~~TOP SECRET~~

HANDLE VIA BYEMAN
CONTROL CHANNELS

COPY 19
BYE-1264-68
SORS 11./23
12 April 1968

no card

UNITED STATES INTELLIGENCE BOARD

SIGINT COMMITTEE

SIGINT OVERHEAD RECONNAISSANCE SUBCOMMITTEE

4

MEMORANDUM FOR MEMBERS OF THE SIGINT OVERHEAD RECONNAISSANCE SUBCOMMITTEE

SUBJECT: Mission Description of the STRAWMAN System (Subsystems THRESHER/7164 and REAPER/7233)

SORS 11.23

The Mission Description of the STRAWMAN System has been furnished to the SORS by the NRO and is herewith distributed for your information. You will note that this Mission Description contains a composite technical payload description as well as a data processing description.

[redacted]

50X1

EXECUTIVE SECRETARY
SIGINT OVERHEAD RECONNAISSANCE SUBCOMMITTEE

Attachment:
a/s

K. 8

~~TOP SECRET~~

GROUP 1
Excluded from automatic downgrading and declassification

8041042

~~(S)~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

ATTACHMENT

THE NRO STAFF

BYE-1264-68
SORS 11./23
12 April 1968

SORS 11.23

MEMORANDUM FOR THE CHAIRMAN, SORS

SUBJECT: Mission Description of SIGINT Missions 7164/7233

The mission description, which also contains the processing data plan as submitted by the National Security Agency, for Missions 7164 (Thresher) and 7233 (Reaper) is forwarded as an attachment to this correspondence. These Elint reconnaissance systems are designed to meet the requirements of USIB D 41.14/246, USIB D 41.14/303, and current attachments thereto.

Missions 7164/7233 are scheduled to be launched in July 1968 into a nominal 75 degrees inclination, 270 nautical mile circular orbit. This will be accomplished utilizing a Thor booster with Agena D second stage. The Agena D satellite will provide on-orbit earth-oriented stabilization; primary power source; a tracking, telemetry and command system; and storage devices for digital and analog data. The total intercept system is designated Strawman on which Thresher (125-2100 MHz) and Reaper (1800-3300 MHz) are subsystems. Orbital life time is 6 months or greater.

Two modes of operation are provided. The Electronic Order of Battle mode (EOB) provides emitter location, frequency, pulse width, pulse repetition interval, and pulse amplitude. The Technical Intelligence mode (TI) provides specific comparison of intercepted to stored data parameters, enables a stop-scan condition, and supplies a predetected output for analog recording.

A mission profile computer program subsystem in support of on-orbit operations with these missions and subsequent Program 770 flight operations has been developed by the NRO. Significantly, this subsystem not only streamlines command and control procedures, but also permits construction of a comprehensive data base which is particularly facile for evaluating mission performance with respect to EOB.

BYE-1264-68

As a supplement to the detailed briefing provided the SORS in October 1967 on this subsystem, an additional briefing will be presented on April 17, 1968. A written description can also be provided subject to your requirements subsequent to the April 17 briefing.

Henry C. Howard
HENRY C. HOWARD
Colonel, USAF
Deputy Director for
Satellite Operations
NRO Staff

Attachment
As Stated

MISSION DESCRIPTION

7164 THRESHER/7233 REAPER

1.0 SYSTEM DESCRIPTION.

1.1 THRESHER.

1.1.1 General.

The Thresher payload is an electronic reconnaissance subsystem capable of intercepting pulsed electronic emissions from ground radiations in the frequency spectrum between 125 and 2100 MHz. Thresher has been designed for the dual mission of obtaining Electronic Order of Battle (EOB) information and Technical Intelligence (TI). In the EOB mode, the subsystem measures and digitizes intercepted signal parameters. These digitized parameters are stored in the memory of a Core Storage Unit (CSU), and read out on command during a tracking station pass. In the TI mode, the Thresher payload responds to stored parameters of signals of special interest and records these recognized signals in the wide-band tape Data Storage Unit (DSU) in the form of a predetected video signal together with appropriate digital marker words. The DSU is read out on command and the above data recorded on a wide-band ground tape recorder.

1.1.2 Major Components.

The Thresher payload (Diagram 1) consists of the following major components:

a. Antennas.

b. Receivers.

c. Central Power Supply.

d. Payload Control Unit.

