Section 3.0 GVAR Transmission Format

3.1 Introduction

This section defines the structure and content of the GOES Variable Format (GVAR) data transmission format used to broadcast meteorological data measured by the independent GOES I-P Imager and Sounder instruments. There are multiple versions of the format, for GOES I-L, GOES M-N, and GOES O-P, as are summarized in Section 3.1.1. The difference in the versions (except V2 to V3) is predominately additions to the later versions, with previously spare fields now being used. Included in the format are Imager and Sounder telemetry and calibration data. In addition, the format provides a capability to insert text messages and spacecraft navigation support data into the GVAR stream.

The GVAR format has its origins in the Operational VAS Mode AAA (Triple A) format used with the previous generation, spin-stabilized GOES spacecraft. The AAA format consisted of a repeating sequence of twelve fixed-length equal size blocks, transmitted in a synchronous fashion at the spin rate of the satellite (i.e., one complete 12-block sequence per spacecraft rotation). In contrast, starting with the GOES I-M series, the GOES satellites are three-axis stabilized, giving the Imager and Sounder a continuous view of the Earth. The GVAR format was developed to permit full use of the capabilities afforded by the new instruments and the continuous Earth view, while maintaining as much commonality with AAA reception equipment as possible.

The following attributes have been used in the Name column of tables residing in Section 3.0:

a. An "*" (asterisk) is used as a wildcard to indicate more information follows the mnemonic. Refer to the Description column for a summary. For example: IGAIN2* in the Name column refers to IGAIN2_P1 through IGAIN2_P7 as indicated in the Description column.

b. A "**" or more asterisks are used to draw the reader's attention directly to a comment in the Description column.

Symbols are also used in Notes that follow tables. These symbols, however, only direct the reader back to a symbol used in the Description column.

3.1.1 Summary of Changes Across Versions of GVAR

The "Version Number" field which resides in Word 8 of the GVAR block header has values 0 through 3 assigned as follows:

Version Number	Spacecraft Supported	Change in relation to Previous Version
0	GOES I - L	Original GVAR specification for GOES I-M

Version Number	Spacecraft Supported	Change in relation to Previous Version
1	GOES I - L	• Midnight Blackbody Calibration Correction (MBCC) information added • Added Current Imager and Sounder Frame Start times to support User Priority Interrupt Processing • Added SPS ID to GVAR Header • Added 4 words to blackbody statistics for BB Dwell Changes
2	GOES M-N	• Imager IR Channel order in Block 1 & 2 changed • New Block 11 added for imager factory coefficients
3	GOES O-P	Support for 8th detector in GOES O-P: Block 11 added for imager factory coefficients including coefficients for the 8th detector Modified blocks for eighth detector: Imager Block 0 • Imager factory coefficients removed • Added data for 8th detector to existing block (using spares at the end of the block) Imager Block 2 • Added data for 8th detector to existing block (using spares at the end of the block) Imager Blackbody Block 11 • Added a 3rd block (necessary for 8th detector) Imager Calibration & Limits Block 11 • Added data for 8th detector to existing block (using spares at the end of the block) Imager ECAL Block 11 • Added a 3rd block (necessary for 8th detector) Imager Spacelook Block 11 • Added a 7th block (necessary for 8th detector)

Note that Versions beyond #1 are not retroactive (i.e. V0 does not exist any more) to GOES I-L. "Version #2" describes the mode of GVAR applicable to GOES M-N data (and includes everything in Version #1). "Version #3" describes the form of GVAR sent for GOES O-P only and includes everything in prior versions as well.

3.2 Scan Format

The GVAR transmission sequence is depicted in Figure 3-1, and Table 3-1 provides an overview of the GVAR block structure. The format consists of twelve distinct blocks numbered 0 – 11. Blocks 0 – 10 are transmitted after the completion of each Imager scan line. Block 10 is then followed by a variable number of Block 11s according to what Sounder scan data, instrument telemetry and other data are available for transmission.

Block 0 and all varieties of Block 11s are fixed, equal-length structures. Blocks 1 – 10 vary in length in accordance with the length of the Imager scan line (i.e., the width of the commanded frame). The minimum block size for Blocks 1 – 10 is 32,208 bits, for scan widths less than 1.9°, while the largest block size is 262,288 bits for a 23°-wide scan. The maximum values indicated in the figure for Blocks 1 – 10 correspond to the manufacturer's specified maximum scan width of 19.2°. Scans having widths up to 23° are possible with either instrument; however, the radiometric and pointing accuracy degrades for widths above 19.2°. The GVAR format handles scans wider than 19.2° with restrictions on operations to allow for special postlaunch tests. During normal operations, the 19.2° limits specified by the manufacturer represent the upper bound.

DOC	IR1	IR2	VIS 1	VIS 2	VIS 3	VIS 4	VIS 5	VIS 6	VIS 7	VIS 8	SAD
0	1	2	3	4	5	6	7	8	9	10	11

– Each GVAR Block has the following:
10,032-bit Synchronization Code
720-bit Header
N-bit Information Field
16-bit CRC

– Blocks 0 and 11 have a fixed-length information field of 64,320 bits.
– Blocks 1 – 10 have variable length information fields directly dependent on frame width (scan width), with a minimum length of 21,440 bits.
– A Single Imager Scan generates Blocks 0–10 in sequence.
– Blocks 0–10 may be followed by any number of Block 11s (0–N), depending on what is available
In priority order, the following Blocks transmitted are:

1. Imager Scan Blocks 0 –10
2. Imager Compensation and Servo Errors – 1 Block 11
3. Sounder Compensation and Servo Errors – 1 Block 11
4. Imager Telemetry Statistics – 1 Block 11
5. Imager Spacelook Statistics and Data – 6 Block 11s
6. Imager Calibration Coefficients and Limits – 1 Block 11
7. Imager ECAL Statistics and Data – 2 Block 11s
8. Imager BB Statistics and Data – 2 Block 11s
9. Imager Visible NLUTs – 2 Block 11s
10. Imager Star Sense Statistics and Data – 9 Block 11s
11. Sounder Documentation Scan Data – 2-523 Block 11s
12. Sounder Telemetry Statistics – 1 Block 11
13. Sounder Spacelook Statistics and Data – 5 Block 11s
14. Sounder Calibration Coefficients and Limits – 2 Block 11s
15. Sounder ECAL Statistics and Data – 3 Block 11s
16. Sounder BB Statistics and Data – 5 Block 11s
17. Sounder Visible NLUTs – 9 Block 11s
18. Sounder Star Sense Statistics and Data – 9 Block 11s
19. GIMTACS Text Messages – 1–2 Block 11s
20. SPS Text Messages – 1 Block 11
21. Imager Factory Coefficients – 1 Block 11
22. Fill Data – 1 Block 11

KEY TO ACRONYMS AND ABBREVIATIONS:			
CRC	Cyclic Redundancy Check	IR n	Infrared Detector n
DOC	Documentation	VIS n	Visible Detector n
ECAL	Electronic Calibration		

Figure 3-1. GVAR Format

Table 3-1. GVAR Format

Parameter	Value
Scan	
Period Blocks and Imager Scan Bit Rate	Variable 11 2,111,360 bps
Block	
Period Synch Length Header Word Length Header Length (Triple Redundant)	15.25 to 104.6 msec 10,032 bits 8 bits per word 90 words (720 bits)
Data Section (by block type)	
Block 0 - Documentation Block Word Size Field Length	 8 bits 8040 words (64,320 bits)
Block 1 - Infrared Block 1 Word Size Field Length Number of Records Line Documentation IR Detector Data	 10 bits *68 to 21,008 words 4 per block 16 words 1 to 5236 words
Block 2 - Infrared Block 2 Word Size Field Length Number of Records Line Documentation IR Detector Data	 10 bits *51 to 15,756 words 3 per block 16 words 1 to 5236 words
Blocks 3 – 10 - Visible Blocks Word Size Field Length Number of Records Line Documentation IR Detector Data	 10 bits *20 to 20,960 words 1 per block 16 words 4 to 20,944 words
Block 11-Sounder Data and Imager Factory Coefficients Word Size Field Length (words) Record Types Number of Records	 6, 8, or 10 bits 10720, 8040, or 6432 7 1 to 8
CRC	16 bits

Note:

* Variable length information fields are subjected to zero packing, filling, to meet the 32,208-bit minimum block length and to satisfy the 16-bit bounding required for the block CRC. Maximum values denote only the data sections resulting from a 19.2° instrument scan.

3.2.1 Imager

The Imager is designed to sense radiant and solar energy from various areas of the Earth. The layout of the Imager instrument detectors is depicted in Figure 3-2. The Imager has a total of 22 (**GOES I-N**) or 24 detectors (**GOES-O** and beyond) split into the following three groups:

a. Eight visible detectors, V1 – V8.

b. Seven (or Eight, **GOES-O** and beyond) primary IR detectors, P1 – P7 (P8, **GOES-O** and beyond).

c. Seven (or Eight, **GOES-O** and beyond) redundant IR detectors, R1 – R7 (R8, **GOES-O** and beyond).

Each of the detectors on a given spacecraft is a member of one of five spectral channels.
The channel numbering for all satellites from **GOES-I** through **GOES-P** is as follows:

Channel	Nominal Wavelength
1	Visible
2	3.9 µm
3	6.75 or 6.5 µm
4	10.7 µm
5	12.0 µm
6	13.3 µm

Note that no Imager will have both channels 5 and 6. Those on **GOES-I** through **GOES-L** have channel 5. Those on **GOES-M** through **P** will have channel 6.

Although physically distinct, the five channels on a given spacecraft are optically overlaid, as illustrated in Figure 3-3. During imaging operations, the detectors are active in either a side 1 or a side 2 configuration, as illustrated in Figure 3-4. In both configurations the visible detector group (V1 – V8) and one of the two IR groups, either primary or redundant, are active. The resultant swath on the Earth's surface generated by either of these two configurations is misaligned in the IR and visible bands as indicated in Figure 3-5. The SPS removes the misalignment by lagging data from the appropriate visible detectors and combining these data with detector data from a subsequent scan. This forms Earth scan swaths in which the visible and IR detector data coincide. In the side 1 detector configuration, data from visible detectors V5 – V8 are lagged. These lagged data are combined with side 1 IR detector data and visible detector V1 – V4 data gathered during the next scan to create a GVAR Block 0 – 10 sequence. This makes V5 the northernmost detector. For the side 2 detector configuration, data from visible detectors V5 – V8 and IR detectors are lagged. The lagged data are combined with data from visible detectors V1 – V4 gathered during the next scan to create a GVAR Block 0 – 10 sequence, making V5 the northernmost detector.

The placement of Imager detector data within the Block 0 – 10 structure shown in Figure 3-1 is recorded in the Imager Documentation Block 0. For **GOES-I** through **GOES-L**, the GVAR does not order the channels according to increasing wavelength, but by the arbitrary system, 4, 5, 2, 3.

(This ordering was based on the old pre-**GOES-I** AAA data stream.) Beginning with **GOES-M** (GVAR version 2), this is changed. The data in GVAR version 2 and beyond will be in order of increasing channel wavelength. For example, for **GOES-M** through **GOES-P** the order will be 2, 3, 4, 6. Block 1 contains IR scan data for channels 4 and 5 (**GOES I-L**), or channels 2 and 3 (**GOES-M** and beyond); Block 2 contains IR data for channels 2 and 3 (**GOES I-L**) or channels 4 and 6 (**GOES-M** and beyond); and, Blocks 3 – 10 contain visible detector data. The IR detector data position within the blocks 1 and 2 is as follows:

For **GOES I-L**

Block 1:	Channel 4, Detector 1
	Channel 4, Detector 2
	Channel 5, Detector 1
	Channel 5, Detector 2
Block 2:	Channel 2, Detector 1
	Channel 2, Detector 2
	Channel 3, Detector 1

For **GOES M-N**

Block 1:	Channel 2, Detector 1
	Channel 2, Detector 2
	Channel 3, Detector 1
	Channel 3, Detector 2
Block 2:	Channel 4, Detector 1
	Channel 4, Detector 2
	Channel 6, Detector 1

For **GOES O and beyond**

Block 1:	Channel 2, Detector 1
	Channel 2, Detector 2
	Channel 3, Detector 1
	Channel 3, Detector 2
Block 2:	Channel 4, Detector 1
	Channel 4, Detector 2
	Channel 6, Detector 1
	Channel 6, Detector 2

The visible detector data position within the blocks 3-10 is as follows:

Block 3:	Visible Detector 5
Block 4:	Visible Detector 6
Block 5:	Visible Detector 7
Block 6:	Visible Detector 8
Block 7:	Visible Detector 1
Block 8:	Visible Detector 2
Block 9:	Visible Detector 3

Block 10: Visible Detector 4

The Imager scans broadcast in GVAR are composed using the IR data to define the output swath. Under some conditions, a full complement of detector data is not available for the Block 0 – 10 sequence. For example, in a side 1 configuration, the first scan of a N-S frame always lacks visible detector data for the northernmost four lines. In this case, a half-sided scan is employed. A full GVAR Block 0 – 10 sequence is constructed of fill data (zeros) substituted for the unavailable detector information. The resulting GVAR blocks generated are sized according to the requirements of the imaging frame width and denoted as containing fill data by way of the Data Valid flag in the corresponding block headers (see Section 3.3.2).

The side 1 start-of-frame, half-sided sequence described above occurs when there is a lack of visible detector data to fully overlay the IR swath. The last scan of the same frame has the opposite condition--four extra lines of visible detector data for which an IR swath is never available. In this case, the excess visible detector data are trimmed.

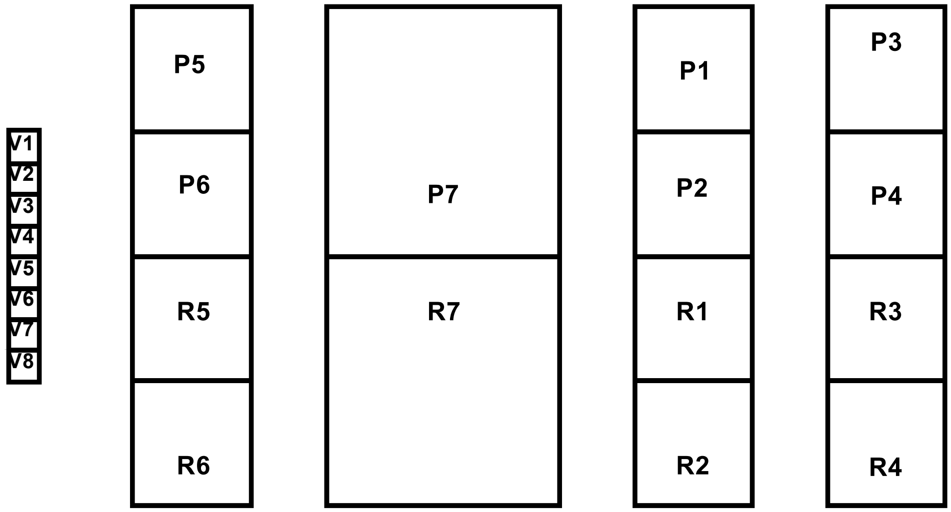
Half-sided Block 0 – 10 sequences are also generated when data disruptive frame breaks are encountered. These frame breaks arise under the following three conditions:

a. An instrument reset.
b. The loss of raw signal synchronization by the SPS.
c. A priority frame interrupt.

The occurrence of an instrument reset causes the Imager to cancel all current or pending activities. The SPS responds to an instrument reset by dumping any lagged data held as a half-sided scan.

The loss of signal synchronization causes the loss of one or more frame scans. When synchronization is subsequently reestablished, the loss (detected as an excessive step in the N-S scan address) triggers a flushing of the currently held lagged data through a half-sided GVAR Block 0 – 10 sequence. The newly acquired scan generates a second half-sided sequence, similar to the start of a frame.

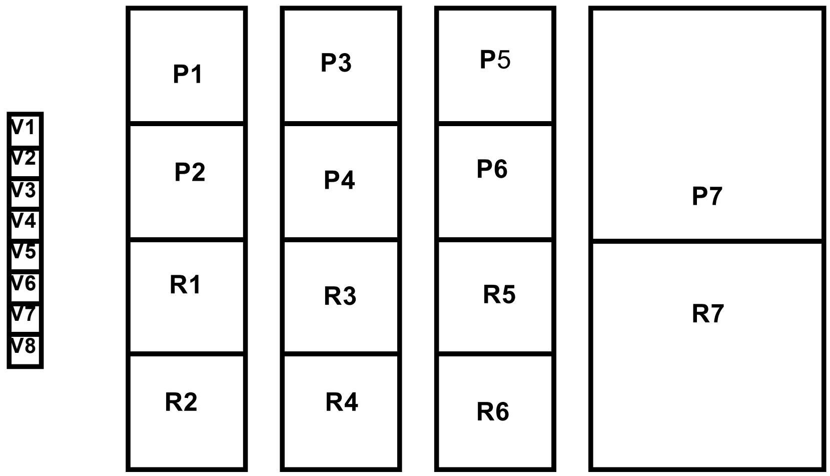
In a similar fashion, the interruption of a lower priority frame by a higher priority frame generates two, successive half-sided Block 0 – 10 sequences; one to flush the lower priority lagged data, and one to start the higher priority frame. At the conclusion of the higher priority frame, two more half-sided sequences are generated, one flushing the higher priority lagged data, and one marking the restart of the interrupted lower priority frame. Note that half-sided scans are not generated for frame breaks caused by star senses since these do not disrupt the scan data sequence.



