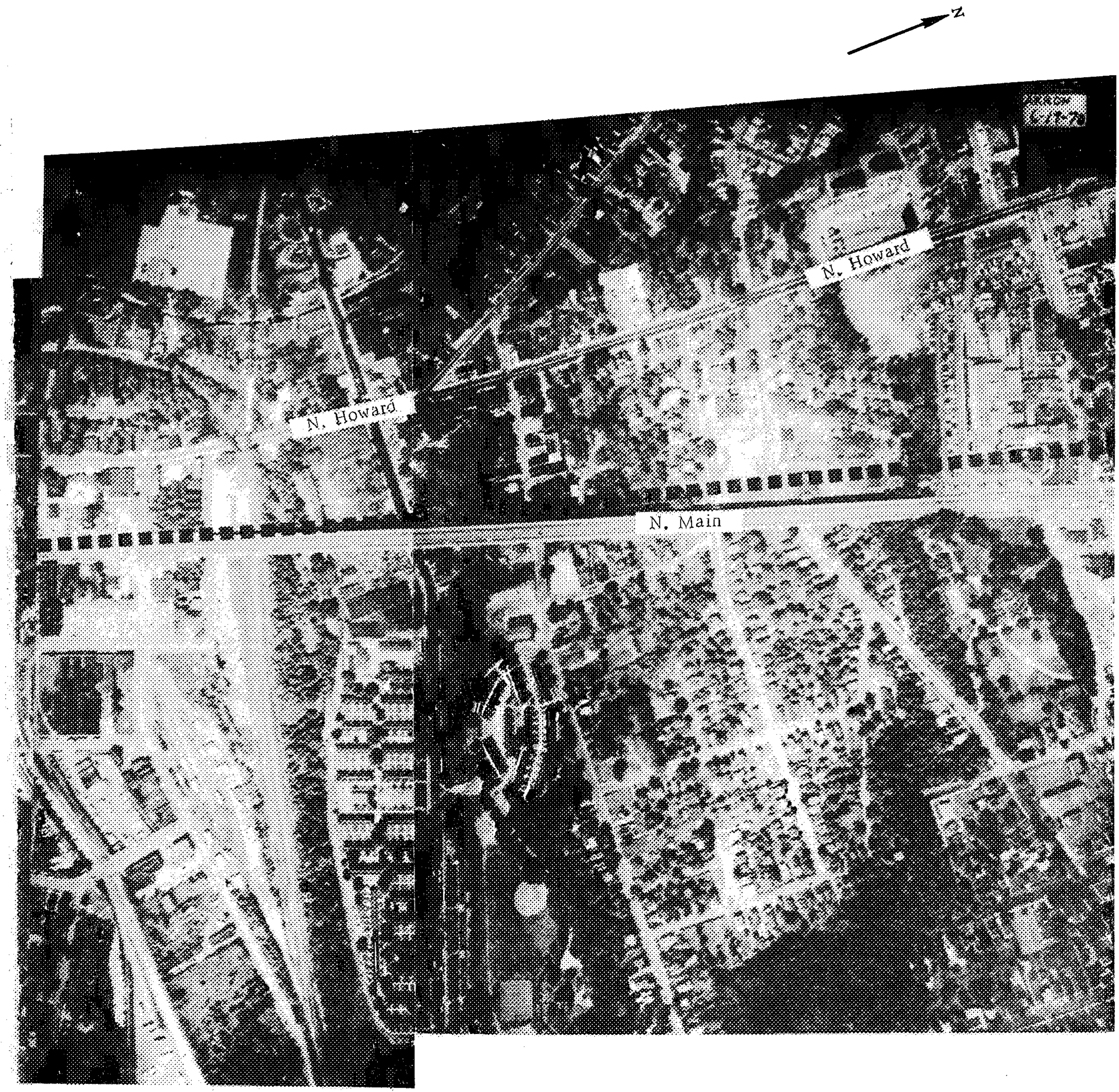


Figure 7-13. Aerial Photographs Along Part of Urban Portion of Flight Path E

SECTION 8

CONCLUSIONS

The instrumentation system assembled for the measurement of RF noise effectively characterized the noise received by its antennas over a bandwidth of 2.5 MHz at 300 MHz, 1 GHz, and 3 GHz. The RMS and average values of the noise were measured along with data from which a statistical description could be derived. This statistical information consisted of an amplitude-probability distribution and an amplitude-frequency-of-occurrence distribution. Magnitude of the noise components at 60 Hz and at 15.75 kHz was also measured. The system contained a monitoring capability that permitted real-time monitoring of the data and auxiliary values and a data-recording subsystem. In addition to the data, sufficient auxiliary information was generated and recorded to permit post-measurement data reduction and presentation.

The general survey of RF noise was conducted in the urban, suburban, and rural areas about the city of Akron, Ohio by taking measurements from the air and from the ground. The general air survey was conducted by flying at 2500 feet (760 meters) above the surface over five flight paths that transversed the city. The general ground survey was conducted by making measurements at five ground sites with the antennas pointing toward the horizon in two azimuthal directions at each site. The measurements were conducted during a heavy traffic period, during a midday period, and during an early evening period. The data was delivered to NASA, Lewis Research Center for post-measurement analysis and presentation.

A limited amount of reduced data from which conclusions could be drawn on the results of the survey was available at the time of this writing. At 300 MHz, the averaged RMS noise level in the rural regions was 11 db less than that in the urban regions and 8 db less than that in the suburban regions. The RMS levels of the 1-GHz and 3-GHz noise data was at or below the receiving system threshold, and similar conclusions could not be made. Variation in noise level with the period of the day during which measurements were made was not significant. The noise measured exhibited a very high peak-to-RMS ratio, as evidenced by the relatively low RMS value at each frequency, relatively low percent-of-time each level comparator was turned on, and relatively large number of pulses exceeding the various comparator thresholds. Considerably more area was surveyed for a given effort from the air; however, the length of time during which noise originating from a specific location was being measured was obviously greatly reduced. Thus, limited time-varying information on noise levels originating from a specific location was obtained from the air survey. Data from the ground survey gave information on the variation of the noise level with time for a specific location but did not well describe the noise environment of a general area since the ground survey antennas "saw" a much smaller area than was seen from the air.

APPENDIX I

PROCEDURE FOR PRELIMINARY SYSTEMS CHECKOUT AND GENERAL SURVEY OF RF NOISE IN AKRON, OHIO

Contract NAS3-11531

8 May 1970

Prepared by A. H. Mills
A. H. Mills
Antenna & Compatibility Laboratories

Approved by M. M. Chazotte
M. M. Chazotte
Ass't. Chief Design Engineer
Antenna & Compatibility Laboratories

GENERAL DYNAMICS
CONVAIR DIVISION

1.0 SCOPE

This procedure covers the contractually required preliminary checkout of the noise measuring systems in Akron, Ohio, and the general survey of radio-frequency noise in Akron using the ground and airborne noise measuring systems assembled by Convair under Contract NAS3-11531. The configuration of each system is defined in this procedure as well as the conditions under which the tests will be performed. The procedures to follow in conducting the preliminary checks and the general survey from the ground and from the air are given along with checklists of detailed specific human operations. The checklists are included as appendices to this procedure.

2.0 SYSTEM CONFIGURATION

A block diagram showing the configuration of both the airborne and the ground RF noise measuring systems is shown in Figure 1. Both systems have the same major components except for addition of the DME and camera in the airborne system. The 12-channel recorder will be used with each system only during the preliminary checkout. Figure 2 provides further detail of the make-up of the antenna and receiving subsystems. Table 1 identifies all the major components in each system. The channel and track assignments in the VCO subsystems are listed in Table 2.