e. Master Local Oscillator

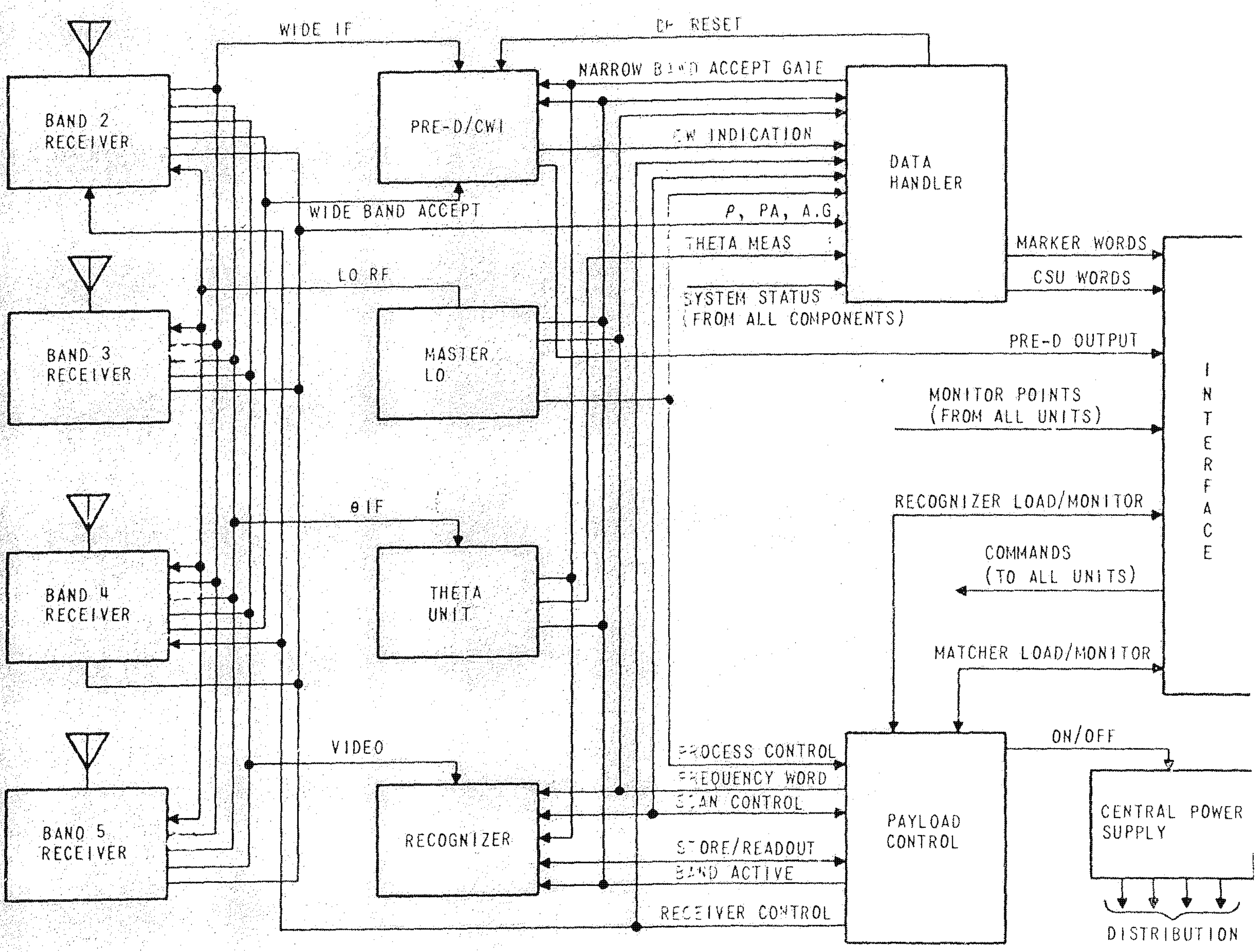

DIAGRAM 1. BLOCK DIAGRAM OF THRESHER PAYLOAD

f. Data Handler Unit.

g. Recognizer Unit.

h. Theta Unit.

i. Pre-D/CWI Unit.

The function of each of these components is discussed in the following paragraphs.

1.1.2.1 Antennas. Each of the four bands in the Thresher payload employs a dual-mode flat-spiral antenna design consisting of a 6-arm spiral cavity and feed system that generates a sum-and-difference mode radiation pattern. The difference between the amplitude measured in the sum mode and that measured in the difference mode is proportional to the apex angle of a ground emitter. An additional property of the dual mode design is the fact that the variation in relative phase between the sum-and-difference mode signals is directly proportional to the azimuthal angle of the emitter location with respect to a fixed vehicle reference.

1.1.2.2 Receivers. Each band utilizes a complete receiver containing two channels. Each channel is in turn a superheterodyne receiver capable of detecting RF pulses within the intended range of operation. One channel receives its excitation from the sum mode feed of the antenna and the other channel receives its excitation from the difference mode feed of the antenna. Both channels are scanned simultaneously by the application of a local oscillator drive derived from an external source. Outputs from the receivers are transmitted to the other components for processing.

1.1.2.3 Central Power Supply. The central power supply provides all the necessary regulated and unregulated voltages to the Thresher payload.

1.1.2.4 Payload Control Unit. The payload control unit provides command storage, payload turn-on and turn-off control, band sequencing, scan controls, programmable frequency limits and storage monitoring for the Thresher payload.

Approved for Release: 2017/08/17 C05099764

1.1.2.5 Master Local Oscillator Unit. The master local oscillator provides a stepped tuned local oscillator signal to each of the receivers over the specified frequency ranges.

1.1.2.6 Data Handler Unit. The data handler performs the functions of digitizing certain parameters of signals presented at its inputs, generates payload time information, processes digital information presented at its input, and generates digital words.

1.1.2.7 Recognizer Unit. The primary function of the recognizer unit is to provide in-flight recognition of eight high priority emitters by comparing intercept digitized parameters with the following stored parameters: frequency, pulse width, pulse repetition interval, and pulse amplitude. In conjunction with these parameters, the length of recording desired in either the field of view or horizon mode can be preselected.

1.1.2.8 Theta Unit. The function of the theta unit is to measure the phase difference from the receiver signal channel (antenna sum mode input) and the receiver inhibit channel (antenna difference mode input) to obtain azimuthal direction.

1.1.2.9 Pre-D/CWI Unit. The function of the predetection (Pre-D) section is to detect the presence of in-band signals and convert them to a specified signal band and amplitude range. The Pre-D output will preserve the pulse width and intrapulse modulation present at the Pre-D IF outputs. The Pre-D will also generate two reference tone frequencies (6 MHz and 46.875 kHz) for timing and a tag burst indicating the recognition of a programmed emitter.

The function of the CW indicator (CWI) is to detect the presence of CW signals that continuously exceed any of three commendable (-100, -90, and -80 dbm) thresholds for 1.6 milliseconds of a 2 millisecond sample period measured from the trailing edge of every accept pulse.