CHANNEL	**1**	**2**	**3**	**4**	**5**
CENTRAL WAVELENGTH (μm)	**0.65**	**3.9**	**6.75**	**10.7**	**12**
DETECTOR IGFOV (μradians)	**28**	**112**	**224**	**112**	**112**

Notes:
μm – micrometers (microns)
μradians – micro radians
IGFOV – Instantaneous Geometric Field-of-View

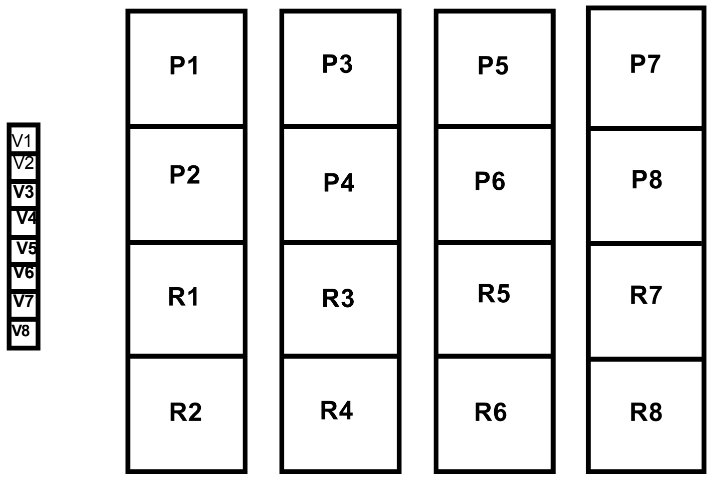
Figure 3-2a. Imager Detector Physical Configuration (GOES I-L)



CHANNEL	**1**	**2**	**3**	**4**	**6**
CENTRAL WAVELENGTH (µm)	**0.65**	**3.9**	**6.5**	**10.7**	**13.3**
DETECTOR IGFOV (µradians)	**28**	**112**	**112**	**112**	**224**

Notes:
µm – micrometers (microns)
µradians – micro radians
IGFOV – Instantaneous Geometric Field-of-View

Figure 3-2b. Imager Detector Physical Configuration (GOES M-N)



CHANNEL	**1**	**2**	**3**	**4**	**6**
CENTRAL WAVELENGTH (μm)	**0.65**	**3.9**	**6.5**	**10.7**	**13.3**
DETECTOR IGFOV (μradians)	**28**	**112**	**112**	**112**	**112**

Notes:
μm – micrometers (microns)
μradians – micro radians
IGFOV – Instantaneous Geometric Field-of-View

Figure 3-2c. Imager Detector Physical Configuration (GOES O and Beyond)

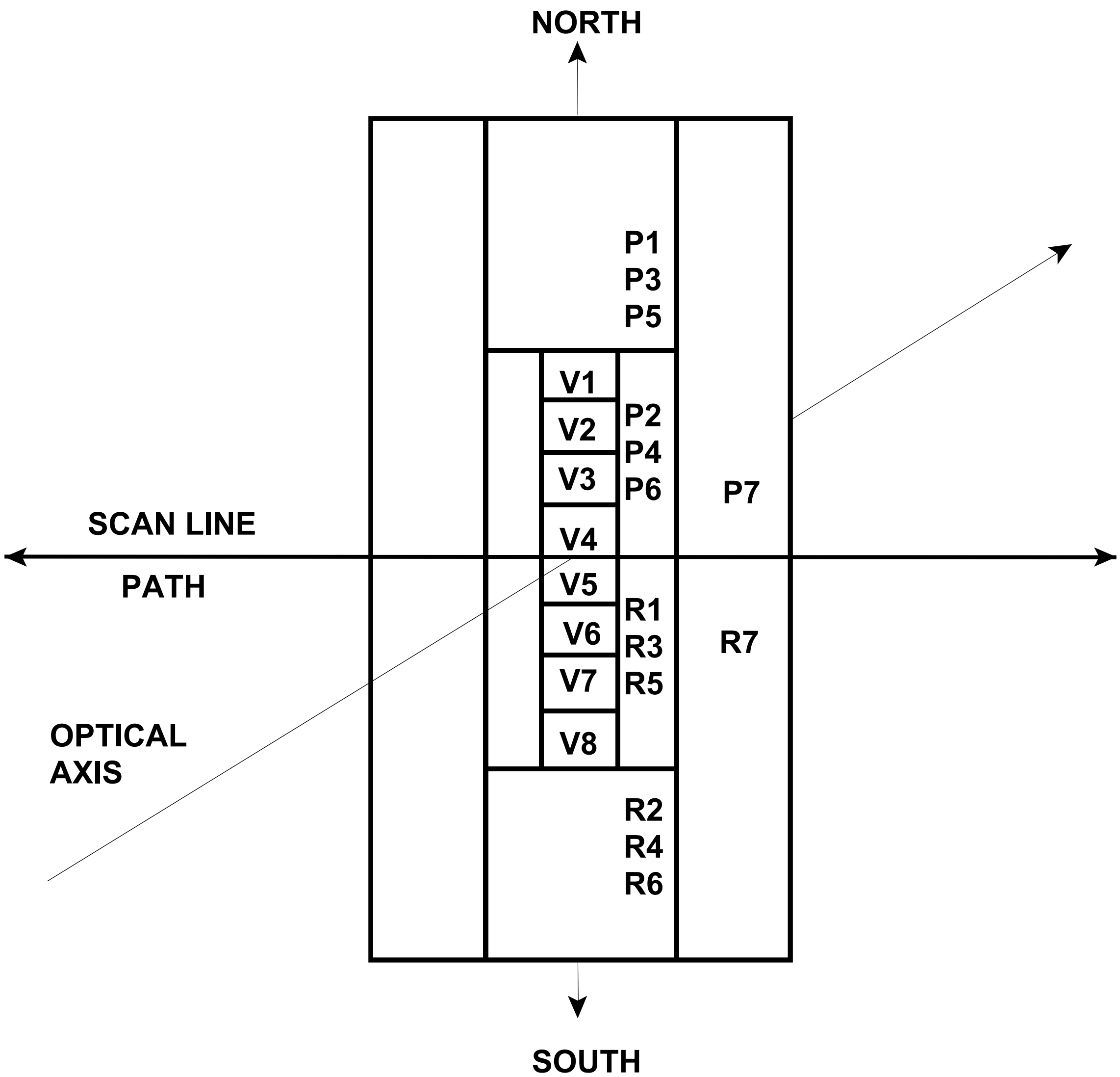


Figure 3-3a. Imager Detector Optical Configuration (GOES I-N)

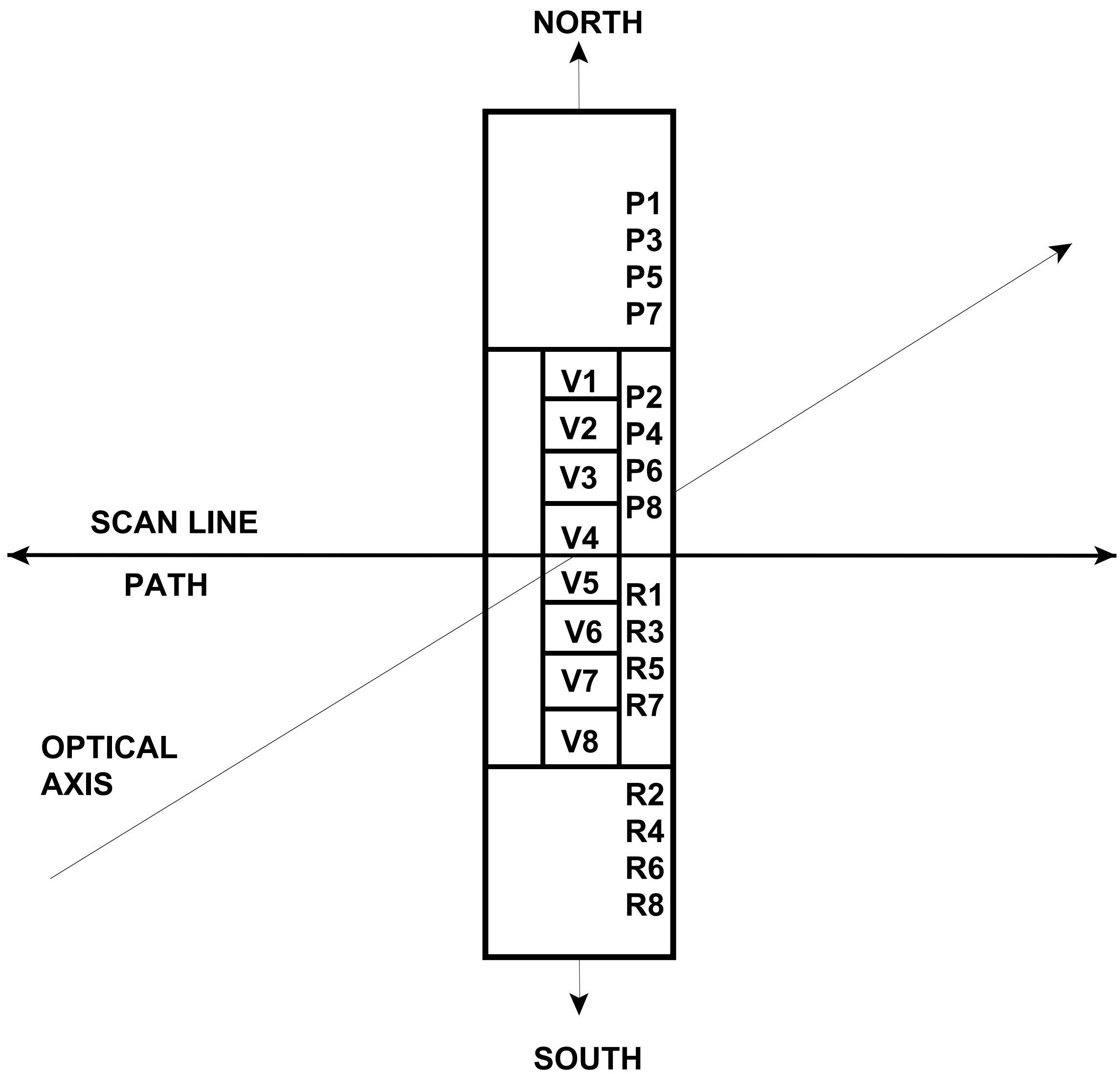


Figure 3-3b. Imager Detector Optical Configuration (GOES O and Beyond)

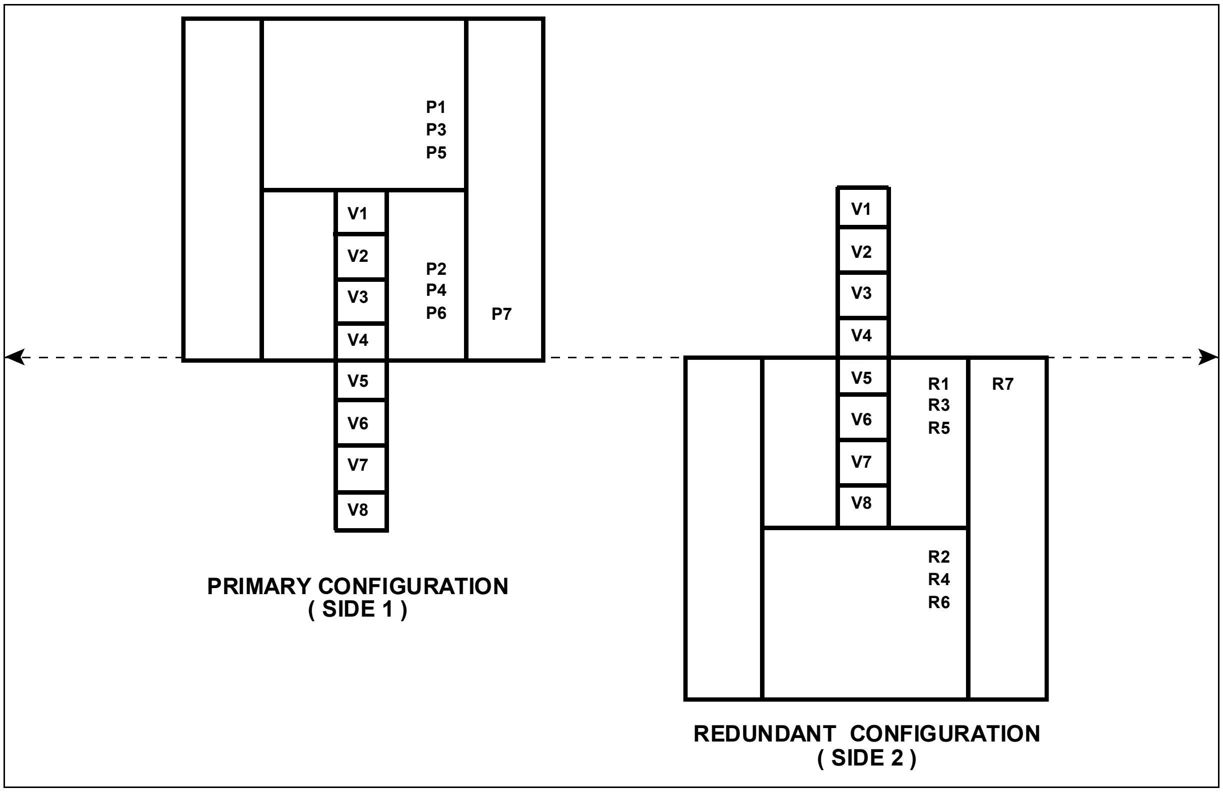
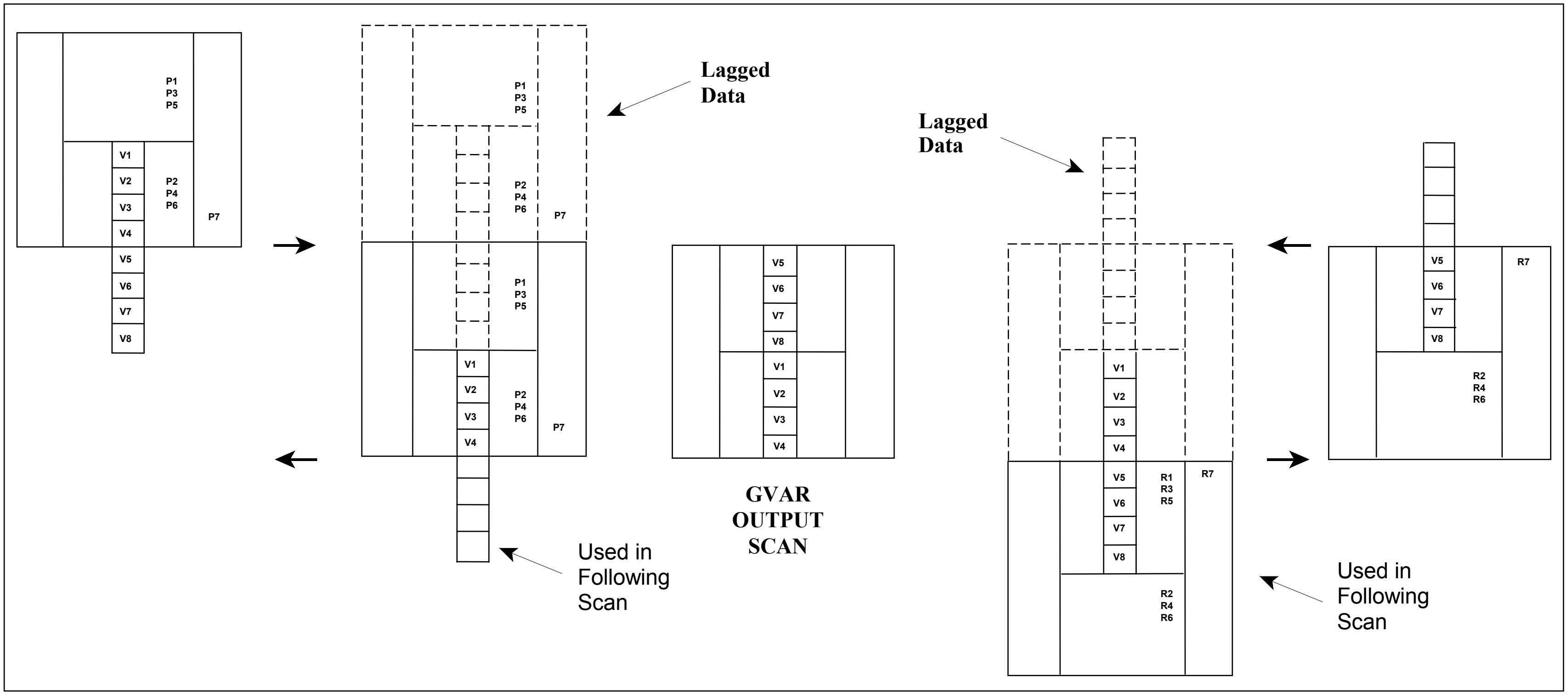


Figure 3-4. Imager Detector Operation Configuration

Figure 3-4 is for **GOES I-N**. For **GOES O-P**, the detector fields of view are changed as shown in Figure 3-3b.



Note: The relationship between detector configurations, input scans, and output scans is illustrated using two successive input scans. Lagged data from the first scan, solid then dotted, is combined with visible data, solid, from the second scan to construct a complete output scan output in GVAR Blocks 1 – 10.

Figure 3-5. Imager Scan Line Generation

Figure 3-5 is for **GOES I-N**. For **GOES O-P**, the detector fields of view are changed as shown in Figure 3-3b.

The above discussion of Imager output scan formation assumes the optical configuration of the IR and visible detectors is invariant. This assumption is a simplification. Actually, the IR detector arrays move about the optical axis as the plate upon which they are mounted flexes due to distortions caused by thermal gradients within the instrument Sun shield. These gradients vary over the course of a day and seasonally.

The magnitude of the IR detector array motion has been characterized in terms of visible detector offsets as follows:

a. N-S offset: –8 to +8 lines
b. E-W offset: –64 to +64 pixels

To ensure co-registration of the IR and visible data, the GVAR scan formation process is dynamically adjusted to compensate for the offsets. Compensations for the N-S offsets are made by adjustments to the recombination algorithm, increasing or decreasing the lagging applied to the visible detector data. Compensations for the E-W offsets are performed by clipping visible data lying outside the IR imagery and filling in missing visible data.

3.2.2 Sounder

Unlike the Imager, all of the Sounder's detectors are concurrently active during operations. The Sounder's detectors are split into a radiometric sounding group and a star sense detection group. The physical and optical layout of the 24 Sounder detectors is depicted in Figure 3-6. The four radiometric detector arrays (4 detectors/array) are physically disjoint but optically coincident and aligned. Three of these arrays work in conjunction with a rotating filter wheel assembly to provide radiometric coverage over 18 distinct IR spectral bands, and the fourth detector array is a visible array. The 19 channels, spectral bands, covered by the Sounder's four radiometric arrays are shown in Table 3-2. The star sense detection array contains eight detectors, physically similar to the Imager's visible detector array.

Sounder detector data is transmitted in GVAR within a Block 11 format sequence following the end of a Sounder scan line, as tabulated in Figure 3-1. Unlike the Imager, no scan-to-scan data lagging is required for the Sounder. Specific details concerning the internals of the Sounder Scan Data Block 11 format and the associated Sounder scan patterns are provided in Section 3.3.7.3.