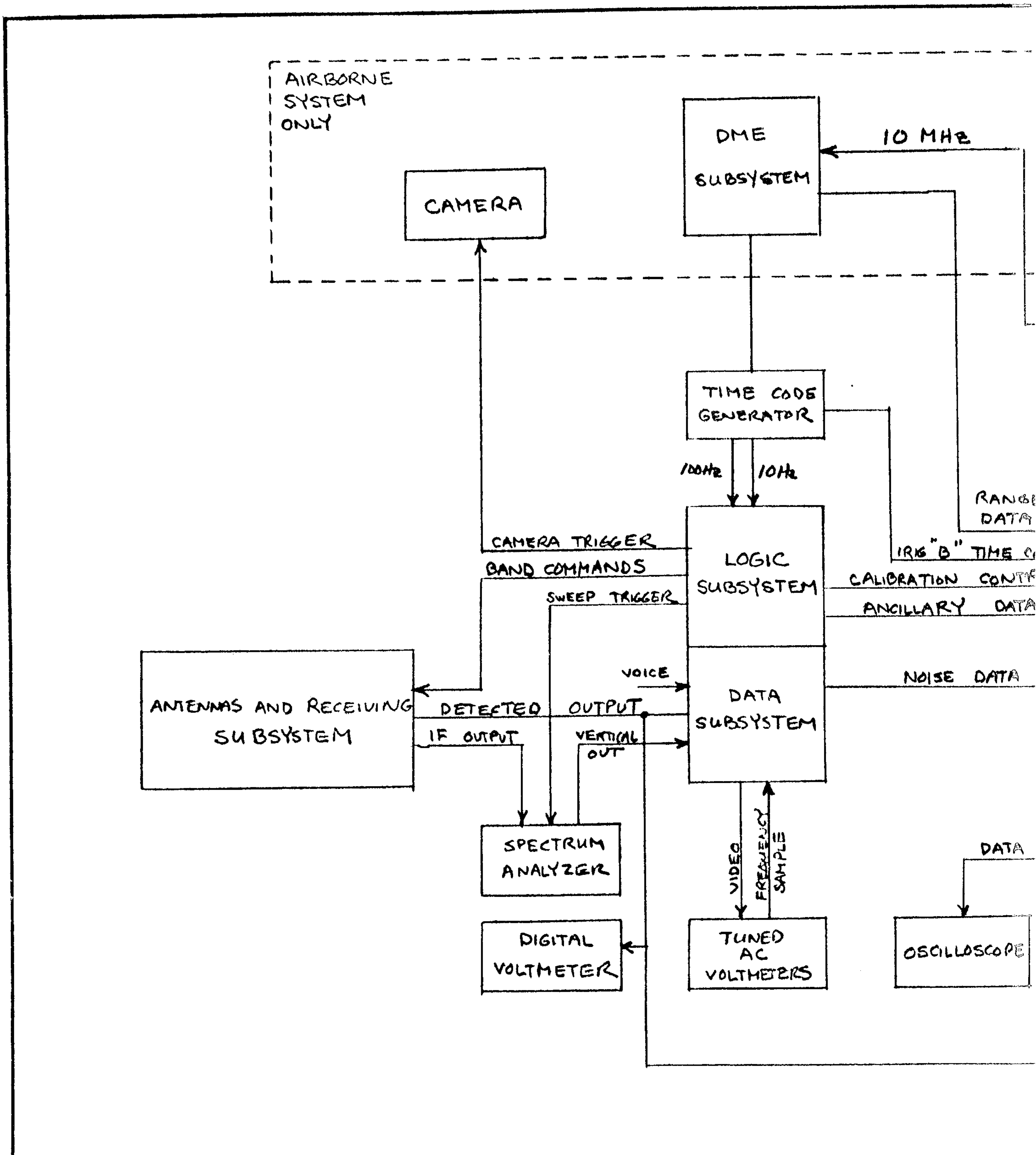
3.0 TEST CONDITIONS

Preliminary checkout of the noise measuring systems in Akron and the general survey will be accomplished under the following conditions:

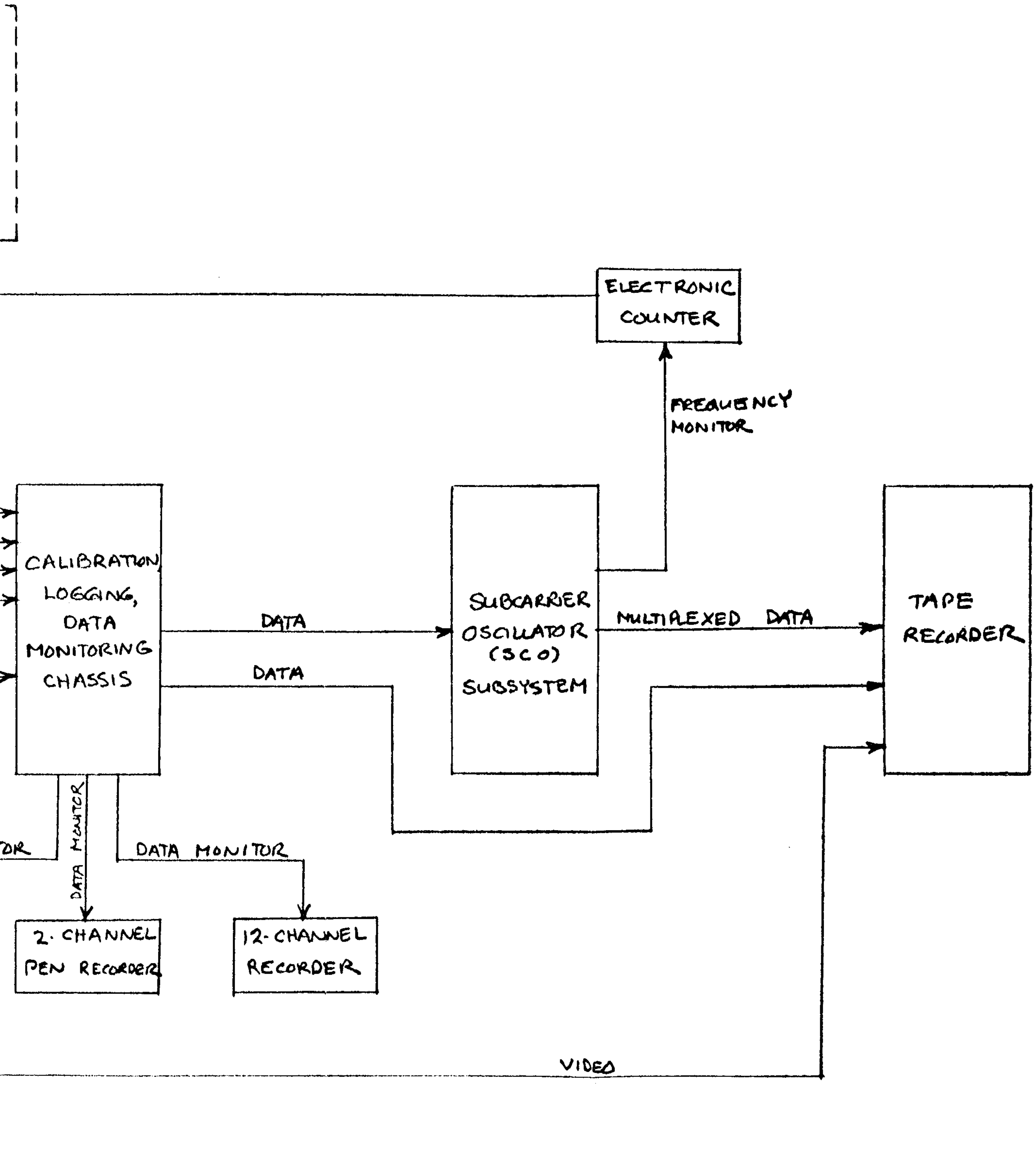
3.1 The noise measuring systems will not be shipped from San Diego to Akron until completion of the San Diego field tests with the systems in accordance with the procedure given in Convair Report No. ZZK-70-011 and approval of the results of the field tests is given by the NASA - LeRC Project Manager. NASA approval of this test procedure is also a prerequisite to shipment of the systems.

3.2 The general survey will not commence in Akron until results of the preliminary checks have been approved by the NASA Project Manager.

3.3 Preliminary checks of the ground noise measuring system will be accomplished with the system installed in the shielded mobile enclosure. The system will be moved to Ground Site No. 1 in Akron. Electrical power will be provided from the mobile power pak.