1.1.3 Parameters.

1.1.3.1 Orbital.

Inclination:	75 ± 1.10 deg (3-sigma)
Regression rate:	23.84 ± 0.05 deg/orbit (3-sigma)

Eccentricity:	Less than 0.005
Period:	94.587 ± 0.20 minutes (3-sigma)
Equatorial Altitude:	270 + 33, -22 n.m. (3-sigma)

1.1.3.2 Receivers.

	2	3	4	5
Radio Frequency (MHz)	125 to 260	260 to 530	530 to 1060	1060 to 2100
Pulse Width (usec)	2.0 to 3800	0.5 to 3800	1.0 to 3800	0.3 to 3800
Pulse Repetition Frequency (PPS)	10 to 10,000	15.4 to 10,000	25 to 10,000	50 to 10,000

1.1.3.3 Digital Measurement Tolerance.

Radio Frequency	Band 2	150 kHz
	Band 3	4 kHz
	Band 4	300 kHz
	Band 5	5 kHz
Pulse Width	Range (us)	Tolerances (us)
	0.3 to 1.25	± 0.25
	1.25 to 16.0	± 0.75
	16.0 to 144.0	± 2.0
	144.0 to 656.0	± 8.0
	656.0 to 3806	± 50
Pulse Repetition Interval	± 0.1 per cent or ± 1.0 us, whichever is greater	
Location	± 10 n.m.	

1.1.3.4 Analog Signal.

Signal Type	0.5 to 5.5 MHz predetected
Bandwidth	5 MHz (3 db points)
Amplitude	160 to 600 mv
Reference Tones	6 MHz ± 5 kHz 46.875 kHz ± 100 Hz

1.1.4 Operational Description.

1.1.4.1 Payload Control. Control of the Thresher payload is accomplished by command signals. Commands may be either real-time commands (RTC) or stored program commands (SPC). The command capability permits a versatile selection of combinations of operations in both the EOB and TI modes. Repeating the band and frequency range:

a.

Band 2	125 to 260 MHz
Band 3	260 to 530 MHz
Band 4	530 to 1060 MHz
Band 5	1060 to 2100 MHz

b. Any one of three scan rates can be selected for any operating receiver. These scan rates are 1, 4, and 16 seconds. Additionally, each band is frequency stepped in a discrete number of steps from low to high frequency. The overall effect is illustrated in the following table:

Band	No. of Steps	Search Step Size (MHz)	Bandwidth (MHz)	Dwell Time in msec for Indicated Scan Time 1	4	16
2	78	1.75	2.0	12.7	51	204
3	156	1.84	4.0	6.4	25.5	102

4	156	3.5	4.0	6.4	25.5	102
5	312	3.72 3.60	5.0	3.2	12.7	51

c. Either full band scan or incremental (priority band) range scan can be selected for portions of a rev or the full rev if desired.

d. The TI mode can be selected to override the EOB mode upon recognition of a selected emitter.

1.1.4.2 Payload Operation.

1.1.4.2.1 EOB Mode. Operation in the EOB mode is initiated by the Payload (PL) Readin On Command. Upon receipt of this command, a start/stop word is generated and frequency scanning is initiated.

The basic frequency scan sequence consists of the four receivers being automatically and sequentially frequency-stepped throughout their bands. Normally the receivers will be scanned from low to high, i.e., bands 2, 3, 4 and 5 - each receiver time-sharing more or less equally with the other receivers and only one receiver being on at a time. A status word group will be generated once for each frequency scan cycle immediately prior to initiating the lowest frequency band. Except for the configuration of the identity bits, the status word content is identical to the start/stop words. Upon the receipt of an intercept, the frequency scan is stopped for a period long enough to process the received information in terms of location and emitter pulse.

The sequence entailed in the acquisition of an emitter is set forth below. Because of the differences in the Bands 2 and 4 receivers and the Bands 3 and 5 receivers, the description of operation will be handled separately. Assume that all bands are enabled and operating in the 4 sec, full scan, field of view, EOB mode, and that an emitter is intercepted in Band 2, then:

a. The receiver generates a stop scan gate if the pulse width of the emitter is within the range of 2 usec to 3.9 msec.

b. The payload control unit generates a dwell gate which commands the receiver to the narrow band mode at the end of the discrete frequency dwell time.

c. As a result of the received intercept, the receiver will commence the processing operation by switching to narrow band operation and determining which of four IF channels contains the intercept. If the intercept results in the output of the narrow band channel falling in the range of 60 to 60.5 MHz, there will be no synthesizer (L.O.) activity change. If the intercept results in the output of the narrow band falling in the 60.5 to 61.0 MHz or the 59.5 to 60.0 MHz ranges, the L.O. will step down or up a frequency increment respectively. If the narrow band falls in the 59.0 to 59.5 MHz range, the L.O. steps up two frequency increments.

d. The receiver will generate a narrow band accept gate if the following criteria are met:

(1) The preset sensitivity is exceeded.

(2) The signal is within the processing bandwidth, i.e., narrow band IF.

(3) The emitter is within the selected circle of coverage.

e. The narrow band accept gate is input to the Data Handler (DH), which in turn generates a DH stop scan output.

f. The DH also receives a start processing gate from the Band 2 receiver.

g. The narrow band accept gate to the DH (item e, above) starts the PRI count. A second accept gate within 100 msec completes the first PRI count, generates an inhibit amplitude gate for pulse amplitude and a rho gate for rho measurements (radial direction) and accepts theta bits from the theta unit for incorporation into the pulse word generated at the completion of the second pulse.

If the next three pulses occur at PRI's within 3.5 per cent of the first PRI, pulse words are generated at the conclusion of each pulse for a total of four pulse words. If the PRI's are not matched, then 16 pulse words are generated. Within 100 usec after the termination of the pulse word group, a time frequency word is generated. However, the time frequency word generation may be delayed up to 3 msec by the input time pulse to prevent incorrect readout of time during time-counter updating.

h. If there were no additional intercepts during the wide-band step, the receivers will resume scanning.

i. Bands 3 and 5 operate the same as described above, with the exception that since these bands lack the narrow band IF capability, all processing is accomplished in a wide-band mode.

j. The Payload Control Unit has the capability of modifying the normal scanning process (full band scan) to select any RF range within the band in accordance with stored commands.