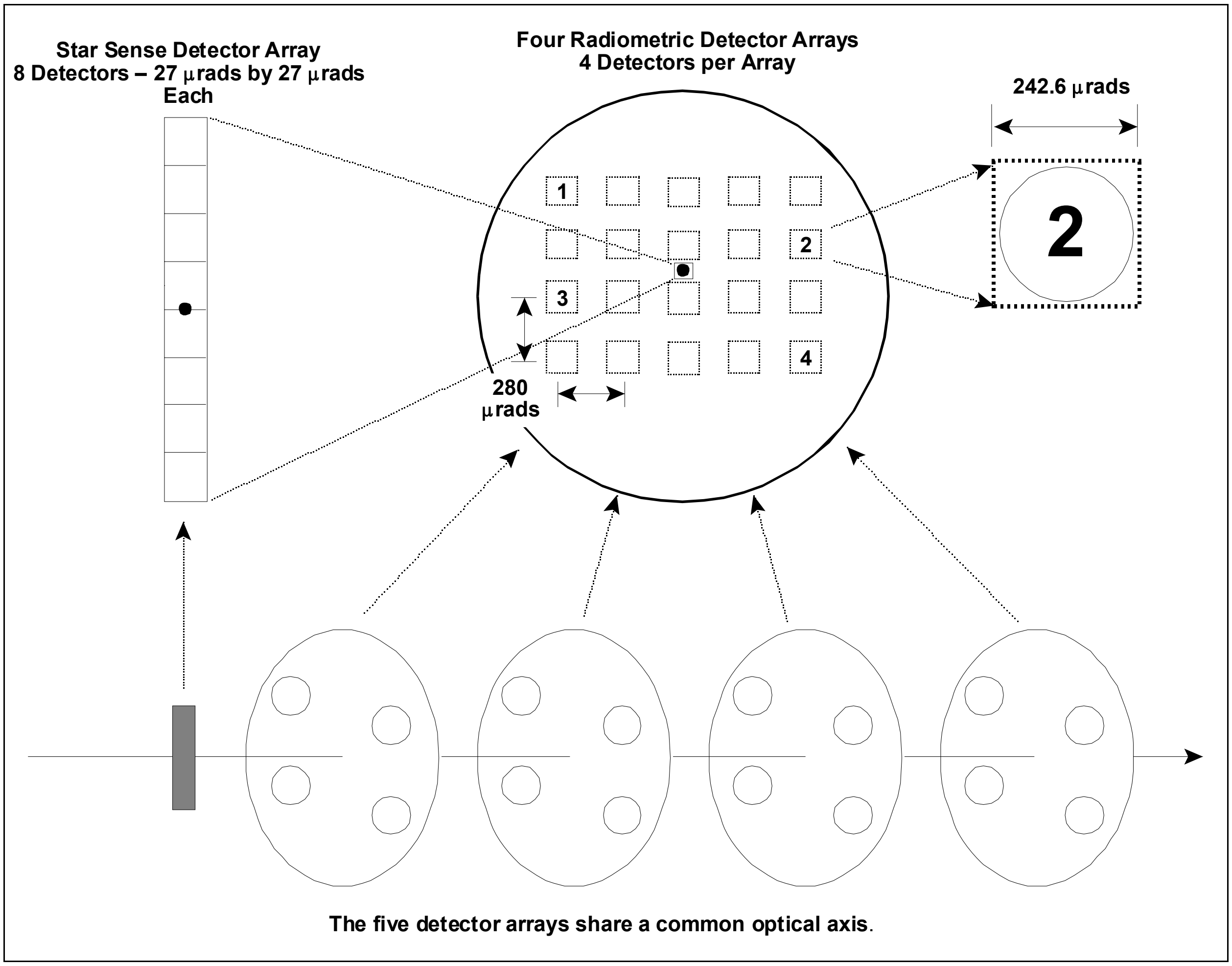


Figure 3-6. Sounder Physical and Optical Detector Configuration

Table 3-2. Sounder Radiometric Channels

Detector	Channel Number	Central Wavelength (microns)	IG Field of View (IGFOV) (µrad)	Purpose
Longwave	1 2 3 4 5 6 7	14.71 14.37 14.06 13.64 13.37 12.66 12.02	224	Temperature Sounding Temperature Sounding Temperature Sounding Temperature Sounding Temperature Sounding Temperature Sounding Surface Temperature
Midwave	8 9 10 11 12	11.03 9.71 7.43 7.02 6.51	224	Surface Temperature Total Ozone Water Vapor Sounding Sounding
Shortwave	13 14 15 16 17 18	4.57 4.52 4.45 4.13 3.98 3.74	224	Temperature Sounding Temperature Sounding Temperature Sounding Temperature Sounding Surface Temperature Surface Temperature
Visible	19	.67	224	Cloud

3.2.3 Yaw-Flipped Spacecraft GVAR Generation

While the capability of operating the GOES I-M spacecraft in a yaw-flip position (a 180° rotation about the yaw axis) was never envisioned, it was necessitated by a solar array drive failure on the **GOES-K** spacecraft. This failure precluded operations in the forward drive direction. To permit proper tracking of the sun while the solar array is moving in the reverse direction, the spacecraft has to be in the yaw-flip position. A number of ground system changes were required to support yaw-flipped operations. By design the GOES N-P spacecraft will have the capability to rotate seasonally 180° about the yaw axis (yaw-flip) to attain lower IR detector patch temperatures and, thereby, improve IR channel radiometric performance.

Other than minor changes to algorithms detailed in the *Earth Location User's Guide*, yaw-flipped spacecraft imagery broadcast in GVAR remains in its nominal Earth orientation; that is, images start at the northernmost point on the Earth and scan in a southerly direction. To accomplish this, both the Imager and the Sounder scan from the bottom to the top of their Field of View (FOV). The SPS then reverses the order of the physical detectors in the instruments to maintain the N-S ordering and also reverses the E-W orientation to correct for that yaw-flip induced reversal.

3.2.3.1 Yaw-Flipped Imager

In the reversed (instrument bottom to top) scanning direction, the Imager's visible and IR detectors essentially swap physical positions relative to those in the normal, upright mode, so the Earth-oriented, northernmost imagery is processed first. Visible detector 8 is swapped with detector 1 and 7 with 2. This pattern continues for the remaining visible detectors. Likewise, IR detector 2 is swapped with detector 1 in channels 2, 4, and 5. The contents of the GVAR Block 1 – 2 sequences are as follows:

GOES I-L

Block 1:	Channel 4, IR Detector 2
	Channel 4, IR Detector 1
	Channel 5, IR Detector 2
	Channel 5, IR Detector 1
Block 2:	Channel 2, IR Detector 2
	Channel 2, IR Detector 1
	Channel 3, IR Detector 1

GOES M-N

Block 1:	Channel 2, IR Detector 2
	Channel 2, IR Detector 1
	Channel 3, IR Detector 2
	Channel 3, IR Detector 1
Block 2:	Channel 4, IR Detector 2
	Channel 4, IR Detector 1
	Channel 6, IR Detector 1

GOES-O and Beyond

Block 1:	Channel 2, IR Detector 2
	Channel 2, IR Detector 1
	Channel 3, IR Detector 2
	Channel 3, IR Detector 1
Block 2:	Channel 4, IR Detector 2
	Channel 4, IR Detector 1
	Channel 6, IR Detector 2
	Channel 6, IR Detector 1

The contents of the GVAR Block 3-10 sequence are as follows:

Block 3:	Visible Detector 4
Block 4:	Visible Detector 3
Block 5:	Visible Detector 2
Block 6:	Visible Detector 1
Block 7:	Visible Detector 8
Block 8:	Visible Detector 7
Block 9:	Visible Detector 6

Block 10: Visible Detector 5

3.2.3.2 Yaw-Flipped Sounder

Detector swapping also takes place for the Sounder to process data from N-S. As shown in Figure 3-6, IR channels 1 – 18 and visible channel 19 have identical 4-detector layouts. Physical detector 4 is swapped with detector 1 and detector 3 with detector 2. The eight star sense detector array has the same layout as the Imager visible array, with detectors 1 – 4 on the top, north side of the optical axis and detectors 5 – 8 on the bottom side. These detectors are swapped in the same manner as the Imager visible detectors, detector 1 with 8 and 4 with 5. The star sense detector data is formatted in the same detector order as the Imager: 4, 3, 2, 1, 8, 7, 6, and 5.

3.2.4 Block Sequencing

The block sequence transmitted within the GVAR stream is actively varied by the priority and availability of each block type. The priority established for a given block type is based primarily on the associated input raw data rates and, to a lesser extent, is assigned to maintain sequential consistency with respect to the instrument functions. Since the Imager has a much higher input raw data rate, the Imager output is assigned a higher priority than the Sounder output. The Block 0 – 10 transmission is followed by a variable number of Block 11s, with Block 11s transmitted in the priority order indicated previously in Figure 3-1.

The Block 11 priority order is followed on a block-by-block output basis. For example, consider a case in which a Sounder Star Sense Statistics and Data Block 11 string comprising nine blocks is the only GVAR data ready for output. Transmission of the first of the nine Block 11s is initiated. While this block is transmitting, an Imager scan string (Blocks 0 – 10) becomes available. The next block transmitted is Block 0 followed by Blocks 1 – 10, in sequence. While the transmission of Block 10 is underway, the available list is again perused, and if no other higher priority blocks are available, the second of the 9-block Sounder star sense string is queued for output following the Block 10.

The established priorities do not, in themselves, explain the GVAR block sequencing that occurs for an active GOES satellite. Comprehending the GVAR block sequence requires an understanding of the general operation of each instrument.

As indicated previously, the Imager and Sounder operate independently of one another and can be commanded to scan variable size frames. While this would seemingly imply fairly random GVAR block sequencing, some aspects of the instruments' behavior follow a predictable pattern that determines the GVAR block sequence. The Imager performs spacelook calibrations at variable rates ranging from once per second to once every 36.6 seconds, depending on the commanded instrument mode. The spacelook calibrations are reported every two minutes in GVAR. The Imager performs Electronic Calibration (ECAL) and BB-Cal every 30 minutes, except when an image scan is in progress. When the scan is in progress, the calibrations are delayed until the end of the image frame. Star senses occur nominally every 30 minutes. These intervals vary somewhat depending on the scanning functions and star senses commanded from the ground. The SPS responds to data generated during these events by generating sequential, fixed sets of Block 11s. As the construction of each set is completed, the SPS places the set in the appropriate priority output queue. For example, the three sequential sets resulting from an Imager spacelook calibration and the four sequential sets from an Imager BB-Cal are, respectively, as follows:

a. One Telemetry Statistics Block 11,
b. Six Spacelook Statistics and Data Block 11s,
c. One Calibration Coefficients and Limits Block 11,

and

a. Two ECAL Statistics and Data Block 11s,
b. Two BB Statistics and Data Block 11s,
c. One Calibration Coefficients and Limits Block 11,
d. Two Visible NLUTs Block 11s.

The Sounder performs a spacelook calibration every two minutes, an ECAL and BB-Cal with every tenth spacelook, every 20 minutes, and a star sense every 30 minutes. As with the Imager, these intervals vary somewhat according to the Sounder commanded scanning functions; but, this variability is much less than for the Imager, because calibration sequences are permitted to interrupt a scan line at raw block boundaries. The GVAR Block 11 set, resulting from a star sense, consists of nine Star Sense Data and Statistics Block 11s. A Block 11 spacelook calibration set is comprised of the following:

a. One Telemetry Statistics Block 11,
b. Five Spacelook Statistics and Data Block 11s,
c. Two Calibration Coefficients and Limits Block 11s.

The Sounder performs an ECAL in conjunction with BB-Cal, with the corresponding GVAR Block 11 set comprised of the following:

3. Three ECAL Statistics and Data Block 11s,
4. Five BB Statistics and Data Block 11s,
5. Two Calibration Coefficients and Limits Block 11s,
6. Nine Visible NLUTs Block 11s.

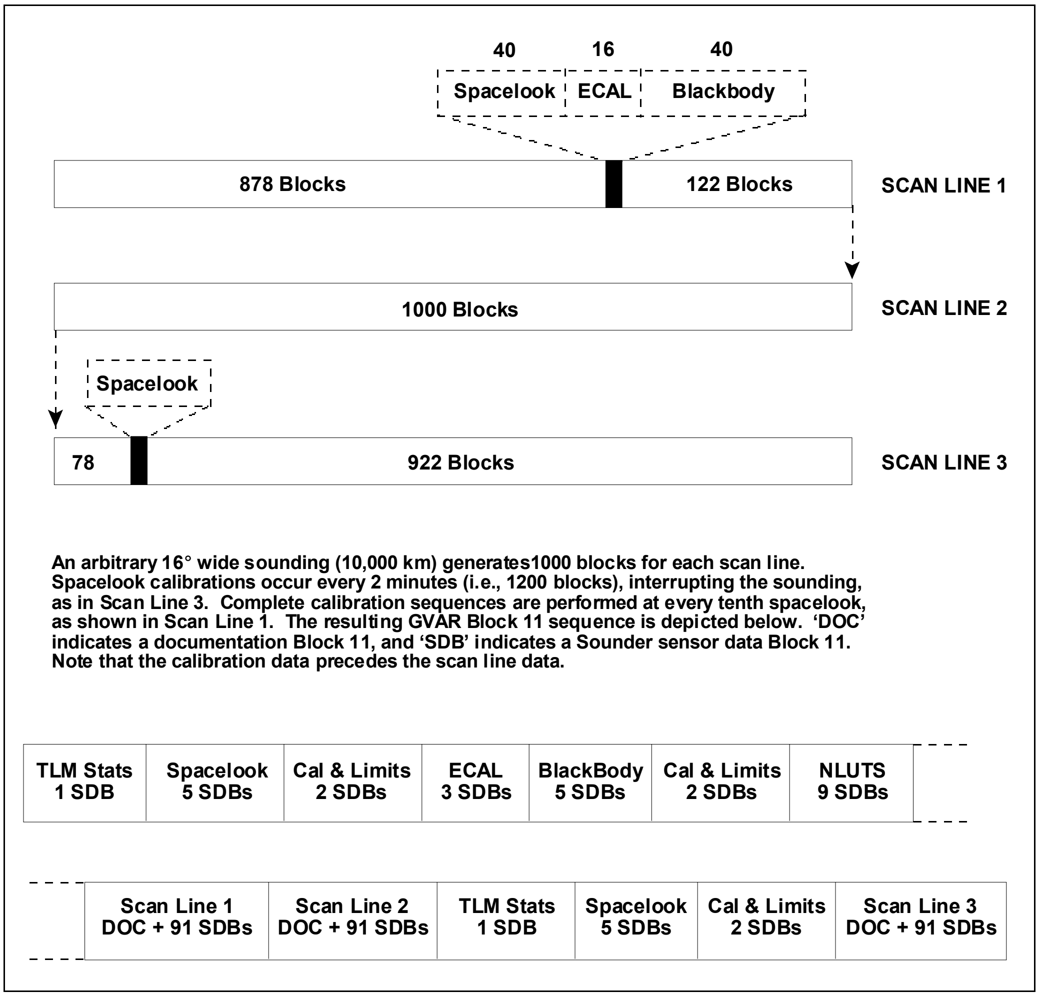
Figure 3-7 illustrates a typical Sounder scan sequence and the Block 11 output strings the SPS generates, with the effects of Imager and Sounder Compensation and Servo Error Data Block 11s ignored for clarity.

The following three points in conjunction with the sets mentioned impact the GVAR bandwidth usage:

a. Each set should occur at fairly regular intervals.
b. The sets are always generated in a particular sequence.
c. Each set is placed in the output queue as it is completed.

3.2.5 Bandwidth Considerations

The output bandwidth available for GVAR is 2,111,360 bps. All of the various GVAR block types must fit within this channel bandwidth without significant delays; otherwise, a data pileup occurs within the SPS, with a concomitant loss of data. The bandwidth requirements can be calculated for each of the instrument block types. For scan related data, the required bandwidth is a function of scan width (frame size). For non-scan data including calibrations, statistics, NLUTs, and star senses, the required bandwidths can be treated as a constant time-dependent overhead. The non-instrument data and messages can be characterized indirectly according to the bandwidth of the associated ingest channels.



Key to Acronyms	
DOC	documentation Block 11
SDB	Sounder sensor data Block 11
TLM	Telemetry

Figure 3-7. Typical Sounder Scan Scenario

Table 3-3 provides the equations describing the Imager bandwidth requirements, including the requirements directly related to instrument scan functions (Blocks 0 – 10 and compensation terms); and, the relatively scan-independent, Block 11 overheads. As previously mentioned, Imager Blocks 1 – 10 vary in length in direct proportion to image scan width, except for a lower limit of 32,208 bits. This block size includes Overhead (O/H) consisting of a 10,032-bit block synchronization code, a 720-bit block header, and a 16-bit block Cyclic Redundancy Check (CRC). The lower limit ensures a minimum block processing time of 15.25 msec at a GVAR receiver. This equates to a maximum block rate of 65.6 GVAR blocks per second and forces a Minimum Data Field Length (MDFL) of 21,440 bits per block; or, one third of the Block 0 and 11 fixed data field length of 64,320 bits. For Imager scan widths of less than approximately 1.9°, this requires GVAR block lengths greater than is warranted by the data contained. The excess space is zero filled. The effect of the MDFL imposition is to raise the bandwidth overhead for small Imager scans.

Table 3-4 provides equations for the Sounder bandwidth requirements. Since all of the Sounder data is transported through Block 11s, no direct MDFL requirement is involved. An MDFL requirement exists to the extent that the Blocks 11s employed are under-utilized when transporting the various data types.

The equations provided in Tables 3-3 and 3-4 ignore instrument dead times. During instrument dead times no data is produced for GVAR transmission. These dead times are generally associated with the slewing of the instrument scan mirror to or from a location where a function is performed; such as star senses, spacelooks, or BB-Cal. The Imager has additional dead times at the frame start and restart, after a spacelook, star sense, and priority interruption. During these times the Imager generates three invalid scans before generating a valid scan. As a result of these simplifications, the equations provide a conservative (slightly high) value of the bandwidth requirements.

It can be assumed that both the Imager and Sounder possess a bandwidth requirement component dependent on the associated frame scan width and a component that is nearly independent of the frame scan width. To assess the bandwidth utilized by GVAR transmissions, each instrument's requirements are computed over the full range of scan widths. The total bandwidth requirement for any combination of frame scan widths can then be computed.