BLOCK DIAGRAM: NOISE MEASURING SYSTEM



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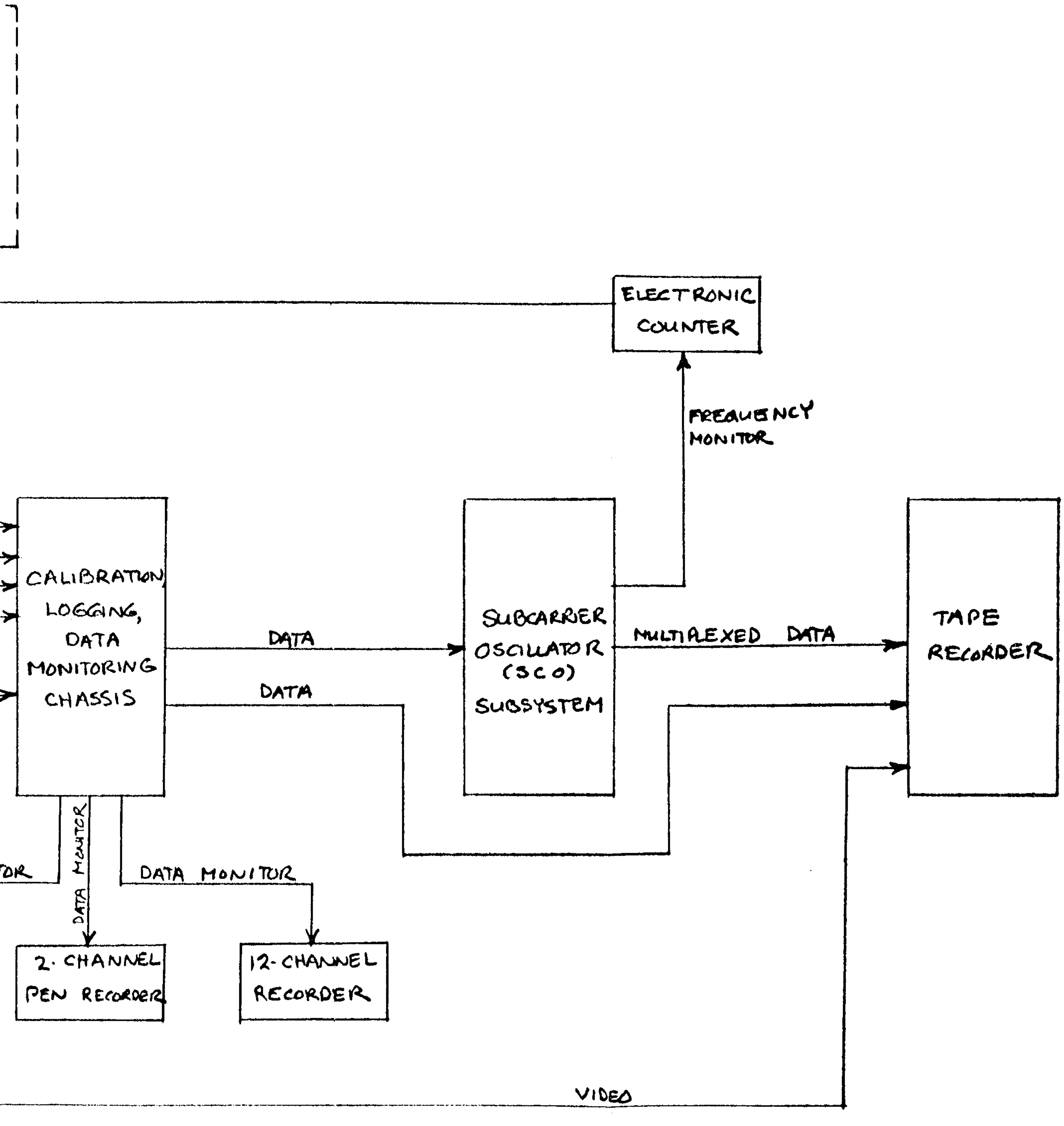
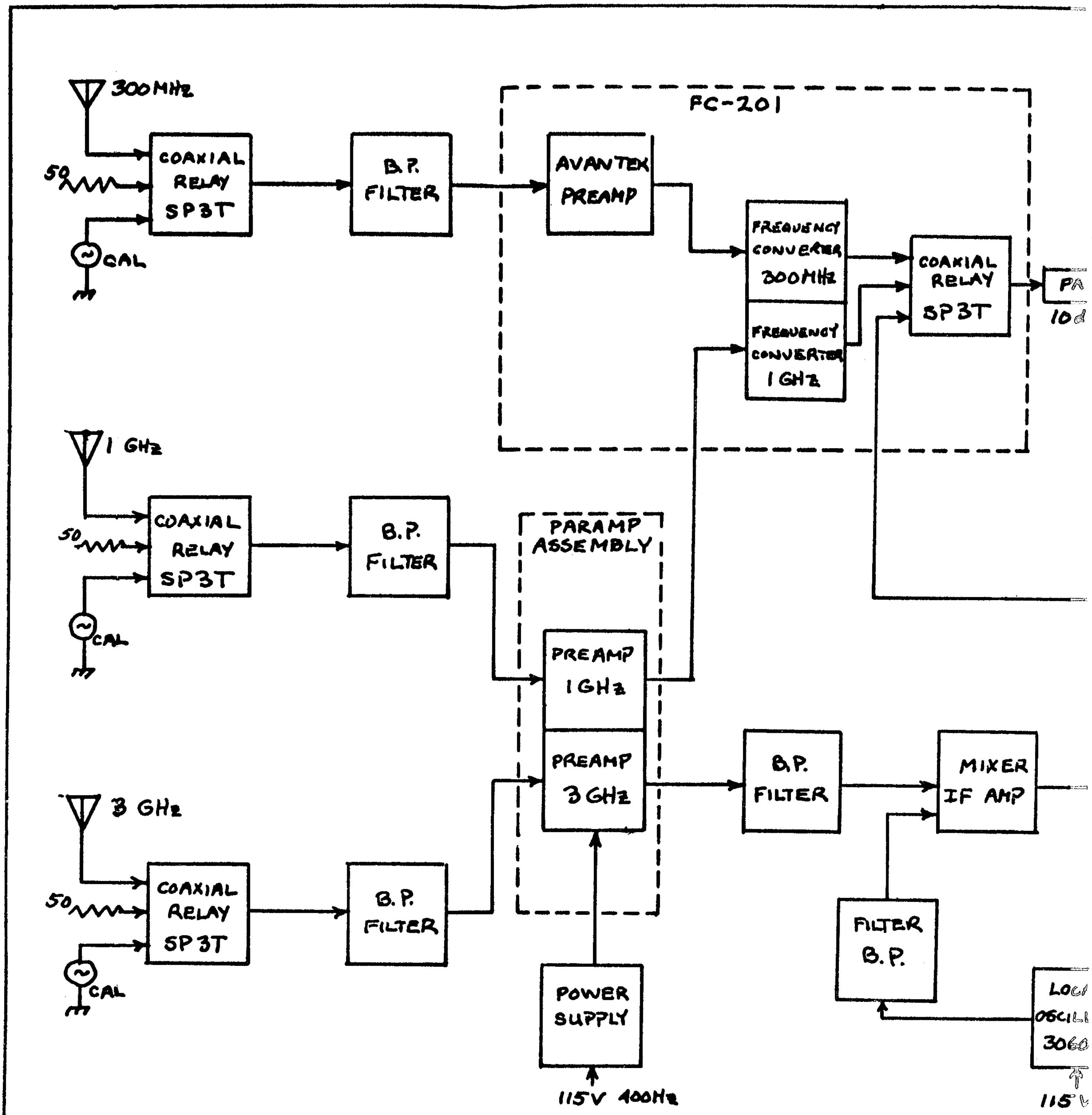
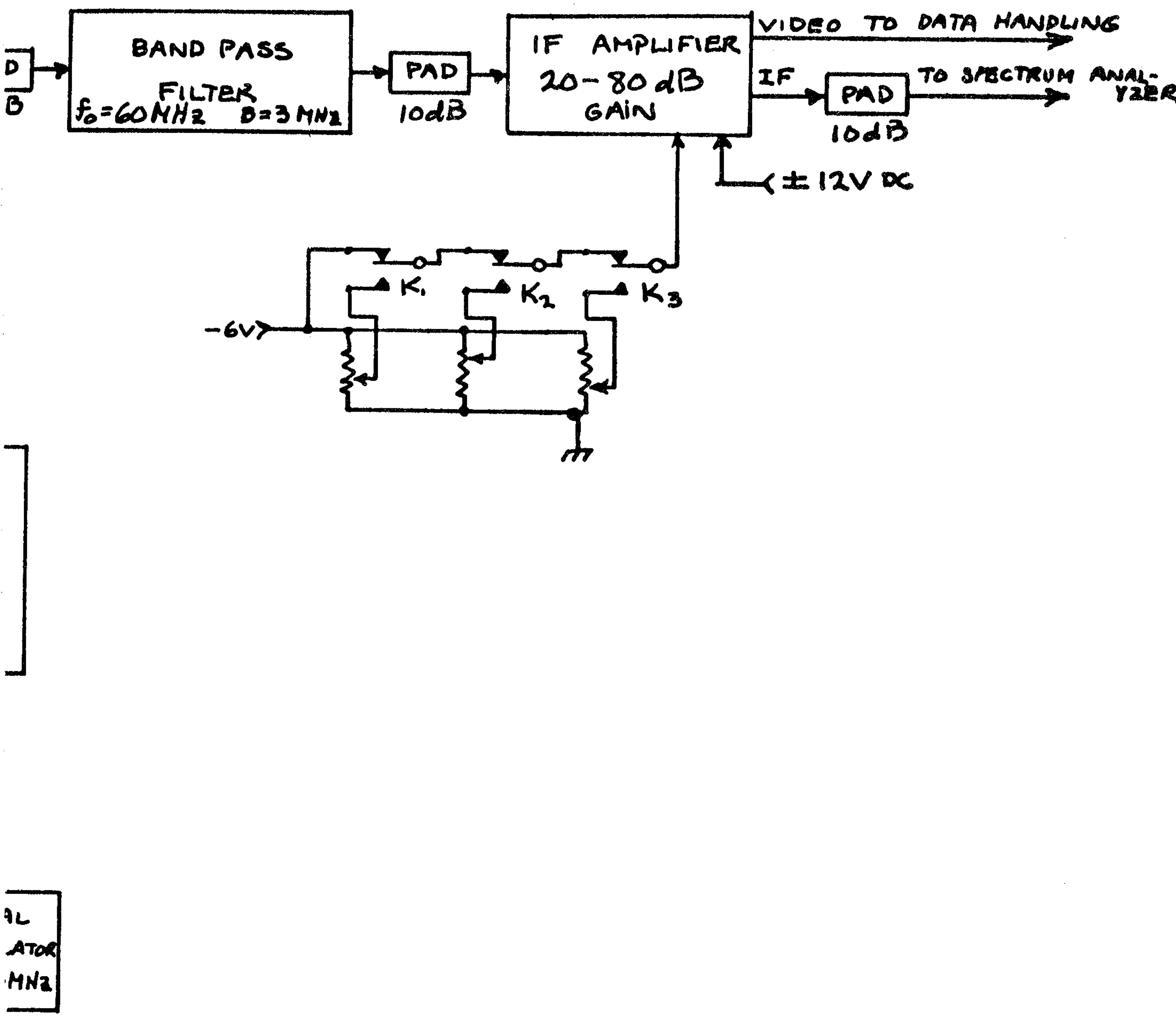
S Kolupaev	12-22-69				



PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE
	12-22-69				



BLOCK DIAGRAM: ANTENNA AND RECEIVING SUBSYSTEM



PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE
S Klupsas	12-22-69				

TABLE I

NOISE MEASURING SYSTEM COMPONENTS

COMPONENT	MANUFACTURER	PART NUMBER
300 MHz Antenna	Andrew	56013
1 GHz Antenna	Andrew	60113-1-S
3 GHz Antenna	Andrew	60119-1-S
Coaxial Relay	Transco	14100
300 MHz Bandpass Filter	Telonic	TTF-375-5-5EE
1 GHz Bandpass Filter	Telonic	TTF-1000-5-5EE
3 GHz Bandpass Filter	Telonic	TTF-2250-5-5EE
300 MHz Preamplifier	Avantek	AG-20-N
1 GHz & 3 GHz Parametric Amplifier	AIL	Model 4088
300 MHz & 1 GHz Frequency Converter	ACL	FC-201
3 GHz Mixer-Preamplifier	RHG	MP 2-4/2 A RFI
60 MHz Bandpass Filter	Telonic	TBA 60-3-5AA
3.060 GHz Local Oscillator (Signal Generator)	HP	8616B
IF Amplifier	RHG	EST 6004 LD
IF Chassis	Convair	-
Spectrum Analyzer	HP	8551/851 Ground 8553B/ 552A/141S Air
AC Microvoltmeter	HP	3410A
Data & Logic Chassis	Convair	-
Time Code Generator	Astrodata	7140
Oscilloscope	HP	120AR Ground 130C Air
2-Channel Pen Recorder	HP	7702
12-Channel Visicorder	Honeywell	1012
Data Monitoring Chassis	Convair	-
VCO Subsystem	EMR	-
Electronic Counter	HP	5245L
Tape Recorder	Precision Instruments	214
DME System	RCA	AVQ-75
DME Control & Interface	Convair	-
Camera	Beatie	Vernitron Model E

TABLE 2

DATA VCO CHANNEL AND TAPE TRACK ASSIGNMENTS

	MEASUREMENT	GROUND SYSTEM	AIRBORNE SYSTEM	IRIG CHANNEL	TAPE TRACK
1.	60 Hz Noise Level	X	X	5	4
2.	15.75 KHz Noise Level	X	X	6	4
3.	Comparator #1	X	X	7	4
4.	Comparator #2	X	X	8	4
5.	Comparator #3	X	X	9	4
6.	Comparator #4	X	X	10	4
7.	Comparator #5	X	X	11	4
8.	Comparator #6	X	X	12	4
9.	Average Noise Level	X	X	13	4
10.	RMS Noise Level	X	X	14	4
11.	Spectrum Analyzer	X	X	15	4
12.	RF Channel ID	X	X	2	6
13.	Reset/Run ID	X	X	3	6
14.	Time/Events ID	X	X	5	5
15.	Azimuth	X		6	6
16.	Camera Shutter		X	6	6
17.	Position Indicator (DME)		X	7	6
18.	Position Indicator (Visual)	X	X	8	6
19.	Voice	X	X		8
20.	Wow and Flutter Reference	X	X	50 KHz	10
21.	Time Code	X	X		2
22.	Video Signal	X	X		12

3.4 During the general ground survey, measurements will be made at five ground sites identified as follows:

a) Ground Site No. 1 — Vacant lot on the north side of Miller Avenue between Sweitzer Avenue and Bellows Street.

b) Ground Site No. 2 — Parking lot within 1 block of intersection of Market Street and Main Street near downtown.

c) Ground Site No. 3 — Parking lot of south side of Green Cross General Hospital near intersection of Sackett Avenue and 25th Street.

d) Ground Site No. 4 — To be selected after review of data obtained during first general air survey measurements.

e) Ground Site No. 5 — To be selected after review of data obtained during first general air survey measurements.

3.5 Preliminary checks of the air noise measuring system will be accomplished with the system installed in the University of California's DC-3 aircraft. Measurements will be made while flying at 2500 feet above the surface over Flight Path E, as described in paragraph 3.6.

3.6 During the general air survey, measurements will be made while flying five flight paths over the city of Akron identified as follows:

a) Flight Path A - This flight path runs from east to west starting at Main Street S in Munroe Falls $\frac{1}{4}$ mile south of Munroe Falls Road. The path is between E. Broadway and Curtis Avenue and between Fall Avenue and Broad Blvd. to the Green Cross General Hospital. The path then goes ESE to the intersection of Shannabrook Drive and Carnette Road, then east over Burlington Road, over Beaumont Drive and ending at Highway 21.

b) Flight Path B - This flight path runs from west to east starting at Highway 21 approximately 3/8 mile north of Minor Road. The path is over Colon Drive, over White Pond, over Orrin Street, over the intersection of Exchange Street and Copley Road, over Grace Park and runs 1/8 mile south of Eastwood Avenue out to Darrow Road where it ends.

3.6 c) Flight Path C - This flight path runs from east to west starting at the intersection of Canton Road and Ardwell Avenue. It runs over Spade Avenue, over Twain Avenue, over Baird Street, over Paris Avenue, over Marie Avenue, over Rockcliff Road and $\frac{1}{4}$ mile north of Reimer Road, ending at Hwy. 21.

d) Flight Path D - This flight path starts in Barberton, runs north-east to the intersection of East Avenue and Morse Street and then north. This path starts south-west of the Chemical Ponds in Barberton, runs north-east over the Tuscarawas River, over the west end of Prentiss Park, over East Avenue to Morse Street. It turns north, going over Packard Drive, over Vinita Avenue, over Castle Blvd., over the intersection of Shannabrook Drive and Carnette Rd., continuing north and ending at W. Steele Corner Road.

e) Flight Path E - This flight path runs from north to south starting at W. Steels Corners Road 1/8 mile west of Steels Croners. The path goes south over 24th Street, over Green Cross General Hospital, over Berwin Street, parallel but to the west of Main Street, over the intersection of Main Street and Market Street bearing a little west of south over Ground Site No. 1, over Moore Street, over Clairmont Avenue, over Holy Cross Pond, over East Reservoir and ending at Turkey Foot Lake Road.

3.7 During the general ground survey, a position code word will be placed on the data tape to indicate ground site number at which the measurements are being made. The code word will also indicate the time when the aircraft is overhead of the ground site during simultaneous air and ground measurements.