Note: The narrow band IF capability is a design feature incorporated for maximum rejection of CW interference in those RF areas where CW is most likely to be intercepted.

1.1.4.2.2 TI Mode. The purpose of the TI mode of operation is to obtain predetected recordings of special signals. Recognition of the signals is achieved by comparing the signal parameters received during EOB operation with eight or less sets of signal characteristics stored in the recognizer unit. The sets of signals are stored in words in the memory of the recognizer unit.

Proper recognizer action requires the first word to contain the lowest frequency and the succeeding words to be in ascending frequency order. No two words may contain the same frequency. Basically, the recognition process works in the following manner. When band code comparison indicates a match and the receiver scan reaches a frequency that lies within the upper and lower limits of that word, the coverage bit selects either accept gates or threshold video pulses before further processing can begin. If no pulse width comparison is made and the receiver frequency moves out of the selected range, a new word is shifted out of the selected range and a new word is shifted out of the memory for comparison.

If the recognizer is in the accept gate mode, video will still be thresholded but also "and" gated with the accept gates. If the band and frequency comparators indicate a match and the emitter has a pulse width that lies between the selected lower and upper limits, the recognizer generates a temporary stop scan output. If the recognizer is in the video processing mode, a temporary wide-band hold is also generated. During this temporary hold, the PRI circuitry makes its comparison and either maintains the stop scan or allows the receiver to resume scanning, depending on whether a complete match was made. If a match occurs, the recognizer generates a DSU available signal and goes into recording mode which depends upon the subword programmed for that particular emitter. The recognized signal will also be recorder digitally in accordance with the criteria for the particular EOB mode.

There are two types of recording modes:

Type 1. If a match occurs and the DSU is not available, the recognizer disregards the word match and removes the stop scan output. However, a DSU request signal is generated for 125 msec. If the DSU is available, one of three modes is executed:

Mode 1. DSU request and stop scan for 2.0 sec.

Mode 2. DSU request and stop scan for 4.0 sec.

Mode 3. DSU request and stop scan for 8.0 sec.

Type 2. If the DSU is not available, a DSU request signal is generated and the stop scan output is maintained for a maximum of 60 seconds or until a DSU available signal is received. If the DSU available signal is received, one of three modes is executed.

Mode 4. DSU request and stop scan for 4 sec.

Mode 5. DSU request and stop scan for 8 sec.

Mode 6. DSU request and stop scan for 300 sec.

If the DSU available signal is not received within the 60 sec. maximum stop scan output time, the stop scan output is removed and the receiver resumes scanning. If the DSU is available, a signal is provided to the interface which will contain a predetected video signal having a sinusoidal wave form which preserves the pulse width and the intrapulse modulation.

The band width is 5 MHz at the 3 db point. The amplitude response of the system consists of four linear steps as shown below:

Receiver Input Power	Pre-D Output Voltage
-55 to -43.5 dbm	160 to 600 mv p-p
-65 to -53.5 dbm	160 to 600 mv p-p
-75 to -63.5 dbm	160 to 600 mv p-p
-85 to -73.5 dbm	160 to 600 mv p-p

The first pulse of an intercept will cause the recognizer to outpus a coarse amplitude signal to the Pre-D unit which results in the Pre-D unit adjusting automatically to one of the four response positions, where it remains while a given intercept is being processed and recorded. The analog signal contains two reference tones: Tone A of 6 MHz and Tone B of 46.875 kHz, which are for resolution of the emitter frequency characteristics. The analog signal also contains a tag pulse when the intercept occurs within the zone of coverage.

1.2 REAPER.

1.2.1 General.

The Reaper payload (Diagram 2) is a frequency-scanning, electronic reconnaissance system that measures the location, frequency, pulse width, pulse repetition interval, and pulse amplitude of electromagnetic emitters in the frequency spectrum between 1800 and 3300 MHz.

Continuous wave emitters can also be processed. The payload digitizes each parameter measurement and outputs a digital word for each confirmed intercept. This output is stored in the CSU in the payload vehicle. Special status words are inserted regularly to identify the operating time period and vehicle attitude.

The Reaper payload produces digital data in dense signal environments by sorting pulse trains according to emitter location. Each digital word contains parameter measurements on four successive pulses from a single small ground area called a space window. This area varies with frequency and target location, from a square 17 miles on a side to a square 12.5 miles on a side.