Figure 3-8a provides the GVAR bandwidth utilization as a function of scan width angle derived using the equations provided in Tables 3-3 and 3-4. It denotes the percentage of the total GVAR bandwidth required as the scanning width is varied from 0.2° to 19.2° for the Imager and Sounder, as well as the total for both. The spare bandwidth is also shown. Figure 3-8b shows on a larger scale the spare GVAR bandwidth in units of Kbps and block11/sec as a function of scan width angle. Since the Imager and Sounder scan widths can be set independently, there are situations where the total bandwidth requirement could exceed the available 2,111,360 bps bandwidth. These regions, or exclusion zones, arise from the following primary sources of GVAR overhead:

a. 10,032-bit block synchronization code (13.4% of each Block 11)
b. 21,440-bit MDFL requirement imposed on small GVAR Blocks 1 – 10
c. Sounder documentation Block 11 prefixing each Sounder scan line output

Table 3-3. Imager GVAR Bandwidth Requirements

General Bandwidth Requirements	Range of Values
MDFL = Minimum Data Field Length (bits)	21,440
ISWD = Imager Scan Width (degrees)	0.2° to 19.2°
IRB = Imager Raw Data (raw blocks)	ISWD (17453.29252 / 64)
IST = Imager Scan Time (seconds)	0.2 + ISWD / 20.02
BOH = Block Overhead (bits)	10,768
NPIR = Number of Primary IR detectors	7 for **GOES I-N** 8 for **GOES-O** and beyond
Imager Block 0 – 10 Bandwidth Requirements:	
If ISWD = 0, then B0 = B1 = B2 = B3 = 0; otherwise	
B0 = Block 0 data length (bits)	64,320
B1 = Block 1 data length (bits)	MDFL if MDFL > 4*(160 + 10 IRB)
	else 4*(160+10 IRB)
B2 = Block 2 data length (bits)	MDFL if MDFL >(NPIR-4) (160 + 10 IRB)
	else (NPIR-4) (160+10 IRB)
B3 = Block 3 data length (bits)	MDFL if MDFL > (160 + 40 IRB)
	else (160 + 40 IRB)
ISCAN = Total B0. B10 length (bits)	B0 + B1 + B2 + 8B3 + (11 BOH)
ISTT = GVAR Tx time (seconds)	ISCAN / 2111360
ISTSN = Spare time/scan (seconds)	IST- ISTT
ISTSC = Spare time/second (seconds)	ISTSN / IST
Imager Block 11 Bandwidth Requirements – in Units of Block 11s per second	
ICSE = Imager Compensation and Servo Errors	1 / 4.3
ITLM = Imager Telemetry Statistics	1 / 120
ISPC = Imager Spacelook Statistics and Data	6 / 120 **GOES I-N** 7/ 120 **GOES-O** and Beyond
IECL = Imager ECAL Statistics and Data	2 / 600 **GOES I-N** 3 / 600 **GOES-O** and Beyond
IBBC = Imager BB Statistics and Data	2 / 600 **GOES I-N** 3 / 600 **GOES-O** and Beyond
ICAL = Imager Cal Coefficients and Limits	1 / 120 + 1 / 600
INUT = Visible NLUTs	2 / 600
ISTR = Star Sense Statistics and Data	9 / 1800
IB11OH = Imager Block 11 Overhead = SUM (ICSE · · ISTR) = 0.31589 **GOES I-L** = 0.31867 GOES –M = 0.33034 **GOES-O** and Beyond	

Table 3-3. Imager GVAR Bandwidth Requirements

General Bandwidth Requirements	Range of Values

Notes:

17453.29252	–	the number of μrads/degree
64	–	the number of μrads/raw data block
0.2	–	the instrument scan reversal time
20.02	–	the instrument scan rate in degrees/second.
BOH	–	the block synch + header + CRC (10,032 + 720 + 16)
SUM	–	a function summing all included components

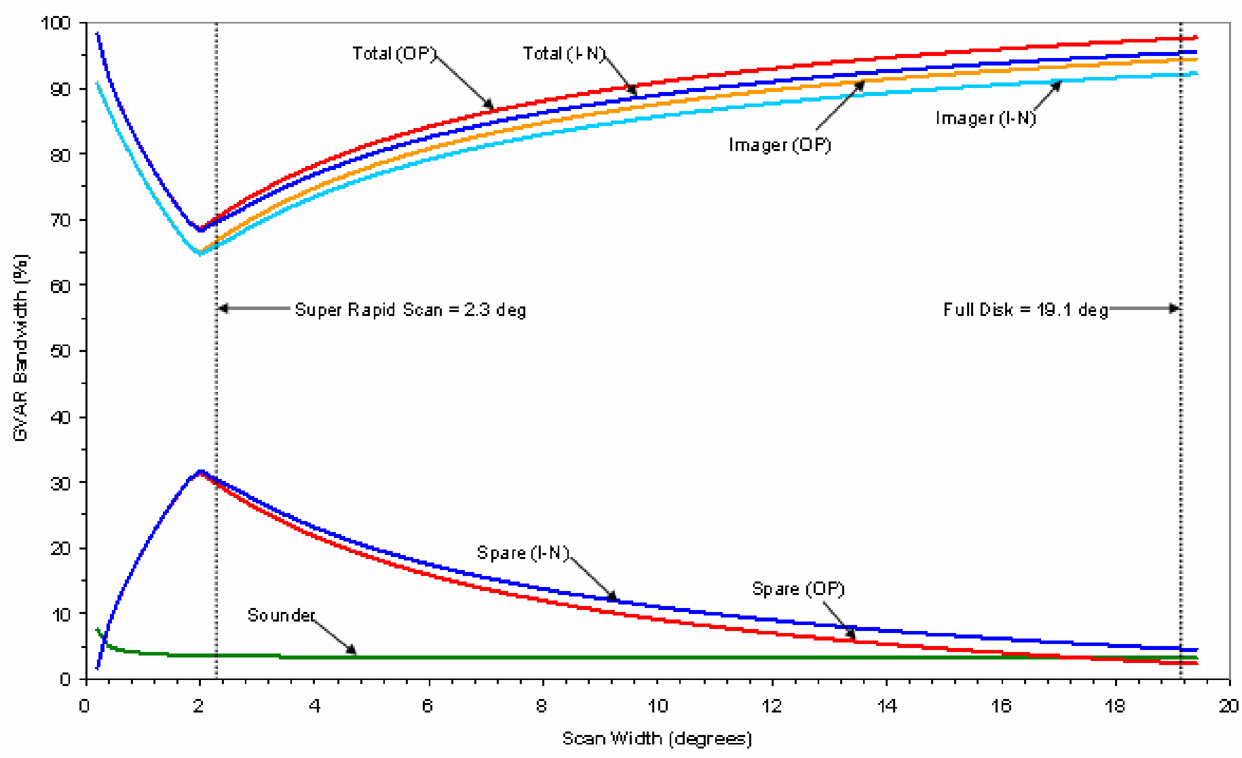
In **GOES-M** and beyond, a new block 11 (Imager Factory Coefficients Block 11) is added. It is transmitted at low priority when no scans are active, and is guaranteed to simply replace a fill block and have no bandwidth impact.

Table 3-4. Sounder GVAR Bandwidth Requirements

General Bandwidth Requirements	Range of Values
SSWD = Sounder Scan Width (degrees)	0.2° to 19.2°
SRB = Sounder Raw Data (blocks)	SSWD (17453.29252 / 280)
SST = Sounder Scan Time (seconds)	0.1 (SRB + 1)
Sounder Block 11 Bandwidth Requirements – in Units of Block 11s per second	
SSCAN = Sounder Documentation/Scan	(1 + RND(0.4091 + SRB / 11)) / SST
SCSE = Sounder Compensation/Servo Errors	1 / 6.4
STLM = Sounder Telemetry Statistics	1 / 120
SSPC = Sounder Spacelook Statistics/Data	5 / 120
SECL = Sounder ECAL Statistics/Data	3 / 1200
SBBC = Sounder BB Statistics/Data	5 / 1200
SCAL = Sounder Cal Coefficients/Limits	2 / 120 + 2 / 1200
SNUT = Sounder Visible NLUTs	9 / 1200
SSTR = Sounder Star Statistics/Data	9 / 1800
SBOH = Sounder Block 11 Overhead	SUM (SSCAN : SSTR)
GVAR Bandwidth Requirements - in bps	
Imager = IBW	(1 - ISTSC) * 2111360 + 75088 IB11OH
Sounder = SBW	75088 SBOH
Spare	2111360 - IBW - SBW

Notes:

17453.29252	–	number of μrads/degree
280	–	number of μrads/raw data block
0.1	–	instrument raw data block time
RND	–	a function rounding to nearest integer
0.4091	–	a factor to force a rounding up if there is one extra raw block
SUM	–	a function summing all included components
2,111,360	–	the available GVAR output rate in bps
75,088	–	the total length of any Block 11 (64,320 + BOH)



Note: Total = Imager + Sounder

Figure 3-8a. GVAR Bandwidth Utilization (GOES I-P)

Of the three sources of overhead, the most negative effects are found at small scan widths where the overheads outweigh the instrument data being transported. For the Imager, the synchronization code and the MDFL represent over 90% of the bandwidth requirement for a 0.2° scan width. A similar scan width for the Sounder yields 57% of the bandwidth requirement being allocated for non-instrument data. As the instrument scan widths are increased, the percentage of the GVAR output bandwidth allocated to overhead declines, approaching 5% for the Imager visible data and 13.4% for Sounder scan data.

In addition to the instrument data, the GVAR stream must also provide transport for text messages, from the SPS operator and GIMTACS. The text messages are low rate in the sense that the ingest channel available for their reception at the SPS is narrow, only 9600 bps. Additionally, their expected frequency of occurrence is very small. To provide room for each of these three sources within the GVAR stream, an allocation of one Block 11 per second should be conservatively safe.

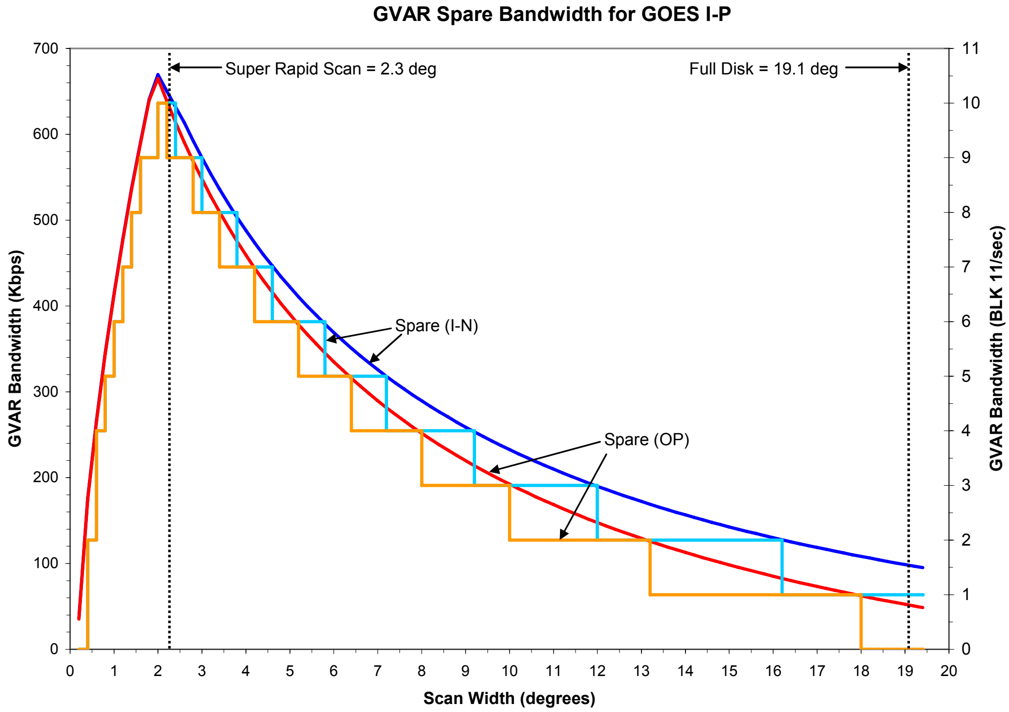


Figure 3-8b. GVAR Spare Bandwidth (GOES I-P)

With this in mind, adequate bandwidth exists to support all functions for both instruments as well as the text data if the following scan width constraints are followed:

Imager: No constraints if Sounder is inactive, not scanning. If the Sounder is active, Imager scan widths should be greater than 0.3°.

Sounder: No constraints if the Imager is inactive. If the Imager is active with a scan width of less than 14.4°, the Sounder scan widths need to be greater than 0.3°. If the Imager scan widths are greater than 14.4°, the Sounder scan widths need to be greater than 0.6°.

It should be realized that these constraints can be relaxed up to the exclusionary zone boundaries without loss of any instrument data. The only penalty invoked by doing so is the amount of time required to complete the transmission of any text that may be ready for GVAR output.

3.2.6 Transmission Delays

The GVAR formatted data is received by a user after some variable time delay from the point at which the data was actually measured by the onboard instruments. There are two primary components in the delay time, transit time and SPS processing time.

Delays caused by signal transit times are in the range from 0.5 to 1.0 seconds and include the following three stages:

a. Satellite-to-SPS: raw data
b. SPS-to-Satellite: GVAR transmission
c. Satellite-to-user: GVAR transmission

The largest time delay component occurs in the SPS processing that transforms the raw data into GVAR formatted data. The Imager data contained within Blocks 1 – 10 is calibrated and data ordered in a W-E sequence. Calibration is performed on the data after it is received within the SPS, and a drift bias measurement has been acquired. The SPS buffers all Imager scan data until it computes the drift bias measurement. The time required to obtain the drift bias measurement varies as a function of the current frame type and can range from approximately 1 – 37 seconds. After IR calibration has been performed, the transmission of Blocks 0 – 10 is enabled.

The SPS performs a similar buffering process on the Sounder data, primarily to permit W-E ordering. Sounder data calibration is performed after all of the raw data for a scan has been received. The calibration procedure generates 76 arrays, one array for each Sounder Channel-Detector (CDET), of calibrated pixel information. These arrays, along with the original raw Sounder data blocks, are then sectioned and packaged into the Sounder Scan Data Block 11 format. A full-width, 19.2°, single-dwell Sounder scan requires 110 Block 11s for complete transmission. The buffering process for an uninterrupted Sounder scan of the above type can extend to as long as 120 seconds. The subsequent calibration and Block 11 sectioning would take between 10 and 15 seconds to perform. Finally, transmission of the 110 Block 11s could take anywhere from 3.9 – 52.9 seconds, depending on the current GVAR output requirements.

3.2.7 Encoding

Prior to bi-phase modulation and uplink of the GVAR stream, the GVAR data undergoes three stages of encoding, as described below and illustrated in Figure 3-9:

a. All even numbered 8-bit bytes, regardless of word length, are complemented; the first byte following initial synchronization being byte number one.

b. Pseudo-random Noise (PN) coding with a PN sequence generated by a shift register whose input is the output of an eXclusive-OR (XOR) gate as shown in Figure 3-9. Bits 8 and 15, the Most Significant Bits (MSBs) of the shift register, are the inputs to this gate. The output of the gate is combined with a data line using a second XOR gate.

c. The PN-coded data stream is passed through an NRZ-S differential encoding process, producing a transition for each logic zero input and none otherwise.

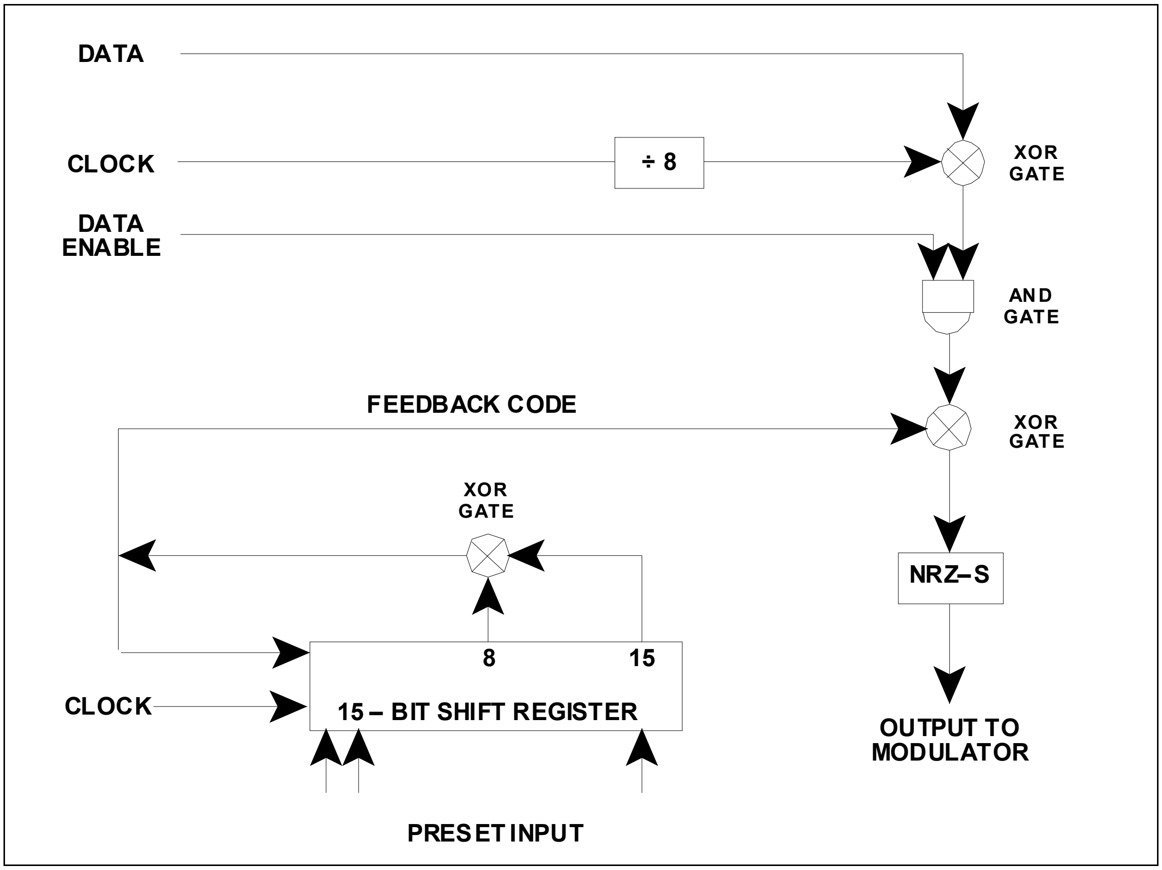


Figure 3-9. GVAR Block Synchronization Preamble Encoding

3.3 Block Format

Each GVAR block contains the following, primary fields:

a. Block Synchronization Code
b. Header
c. Data Section
d. Cyclic Redundancy Check.

Fields one, two, and four are fixed in size and have an internal structure identical for all GVAR blocks. Field three, the Data Section, has an internal substructure dependent on the block type. GVAR Blocks 1 – 10 have data sections with constant internal structures, but whose sizes vary as a function of the Imager's scan line length. Blocks 0 and 11 have fixed, equal-length data sections. Block 0 maintains an unchanging structure, and Block 11 has a number of different internal structures defined according to the usage of the block.

The following sections describe the four primary fields with the data field presented last because the definitions constitute the bulk of the document.

3.3.1 Block Synchronization Code

Each GVAR block is prefaced with a 10,032-bit code for synchronizing the receive equipment. The code is a PN sequence generated as described in Section 3.2.7 and shown in Figure 3-9. The shift register is preset to 51,665 octal.

3.3.2 Block Header

The GVAR header has been defined to maintain compatibility with the AAA format header. It consists of 30 eight-bit words, three copies of which are transmitted in each header field to increase the chances of error-free recovery. An error check field completes each header. Figure 3-10 depicts the header organization, and Table 3-5 describes the header contents.