3.8 During the general air survey, a position code word will be placed on the data tape to indicate the flight path over which the aircraft is flying, the start and the end of each flight path as well as when the aircraft flies over the following landmarks:

a) Landmark No. 1 - Ground Site No. 1

b) Landmark No. 2 - Ground Site No. 2

c) Landmark No. 3 - Ground Site No. 3

d) Landmark No. 4 - Intersection of Flight Path B and Flight Path D

3.8 e) Landmark No. 5 -

(for Flight Path A)- Intersection of Flight Path A and Flight Path D

(for Flight Path C)- Intersection of Flight Path C and Flight Path D

(for Flight Path D)- Intersection of Flight Path C and Flight Path D.

3.9 The preliminary checks of both the air and ground noise measuring systems will be conducted during periods of relatively high traffic conditions.

3.10 The NASA Project Manager, or his duly authorized representative, will be present during the preliminary checks in Akron to coordinate data reduction and to approve test results and required adjustments in the system parameters settings.

3.11 Measurements on the ground and in the air will be made during the following time periods but not on Saturdays, Sundays or holidays:

a) 0630 to 0830 and/or 1600 to 1800 (ground and air)

b) Any two-hour period between 1000 and 1500 (ground and air)

c) 2000 to 2200 (air only).

3.12 Measurements on the ground and in the air will be made on days with:

a) No precipitation,

b) A minimum cloud cover of 2000 feet above the flight altitude,

c) 5 miles of visibility.

3.13 Ground survey log sheets, flight log sheets and tape log sheets will be filled in at the appropriate times during the survey and will be submitted to NASA with the rest of the data.

3.14 Test data to be recorded during the preliminary checks and during the ground and air general surveys will include the following:

a) Magnetic tape recording

b) 2-channel pen recording

c) 12-channel recording (preliminary survey only)

d) VCO frequency record

e) Photographs.

3.15 Both noise measuring systems will be tuned to receive signals in bandwidths of 2.5 to 3.0 MHz centered about 300 MHz, 1 GHz and 3 GHz for bands 1, 2 and 3 respectively. If CW signals in the bandwidth of any channel prevent the measurement of noise, the channel may be retuned to a clear channel frequency.

3.16 During the preliminary checks, connections will be made between the 12-channel visicorder and the inputs to the VCO's to permit the following direct recording:

a) Trace No. 1 - RMS data

b) Trace No. 2 - Avg data

c) Trace No. 3 - #1 comparator data

d) Trace No. 4 - #2 comparator data

e) Trace No. 5 - #3 comparator data

f) Trace No. 6 - #4 comparator data

g) Trace No. 7 - #5 comparator data

h) Trace No. 8 - #6 comparator data

i) Trace No. 9 - Time/Events ID

j) Trace No. 10 - RF Band ID

k) Trace No. 11 - Time Code

l) Trace No. 12 - Camera Pulse

3.17 During the preliminary checks, connections will be made between the 2-channel pen recorder and the monitoring panel to permit the following direct recording:

a) Channel 1 - DME range data (air system)
- 60 Hz noise level (ground system)

b) Channel 2 - Position code, visual

3.18 During the air and ground general surveys, connections will be made between the 2-channel pen recorder and the VCO inputs to permit the following direct recording:

a) Channel 1 - RMS data

b) Channel 2 - #4 comparator data.

3.19 The magnetic tape, 2-channel pen recording and 12-channel recording will be identified to indicate whether it is from ground or air survey, by month, by day and by the approximate starting time of the recording. Example: G-04-14-0930 would indicate a recording of ground survey data taken during the fourth month, 14th day, starting at approximately 0930.

4.0 PRELIMINARY CHECKOUT

4.1 Objectives. The objectives of the preliminary checkout of the ground and air noise measuring systems in Akron are to:

4.1.1 Verify that the systems have not been damaged or changed by shipment or movement.

4.1.2 Retest and check if gains and levels set in the field tests are applicable to measurements in Akron.

4.1.3 Make necessary adjustments to the comparator reference voltages and integrator time constants in an attempt to have the recorded data meet the following criteria while measuring noise in an urban area during heavy traffic condition.

a. Levels and voltages representing 60 to 75% of bandwidth are filled 80% of the measurement time at 300 MHz.

b. Levels and voltages representing 30 to 60% of the bandwidth are filled 80% of the measurement time at 1 GHz.

c. Levels and voltages representing 10 to 30% of the bandwidth are filled 80% of the measurement time at 3 GHz.

d. Levels and voltages representing saturation of the highest comparator level are filled less than 2% of the measurement time.

e. Outputs representing no external noise will be less than 1% of the bandwidth for 300 MHz and 1 GHz, and less than 2.5% for 3 GHz.

4.2 Procedure for Ground System Preliminary Checks.

4.2.1 Move the ground noise measuring system installed in the mobile shielded enclosure and the mobile power pak to Ground Site No. 1. Level the truck with jacks at the rear corners. Make the 60 Hz and 400 Hz electrical connections between the power pak and the truck. Start the diesel engine and the 400 Hz M-G set.

4.2.2 Erect the antenna tower from its tilted position. Raise the tower so the antennas are approximately 30 feet above the ground.

4.2.3 Apply electrical power to the ground noise measuring system. Follow the checklist in Appendix A. Allow 30 minute for system warm-up and stabilization.

4.2.4 Prepare the time code generator, tape recorder, 2-channel pen recorder, 12-channel recorder and the oscilloscope for use following the checklist in Appendix B.

4.2.5 Measure and record the VCO frequencies following the checklist in Appendix C.

5.2.6 Set the RF subsystem gain for each band following the checklist in Appendix D.

4.2.7 Fill in a ground survey log sheet, tape log sheet and annotate the 2-channel and 12-channel recorders' paper. Start the tape recorder and identify the tape on the voice track. Stop the tape recorder.

4.2.8 Place the receiving system in Band 1 (300 MHz). Start the 2-channel pen recorder. Rotate the antennas in azimuth through 360 degrees while determining the direction from which the highest noise is received. Return the antennas to this azimuth. Stop the pen recorder. Adjust the azimuth VCO frequency to indicate this direction using the formula:

VCO freq (Hz) = 1572 + .712 azimuth (degrees CW from magnetic north).

4.2.9 Start recording data following the checklist of Appendix F. Record data for 20 minutes. During this recording, periodically monitor the inputs to all the VCO's on the oscilloscope. At the end of the 20 minute period, stop the tape recorder, 2-channel pen recorder and the 12-channel recorder.

4.2.10 Compare the data levels with the requirement of paragraph 4.1.3. With the approval of the NASA Project Manager, make gain and level adjustments as necessary to have the data at the correct levels. Repeat steps 4.2.7 and 4.2.9.

4.2.11 Compare data levels again with the requirements. Repeat step 4.2.10 if considered necessary by the NASA Project Manager.

4.2.12 Shut down the system. Deliver all data to the NASA Project Manager.

4.3 Procedure for Air System Preliminary Checks.

4.3.1 With electrical power supplied to the aircraft from the ground auxiliary power unit, start the aircraft's 60 Hz and 400 Hz alternators. Insure that electrical connections are made between the aircraft's 28 VDC, the 60 Hz and the 400 Hz supplies and the noise measuring system. Apply electrical power to the noise measuring system following the checklist in Appendix G. Allow 30 minutes for system warm-up and stabilization.

4.3.2 Prepare the time code generator, tape recorder, 2-channel pen recorder, 12-channel recorder and oscilloscope for use following the checklist in Appendix B. Prepare the camera following the checklist in Appendix H.

4.3.3 Measure and record the VCO frequencies following the checklist in Appendix C.

4.3.4 Set the RF subsystem gain for each band following the checklist in Appendix D.

4.3.5 Fill in a flight log sheet, tape log sheet and annotate the 2-channel and 12-channel recorders' paper. Start the tape recorder and identify the tape on the voice track. Stop the tape recorder.

4.3.6 Shut down the system. Turn off the APU and prepare for the flight test.

4.3.7 After the aircraft is in flight and the 60 Hz and 400 Hz alternators have been turned on, apply electrical power to the noise measuring system following the checklist in Appendix G. Allow 30 minutes for system warm-up and stabilization.

4.3.8 Recheck the RF subsystem gain for each band. Reset the time code generator. Tune the DME to Briggs VORTAC (112.4 MHz).

4.3.9 Instruct the pilot to fly over Flight Path E at 2500 feet above the surface at 100 ±10 knots. Set the flight number control switch to Flight Path E.

4.3.10 At approximately 3 minutes befor the start of the flight path, go through the steps of Appendix F for starting data recordings.