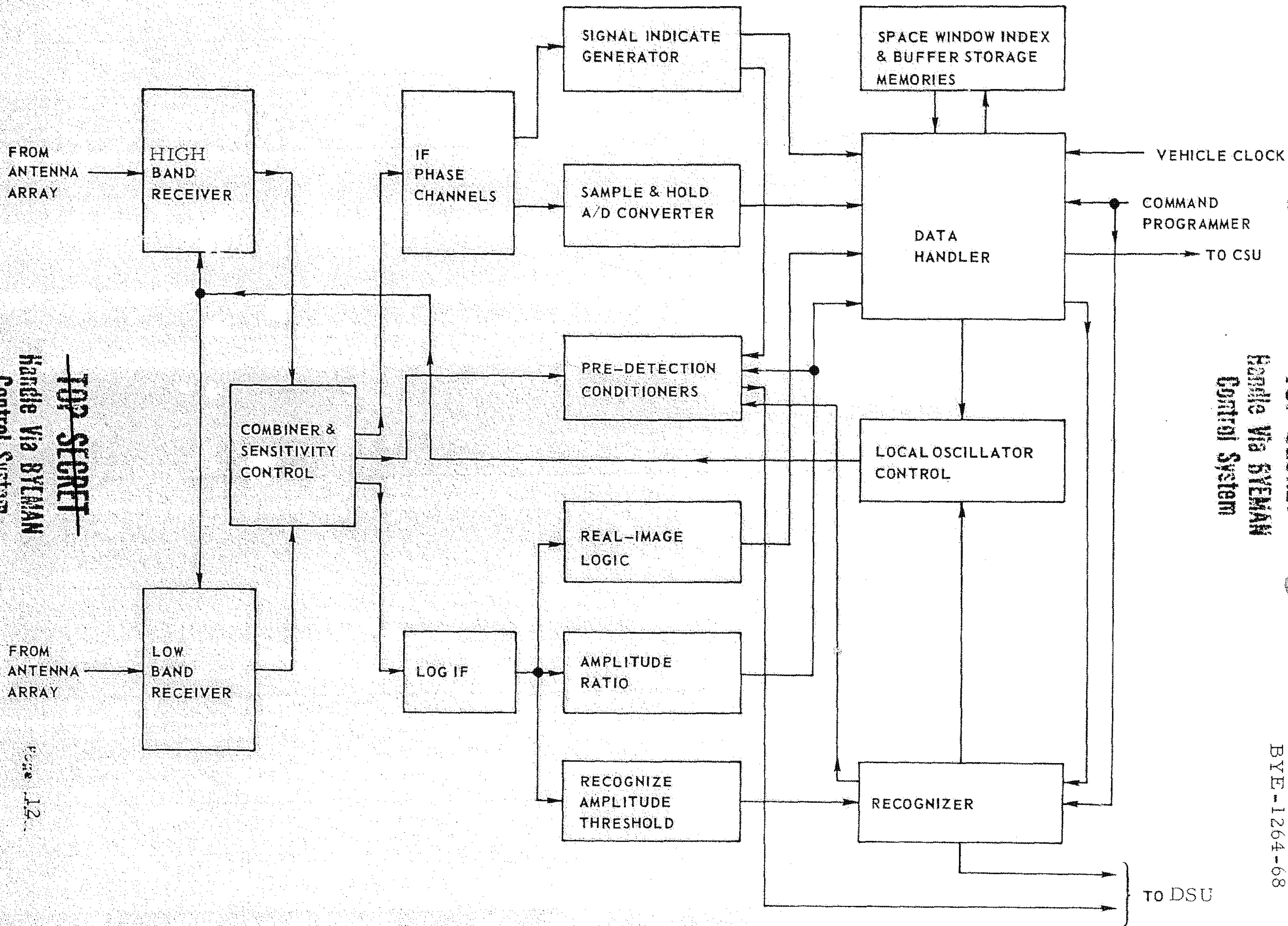

DIAGRAM 2 BLOCK DIAGRAM OF REAPER PAYLOAD

~~TOP SECRET~~
Handle Via BYEMAN
Control System

~~TOP SECRET~~
Handle Via BYEMAN
Control System

BYE-1264-68

Approved for Release: 2017/08/17 C05099764

Simultaneously with the processing of digital data, the payload matches measured emitter parameters against stored data (recognition sets). A data match will stop the system on the emitter frequency and cause the payload to output a predetected IF signal and a supplemental digital word for recording on the DSU-II wide-band analog tape recorder. Provision is also made to output this data while the payload is scanning and the DSU is in the steady state record mode.

1.2.2 Major Components.

The Reaper payload is an integral system consisting of six major functional sections. These are:

a. Antenna.

b. RF assembly.

c. IF assembly.

d. Data handler.

e. Command interface assembly.

f. Power supply.

The fundamental payload structure is a flat aluminum honeycomb panel approximately 47 by 51 inches. The panel has an irregular shape to allow for vehicle and Thresher payload outline constraints. The antennas and the various circuit boxes are distributed on this panel. The total depth of the payload structure is 16 inches. Weight is 234 lbs.

1.2.2.1 Antennas. Twelve antennas are used, six in the low band (1800 to 2437.5 MHz) and six in the high band (2400 to 3300 MHz). Five antennas in each nest comprise the phase array. The sixth antenna is a spiral fed horn designed to obtain a difference pattern for amplitude ratio determination. The phase antennas are circularly polarized and have a maximum gain of 20 db.

1.2.2.2 RF Assembly. The RF assembly consists of the following elements:

a. RF bandpass filters.

b. RF checkout board (RFCO).

c. RF calibrator.

d. Stripline mixer.

e. Local oscillator.

The RF calibrator provides a comb generator output at frequencies of 1800, 2100, 2400, 2700, 3000, and 3300 MHz. Every 256 seconds the calibrator is gated on for 8 seconds. The generator is turned on for 4 msec at each change frequency step. The signal is modulated to produce 1 usec pulse with 500 usec PRI. Calibrator intercepts processed by the payload will be indicated by a code in the word. The noise figure of the RF front end is established by the mixer. The mixer single sideband noise figure is 8 db maximum.

The local oscillators are electronically-tuned, solid state microwave YIG oscillators. One oscillator is required for the low band and one for the high band. Control is provided by a D/A converter. The digital control count changes 1 count for each 2.5 MHz frequency step.

1.2.2.3 IF Assembly. The IF assembly contains the following elements:

a. Sixteen IF preamplifiers.

b. Five phase channels.

c. Two log IF (Amplitude) channels.

d. Signal Indicates (SI) generator.

e. Real/Image confirm circuit.

f. A/R inhibit circuit.

g. Threshold circuit.

h. Analog-to-digital converter.

i. Frequency confirm circuit.

j. Pulse width confirm circuit.

k. Tag and tone generator.

The center frequency of the IF channels is 20 MHz. The frequency confirm bandwidth is 3 MHz. The bandwidth of the phase channels is nominally 6 MHz. The log IF bandwidth is nominally 4.5 MHz. The signal for the predetected output is taken from the IF preamplifiers where the bandwidth is nominally 10 MHz.