Two additional fields are defined in words in the GVAR header that are unused in the AAA format. The *range* word was added to support satellite ranging functions. It contains information which is only useful to the OGE. A GVAR block sequence counter has been added to permit a receiver to determine the number of GVAR blocks which have been transmitted. The GVAR variability in block sequence and length prevents usage of a timed counter as was permitted by AAA.

```
WORD
     |----------------------------------------------|
 1   |             BLOCK IDENTIFICATION             |
     |----------------------------------------------|
 2   |                  WORD SIZE                   |
     |----------------------------------------------|
 3   |                                              |
     |                                              |
 4   |                  WORD COUNT                  |
     |----------------------------------------------|
 5   |                                              |
     |                                              |
 6   |            PRODUCT IDENTIFICATION            |
     |----------------------------------------------|
 7   |                 REPEAT FLAG                  |
     |----------------------------------------------|
 8   |                VERSION NUMBER                |
     |----------------------------------------------|
 9   |               DATA VALID FLAG                |
     |----------------------------------------------|
10   |             ASCII / BINARY FLAG              |
     |----------------------------------------------|
11   |                    SPS ID                    |
     |----------------------------------------------|
12   |                  RANGE WORD                  |
     |----------------------------------------------|
13   |             VALID BLOCK SEQUENCE             |
     |                                              |
14   |                   COUNTER                    |
     |----------------------------------------------|
15   |                   SPARES                     |
     |                                              |
16   |                                              |
     |----------------------------------------------|
17   |               CURRENT SPS TIME               |
 .   |             (CDA BCD TIME CODE)              |
 .   |                                              |
 .   |                                              |
24   |----------------------------------------------|
25   |                   SPARES                     |
 .   |                                              |
28   |                                              |
     |----------------------------------------------|
29   |                 ERROR CHECK                  |
     |                    FIELD                     |
     |                                              |
30   |----------------------------------------------|
```

Figure 3-10. Header Organization

Table 3.5 Header Content

Word	Contents	Description
1	Block ID	An 8-bit binary number used to identify a GVAR block as follows: 240 = GVAR Block 0 1 = GVAR Block 1 2 = GVAR Block 2 3 = GVAR Block 3 4 = GVAR Block 4 5 = GVAR Block 5 6 = GVAR Block 6 7 = GVAR Block 7 8 = GVAR Block 8 9 = GVAR Block 9 10 = GVAR Block 10 11 = GVAR Block 11 15 = Equipment Idle Block*
2	Word Size	An 8-bit binary number giving the word bit length of the subsequent information field as follows: 6 = 6-bit word size 8 = 8-bit word size 10 = 10-bit word size
3-4	Word Count	A 16-bit binary number giving the number of words contained in the subsequent information field plus two. The extra two represents the two 8-bit words containing the block CRC.
5-6	Product ID	A 16-bit binary number used to identify information field data. Numbers used are as follows: 0 = No Data 1 = AAA IR Data 2 = AAA Visible Data 3 = GVAR Imager Documentation 4 = GVAR Imager IR Data 5 = GVAR Imager Visible Data 6 = GVAR Sounder Documentation 7 = GVAR Sounder Scan Data 8 = GVAR Compensation Data 9 = GVAR Telemetry Statistics 10 = Not Used (was GVAR AUX Text) 11 = GIMTACS Text 12 = SPS Text 13 = AAA Sounding Products 14 = GVAR ECAL Data 15 = GVAR Spacelook Data 16 = GVAR BB Data 17 = GVAR Calibration Coefficients 18 = GVAR Visible NLUTs 19 = GVAR Star Sense Data 20 = Imager Factory Coefficients 21–1000 = Unassigned
Note: * The Equipment Idle Block (EIB - Block 15) is generated automatically by the GVAR transmission hardware when no other block definitions are present. The EIB is 32,208 bits in length and includes 21,440 zero data bits.		
7	Repeat Flag	An 8-bit flag that indicates whether the data being transmitted is new data or a repeat of data previously transmitted: 0 = Data Repeat 1 = New Data

Word	Contents	Description
8	Version Number	An 8-bit binary number that indicates GVAR version. See Section 3.1.1 for explanation: 0 = GOES I through L original specification 1 = GOES I thru L MBCC information added 2 = GOES M-N 3 = GOES O-P
9	Data Valid	The following 8-bit flag which indicates whether the transmitted data is usable or only filler: 0 = Filler Data 1 = Valid Data
10	ASCII/Binary	The following 8-bit flag that indicates the format of the data in the data field to be either ASCII or binary: 0 = Binary Data 1 = ASCII Data
11	SPS ID	A binary number identifying the source SPS, which formats the GVAR stream. Values 1 to 9 denote SPS1 to SPS9, respectively.
12	Range Word	An 8-bit word used for ranging functions. The first 4 bits are a binary number identifying the data source spacecraft. The last four digits are always zero except when a ranging function is in progress; then, they are set to ones according to the type of ranging function. The first 4 bits have a value as follows: 8 = GOES-I 9 = GOES-J 10 = GOES-K 11 = GOES-L 12 = GOES-M 13 = GOES-N 14 = GOES-O 15 = GOES-P The last 4 bits have the following possible hexadecimal values: 0 = Not a measurement block 7 = Satellite ranging measurement block F = Ground path delay measurement block
13-14	Block Count	A 16-bit continuous count of GVAR blocks transmitted. Values range from 0 to 65,535, inclusive, rolling over to 0 following 65,535. Count is incremented by 1 for each successive GVAR block transmitted. Count does not increment for Equipment Idle Blocks.
15-16	None	Spares–not used
17-24	SPS Time	A 64-bit BCD time code applied at CDA at transmission time.
25–28	None	Spares–not used
29–30	Error Check	A 16-bit error checking field used to validate transmission accuracy of the header information. This is derived in the same way as the information field error check, CRC. See Section 3.3.3.

3.3.3 Block Cyclic Redundancy Check

The error detection method employed in the GVAR transmission involves a CRC. The process is an algebraic procedure based on modulo-2 division using a polynomial to generate and check the FCS. At the transmitter, the initial remainder of the division is preset to 16 ones. After the all-ones preset, the initial remainder is then modified by division of the generator polynomial. This division is performed on the contents of the field being checked. Upon completion of the division process, the ones complement of the resulting remainder is transmitted as the 16-bit FCS.

The generator polynomial is then specified by International Telegraph and Telephone Consultative Committee (CCITT) Recommendation V41 and is as follows:

$$x^{16} + x^{12} + x^5 + 1$$

3.3.4 Block 0 Data Section

The GVAR Block 0 information field is 64,320 bits in length. It consists of 8040 8-bit words divided into the following partitions:

Words	Description
1–278	Instrument and Scan Status
279–1626	Instrument Orbit and Attitude (O&A) Data
1627–2306	Scan Reference Data
2307–5386	Grid Data
5387–6304	Scan Reference and Calibration Data
6305–8040	Factory Parameters/8th IR detector Calibration Data

GVAR versions 1 through 2 include Factory Parameters in Words 6305-8040, but in version 3 (**GOES-O**), the words contain Calibration Data for the eighth IR detector. The layout and definition of these six partitions is provided in Table 3-6a-c. Supporting commentary is provided in the following subsections.

3.3.4.1 Instrument and Scan Status

This partition summarizes the state of the Imager and the current imaging frame. Time tags denoting significant events and identifying various process entities are provided. Additionally, coordinate information locating points are included for the various reference frames.

The flag bits in words 3 – 6 provide the primary status for the accompanying Block 1 – 10 data. They denote the presence of normal or priority frame data and provide frame-start/frame-end indicators. They are also used to denote whether or not a data loss condition has been detected. The detector relevant flags in bits 14 – 31 are controlled by the OGE operators. They indicate the type of processing performed by the SPS on the raw detector data, such as whether or not visible normalization and IR calibration have been performed. The side 1 or side 2 flag denotes which set of IR detectors the SPS currently considers to be active; and, also indicates the output scan formation approach and database coefficients for conversions. The condition of the imaging detector data, valid or substituted, is also indicated by these flags.

3.3.4.2 Instrument O&A Data

This partition contains the parameters and coefficients currently in use which describe the Imager O&A data. The data in this section is acquired from the OATS. How the data is used depends upon the status of the IMC function. If IMC is active, the O&A data is valid for a fixed period called the registration interval. If IMC is not active, the O&A values only apply to a single point in time. Under these conditions, the O&A information must be translated through time to the desired calculation point.

3.3.4.3 Scan Reference Data

This partition provides co-registration table identity and the E-W co-registration offset terms currently available to the SPS. The N-S offsets are contained in the fifth partition, words 6235 – 6282. The co-registration index, word 1679, denotes which of the 48 offsets is currently in use. If this word is zero, co-registration functions are disabled.

Also contained in this partition are copies of the current and latest lagged raw header and trailer data associated with the output scan contained in GVAR Blocks 1 – 10. The raw contents of the most recent telemetry data blocks are also provided, including copies of the four command registers. The oldest lagged header and trailer data blocks are included in the fifth partition.

3.3.4.4 Grid Data

The grid data partition provides up to 1024 grid points. A grid point in this context refers to a particular feature of the Earth’s surface whose geographic latitude and longitude coordinates are known. If an Imager swath intersects this feature, the particular pixel having the same geographic coordinates is recorded as a grid point. All grid point intersections are associated with the Imager visible data contained in GVAR Blocks 3 – 10.

The gridding partition contains two sets of two arrays, each set recording up to 512 intersections associated with a particular grid point database. The two arrays, comprising a set, are parallel in that the i^{th} entry in one denotes the intersecting detector, while the i^{th} entry in the other denotes which pixel for that detector actually intersected the feature.

3.3.4.5 Scan Reference and Calibration Data

This partition starts with the oldest lagged header and trailer data blocks associated with the current output scan. It ends with the N-S co-registration offset array. In between are the IR calibration data sets associated with the output scan.

Each Imager output scan in the GVAR data stream has a specific set of calibration terms assigned to the IR data. These terms (bias, first- and second-order gains, and bias rates) are provided in this partition. Included with the terms are the statistics for the clamped and drift bias measurements from which the bias rates were computed, and interpolated western edge bias terms.

3.3.4.6 Factory Parameters

Through **GOES-N**, this partition provides factory measured calibration coefficients for each of the 22 imaging detectors along with the misalignments of the detectors with respect to the instruments optical axis. The coefficients required to convert raw telemetry counts to engineering units are provided for those points employed during formation of GVAR data. Starting with **GOES-M**, this data also appears in a separate Block 11. Starting with **GOES-O**, the Factory Parameters are replaced in Block 0 with calibration data for an additional IR imager.

3.3.5 Blocks 1 and 2 – Imager IR Data

Imager data from the active IR detectors is carried in the information fields of GVAR Blocks 1 and 2. Data for each of the detectors is packaged using the same two-partition record format. The first partition provides line documentation information. The second partition contains the detector data.

The grouping of the detector data records within each block is illustrated in Figure 3-11 along with a depiction of the record layout. Also indicated in the figure is the number (1-7) used by the SPS for each detector in the normal and yaw-flipped modes.

Table 3-6a. Imager Documentation Block 0 (Words 0-6304) Format Definition

Word	Name	Description
1	SPCID	Spacecraft ID - a binary number identifying the source satellite as follows: 8 = GOES-I 9 = GOES-J 10 = GOES-K 11 = GOES-L 12 = GOES-M 13 = GOES-N 14 = GOES-O 15 = GOES-P
2	SPSID	SPS Identity: a binary number identifying the source SPS which formatted the GVAR data stream. Values 1–9 are assigned to SPS1–SPS9, respectively.
3–6	ISCAN	Imager Scan status is provided in four words (32 bits); bit 0 is the Most Significant Bit (MSB) of word 3, and bit 31 is the Least Significant Bit (LSB) of word 6. For each status bit that does not have a bit value of 0 listed below, a value of 0 represents a condition that is the opposite, or negative of the condition associated with a bit value of 1. For example, if bit 0 has a value of 1, a frame start occurred on this scan; if bit 0 has a value of 0, no frame start occurred on this scan. **Bit** **Value** **Condition** 0 = 1 if frame start 1 = 1 if frame end 2 = 1 if frame break - line(s) lost 3 = 1 if pixel(s) lost 4 = 1 if priority 1 frame data 5 = 1 if priority 2 frame data 6 = 0 if west-to-east scan = 1 if east-to-west scan 7 = 0 if north-to-south frame = 1 if south-to-north frame 8 = 1 if IMC active 9 = 1 if lost header block 10 = 1 if lost trailer block 11 = 1 if lost telemetry data 12 = 1 if (star sense) time break 13 = 0 if side 1 (primary) active = 1 if side 2 (secondary) active 14 = 1 if visible normalization active 15 = 1 if IR calibration active 16 = 1 if yaw flip processing enabled 17–23 = Correspond to active IR detectors 1–7. A set bit indicates the associated detector data is invalid. 24–31 = Correspond to visible detectors 1–8. A set bit indicates the associated detector data is invalid. (GOES O-P, 8th IR det @ wd#6305)
7-22	IDSUB	A 16-entry detector substitution matrix. The first entry denotes the number of substitutions in effect (ranges 0 = none to 15 = all for GOES I-N and 16 = all for GOES O-P). The last 15 entries are sequentially assigned to detectors IR1 – IR7, V1 – V8). A non-zero value indicates the associated detector data in Blocks 1 – 10 is substituted data acquired from the detector whose number is entered. GOES O-P, 8th IR det @ wd#6306.
Words 23 – 150 provide CDA time tags for 16 specific events. Each time tag is eight words in length, formatted as follows:		
Word	**Bits**	**BCD Formatted Contents**

1	0-3 4-7	Year in 1000s Year in 100s
2	0-3 4-7	Year in 10s Year in 1s
3	0-3 4-7	Day of Year (DOY) in 100s, bit 0 = 1 indicates the time code generator is flywheeling DOY in 10s
4	0-3 4-7	DOY in 1s Hours in 10s
5	0-3 4-7	Hours in 1s Minutes in 10s
6	0-3 4-7	Minutes in 1s Seconds in 10s
7	0-3 4-7	Seconds in 1s Msec in 100s
8	0-3 4-7	Msec in 10s Msec in 1s
23-30	TCURR	Current SPS time
31-38	TCHED	Time of current header block
39-46	TCTRL	Time of current trailer block
47-54	TLHED	Time of lagged header block
55-62	TLTRL	Time of lagged trailer block
63-70	TIPFS	Time of priority frame start
71-78	TINFS	Time of normal frame start
79-86	TISPC	Time of last spacelook calibration
87-94	TIECL	Time of last ECAL
95-102	TIBBC	Time of last BB-Cal
103-110	TISTR	Time of last star sense
111-118	TIRAN	Time of last ranging measurement
119-126	TIIRT	Time tag of current IR calibration set
127-134	TIVIT	Time tag of current visible NLUT set
135-142	TCLMT	Time tag of current Limits sets
143-150	TIONA	Time tag current O&A set implemented
The following 128 words provide information associated with the Imager's reference frames and the current imaging frame:		
151-152	RISCT	Relative output scan sequence count since frame start. Ranges 1-1974.
153-154	AISCT	Absolute number of the current output scan. Values of 1-1974 correspond to output scans (northernmost to southernmost).
155-156	INSLN	The number of the northernmost visible detector scan line in the current scan. Inclusive values of 1 to 15,780 correspond to detector lines (northernmost to southernmost).
157-158	IWFPX	The number of the westernmost visible pixel in the current frame. Inclusive values of 1 to 30,677 correspond to the pixels (westernmost to easternmost).

159-160	IEFPX	The number of the easternmost visible pixel in the current frame. Inclusive values of 4 to 30,680 correspond to the pixels (westernmost to easternmost).
161-162	INFLN	The number of the northernmost visible detector scan line in the current frame. Inclusive values of 1-15,780 correspond to detector lines (northernmost to southernmost).
163-164	ISFLN	The number of the southernmost visible detector scan line in the current frame. Inclusive values of 8 to 15,787 correspond to detector lines (northernmost to southernmost).
165-166	IMDPX	The number of the visible pixel corresponding to an instrument azimuth of 0°. Nominal value, ½ full range, is 15,340. This value is an instrument-specific constant.
167-168	IMDLN	The number of the scan line corresponding to an instrument elevation of 0°. Nominal value, ½ full range, is 7894. This value is an instrument-specific constant.
169-170	IMDCT	The number of the output scan corresponding to an instrument elevation of 0°. Nominal value, ½ full range, is 987. This value is an instrument-specific constant.
The following four terms (words 171-182) are computed using the current O&A set. If IMC is active, the terms reflect the reference subsatellite point position. If IMC is off, the terms reflect the actual subsatellite point.		
171-172	IGVLN	The number of the visible detector scan line intersecting the subsatellite point.
173-174	IGVPX	The number of the visible pixel intersecting the subsatellite point.
175-178	SUBLA	The subsatellite point latitude value is a floating point number with units of degrees.
179-182	SUBLO	The subsatellite point longitude value is a floating point number with units of degrees.
183	CZONE	Current compensation zone (0–32) is an 8-bit integer number. A zero value indicates that no compensation is being performed. Values 1–32 denote the latitudinal zone for which corrections are applied.
184	V1PHY	The physical detector number 1–8 assigned to GVAR Block 3.
185-186	G1CNT	GRID 1 active entry count 0–512 is a 16-bit integer number. See words 2307–5386.
187-188	G2CNT	GRID 2 active entry count 0–512 is a 16-bit integer number. See words 2307–5386.
189-190	PBIAS	E-W grid bias (0 ± 12546 pixels) is a signed 15-bit integer number denoting the pixel offset employed for the grid data. A value of zero indicates the grid is not shifted from the locations computed using the current O&A.
191–192	LBIAS	N-S grid bias (0 ± 7892 pixels) is similar to E-W grid bias, except in the N-S direction.
193	ISCP1	Odd parity byte computed for words 3-4 (part of ISCAN).
194		Spare – not used
195–198	IDBER	Current raw data Bit Error Rate (BER) is a floating point number denoting the most recent measure of raw data error rate. Nominal values are on the order of 1.0E–6.
199–202	RANGE	Most recently computed range – a floating point value denoting the number of 50-MHz clock counts for signal transmission from satellite to ground.