4.3.11 Connect the camera control leads to the camera. Set the camera control switch on the data and logic chassis to take pictures at 10-second intervals.

4.3.12 When the airplane passes over the start of the flight path, passes over each landmark, and passes over the end of the flight path, indicate this using the visual position code. Record on the flight log sheet the time each event takes place.

4.3.13 Periodically during the flight, identify on the visicorder record and on the voice track of the tape, the location at that time of the aircraft, the frame number on the camera, the DME indicator range and any unusual characteristics noted in the data. Also, periodically monitor the inputs to all VCO's on the oscilloscope.

4.3.14 At the completion of flying over Flight Path E, disconnect the camera control leads. Switch the RF input to the 50 ohm position. Record this data for 30 seconds.

4.3.15 Switch the system to "cal". Run a 5-point calibration following the checklist in Appendix E.

4.3.16 Shut down the system, complete all log sheets and return to the airport.

4.3.17 Compare the data levels with the requirements of paragraph 4.1.3. With the approval of the NASA Project Monitor, make gain and level adjustments as necessary to have the data at the correct levels. Repeat steps 4.3.1 through 4.3.16 if significant changes are made to parameter settings.

4.3.18 Deliver all data to the NASA Project Manager.

5.0 GENERAL SURVEY

5.1 Objectives. The objectives of the general survey of indigenous electromagnetic noise in Akron are to make measurements at five ground locations and over five flight paths. Ground measurements will be made during two time periods of the day while airborne measurements will be made during three time periods.

5.2 Schedule. The planned sequence of task to accomplish the general ground and air surveys is as follows:

a) Ground measurements at Site No. 1 during 1000 to 1200 period.

b) Ground measurements at Site No. 1 during 0630 to 0830 period.

c) Move gound system to Site No. 2.

d) Simultaneous ground measurements at Site No. 2 and air measurements during 1000 to 1200 period.

e) Ground measurements at Site No. 2 during 0630 to 0830 period.

f) Move ground system to Site No. 3.

g) Air measurements during 2000 to 2200 period.

5.2 h) Ground measurements at Site No. 3 during 1000 to 1200 period.

i) Simultaneous ground measurements at Site No. 3 and air measurements during 0630 to 0830 period.

j) Move ground system to Site No. 4.

k) Ground measurements at Site No. 4 during 1000 to 1200 period.

l) Ground measurements at Site No. 4 during 0630 to 0830 period.

m) Move ground system to Site No. 5.

n) Ground measurements at Site No. 5 during 1000 to 1200 period.

o) Ground measurement at Site No. 5 during 0630 to 0830 period.

5.3 Procedure for General Ground Survey.

5.3.1 The following steps will be followed for the measurement of noise at each ground site for each time period.

5.3.2 Level the truck with jacks at the rear corners. Make the 60 Hz and 400 Hz electrical connections between the power pak and the truck. Start the diesel engine and the 400 Hz M-G set.

5.3.3 Erect the antenna tower from its tilted position. Raise the tower so the antennas are approximately 30 feet above the ground.

5.3.4 Apply electrical power to the ground noise measuring system. Follow the checklist in Appendix A. Allow 30 minutes for system warm-up and stabilization.

5.3.5 Prepare the time code generator, tape recorder, 2-channel pen recorder and the oscilloscope for use following the checklist in Appendix B.

5.3.6 Measure and record the VCO frequencies following the checklist in Appendix C.

5.3.7 Set the RF subsystem gain for each band following the checklist in Appendix D.

5.3.8 Fill in a ground survey log sheet, tape log sheet and annotate the 2- channel recorder paper. Start the tape recorder and identify the tape on the voice track. Stop the tape recorder.

5.3.9 Place the receiving system in Band 1 (300 MHz). Start the 2-channel pen recorder. Rotate the antennas in azimuth through 360 degrees while determining the direction from which the highest noise is received. Return the antennas to this azimuth. Stop the pen recorder. Adjust the azimuth VCO frequency to indicate this direction using the formula:

5.3.9 (Continued)

VCO freq (Hz) = 1572 + .712 x azimuth (degrees CW from magnetic north).

5.3.10 Start recording data following the checklist in Appendix F. Record data for 15 minutes. During this recording, periodically monitor the inputs to all the VCO's on the oscilloscope. At the end of the 15 minute period, switch the RF input selector to the "50 ohm" position. Record this data for 30 seconds, then place the system in reset, stop the tape recorder and 2-channel pen recorder.

5.3.11 Rotate the antenna 180 degrees in azimuth. Adjust the azimuth VCO frequency to indicate this direction. Reset the RF subsystem gain for each band following the checklist in Appendix D.

5.3.12 Start recording the data following the checklist in Appendix F. Record data for 15 minutes. During this recording, periodically monitor the inputs to all the VCO's on the oscilloscope. At the end of the 15 minute period, switch the RF input selector to the "50 ohm" position. Record this data for 30 seconds. Place the logic system in the "cal" position and run a 5-point calibration following the checklist in Appendix E.

5.3.13 Stop the 2-channel recorder and the tape recorder.

5.3.14 Shut down the system and complete all log sheets.

5.4 Procedure for General Air Survey.

5.4.1 The below steps will be followed for the measurement of noise from the air during each of the three time periods, with the exception that during the second and third flights, pictures will be taken manually at approximately one-minute intervals when the aircraft is over key intersections , distinguishing buildings or high noise areas.

5.4.2 With electrical power supplied to the aircraft from the ground auxiliary power unit, start the aircraft's 60 Hz and 400 Hz alternators. Insure that electrical connections are made between the aircraft's 28 VDC, the 60 Hz and the 400 Hz supplies and the noise measuring system. Apply electrical power to the noise measuring system following the checklist in Appendix G. Allow 30 minutes for system warm-up and stabilization.

5.4.3 Prepare the time code generator, tape recorder, 2-channel pen recorder and oscilloscope for use following the checklist in Appendix B. Prepare the camera following the checklist in Appendix H.

5.4.4 Measure and record the VCO frequencies following the checklist in Appendix C.

5.4.5 Set the RF subsystem gain for each band following the checklist in Appendix D.

5.4.6 Fill in a flight log sheet, tape log sheet and annotate the 2-channel recorder paper. Start the tape recorder and identify the tape on the voice track. Stop the tape recorder.

5.4.7 Shut down the system. Turn off the APU and prepare for the flight.

5.4.8 After the aircraft is in flight and the 60 Hz and 400 Hz alternators have been turned on, apply electrical power to the noise measuring system following the checklist in Appendix G. Allow 30 minutes for system warm-up and stabilization. Establish communication with the ground based noise measuring team.

5.4.9 Recheck the RF subsystem gain for each band. Reset the time code generator. Tune the DME to Akron VORTAC (114.6 MHz).

5.4.10 Instruct the pilot to fly over Flight Path A at 2500 feet above the surface at 100 ±10 knots. Set the flight number control switch to Flight Path A.

5.4.11 At approximately 3 minutes before the start of the flight path, go through the steps of Appendix F for starting data recordings.

5.4.12 Connect the camera control leads to the camera. Set the camera control switch on the data and logic chassis to take pictures at 10-second intervals.

5.4.13 When the airplane passes over the start of the flight path, passes over each landmark, and passes over the end of the flight path, indicate this using the visual position code. Record on the flight log sheet the time each event takes place.

5.4.14 Periodically during the flight, identify on the voice track of the tape, the location atthat time of the aircraft, the frame number on the camera, the DME indicator range and any unusual characteristics noted in the data. Also, periodically monitor the inputs to all VCO's on the oscilloscope.

5.4.15 At the completion of flying over Flight Path A, disconnect the camera control leads. Switch the RF input to the "50 ohm" position. Record this data for 30 seconds.

5.4.16 Switch the system to "cal". Run a 5-point calibration following the checklist in Appendix E. Place the system in "reset."

5.4.17 Recheck the RF subsystem gain for each band.

5.4.18 Instruct the pilot to fly over Flight Path B at 2500 feet above the surface at 100 ±10 knots. Set the flight number control switch to Flight Path B.

5.4.19 At approximately 3 minutes before the start of the flight path, go though the steps of Appendix F for starting data recordings.

5.4.20 Connect the camera control leads to the camera. Set the camera control switch on the data and logic chassis to take pictures at 10-second intervals.

5.4.21 When the airplace passes over the start of the flight path, passes over each landmark, and passes over the end of the flight path, indicate this using the visual position code. Record on the flight log sheet the time each event takes place.

5.4.22 Periodically during the flight, identify on the voice track of the tape, the location at that time of the aircraft, the frame number on the camera, the DME indicator range and any unusual characteristics noted in the data. Also, periodically monitor the inputs to all VCO's on the oscilloscope.