1.2.2.4 Digital Assembly. The digital assembly or data handler processes and encodes received signal parameters, status time, and attitude information. The data handler also provides buffer storage for the output words and controls the frequency scan circuits.

The recognizer is a major subassembly of the digital assembly. It stores the eight recognition sets and compares these against the encoded parameters from the data handler when enabled.

1.2.2.5 Command Interface Assembly. The command interface is a relay assembly that provides isolation for commands from the vehicle.

1.2.2.6 Power Supply. The payload uses two DC-to-DC converters operating from the vehicle battery bus. The auxiliary supply is continuously on and supplies power to the time accumulator, the L.O. oven heater, and certain telemetry circuits. The main supply is turned on only for readin. The main supply draws 10.5 amperes nominally. The auxiliary supply draws 1.0 ampere.

1.2.3 Parameters.

1.2.3.1 Frequency.

Frequency Range:	1800 to 3300 MHz, with marginal performance to 1760 and 3340 MHz
Frequency Step:	2.5 MHz

Frequency Resolution:	1 MHz
Frequency Accuracy:	$\pm$ 0.3 per cent
Frequency Repeatability:	$\pm$ 1 MHz for 10 minutes
Capture Band:	6 MHz (2 x 3 MHz)
Scan Rate:	5 sec nominal, 15 sec in alternate mode

1.2.3.2 Direction Finding.

Accuracy:	7.5 n.m. radius
Resolution:	11.25 electrical degrees

1.2.3.3 Pulse Amplitude.

Accuracy:	$\pm$ 5.0 db
Resolution:	2.5 db

1.2.3.4 Pulse Width.

Encoding Range:	0 to 7.875 usec
Accuracy:	$\pm$ 0.25 usec
Resolution:	0.125 usec
Minimum PW:	0.4 usec
Maximum PW:	Signals greater than 24 usec are encoded as CW

1.2.3.5 Pulse Repetition Interval.

Encoding Range:	100 to 8000 usec
Resolution:	1.0 usec

1.2.3.6 Time.

Encoding Range:	8 days
Resolution:	1/8 sec.

1.2.3.7 Dynamic Range.

Sensitivity:	Adjustable by command to -93 dbm, -88 dbm, or -83 dbm at an elevation angle of 23 degrees
Range:	40 db above T_{min}

1.2.3.8 Field-of-View.

	Cross-Track	In-Track
Maximum	246 n.m.	90.6 n.m.
Minimum	173 n.m.	66.5 n.m.

1.2.3.9 Analog Output.

Linear to 600 mv peak-to-peak.

Automatic selection of one of four linear ranges.

1.2.3.10 Recognition Sets.

Resolution:

Frequency:	5 MHz
PW	0.25 usec
PRI	64 usec
Amplitude:	T_{min}, $T_{min} + 5$ db, $T_{min} + 10$ db, and $T_{min} + 15$ db
Number of Sets:	8

1.2.3.11 Recognizer Output Modes

Mode	Wait Time (Sec)	Record Time (Sec)
1	0	2
2	0	4
3	0	8
4	60	4
5	60	8
6	60	300

1.2.3.12 Partial Scan Limits.

Memory Capacity: 2 ranges

Frequency Resolution: 5 MHz

1.2.4 Data.

Three CSU and two DSU are associated with the PV/PL combination. In normal operation, CSU No. 1 is assigned to the Thresher PL, CSU No. 2 to the Reaper PL, and CSU No. 3 to the stored status telemetry. The capability exists, however, to switch data sources. Switching between units when necessary is accomplished by command as readin and readout of the units. The two DSU's are not assigned to any particular payload, which permits a trade-off between the mission life and the shorter tape-recorder (DSU) life. By sharing a DSU between two payloads on either a priority or a first-come first-serve basis, the total life of the two units can be extended to conform with the estimated mission life. Analog data will be transmitted to ground tracking station via the Wide-Band Data Link (WBDL) Transmitter and the digital data, CSU inputs, and vehicle telemetry data will be multiplexed in the base band assembly unit and transmitted to ground stations via the Space-Ground Link System transmitter. Diagrams 3 and 4 depict the flow of digital and analog data from readout at the tracking stations through intermediate and final processing.