203–206	GPATH	Most recent range calibration ground path delay: a floating point value denoting the number of 50-MHz clock counts that the GVAR signal takes to transit through CDA station equipment.
207–210	XMSNE	The call tower range calibration value – a floating point value denoting the number of 50-MHz clock counts that the GVAR signal takes to transit the satellite transmission electronics.
211–218	TGPAT	CDA TOD of GPATH measurement, format as provided for words 23–30.
219–226	TXMSN	CDA TOD of XMSNE measurement, format as provided for words 23–30.
227–228	ISTIM	Current line scan time in integer msec computed as TCTRL – TCHED.
229	IFRAM	Current frame counter. Integer ranging from 0 to 255 identifying current frame; rolls over to 0 following 255.
230	IMODE	Current imaging mode. Integer value as follows: 1 = Routine 2 = Rapid scan operation 3 = Super rapid scan operation 4 = Checkout or special short-term operations 0, 5 -255 = Currently undefined.
The following four floating point values are in units of degrees. Off-Earth coordinates have a value of 999999.		
231–234	IFNW1	Current frame – northwest corner latitude
235–238	IFNW2	Current frame – northwest corner longitude
239–242	IFSE1	Current frame – southeast corner latitude
243–246	IFSE2	Current frame – southeast corner longitude
247	IG2TN	Second order gain interpolation table index number. Integer value of 1, 2, or 3 denoting which of the three possible tables is reported in IG2IT (see words 6779–7002).
248	ISCP2	Repeat of ISCP1 (see word 193)
249–250	ISCA2	Repeat of words 3-4 (part of ISCAN)
251-258	CIFST	Current Imager Frame Start Time. CDA time tag - 8 words formatted in same manner as defined for words 23-150.
259–277		Spares – not used
278	PXOR1	Longitudinal parity XOR of words 1–277
The following partition provides the Imager O&A parameters. The format and engineering units of each variable are denoted in parenthesis. The partition is sized to hold the largest expected O&A set. In general, the actual number of parameters in effect is less than the maximum and varies over time. The numeric parameters (words 535–538 and 659–662) are used to denote the number of active terms employed for the roll attitude angle. In a similar fashion, each of the remaining four angles modeled by the O&A set is provided with numeric parameters defining the number of active terms. Inactive terms are not compressed out of the O&A set; their places are occupied by zeroed data words.		
279-282	IMCID	IMC Identifier (4 ASCII characters)
283-294		Spares – not used
295–298	REFLO	Reference Longitude (positive east, R*4, radians)
299–302	REFRA	Reference radial distance from nominal (R*4, kilometers [km])
303–306	REFLA	Reference Latitude (positive north, R*4, radians)
307–310	REFOR	Reference Orbit Yaw (R*4, radians)

311–314	REROL	Reference Attitude: Roll (R*4, radians)
315–318	REPIT	Reference Attitude: Pitch (R*4, radians)
319–322	REYAW	Reference Attitude: Yaw (R*4, radians)
323–330	EPODT	Epoch Date or Time: Standard BCD time format
331–334	IMCSET	IMC set enable time from epoch (R*4, minutes)
335–338	COROL	Spacecraft compensation: Roll (R*4, radians)
339–342	COPIT	Spacecraft compensation: Pitch (R*4, radians)
343–346	COYAW	Spacecraft compensation: Yaw (R*4, radians)
347–398	CHLON	Change in longitude from ref. (13 at R*4, radians)
399–442	CHRAD	Change in radial distance from ref. (11 at R*4, km)
443–478	SINLA	Sine geocentric latitude, total (9 at R*4, no units)
479–514	SIYAW	Sine orbit yaw, total (9 at R*4, no units)
515–518	DAYSO	Daily solar rate (R*4, radians per minute)
519–522	START	Exponential start time from epoch (R*4, minutes)
Words 523–742 apply to Roll attitude angle:		
523–526	EXMAGR	Exponential magnitude (R*4, radians)
527–530	EXTICR	Exponential time constant (R*4, minutes)
531–534	MATANR	Constant, mean attitude angle (R*4, radians)
535–538	SINANR	Number of sinusoids or Angles (I*4, none)
539–542	MAG1SR	Magnitude of first-order sinusoid (R*4, radians)
543–546	PA1SDR	Phase angle of first-order sinusoid (R*4, radians)
547–658	**	**Repeat 539–546 for 2nd – 15th sinusoids (R*4, radians) MAG#SR, where # = 2 - 9; MA##SR, where ## = 10 - 15 PA#SDR, where # = 2 - 9; PA##SR, where ## = 10 - 15
659–662	NUMMSR	Number of monomial sinusoids (I*4, no units)
663–666	OAPS1R	Order of applicable sinusoid (I*4, no units)
667-670	O1MSDR	Order of first monomial sinusoid (I*4, no units)
671-674	MMSD1R	Magnitude of monomial sinusoid (R*4, radians)
675-678	PAMS1R	Phase angle of monomial sinusoid (R*4, radians)
679–682	AEMZ1R	Angle from epoch where monomial is zero (R*4, radians)
683–702	**	**Repeat 663–682 for second monomial OAPS2R O2MSDR MMSD2R PAMS2R AEMZ2R

703–722	**	**Repeat 663–682 for third monomial OAPS3R O3MSDR MMSD3R PAMS3R AEMZ3R
723–742	**	**Repeat 663–682 for fourth monomial OAPS4R O4MSDR MMSD4R PAMS4R AEMZ4R
743–962	**	**Repeat 523–742 for Pitch attitude angle EXMAGP EXTICP MATANP SINANP MAG#SP, where # = 1 - 9, MA##SP where ## = 10 - 15 PA#SDP, where # = 1 - 9, PA##SP where ## = 10 - 15 NUMMSP OAPS#P, where # = 1 - 4 O#MSDP, where # = 1- 4 MMSD#P, where # = 1 - 4 PAMS#P, where # = 1 - 4 AEMZ#P, where # = 1 – 4
963-1182	**	**Repeat 523–742 for Yaw attitude angle EXMAGY EXTICY MATANY SINANY MAG#SY, where # = 1 - 9, MA##SY where ## = 10 - 15 PA#SDY, where # = 1 - 9, PA##SY where ## = 10 - 15 NUMMSY OAPS#Y, where # = 1 - 4 O#MSDY, where # = 1- 4 MMSD#Y, where # = 1 - 4 PAMS#Y, where # = 1 - 4 AEMZ#Y, where # = 1 - 4
1183–1402	**	**Repeat 523–742 for Roll Misalignment angle EXMAGRM EXTICRM MATANRM SINANRM MAG#SRM where # = 1 - 9, MA##SRM where ## = 10 - 15 PA#SDRM, where # = 1 - 9, PA##SRM where ## = 10 - 15 NUMMSRM OAPS#RM, where # = 1 - 4 O#MSDRM, where # = 1- 4 MMSD#RM, where # = 1 - 4 PAMS#RM, where # = 1 - 4 AEMZ#RM, where # = 1 - 4

1403–1622	**	**Repeat 523–742 for Pitch Misalignment angle EXMAGPM EXTICPM MATANPM SINANPM MAG#SPM where # = 1 - 9, MA##SPM where ## = 10 - 15 PA#SDPM, where # = 1 - 9, PA##SPM where ## = 10 - 15 NUMMSPM OAPS#PM, where # = 1 - 4 O#MSDPM, where # = 1- 4 MMSD#PM, where # = 1 - 4 PAMS#PM, where # = 1 - 4 AEMZ#PM, where # = 1 - 4'
1623–1624	ISCA3	**Repeat of words 3-4 (part of ISCAN)
1625	ISCP3	**Repeat of ISCP1 (see word 193)
1626	PXOR2	Longitudinal parity (XOR) of words 279–1625
The terms below are used to adjust the visible Imagery transmitted in GVAR so that it coregisters with the accompanying IR Imagery. If SPS co-registration is enabled, word 1679 has a non-zero index (1–48) indicating which visible correction terms (words 1631–1678 for pixels, 6235–6282 for lines) are being used. If SPS co-registration is disabled, word 1679 is zero.		
1627–1630	COTID	Co-registration Table ID (4 ASCII characters)
1631–1678	EWHCT*	(1 x 48) E-W half-hourly correction terms EWHCT_P0 - P47
1679	ICTCA	Index of correction terms currently active
1680–1690		Spares – not used
In the following, an abbreviated form of the raw header and trailer data blocks associated with the current scan are provided. The downlinked raw data has a 10-bit word length, with each block containing 48 words. The first two words of each block contain a synchronization code and a block ID not included here. Each 10-bit word is embedded in two sequential 8-bit words: First word bits 0–5: not used – zeros bits 6–7: two MSBs of 10-bit word Second word bits 0–7: eight LSBs of 10-bit word		
Specific definitions of the contents of the 10-bit raw data words can be acquired from the *Instrument to OGE Interface Specification*.		
1691–1782	CSRHB	Current scan raw header data block
1783–1874	CSRTB	Current scan raw trailer data block
1875–1966	LLSRH	Latest lagged scan raw header data block
1967–2058	LLSRT	Latest lagged scan raw trailer data block
The Imager telemetry raw data section which follows consists of 122 10-bit words, each 10-bit word formatted as described above. It contains a copy of each of the four command register status reports, as well as the 78 raw telemetry data words acquired from the most recent 39 telemetry blocks contained in a scan reversal sequence. The notation "B(MSB–LSB)" is used to indicate the bit position of the source data in the downlinked raw data block. Specific definitions of the contents of the status reports, as well as a listing of the telemetry points contained, can be found in reference document SJ-572022.		
2059–2080	B1CRR	Block 1 command register 1 report, B(20–129)
2081–2102	B2CRR	Block 2 command register 2 report, B(20–129)
2103–2124	B3CRR	Block 3 command register 3 report, B(20–129)

2125–2146	B4CRR	Block 4 command register 4 report, B(20–129)
2147–2148	B1TW1	Block 1, telemetry word 1, B(230–239)
2149–2150	B1TW2	Block 1, telemetry word 2, B(470–479)
2151–2302	**	**Repeat 2147–2150 for blocks 2 – 39 B#TW1 where # = 2 - 39 B#TW2, where # = 2 - 39
2303–2305		Spares – not used
2306	PXOR3	Longitudinal parity (XOR) of words 1627–2305
In the following partition, four arrays are used to provide up to 1024 grid points for the current output scan. The grid points represent two distinct databases.		
2307–2818	GD1DA	Grid (database 1) detector array
2819–3330	GD2DA	Grid (database 2) detector array
3331–4354	GD1PA	Grid (database 1) pixel array
4355–5378	GD2PA	Grid (database 2) pixel array
Each of the GRID arrays above contain up to 512 entries. The number of entries varies for different output scans as a function of the number of grid points intersected by the scan. For any given scan, the current number of entries is indicated by words 185–188 (G1CNT, G2CNT). Each entry is defined using the formats shown below. A GRID POINT record consists of an entry from both the Detector and the PIXEL arrays. A Detector entry is an 8-bit (I*1) binary number denoting the logical visible detector which “saw” the grid coordinate. Corresponds to GVAR blocks by: = 1 for GVAR Block 3 = 2 for GVAR Block 4 = 3 for GVAR Block 5 = 4 for GVAR Block 6 = 5 for GVAR Block 7 = 6 for GVAR Block 8 = 7 for GVAR Block 9 = 8 for GVAR Block 10		
A pixel entry is a 16-bit (I*2) binary number which locates a virtual visible pixel in the Detector- denoted GVAR block. The located pixel corresponds to a particular GRID set coordinate. Values range from 0 for no pixel up to 25,092. A value of 1 indicates the first pixel in the associated GVAR block and 2 the second. The pixel value continues to rise in conjunction with the associated GVAR block.		
5379–5380	GS1RL	Grid Set No. 1 Revision level
5381–5382	GS2FL	Grid Set No. 2 Revision level
5383–5385		Spares – not used
5386	PXOR4	Longitudinal parity (XOR) of words 2307–5385
The following information is used to identify the oldest raw instrument scan that may be providing some of the detector data in the current output GVAR scan. Whether this information is required for the landmarking function is dependent upon the following three factors: 1. The current frame N-S scan direction. 2. The detector electronics side which is active. 3. The co-registration terms currently in use.		
The format of the header and trailer data is the same as described for words 1691–2058. The time code formats are the same as defined for words 23–150.		
5387–5478	OLSRH	Oldest lagged scan raw header data block

5479–5570	OLSRT	Oldest lagged scan raw trailer data block
5571–5578	TOHED	Time of oldest lagged header block
5579–5586	TOTRL	Time of oldest lagged trailer block
The IR calibration term arrays in words 5587–5698 below are all in Real*4 format. Each array is sized to hold one (1) term for each of the seven active physical IR detectors. The IWBIAS terms apply to the westernmost IR pixels in the GVAR data stream. The bias term for the N^{th} west-to-east pixel in the line can be computed using the bias-rate terms IBRATE as follows: BIAS(n) = IWBIAS + (*N* – 1) IBRATE Note that the first-order gain is computed by one of the modes 1-7 when MBCC is set off, and by one of the modes 8-14 when MBCC is set on. The MBCC indicator in words 503-516 (IR detectors 1-7) and words 7754-7755 (8^{th} IR detector) of Table 3-28 indicates the MBCC status. When the indicator is 0, the MBCC is set off. When it is 1, the MBCC is set on, but the original, physical, slope is used. When it is 2, the MBCC is set on, and the slope computed by regression is used.		
5587–5614	IWBIAS*	(4 x 7) IR calibration bias term IWBIAS_P1 - P7 GOES O-P 8^{th} IR det @ wd#6307
5615–5642	IGAIN1*	(4 x 7) IR calibration first-order gain IGAIN1_P1 - P7 GOES O-P 8^{th} IR det @ wd#6311
5643–5670	IGAIN2*	(4 x 7) IR calibration second-order gain IGAIN2_P1 - P7 GOES O-P 8^{th} IR det @ wd#6315
5671–5698	IBRATE*	(4 x 7) IR calibration bias rate IBRATE_P1 - P7 GOES O-P 8^{th} IR det @ wd#6319
5699–5706	WMIRPX	CDA TOD of westernmost IR pixel
Imager IR Clamped Bias Statistics		
5707–5714	CLBIDA	CDA TOD of clamped bias data
5715–5728	TOTSSC*	(2 x 7) Total sample size TOTSSC_P1 - P7 GOES O-P 8^{th} IR det @ wd#6323
5729–5742	FILSSC*	(2 x 7) Filtered sample size FILSSC_P1 - P7 GOES O-P 8^{th} IR det @ wd#6325
5743–5756	UFMNVCC*	(2 x 7) Unfiltered minimum value – counts UFMNVCC_P1 - P7 GOES O-P 8^{th} IR det @ wd#6327
5757–5770	FIMNVCC*	(2 x 7) Filtered minimum value – counts FIMNVCC_P1 - P7 GOES O-P 8^{th} IR det @ wd#6329
5771–5784	UFMXVCC*	(2 x 7) Unfiltered maximum value – counts UFMXVCC_P1 - P7 GOES O-P 8^{th} IR det @ wd#6331
5785–5798	FIMXVCC*	(2 x 7) Filtered maximum value – counts FIMXVCC_P1 - P7 GOES O-P 8^{th} IR det @ wd#6333

5799–5826	UFMEVCC*	(4 x 7) Unfiltered mean value – counts UFMEVCC_P1 - P7 GOES O-P 8th IR det @ wd#6335
5827–5854	FIMEVCC*	(4 x 7) Filtered mean value – counts FIMEVCC_P1 - P7 GOES O-P 8th IR det @ wd#6339
5855–5882	UFSDCC*	(4 x 7) Unfiltered standard deviation (σ) – counts USFDCC_P1 - P7 GOES O-P 8th IR det @ wd#6343
5883–5910	FISGCC*	(4 x 7) Filtered σ – counts FISGCC_P1 - P7 GOES O-P 8th IR det @ wd#6347
5911–5938	FISGRC*	(4 x 7) Filtered σ – radiance FISGRC_P1 - P7 GOES O-P 8th IR det @ wd#6351
5939–5966	FISGTC*	(4 x 7) Filtered σ – temperature FISGTC_P1 - P7 GOES O-P 8th IR det @ wd#6355
5967–5970	CMASFC*	Clamp mode and status flags Note: Status flags for 8th IR detector are in word 6363. CMASFC_P0 - P17 GOES O-P 8th IR det @ wd#6359
Imager IR Drift Bias Statistics		
5971–5978	CDADBD	CDA TOD of drift bias data
5979–5992	TOTSSD*	(2 x 7) Total sample size TOTSSD_P1 - P7 GOES O-P 8th IR det @ wd#6363
5993–6006	FILSSD*	(2 x 7) Filtered sample size FILSSD_P1 - P7 GOES O-P 8th IR det @ wd#6365
6007–6020	UFMNVCD*	(2 x 7) Unfiltered minimum value – counts UFMNVCD_P1 - P7 GOES O-P 8th IR det @ wd#6367
6021–6034	FIMNVCD*	(2 x 7) Filtered minimum value – counts FIMNVCD_P1 - P7 GOES O-P 8th IR det @ wd#6369
6035–6048	UFMXVCD*	(2 x 7) Unfiltered maximum value – counts UFMXVCD_P1 - P7 GOES O-P 8th IR det @ wd#6371
6049–6062	FIMXVCD*	(2 x 7) Filtered maximum value – counts FIMXVCD_P1 - P7 GOES O-P 8th IR det @ wd#6373
6063–6090	UFMEVCD*	(4 x 7) Unfiltered mean value – counts UFMEVCD_P1 - P7 GOES O-P 8th IR det @ wd#6375

6091–6118	FIMEVCD*	(4 x 7) Filtered mean value – counts FIMEVCD_P1 - P7 GOES O-P 8th IR det @ wd#6379
6119–6146	UFSDCD*	(4 x 7) Unfiltered σ – counts UFSDCD_P1 - P7 GOES O-P 8th IR det @ wd#6383
6147–6174	FISGCD*	(4 x 7) Filtered σ – counts FISGCD_P1 - P7 GOES O-P 8th IR det @ wd#6387
6175–6202	FISGRD*	(4 x 7) Filtered σ – radiance FISGRD_P1 - P7 GOES O-P 8th IR det @ wd#6391
6203–6230	FISGTD*	(4 x 7) Filtered σ – temperature FISGTD_P1 - P7 GOES O-P 8th IR det @ wd#6395
6231–6234	CMASFD*	Clamp mode and status flags. Note: Status flags for 8th IR detector are in word 6403. CMASFD_P0 - P17 GOES O-P 8th IR det @ wd#6399
6235–6282	NSHCT*	(1 x 48) N-S half-hourly correction terms NSHCT_P0 - P47
6283–6286	SCCELO	(4 x 1) Scan Clamp E-W clipping edge limb offset
6287–6288	IMBOOST	When relativization is active, this is the amount of boost (the arbitrary count level of space)
6289	IRELON	Relativization indication, 1 indicates the function is active
6290-6296	IMBCG1M*	Actual IR calibration first order gain mode (slope computation mode for each of 7 detectors) [1x7] Expected values: 1-14 IMBCG1M_P1 - P7 GOES O-P 8th IR det @ wd#6400
6297-6303		Spares – not used
6304	PXOR5	Longitudinal parity (XOR) of words 5387–6303

The co-registration 30 minute correction terms defined in words 1631–1678 and 6235–6282 are formed using 2s complement notation within the 8-bit fields. Valid ranges are –64 to +64 pixels for E-W terms and –8 to +8 lines for N-S terms.