5.4.23 At the completion of flying over Flight Path B, disconnect the camera control leads. Switch the RF input to the "50 ohm" position.

5.4.24 Switch the system to "cal". Run a 5-point calibration following the checklist in Appendix E.

5.4.25 Recheck the RF subsystem gain for each band.

5.4.26 Instruct the pilot to fly over Flight Path C at 2500 feet above the surface at 100 ±10 knots. Set the flight number control switch to Flight Path C.

5.4.27 At approximately 3 minutes before the start of the flight path, go through the steps of Appendix F for starting data recordings.

5.4.28 Connect the camera control leads to the camera. Set the control switch on the data and logic chassis to take pictures at 10-second intervals.

5.4.29 When the airplane passes over the start of the flight path, passes over each landmark, and passes over the end of the flight path, indicate this using the visual position code. Record on the flight log sheet the time each event takes place.

5.4.30 Periodically during the flight, identify on the voice track of the tape, the location at that time of the aircraft, the frame number on the camera, the DME indicator range and any unusual characteristics noted in the data. Also, periodically monitor the inputs to all VCO's on the oscilloscope.

5.4.31 At the completion of flying over Flight Path C, disconnect the camera control leads. Switch the RF input to the "50 ohm" position. Record this data for 30 seconds.

5.4.32 Switch the system to "cal". Run a 5-point calibration following the checklist in Appendix E.

5.4.33 Recheck the RF subsystem gain for each band. Tune the DME to Briggs VORTAC (112.4 MHz).

5.4.34 Instruct the pilot to fly over Flight Path D at 2500 feet above the surface at 100 ±10 knots. Set the flight number control switch to Flight Path D.

5.4.35 At approximately 3 minutes before the start of the flight path, go through the steps of Appendix F for starting data recordings.

5.4.36 Connect the camera control leads to the camera. Set the camera control switch on the data and logic chassis to take pictures at 10-second intervals.

5.4.37 When the airplane passes over the start of the flight path, passes over each landmark, and passes over the end of the flight path, indicate this using the visual position code. Record on the flight log sheet the time each event takes place.

5.4.38 Periodically during the flight, identify on the voice track of the tape, the location at that time of the aircraft, the frame number on the camera, the DME indicator range and any unusual characteristics noted in the data. Also, periodically monitor the inputs to all VCO's on the oscilloscope.

5.4.39 At the completion of flying over Flight Path D, disconnect the camera control leads. Switch the RF input to the "50 ohm" position. Record this data for 30 seconds.

5.4.40 Switch the system to "cal". Run a 5-point calibration following the checklist in Appendix E.

5.4.41 Recheck the RF subsystem gain for each band.

5.4.42 Instruct the pilot to fly over Flight Path E at 2500 feet above the surface at 100 ±10 knots. Set the flight number control switch to Flight Path E.

5.4.43 At approximately 3 minutes before the start of the flight path, go through the steps of Appendix F for starting data recordings.

5.4.44 Connect the camera control leads to the camera. Set the camera control switch on the data and logic chassis to take pictures at 10-second intervals.

5.4.45 When the airplane passes over the start of the flight path, passes over each landmark, and passes over the end of the flight path, indicate this using the visual position code. Record on the flight log sheet the time each event takes place.

5.4.46 Periodically during the flight, identify on the voice track of the tape, the location at that time of the aircraft, the frame number on the camera, the DME indicator range and any unusual characteristics noted in the data. Also, periodically monitor the inputs to all VCO's on the oscilloscope.

5.4.47 At the completion of flying over Flight Path E, disconnect the camera control leads. Switch the RF input to the "50 ohm" position. Record this data for 30 seconds.

5.4.48 Switch the system to "cal". Run a 5-point calibration following the checklist in Appendix E.

5.4.49 Shut down the system, complete all log sheets and return to the airport.

APPENDIX A

CHECKLIST FOR APPLYING ELECTRICAL POWER TO GROUND NOISE MEASURING SYSTEM

CHECK (✓) WHEN COMPLETED	ITEM
	1. Turn on 60 Hz and 400 Hz circuit breakers inside of the truck.
	2. Apply power to the parametric amplifiers power supplies (3 switches).
	3. Apply power to the electronic counter.
	4. Apply power to the time-code generator. Push "reset" and "start" switches.
	5. Apply power to the two AC microvoltmeters (2 switches).
	6. Apply power to the digital voltmeter.
	7. Apply power to the 3.060 GHz local-oscillator (HP 8616 signal generator).
	8. Apply power to the subcarrier oscillator subsystem. Turn on power at the two modular power supplies and insure that each VCO power swtich is on.
	9. Apply power to the spectrum analyzer.
	10. Apply power to the six DC power supplies (+28V, +20V, +12V, +5V, -12V and -20V).
	11. Apply power to the oscilloscope.
	12. Apply power to the 2-channel pen recorder.
	13. Apply power to the tape recorder's motor drive amplifier.
	14. Apply power to the tape recorder.
	15. Apply power to the 12-channel recorder (preliminary checkout only).

APPENDIX B

CHECKLIST FOR PREPARING TIME CODE GENERATOR, TAPE RECORDER, 2-CHANNEL PEN RECORDER, 12-CHANNEL RECORDER AND OSCILLOSCOPE FOR USE.

CHECK (✓) WHEN COMPLETED	ITEM

A. Time Code Generator

1. Insure that the time base switch is in the "Int" position.
2. Insure that the shorting pen is inserted into SW 20.
3. Push in "reset" and "stop" switches.
4. Set in seconds, minutes, hours and days corresponding to time approximately 2 minutes ahead of present time.
5. When actual time reaches preset time, push in "start" switch.
6. Place the shorting pin into SW 21.
7. Set frame rate of serial code switch to "30 Sec" position.

B. Tape Recorder

1. Insure that the drive assembly is adjusted to give a tape speed of 15 inches per second on "high" drive.
2. Push "high"/"low" switch to obtain "high" drive.
3. Clean the tape heads with head cleaner fluid.
4. Load the tape recorder with a reel of tape.
5. Push "drive" switch and advance tape for 5 seconds. Push "stop" switch. Recorder is now ready for recording.

C. 2-Channel Pen Recorder

1. Check the supply of paper in the recorder. If there is less than 10% of a roll remaining, load the recorder with a new roll.
2. Push in the "Second" chart speed switch and the "Timer" switch.
3. Push in the "5mm" chart speed switch.
4. Adjust the pen heat control to give the proper trace on the paper.
5. Adjust the range, gain and position for each channel to give 50mm of upward deflection (from the lower edge of the grid to the upper edge) when the input voltage is varied from 0 to +5 volts.
6. Push in the "Stop" switch. The recorder is now ready for use.

D. 12-Channel Recorder (for preliminary checkout only)

1. Check the supply of paper in the recorder. If there is less than 10% of a roll remaining, load the recorder with a new roll.
2. Turn the lamp switch on. After the lamp starts, allow it 2-minutes for warm-up and stabilization.
3. Turn the motor switch on. (Cont. on next page)

APPENDIX B
(Continued)

CHECK (✓) WHEN COMPLETED	ITEM
	D. 4. Set chart speed to .4 inches per second. 5. Turn on the two florescent lamps. 6. Turn recording switch to "on". 7. Adjust the spot intensity control for the best trace on the paper. 8. Turn the recording switch to "off". Recorder is now ready for use.
	E. Oscilloscope 1. Adjust the horizontal and vertical position controls so that the trace starts at the left-hand vertical gradicle line and is 2 centimeters below the middle horizontal gradicle line. 2. Adjust the focus and intensity to give the proper trace. 3. Set the Sync selector switch to "Int +". 4. Set the vertical sensitivity toggle switch to "DC". 5. Set the Sweep Expand switch to "xl". 6. Adjust the vertical sensitivity to provide a deflection of 1 centimeter per volt. 7. Adjust the sweep time to give the best presentation of the data being observed.

APPENDIX C

CHECKLIST FOR RECORDING SCO FREQUENCIES

CHECK (✓) WHEN COMPLETED	
	1. Place the system mode switch on the data and logic chassis in the "cal" position.
	2. Connect the 60 Hz VCO output to the input of the counter.
	3. Record the frequency for each input level as the calibrate level switch on the monitoring chassis is placed in the "0%" and "100%" positions.
	4. Repeat step 3 with the counter connected to each data VCO output.
	5. Measure and record the frequencies of the RF channel ID VCO for Band 1, Band 2 and Band 3.
	6. Measure and record the frequencies of the Reset/Run ID VCO for reset and run conditions.
	7. Measure and record the frequencies of the Time/Events ID VCO for Time, Events and no sampling conditions.
	8. (Airborne system only) - Measure and record the frequencies of the Camera Shutter VCO at its two input levels.
	9. (Airborne system only) - Measure and record the frequencies of the DME Position Indicator VCO at its three input levels.
	10. Measure and record the frequencies of the Visual Position Indicator VCO at its three input levels.
	11. Measure and record the frequency of the 50 KHz reference oscillator.