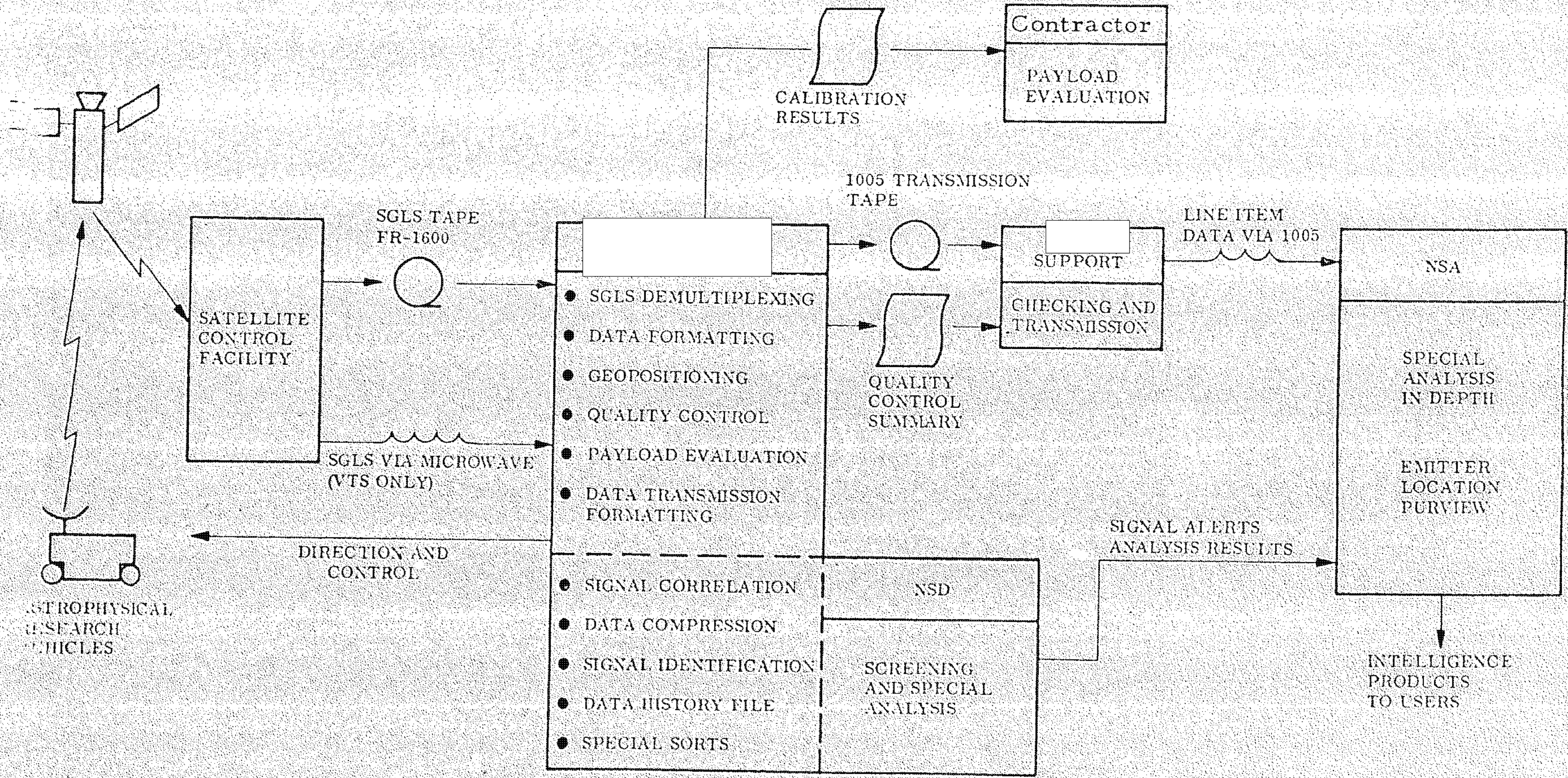

Diagram 4. Thresher and Reaper Digital Data Flow

BYE-1264-68

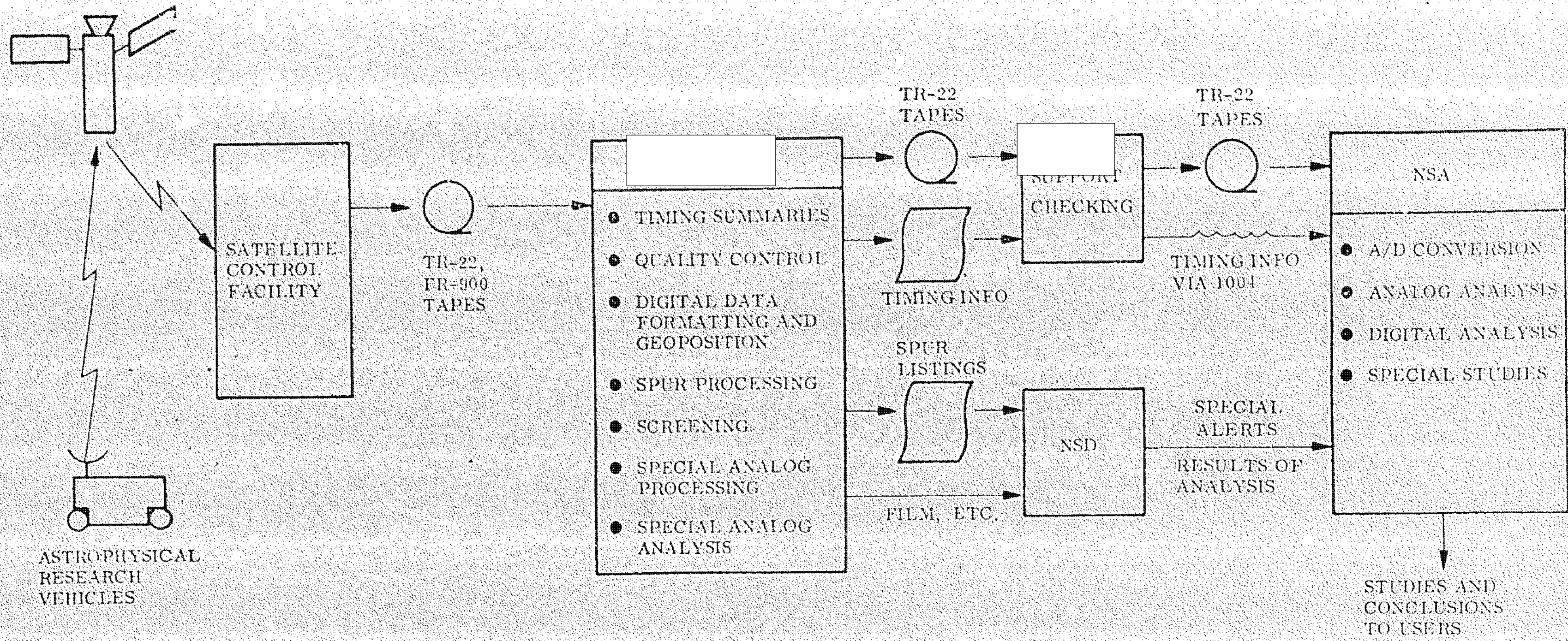

DIAGRAM 3. Analog Data Flow

50X1

Approved for Release: 2017/08/17 C05099764

1.2.5 Frequency Scan Characteristics.

The Reaper payload processes intercepts in the band from 1760 to 3340 MHz. The payload, however, is specified to be accurate only between 1800 and 3300 MHz. The payload uses a scanning super-heterodyne receiver to cover the complete band in 5 second (nominal). Scan time increases with the number of intercepts. The receiver steps frequency in 2.5 MHz steps, stopping at each step for 6.14 msec - two msec are allowed for settling time. If a signal is received, the dwell time is extended to 22.5 msec. An alternate dwell is commandable where the basic dwell time is 22.5 msec and the extended dwell time is 45 msec. The band is split at 2440 MHz. Separate antennas and separate local oscillators are used in the two sub-bands. Both real and image signals are processed in normal scan. Frequency search can be programmed to scan segments of the band. Only real signals are processed in the partial scan mode.