The two clamp mode and status flag fields defined in words 5967–5970 and 6231–6234 are identically structured within the 32 bits allocated for each. The first word, 5967 and 6231, identifies the clamp mode active at the time the associated space data was acquired. It takes on one of the following values:

4 = scan clamp mode active
2 = 9.2-second space clamp mode active
1 = 36.6-second space clamp mode active
0 = mode unknown

The remaining 24 bits, words 5968–5970 and 6232–6234, are used to flag status and alarm conditions associated with the data. These bits are identified as bits 0–23, where the MSB (bit 0) is the left-most bit of the first word (5968, 6232). The bits are set to one if the associated condition is true. They are reset to zero if the condition is false. The bits assignments are as follows:

Bit	Detector GOES I-L	Detector GOES M-N	True Condition
00			Unassigned (always zero)
01	4/1	2/1	invalid calibration condition (no statistics)
02	4/2	2/2	invalid calibration condition (no statistics)
03	5/1	3/1	invalid calibration condition (no statistics)
04	5/2	3/2	invalid calibration condition (no statistics)
05	2/1	4/1	invalid calibration condition (no statistics)
06	2/2	4/2	invalid calibration condition (no statistics)
07	3/1	6/1	invalid calibration condition (no statistics)
08			Unassigned (always zero)
09	4/1	2/1	excessive drift rate alarm
10	4/2	2/2	excessive drift rate alarm
11	5/1	3/1	excessive drift rate alarm
12	5/2	3/2	excessive drift rate alarm
13	2/1	4/1	excessive drift rate alarm
14	2/2	4/2	excessive drift rate alarm
15	3/1	6/1	excessive drift rate alarm
16–20			Unassigned (always zero)
21			Space clamp side active (1–East)
22			Excessive interpolation interval
23			Atmospheric exclusion zone activated

Note that for GOES O-P, there is an 8th detector, and the flags for the 8th detector are at words 6359 (corresponding to 5968-5970) and 6399 (corresponding to 6232-6234). Refer to Table 3-6c.

Table 3-6b. Imager Documentation Block 0 (Words 6305-8040) (GOES I-N) Format Definition

Word	Name	Description
In the remaining partition, coefficients and parameters that were measured prior to launch (factory values) are provided. For the most part, these values serve as a historical reference to be used in evaluating the current condition of the imaging detectors. In a few instances, the values are used throughout the life of the instrument as part of the normal calibration functions. The nadir location of the instrument is measured in terms of cycles and increments in the N-S and E-W directions (see Section 3.4). Cycles are expressed as an 8-bit integer number ranging from 0 to 127. Increments are expressed as a 16-bit integer number ranging from 0 to 6135.		
6305	IOFNC	Instrument nadir, N-S cycles
6306	IOFEC	Instrument nadir, E-W cycles
6307–6308	IOFNI	Instrument nadir, N-S increments
6309–6310	IOFEI	Instrument nadir, E-W increments
For each of the 22 detectors (8 visible, 14 IR), two 16-bit integer values provide the X (E-W) and the Y (N-S) µradian offset of the detector centroid from the instrument's optical axis, as follows:		
6311–6354	VD#XO PI#XO RI#XO	Repeat for 20 detectors as follows: Detector X-Offsets where # = Visual detectors 1 - 8 Primary IR detectors 1 - 7 Redundant IR detectors 1 - 7
6355–6398	VD#YO PI#YO RI#YO	Repeat for 20 detectors as follows: Detector Y-Offsets where # = Visual detectors 1 - 8 Primary IR detectors 1 - 7 Redundant IR detectors 1 - 7
A set of characteristic response coefficients is provided for each of the 22 Imager detectors. The characteristic response coefficients are the initial calibration coefficients associated with the detectors. The scaling factors are used to generate a 10-bit value from each calibrated IR pixel. All entries are single precision floating point numbers. Each of the following arrays contains eight elements, one element per visible detector. The elements are ordered within each array in increasing physical detector number, with element 1 assigned to physical visible detector 1. This pattern continues for all the elements within each array.		
6399–6430	IVCRB*	Visible detectors characteristic response bias coefficients array. IVCRB_P0 - P7
6431–6462	IVCR1*	Visible detectors characteristic response first-order gain coefficients array. IVCR1_P0 - P7
6463–6494	IVCR2*	Visible detector characteristic response second-order gain coefficients array. IVCR2_P0 - P7
6495–6498	IVRAL	Visible detectors radiance-to-albedo conversion factor, one value for all eight detectors.

In the following arrays the first five each contain 14 elements, one element per IR detector. The first seven elements in each array apply to the seven side 1 (primary) detectors; the last seven, to the side 2 (redundant) detectors. Within each group of seven, the elements are ordered in the same 1–7 sense as follows:

For GOES I-L:

1 – channel 4 north
2 – channel 4 south
3 – channel 5 north
4 – channel 5 south
5 – channel 2 north
6 – channel 2 south
7 – channel 3

For GOES M-N:

1 – channel 2 north
2 – channel 2 south
3 – channel 3 north
4 – channel 3 south
5 – channel 4 north
6 – channel 4 south
7 – channel 6

6499–6554	IICRB*	Characteristic response bias coefficients IICRB_P0 - P13
6555–6610	IICR1*	Characteristic response first-order gain coefficients IICR1_P0 - P13
6611–6666	IICR2*	Characteristic response second-order gain coefficients IICR2_P0 - P13
6667–6722	IISFB*	Scale factors bias coefficients IISFB_P0 - P13
6723–6778	IISF1*	Scale factors first-order gain coefficients IISF1_P0 - P13
6779–7002	IG2IT*	Second gain interpolation table. This array contains 56 elements, 4 elements for each of the 14 IR detectors. The first 28 elements apply to the side 1 detectors, the last 28 to side 2. Within each group of 28, the elements are sequentially ordered (in groups of four) in the same 1–7 sense defined previously. IG2IT_P0 - P55
7003–7018	IG2BP*	Second gain baseplate temperature interpolation pivot points. Four baseplate temperatures at which IG2IT gains were measured. Access this table with baseplate temperature to determine linear interpolation factors to use within IG2IT. IG2BP_P0 - P3
7019–7242	IBBTR*	BB temperature-to-target radiance conversion coefficients. An array of 56 elements, 4 elements for each of the 14 IR detectors. Elements are ordered in the same manner as described for IG2IT. IBBTR_P0 - P55
7243–7266	IPRNG*	Patch temperature control ranges. An array of six elements, two elements for each of the three patch temperature control ranges. Each pair of elements defines the lower and upper temperature limit assigned to a patch control point. IPRNG_P0 - P5
7267–7366		Spares – not used

In the following section, conversion coefficients are provided for each telemetry point whose engineering units value is used for calibration or alarm monitoring functions by the SPS. Conversion factors of unused telemetry points may be acquired from reference document SJ-572022.

7367–7370	IEL1A	Imager Electronics Temperature side No. 1 coefficients. Final letter of term name (A–F) denotes type. See Eq 3.6-5 and 3.6-6 for usage.
7371–7374	IEL1B	Imager Electronics Temperature side No. 1 coefficients.
7375–7378	IEL1C	Imager Electronics Temperature side No. 1 coefficients.

7379–7382	IEL1D	Imager Electronics Temperature side No. 1 coefficients.
7383–7386	IEL1E	Imager Electronics Temperature side No. 1 coefficients.
7387–7390	IEL1F	Imager Electronics Temperature side No. 1 coefficients.
The A–F naming convention used above with IEL1_ is also used for the following thermistor terms:		
7391–7414	IEL2*	Electronics No. 2 thermistor terms IEL2A - 2F
7415–7438	IBP1*	Baseplate thermistor No. 1 terms IBP1A - 1F
7439–7462	IBP2*	Baseplate thermistor No. 2 terms IBP2A - 2F
7463–7486	IBP3*	Baseplate thermistor No. 3 terms IBP3A - 3F
7487–7510	IBP4*	Baseplate thermistor No. 4 terms IBP4A - 4F
7511–7534	IBP5*	Baseplate thermistor No. 5 terms IBP5A - 5F
7535–7558	IBP6*	Baseplate thermistor No. 6 terms IBP6A - 6F
7559–7582	IBB1*	BB thermistor No. 1 terms IBB1A - 1F
7583–7606	IBB2*	BB thermistor No. 2 terms IBB2A - 2F
7607–7630	IBB3*	BB thermistor No. 3 terms IBB3A - 3F
7631–7654	IBB4*	BB thermistor No. 4 terms IBB4A - 4F
7655–7678	IBB5*	BB thermistor No. 5 terms IBB5A - 5F
7679–7702	IBB6*	BB thermistor No. 6 terms IBB6A - 6F
7703–7726	IBB7*	BB thermistor No. 7 terms IBB7A - 7F
7727–7750	IBB8*	BB thermistor No. 8 terms IBB8A - 8F
7751–7774	IOP1*	Scan mirror thermistor terms IOP1_A - F
7775–7798	IOP2*	Primary mirror thermistor terms IOP2_A - F
7799–7822	IOP3*	Secondary mirror thermistor No. 1 terms IOP3_A - F
7823–7846	IOP4*	Secondary mirror thermistor No. 2 terms IOP4_A - F
7847–7870	IOP5*	Baffle thermistor No. 1 terms IOP5_A - F

7871–7894	IOP6*	Baffle thermistor No. 2 terms IOP6_A - F
7895–7918	IOP7*	Aft optics thermistor terms IOP7_A - F
The next four telemetry points use the following mapping to convert raw counts to engineering units: Temp = A + BX + CX^2 + DX^3. The last two terms (E-F) are set equal to zero.		
7919–7942	IOP8*	Cooler radiator PRT terms IOP8_A - F
7943–7966	IOP9*	Wide range IR detector PRT terms IOP9_A - F
7967–7990	IOPA*	Narrow range IR detector PRT terms IOPAA - F
7991–8014	ICHT*	Cooler housing PRT terms ICHTA - F
The remaining two telemetry points use a simple linear, gain and bias, mapping to convert raw counts to engineering units.		
8015–8022	IPVGB*	Patch control voltage gain or bias terms IPVGB_P0 – P1
8023–8030	IICGB*	Instrument current gain or bias terms IICGB_P0 - P1
8031–8039		Spares – not used
8040	PXOR6	Longitudinal parity (XOR) of words 6305–8039

Table 3-6c. Imager Documentation Block 0 (Words 6305-8040) (GOES-O and Beyond) Format Definition

Word	Name	Description
6305-6305	ISCAN8	Status of IR detector 8. A set bit indicates the associated detector data is invalid. GOES I-N IR dets 1-7 @ wd#3-6 bits 17-23
6306-6306	IDSUB8	Substitution indicator for IR detector 8. A non-zero value indicates the detector 8 data in Blocks 1 – 10 is substituted data acquired from the detector whose number is entered. GOES I-N IR dets 1-7 @ wd#7-22
IR Calibration Bias Terms for 8th IR detector (see words 5587-5698 for IR detectors 1-7)		
6307-6310	IWBIAS_P8	(4 x 1) IR calibration bias term. GOES I-N IR dets 1-7 @ wd#5587
6311-6314	IGAIN1_P8	(4 x 1) IR calibration first-order gain. GOES I-N IR dets 1-7 @ wd#5615
6315-6318	IGAIN2_P8	(4 x 1) IR calibration second-order gain. GOES I-N IR dets 1-7 @ wd#5643
6319-6322	IBRATE_P8	(4 x 1) IR calibration bias rate. GOES I-N IR dets 1-7 @ wd#5671
Imager IR Clamped Bias Statistics for 8th IR detector (see words 5715-5970 for IR detectors 1-7)		
6323-6324	TOTSSC_P8	(2 x 1) Total sample size. GOES I-N IR dets 1-7 @ wd#5715
6325-6326	FILSSC_P8	(2 x 1) Filtered sample size. GOES I-N IR dets 1-7 @ wd#5729
6327-6328	UFMNVCC_P8	(2 x 1) Unfiltered minimum value – counts. GOES I-N IR dets 1-7 @ wd#5743
6329-6330	FIMNVCC_P8	(2 x 1) Filtered minimum value – counts. GOES I-N IR dets 1-7 @ wd#5757
6331-6332	UFMXVCC_P8	(2 x 1) Unfiltered maximum value – counts. GOES I-N IR dets 1-7 @ wd#5771
6333-6334	FIMXVCC_P8	(2 x 1) Filtered maximum value – counts. GOES I-N IR dets 1-7 @ wd#5785
6335-6338	UFMEVCC_P8	(4 x 1) Unfiltered mean value – counts. GOES I-N IR dets 1-7 @ wd#5799
6339-6342	FIMEVCC_P8	(4 x 1) Filtered mean value – counts. GOES I-N IR dets 1-7 @ wd#5827
6343-6346	UFSDCC_P8	(4 x 1) Unfiltered standard deviation (σ) – counts. GOES I-N IR dets 1-7 @ wd#5855
6347-6350	FISGCC_P8	(4 x 1) Filtered σ – counts. GOES I-N IR dets 1-7 @ wd#5883
6351-6354	FISGRC_P8	(4 x 1) Filtered σ – radiance. GOES I-N IR dets 1-7 @ wd#5911
6355-6358	FISGTC_P8	(4 x 1) Filtered σ – temperature. GOES I-N IR dets 1-7 @ wd#5939
6359-6359	CMASFC*	Clamp Status Flags for 8th IR detector. GOES I-N IR dets 1-7 @ wd#5967 CMASFC_P18 - P19 Flags for other detectors are in words 5968-5970. Meaning of flags is as follows: **Bit** **True Condition** 00 Unassigned (always zero) 01 invalid calibration condition for 8th IR detector (channel 6 det 2) (no statistics) 02 excessive drift rate alarm for 8th IR detector (channel 6 det 2) 03-07 Unassigned (always zero)
6360-6362		SPARE
Imager IR Drift Bias Statistics for 8th IR detector (see words 5979-6234 for IR detectors 1-7)		
6363-6364	TOTSSD_P8	(2 x 1) Total sample size. GOES I-N IR dets 1-7 wd#5979
6365-6366	FILSSD_P8	(2 x 1) Filtered sample size. GOES I-N IR dets 1-7 wd#5993

6367-6368	UFMNVCD_P8	(2 x 1) Unfiltered minimum value – counts. GOES I-N IR dets 1-7 wd#6007
6369-6370	FIMNVCD_P8	(2 x 1) Filtered minimum value – counts. GOES I-N IR dets 1-7 wd#6021
6371-6372	UFMXVCD_P8	(2 x 1) Unfiltered maximum value – counts. GOES I-N IR dets 1-7 wd#6035
6373-6374	FIMXVCD_P8	(2 x 1) Filtered maximum value – counts. GOES I-N IR dets 1-7 wd#6049
6375-6378	UFMEVCD_P8	(4 x 1) Unfiltered mean value – counts. GOES I-N IR dets 1-7 wd#6063
6379-6382	FIMEVCD_P8	(4 x 1) Filtered mean value – counts. GOES I-N IR dets 1-7 wd#6091
6383-6386	UFSDCD_P8	(4 x 1) Unfiltered standard deviation (σ) – counts. GOES I-N IR dets 1-7 wd#6119
6387-6390	FISGCD_P8	(4 x 1) Filtered σ – counts. GOES I-N IR dets 1-7 wd#6147
6391-6394	FISGRD_P8	(4 x 1) Filtered σ – radiance. GOES I-N IR dets 1-7 wd#6175
6395-6398	FISGTD_P8	(4 x 1) Filtered σ – temperature. GOES I-N IR dets 1-7 wd#6203
6399-6399	CMASFD*	Clamp Status Flags for 8th IR detector. GOES I-N IR dets 1-7 wd#6231 CMASFD_P18 – P19 Flags for other detectors are in words 5968-5970. Meaning of flags is as follows: **Bit** **True Condition** 00 Unassigned (always zero) 01 invalid calibration condition for 8th IR detector (channel 6 det 2) (no statistics) 02 excessive drift rate alarm for 8th IR detector (channel 6 det 2) 03-07 Unassigned (always zero)
6400-6400	IMBCG1M_P8	Actual IR calibration first order gain mode for the 8th IR detector. For other IR detectors, see words 6290-6296.
6401-8040		SPARE

	IR CHANNEL (GOES I-L)	IR CHANNEL (GOES M-N)	NORMAL MODE		YAW-FLIPPED MODE	
			DETECTOR	SPS IR	DETECTOR	SPS IR
GVAR Block 1 has 4 IR Records	4	2	1	1	2	2
	4	2	2	2	1	1
	5	3	1	3	2	4
	5	3	2	4	1	3
GVAR Block 2 has 3 IR Records	2	4	1	5	2	6
	2	4	2	6	1	5
	3	6		7		7
Imager IR Detector Record Layout in Bits	**LINE DOCUMENTATION – 160 BITS**					
	Detector Data – from 10 Bits to 52,360 Bits					

Figure 3-11a. Imager IR Detector Data Order in GVAR (GOES I-N)

	IR CHANNEL (GOES O-P)	NORMAL MODE		YAW-FLIPPED MODE	
		DETECTOR	SPS IR	DETECTOR	SPS IR
GVAR Block 1 has 4 IR Records	2	1	1	2	2
	2	2	2	1	1
	3	1	3	2	4
	3	2	4	1	3
GVAR Block 2 has 4 IR Records	4	1	5	2	6
	4	2	6	1	5
	6	1	7	2	8
	6	2	8	1	7

Imager IR Detector Record Layout in Bits	LINE DOCUMENTATION – 160 BITS
	Detector Data – from 10 Bits to 52,360 Bits

Figure 3-11b. Imager IR Detector Data Order in GVAR (GOES O and Beyond)

3.3.5.1 Line Documentation

The line documentation segment is used to uniquely identify the detector data segment through the use of a scan line sequence counter, spacecraft code, and detector ID information. A line documentation segment is 160 bits in length, consisting of 16 10-bit words.

3.3.5.2 IR Detector Data

The IR detector data segment contains the scan line data for the associated detector. This segment varies in length directly with the scan line, reaching a maximum nominal length of 52,360 bits, 5236 pixels, for a 19.2° wide scan. A worst case maximum length of 62,730 bits occurs if the full 23° wide FOV of the instrument is scanned. Data within this segment is always ordered from west-to-east, regardless of the original scan line direction. Each 10-bit pixel within this segment is formatted with the MSB first.