APPENDIX D

CHECKLIST FOR SETTING RECEIVER SUBSYSTEM GAINS

CHECK (✓) WHEN COMPLETED

1. Place the system mode switch on the data and logic chassis in the "run" position. Set the cycle time switch to the "3" second position.

2. Connect the events integrator of the No. 1 comparator to the input of the oscilloscope.

3. Place the band select switch on the IF chassis in the "Band 1" position. Using the HP 608 signal generator, ensure that the RF input filter tuning is optimized for the frequency to which the system is tuned.

4. Place the rf input switch in the "50 ohm" position.

5. Decrease the Band 1 IF gain to a low level. Observe the drift of the integrator on the oscilloscope. If it is greater than 20 millivolts during the integration period, adjust it to bring it below this level.

6. Slowly increase the Band 1 IF gain until the integrator fills to a level of 40 millivolts. Lock the gain potentiometer at this value.

7. Place the band select switch on the IF chassis in the "Band 2" position. Using the HP 612 or HP 614 generator, optimize the 1 GHz parametric amplifier "FREQ ADJUST" control for the frequency to which the system is tuned. Switch the input to the 50 ohm termination.

8. Decrease the band 2 IF gain to a low level. Slowly increase the gain until the integrator fills to a level of 40 millivolts. Lock the gain potentiometer at this value.

9. Place the band select switch on the IF chassis in the "Band 3" position. Using the HP 616 signal generator, optimize the 3 GHz parametric amplifier "FREQ ADJUST" control for the frequency to which the system is tuned. Then switch the input to the 50-ohm termination.

10. Decrease the Band 3 IF gain to a low level. Slowly increase the gain until the integrator fills to a level of 40 millivolts. Lock the gain potentiometer at this value.

(Continued on Next Page)

APPENDIX D

CHECKLIST FOR SETTING RECEIVER SUBSYSTEM GAINS

(CONTINUED)

CHECK (✓)
WHEN
COMPLETED

11. Check the RMS VCO frequencies for each band with the 50 ohm termination on the input. If the frequencies are not between 23,617 and 23,650 Hz for Bands 1 and 2 and between 23,568 and 23,650 Hz for Band 3, make the necessary adjustment on the output scaling amplifier.

12. Check the Avg VCO frequencies for each band with the 50 ohm termination on the input. If the frequencies are not between 15,566 and 15,588 Hz for Bands 1 and 2 and between 15,533 and 15,588 Hz for Band 3, make the necessary adjustment on the output scaling amplifier.

APPENDIX E

CHECKLIST FOR PERFORMING THE FIVE-POINT CALIBRATION RUN

CHECK (✓) WHEN COMPLETED	ITEM
	1. Place the system mode switch on the data and logic chassis in the "cal" position.
	2. Place the calibrate level switch on the monitoring chassis in the "0" position.
	3. Record the 0% level for about 10 seconds.
	4. Place the calibrate level switch in the "25%" position. Record this level for about 10 seconds.
	5. Place the calibrate level swtich in the "50%" position. Record this level for about 10 seconds.
	6. Place the calibrate level switch in the "75%" position. Record this level for about 10 seconds.
	7. Place the calibrate level switch in the "100%" position. Record this level for about 10 seconds.
	8. Place the calibrate level switch on the monitoring chassis in the "0" position.

APPENDIX F

CHECKLIST FOR STARTING DATA RECORDING

CHECK (✓) WHEN COMPLETED	ITEM
	1. Place the logic system in "Reset". Switch the rf input switch on the IF chassis to the "50 ohm" position.
	2. Push the "drive" and "Record" buttons on the tape recorder.
	3. Place the system mode switch on the data and logic chassis in the "cal" position.
	4. Run a 5-point calibration following the checklist of Appendix E.
	5. Place the system mode switch on the data and logic chassis in the "run" position.
	6. Start the visicorder (preliminary checkout only) and pen recorder.
	7. After 30 seconds, switch the rf input switch on the IF chassis to the "Ant" position.

APPENDIX G

CHECKLIST FOR APPLYING ELECTRICAL POWER
TO THE AIRBORNE NOISE MEASURING SYSTEM

CHECK (✓) WHEN COMPLETED	ITEM
	1. Apply power to the two AC microvoltmeters (2 switches).
	2. Apply power to the digital voltmeter.
	3. Apply power to the FC-201 frequency converter.
	4. Apply power to the 3.060 GHz local oscillator (HP 8616 signal generator).
	5. Apply power to the time-code generator. Push the "reset" and "start" swtiches.
	6. Apply power to the DME.
	7. Apply power to the spectrum analyzer.
	8. Apply power to the parametric amplifiers power supplies (3 switches).
	9. Apply power to the subcarrier oscillator subsystem. Turn on power at the two modular power supplies and insure that each VCO power switch is on.
	10. Apply power to the oscilloscope.
	11. Apply power to the 2-channel pen recorder.
	12. Apply power to the 5 DC power supplies (+20V, -12V, +5V, -12V and -20V).
	13. Apply power to the electronic counter.
	14. Apply power to the tape recorder's motor drive.
	15. Apply power to the tape recorder.
	16. Apply power to the 12-channel recorder (preliminary check-out only).

APPENDIX H

PROCEDURE FOR CAMERA PREPARATION

CHECK (✓) WHEN COMPLETED	ITEM
	1. Make electrical connections between the camera, the 115 VAC 60 Hz power and the camera control circuitry.
	2. Install a magazine of film in the camera.
	3. Set up the frame ID in the camera to give the date, identify the flight and set the initial frame number. Set and start the camera's clock.
	4. Record the inital frame number on the flight log sheet.
	5. Set the camera time switch on the data and logic chassis in the "10 sec" position.
	6. When data is being recorded, periodically annotate the voice track with the frame number.

VCO FREQUENCIES

DATA VCO	0% Level Bandedge Freq.	0% Level Actual Freq.	100% Level Bandedge Freq.	100% Level Actual Freq.
60 Hz Noise	1398		1202	
15.75 KHz Noise	1828		1572	
Comp. No. 1	2473		2185	
Comp. No. 2	3225		2850	
Comp. No. 3	4193		3705	
Comp. No. 4	5805		5130	
Comp. No. 5	7901		6983	
Compl. No. 6	11,288		9975	
Avg. Noise	15,588		13,412	
RMS	23,650		20,350	
Spect. Anal.	32,250		27,750	

CODING VCO	Lower Level Nominal Freq.	Lower Level Actual Freq.	Medium Level Nominal Freq.	Medium Level Actual Freq.	Upper Level Nominal Freq.	Upper Level Actual Freq.
RF Channel ID	602		560		518	
Reset/Run ID	785		-	-	675	
Time/Event ID	1398		1300		1202	
Camera Shutter	1828		-	-	1572	
DME Position Indicator	2473		2300		2127	
Visual Position Indicator	3225		3000		2775	

	Expected Freq.	Actual Freq.
Reference Oscillator	50,000 Hz	

GROUND SURVEY LOG

Date: ____________________

Time of Measurement Period: ____________________

Time Aircraft Passes Overhead: ____________________

Operators: ____________________

Location: ____________________

Ground Temperature: ____________________

Visibility: ____________________

Cloud Cover: ____________________

Description of Area: ____________________

Tape Numbers at this Site: ____________________

Cycle Time Used: ____________________

Antenna Height: ____________________

Comments: ____________________

TAPE LOG

Tape Number: ______________________________

Date: ______________________________

Approximate Starting Time: ______________________________

Operators: ______________________________

Comment: ______________________________

____

____

____

FLIGHT LOG

Date: ______________________

Time of Measurement Period: ______________________

Operators: ______________________

Altitude: ______________________

Flight Speed: ______________________

Flight Paths Covered: ______________________

Temperature: ______________________

Visibility: ______________________

Cloud Cover: ______________________

Camera Frame Numbers: ______________________

Cycle Time Used: ______________________

Time of: \ Flight Path	A	B	C	D	E
Start of Flight Path					
Over first Landmark					
Over 2nd Landmark					
End of Flight Path					

Comments ______________________

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