1.2.6 Direction-Finding Techniques.

Emitter location is determined by measuring the relative phase of the received signal in an interferometer array of five antennas. Simultaneous phase measurements are made in orthogonal directions on each received pulse. Both coarse and fine phase measurements are made. The combination of coarse and fine phase permits phase ambiguities to be resolved.

On the ground, the transmitted phase readings are used to compute the direction cosines of the line-of-sight to each emitter. From the direction cosines and ephemeris data, the precise geographical location of each emitter can be computed.

The Reaper payload is capable of locating emitters, with respect to the boresight of the antenna nest, within a 7.5 n.m. radius, with a probability of 95 per cent. This accuracy is obtained for target locations out to an elevation angle of 32 deg from antenna boresight. For received signals with a signal-to-noise ratio less than 20 db (PA: -82 dbm), the quoted accuracy is obtained by averaging a minimum of two intercept words (8 pulses). For signal strengths greater than -82 dbm, this accuracy can be obtained with a single pulse measurement.

Vehicle alignement, attitude errors and knowledge of the ephemeris will add to the payload error and increase the overall system error to about 10 n.m.

1.2.7 Field-of-View (FOV).

The half-power beamwidth of the phase channel antennas is typically 40 to 50 degrees, but confirmed intercepts are normally generated only for targets within the phase field-of-view. The phase field-of-view is generated by a logic function that rejects all pulses that do not meet the following unambiguous phase criteria:

-450 Cross-Track Phase (X) $\leq$ 450 degrees

-180 In-Track Phase (Y) $\leq$ 180 degrees

The size of the projected FOV varies with frequency, the smallest size occurring at the highest frequency in each band. The dimensions are: minimum 66.5 x 173 n.m. - maximum 90.6 x 246 n.m. A coarse amplitude ratio field-of-view (A/R circle) is also generated. The A/R circle is always greater than the phase field-of-view. The A/R circle eliminates poke-through from horizon emitters.

1.2.8 Intercept Confirm Logic

An intercept is confirmed when the payload receives two valid pulses from the same space window on a single frequency dwell. A valid pulse meets the following criteria:

a. Signal strength greater than the digital threshold (T_{min}). T_{min} is normally set for a signal of -93 dbm at an elevation angle of 23 degrees. It is adjustable to -88 dbm and to -83 dbm by command.

b. Pulse width greater than 0.4 msec.

c. Frequency centered in the IF passband with $\pm$ 1.5 MHz.

d. Real or image.

e. Within A/R circle.

f. Within phase field-of-view.

g. Signal strength less than T_{max} (T_{min} + 40 db).

1.2.9 Space Window Logic.

The phase readings of each pulse received during a single dwell period are compared against previous pulses received on that dwell. Pulses determined to be from the same space window are formatted into a single intercept word. Four pulses constitute an intercept. Additional pulses from the same space window are rejected. Up to 64 different space windows can be established for a single dwell period. All space windows are reset at the end of the dwell.

Processing of different emitters proceeds in parallel during the dwell period. A digital processing time of approximately 50 usec is needed for each confirmed pulse. About 5 to 10 usec is needed to reject pulses that do not meet confirm criteria. The size of the space window is 67.5 electrical degrees in the X and Y directions. Each space window is centered on the phase of the first pulse from each emitter.

1.2.10 CW Operation.

A signal with a duration greater than 24 usec is identified by the payload as CW. If the signal is confirmed, the payload outputs an intercept word with maximum pulse width and minimum PRI readings. Other signals present during the same dwell period must exceed the amplitude of the CW signal by 15 db to be processed. Intercept words generated on signals superimposed on the CW will have a "CW-Bit" indication. No such indication is given the CW signal itself.

1.2.11 Signal Recognizer Operation.

The Reaper payload can store selected parameters on eight different emitters. The stored parameters can be changed by sending a new memory load in real-time, using the vehicle binary-digital command mode. Emitters to be recognized can be selected by command. Up to four emitter sets can be compared at a given frequency step, that is, the stored frequency parameters of four sets can overlap without affecting normal operation.

Each set contains indicating field-of-view or horizon-to-horizon recognition. Field-of-view operation requires the signal to meet all normal data handler confirm criteria. Horizon operation does not require a phase FOV or A/R circle confirm.

The recognizer executes one of six output modes when a parameter match is obtained. Each mode has a different wait/record time combination as set forth in paragraph 1.2.3.11.

1.2.12 Analog Output.

The payload outputs a predetected analog signal supplemented with a digital marker word upon recognition. The nominal frequency is 3 MHz. The bandwidth of the output is 0.5 to 5.5 MHz. A tag pulse following the signal pulse indicates that the target is within the A/R circle. Reference tones at 6 MHz and 46.875 kHz are provided to assist in data evaluation. The transfer characteristic of the predetected output is linear up to a maximum output voltage of 600 mv peak-to-peak. One of four dynamic ranges is detected by the recognizer, by measuring the amplitude of the first recognized pulse.