Table 3-7. Blocks 1–10 Line Documentation Definition

Word	Name	Description
1	SPCID	Spacecraft ID – a binary number identifying the source satellite as follows: 8 = GOES-I 9 = GOES-J 10 = GOES-K 11 = GOES-L 12 = GOES-M 13 = GOES-N 14 = GOES-O 15 = GOES-P
2	SPSID	SPS ID – a binary number identifying the source SPS, which formats the GVAR stream. Values 1 to 9 denote SPS1 to SPS9, respectively.
3	LSIDE	A binary number denoting the current active detector configuration. A value of 0 indicates side 1 is active; a value of 1023 indicates side 2 is active.
4	LIDET	A binary number denoting the physical detector identified as the data source. Values range from 1 – 8 for the visible channel and from 1 – 8 for the IR channels (see Figure 3-11).
5	LICHA	A binary number identifying the source channel. Values range from 1 –- 6, as follows: __Value__ __Channel__ __Wavelength__ 1 01 visible 2 02 3.9 microns 3 03 6.75 or 6.5 microns 4 04 10.7 microns 5 05 12.0 microns 6 06 13.3 microns No imager will have both channels 5 and 6. Those on **GOES-I** through **GOES-L** have channel 5. Those on **GOES-M** through **P** will have channel 6.
6–7	RISCT	A binary number ranging from 1 – 1974 denoting the relative output scan count since the start of the imaging frame.
8	L1SCAN*	Imager scan status word 1: Bits 0–3 are not used. Bits 4–9 are duplicates of bits 2–7 of the ISCAN field and are defined in Table 3-6a.
9	L2SCAN*	Imager scan status word 2: Bits 0–1 are not used. Bits 2–9 are duplicates of bits 8–15 of the ISCAN field and are defined in Table 3-6a.
10–11	LPIXLS	A binary number denoting the number of pixels contained in the detector data record.
12-13	LWORDS	A binary number denoting the number of words contained in the detector record, from word 1 of the line documentation to the last word in the detector data partition. This number, minus the 16 words of line documentation and the number of pixels contained in the detector data partition (see words 10–11), denotes the number of zero-valued words appended to the record for packing purposes. The packing is performed for the following three reasons: 1. To ensure consistent record bounding for the multi-record GVAR Blocks 1 and 2. 2. To ensure the overall length of the GVAR block information field is a multiple of 16 bits, permitting the proper computation of the block CRC. 3. To ensure the minimum GVAR block size of 32,208 bits is satisfied.
14	LZCOR	An 8-bit binary number denoting the value of the zonal correction (pixel offset) employed at the western edge of the scan line.

Table 3-7. Blocks 1–10 Line Documentation Definition

Word	Name	Description
15	LLAG	A binary number (0, 1, or 2) denoting which scan (current, latest lagged, or oldest lagged, respectively) the detector data was acquired from. This information can be used to access Block 0 documentation associated with a particular scan, such as the associated header time tags (TCHED, TLHED, or TOHED, respectively).
16	SPARE	Spare–not used

3.3.6 Blocks 3–10 Imager Visible Data

Image data from the Imager's eight visible detectors is carried in the data section fields of GVAR Blocks 3 – 10, one detector per block. Each of the GVAR Blocks 3 – 10 is assigned to a specific logical detector as illustrated in Figure 3-12. This assignment causes the northernmost pixel data to always occur in Block 3 and the southernmost pixel data to be in Block 10. The remaining pixel information is distributed in a north-to-south order across Blocks 4 – 9.

Figure 3-12 also illustrates the relationship between physical visible detectors and logical visible detectors for the normal and yaw-flipped spacecraft modes. This relationship is the same for both primary (side 1) and redundant (side 2) detector configurations. Note that this mapping of physical to logical detector only holds if the co-registration N-S offset in use is zero. For any active non-zero offset, the northernmost logical detector in Block 3 will be represented by a physical detector other than five. Note that this will also be the case for inverted spacecraft. Which physical detector represents the northernmost detector in an output scan is defined in word 184 of the associated Block 0.

Visible detector data is packaged using the same two-partition record format employed for the IR detector data. The first partition provides line documentation, and the second contains the detector data.

	GVAR BLOCK	NORMAL MODE DETECTOR		YAW-FLIPPED MODE DETECTOR	
		LOGICAL	PHYSICAL	LOGICAL	PHYSICAL
Each Imager Visible Detector Record Occupies One GVAR Block	3	1	5	1	4
	4	2	6	2	3
	5	3	7	3	2
	6	4	8	4	1
	7	5	1	5	8
	8	6	2	6	7
	9	7	3	7	6
	10	8	4	8	5
Imager Visible Detector Record Layout in Bits	LINE DOCUMENTATION – 160 BITS				
	Detector Data – from 40 Bits to 209,440 Bits				

Figure 3-12. Imager Visible Detector Logical Versus Physical Ordering

3.3.6.1 Line Documentation

The line documentation segment is used to uniquely identify the detector data segment through the use of a scan line sequence counter, spacecraft code, and detector ID information. A line documentation segment is 160 bits in length, consisting of 16 10-bit words. Table 3-7 defines the line documentation segment contents.

3.3.6.2 Visible Detector Data

The visible detector data segment contains the normalized scan line data for the associated detector. This segment varies in length directly with the scan line, reaching a maximum nominal length of 209,440 bits, 20,944 pixels, for a 19.2° wide scan. A worst case maximum length of 250,920 bits occurs if the full 23° wide FOV of the instrument is scanned. Data within this segment is always ordered from west-to-east, regardless of the original scan line direction. Note that each 10-bit pixel within the segment is ordered with the MSB first.

3.3.7 Block 11 – Sounder and Auxiliary Data

The GVAR Sounder/Auxiliary Data (SAD) Block 11 is a fixed-length block equal in size to the Imager documentation Block 0. The internal structure of a SAD Block 11 depends upon the type of data being transported. The permissible SAD Block data types are as follows:

a. Sounder Documentation Data
b. Sounder Scan Data
c. Instrument Compensation Terms
d. Instrument Spacelook Calibration Data
e. Instrument BB-Cal Data
f. Instrument ECAL Data
g. Instrument Telemetry Statistics
h. Instrument Calibration Coefficients
i. Instrument Normalization Lookup Tables
j. Instrument Star Sense Data
k. GIMTACS or SPS Text Messages
l. Imager Factory Coefficients
m. Fill Data.

The following is a layout of the 75,088-bit SAD Block 11s:

Field	Length
P/N Synch code	10032
Header	720
Data Section	64320
CRC	16

The P/N Synch code, Header, and CRC are described in Sections 3.3.1, 3.3.2, and 3.3.3, respectively.

The 64,320-bit data section is partitioned into two, fixed-length regions. The first region is 240 bits in length and called the SAD Block Identifier (SAD ID). The second region is 64,080 bits in length and defined in accordance with the type of data being transported. The word size employed in the data section also depends on the type of data being transported. Word sizes of 6, 8, and 10 bits are permitted.

The number of words for each of the two regions for the various word sizes are as follows:

Word Size (Bits)	Region 1 (Number of Words)	Region 2
6	40	10680
8	30	8010
10	24	6408

3.3.7.1 SAD ID

The 240-bit SAD ID provides a simple means of identifying which type of data is contained within the block. It also provides a data segmentation mechanism permitting transport of strings whose length exceed the capacity of a single block.

The first nine words, seven fields, in a SAD ID are always defined in the same fashion regardless of the data type or word length. They are defined in terms of six-bit fields, right-adjusted and bounded within 6-, 8-, or 10-bit words. This ensures compatibility with the three word sizes supported by the Block 11 format. These fields, defined in Table 3-8 and illustrated in Figure 3-13, identify the particular data types contained within the block. The fields also provide a linkage mechanism for multi-block sequences. Table 3-9 defines the additional fields used to support text messages.

Table 3-8. SAD Block 11 Identifier

Words	Name	Description
1	SAD_SCID_*	Spacecraft Identity: a binary number identifying the source satellite as follows: 8 = GOES-I 9 = GOES-J 10 = GOES-K 11 = GOES-L 12 = GOES-M 13 = GOES-N 14 = GOES-O 15 = GOES-P
2	SAD_SPSID_*	SPS ID a binary number identifying the source SPS which formatted the GVAR data stream. Values 1 – 9 are assigned to SPS1 to SPS9, respectively.
3	SAD_DATAID_*	Data Identity – a binary number denoting the SAD block type as follows[#]: x '01' = 01 Fill data x '07' = 07 Imager compensation terms x '0E' = 14 Sounder compensation terms x '15' = 21 Imager telemetry statistics x '16' = 22 Imager spacelook data x '19' = 25 Imager calibration coefficients and limits x '1A' = 26 Imager ECAL data x '1C' = 28 Imager BB data x '1F' = 31 Imager NLUTs data x '20' = 32 Sounder documentation data x '23' = 35 Sounder scan data x '25' = 37 Sounder telemetry statistics x '26' = 38 Sounder spacelook data x '29' = 41 Sounder calibration Coefficients and limits x '2A' = 42 Sounder ECAL data x '2C' = 44 Sounder BB data x '2F' = 47 Sounder NLUTs data x '31' = 49 Imager Factory Coefficients x '32' = 50 GIMTACS text message x '34' = 52 SPS text message x '38' = 56 Reserved x '3B' = 59 Imager star sense data x '3D' = 61 Sounder star sense data
4	SAD_FIRSTBLOCK_*	First Block Flag – a 6-bit flag set to 63 (x '3F') if the SAD Block is the first of a series. Otherwise, the value is set to 0.[†]
5	SAD_LASTBLOCK_*	Last Block Flag – a 6-bit flag set to 63 (x '3F') if the SAD Block 11 is the last of a series. Otherwise, the value is set to 0.[†]
6-8	SAD_BLOCKCOUNT_*	Block Count – an 18-bit binary number representing the number of blocks within a sequence of blocks. Starts as 1 when First Block Flag is set and increments for each block after until Last Block Flag is set.
9	SAD_RECORDCOUNT_*	RECORD COUNT – a 6-bit binary count of records in block; 0 to 63 corresponding to 1 to 64 records. Set to 63 (x '3F') for fill data.
10–20	***	***Used to support text messages. Refer to Table 3-9.
21	SAD_YAW_FLIP_*	YAW-FLIP FLAG – a 6-bit flag set to 63 (x '3F') if the satellite is currently yaw-flipped. Otherwise, the value is reset to 0.
22–N	SAD_SPARES_*	Spare–not used**

Notes:

- # The numbers used in word 3 ensure that single-bit transmission errors do not result in misidentification of the data in the block.
- † If a complete sequence of data is contained in a single SAD Block, both the FIRST and LAST BLOCK FLAGs are set to 63, x ‘3F’.
- ** N = 40, 30, or 24 for 6-, 8-, or 10-bit word sizes, respectively.

WORDS	BITS										
					0	1	2	3	4	5	6-Bit Words
			0	1	2	3	4	5	6	7	8-Bit Words
	0	1	2	3	4	5	6	7	8	9	10-Bit Words
01	x	x	x	x	S/C IDENTITY						Words 1–9 and 21–N are always defined
02	x	x	x	x	SPS IDENTITY						the same way regardless of the
03	x	x	x	x	DATA IDENTITY						SAD Block 11 data type or word length:
04	x	x	x	x	FIRST BLOCK FLAG						6-bit, right-adjusted fields.
05	x	x	x	x	LAST BLOCK FLAG						Table 3-8 provides the definitions
06	x	x	x	x	BLOCK						(x = bit not used)
07	x	x	x	x							(b = bit field open)
08	x	x	x	x	COUNT						
09	x	x	x	x	RECORD COUNT						
10											Words 10–20 are defined according
•											to the application.
•											Table 3-9 provides the definitions.
20											
21	x	x	x	x	YAW-FLIP FLAG						
22	x	x	x	x	Spare–not used.						
23	x	x	x	x	Spare–not used.						SAD ID has:
24	b	b	b	b	b	b	b	b	b	b	24 ten-bit words
25			b	b	b	b	b	b	b	b	
•											
30			b	b	b	b	b	b	b	b	or 30 eight-bit words
31					b	b	b	b	b	b	
•											
40					b	b	b	b	b	b	or 40 six-bit words

Figure 3-13. SAD Block 11 Identifier

Table 3-9. SAD ID Text Messge Block 11

Words	Name	Description
10	NA	Source ID -- an 8-bit binary number denoting the following message originator: See Note 3, Figure 4-6.
11-12	NA	Number of Words -- a 16-bit count of the number of characters in the data section that follows.
13-20	NA	Time Queued -- a 64-bit BCD-encoded CDA time tag denoting when the Block 11 was queued for transmission. The format of the eight words comprising this tag is the same as that described for words 59-178 in Table 3-10.

3.3.7.2 Sounder Scan Documentation

The Sounder Scan Documentation Block 11 is analogous in function to the Imager documentation Block 0. It has the same priority as a Sounder Scan Block 11. The Sounder Scan Documentation Block 11 is always the first block of a Block 11 sequence constituting a Sounder scan line and consists of 8040 eight-bit words divided into the following four partitions:

Partition	Word Range
SAD ID (see Section 3.3.7.1)	1–30
Instrument and Scan Status	31–306
Sounder O&A parameters	307–1718
Factory Parameters	3005–8040

The SAD ID is described in Section 3.3.7.1 and its layout specified in Table 3-8 and 3-9. The remaining three partitions are described in the following sections and their layout specified in Table 3-10.

3.3.7.2.1 Instrument and Scan Status

This partition summarizes the status of the Sounder, the current sounding frame, and the radiometric detectors. Time tags denoting significant events and identifying various process entities are provided. In addition, coordinate information locating points is provided for the various reference frames.

3.3.7.2.2 Sounder O&A Data

This partition contains the parameters and coefficients describing the Sounder O&A data acquired from the OATS. The usage of the contained information depends upon the status of the IMC function. If IMC is enabled, the O&A data is valid for a fixed period called the registration interval. If IMC is disabled, the O&A values apply only to a single point in time. Under these conditions, the O&A information must be translated through time to the desired calculation point.

3.3.7.2.3 Factory Parameters

This partition provides factory measured calibration coefficients associated with each of the 76 channel-detectors. The detector misalignments with respect to the instrument's optical axis are included. In addition, the coefficients required to convert raw telemetry counts to engineering units are provided for those points employed by the SPS in processing the Sounder data stream.

Table 3-10. Sounder Scan Documentation Block 11 Format

Word	Name	Description

31–32	SSCAN*	Sounder scan status in two words, 16 bits. The MSB is bit 0 of word 1, and the LSB is bit 15 of word 2. For each status bit that does not have a bit value of 0 listed below, a value of 0 represents a condition that is opposite or negative of the condition associated with a bit value of 1. For example, if bit 0 has a value of 1, a frame start occurred on this scan; if bit 0 has a value of 0, no frame start occurred on this scan.
		Bits / **Value** / **Condition**
		0 / 1 / Frame start
		1 / 1 / Frame end
		2 / 1 / Frame break – line(s) lost
		3 / 1 / Line break – pixel(s) lost
		4 / 1 / Priority 1 frame data
		5 / 1 / Priority 2 frame data
		6 / 0 / W-E scan
		  / 1 / E-W scan
		7 / 0 / N-S frame
		  / 1 / S-N frame
		8 / 1 / IMC enabled
		9 / 1 / Dwell mode = 4
		10 / 1 / Dwell mode = 2
		11 / 1 / Dwell mode = 1
		12 / 1 / N-S step mode = double
		13 / 0 / Side 1 electronics active
		  / 1 / Side 2 electronics active
		14 / 1 / Visible normalization enabled
		15 / 1 / IR calibration enabled
		SSCAN_P0 through SSCAN_P15

33–42	SDSTA*	Detector status in 10 words, 80 bits. First 76 bits, correspond to the 76 CDET in the Sounder, 1 bit per CDET in increasing CDET (1-1, 1-2, 1-3, 1-4, 2-1, …, 19-4) order. A set bit indicates the data for the associated CDET are suspect or invalid. The last 4 bits of word 42 are not used and always reset to zeros. SDSTA1 - 10
43–44	SRBCT	Total number of raw scan data blocks included in this scan. For dwell=1 or 2, values can range from 1 to a maximum of 1434 for a 23 deg wide frame. For dwell=4, the maximum is 5736 for a 23 deg wide frame.
45–46	SGBCT	Total number of Block 11s comprising the Sounder scan, including the Documentation Block. Values can range from 2 to a maximum of 132, 523 if dwell = 4, for a 23° wide scan with no line breaks.
47–48	SLOCT	Number of line breaks, raw data synchronization losses, contained in this scan.
49–50	SSBRK	Number of the pixel following the first star sense break. Ranges from 0–1758; 0 means no break.
51–52	SCBRK	Number of the pixel following the first calibration break. Ranges from 0– 1758; 0 means no break.
53	SSCP1	Odd parity byte computed for SSCAN (see words 31–32).
54	SRELON	Relativization indication, 1 indicates function is active.
55–56	SNBOOST	With relativization enabled, this is the amount of boost (the arbitrary space count level).
57	YAWFL	Yaw-flip flag; bit 0 = 1 if the satellite is flipped, else = 0.

58		Spare–not used
Words 59 – 178 provide 8-word CDA time tags for 15 specific events, with each time tag formatted as follows:		
Word	**Bits**	**BCD Formatted Contents**
1	0–3	Year in 1000s
	4–7	Year in 100s
2	0–3	Year in 10s
	4–7	Year in 1s
3	0-3	DOY in 100s *
	4-7	DOY in 10s
4	0–3	DOY in 1s
	4–7	Hours in 10s
5	0-3	Hours in 1s
	4–7	Minutes in 10s
6	0-3	Minutes in 1s
	4–7	Seconds in 10s
7	0-3	Seconds in 1s
	4–7	Msec in 100s
8	0-3	Msec in 10s
	4–7	Msec in 1s
Note: * Word 3, bit 0 = 1 indicates the time code generator has lost its external synchronization signal and is operating with an internal oscillator, a mode called flywheeling.		
59–66	TSCURR	Current SPS time
67–74	TSCLS	Time of scan line start
75–82	TSCLE	Time of scan line end
83–90	TCSLS	Time of calibration set at line start
91–98	TCSLE	Time of calibration set at line end
99-106	TSPFS	Time of priority frame start
107–114	TSNFS	Time of normal frame start
115–122	TSSPC	Time of last spacelook calibration
123–130	TSECL	Time of last ECAL
131–138	TSBBC	Time of last BB-Cal
139–146	TSSTR	Time of last star sense
147–154	TLRAN	Time of last ranging measurement
155–162	TSVIT	Time Tag of visible NLUTs set used
163–170	TSCLMT	Time Tag of current Limits set

171–178	TSONA	Time Tag current O&A set implemented
179–180		Spares–not used
The following 126 words provide information associated with the Sounder's reference frames and the current frame:		
181–182	RSSCT	Relative output scan sequence count since frame start. Ranges 1–396.
183–184	ASSCT	The current output scan number. Values of 1 – 396 correspond to scan swaths, northernmost to southernmost, in the Sounder's 9-cycle FOV.
185–186	SNSLN	The number of the northernmost visible detector scan line in the current scan. Inclusive values of 1 – 1579 correspond to detector lines, northernmost to southernmost, in the Sounder's 9-cycle FOV.
187–188	SWFPX	The number of the westernmost visible pixel in the current frame. Inclusive values of 1 – 1754 correspond to the pixels, westernmost to easternmost, in the instrument's 5-cycle FOV.
189–190	SEFPX	The number of the easternmost visible pixel in the current frame. Inclusive values of 5 – 1758 correspond to the pixels, westernmost to easternmost, in the Sounder's 5-cycle FOV.
191–192	SNFLN	The number of the northernmost visible detector scan line in the current frame. Inclusive values of 1 – 1579 correspond to detector lines, northernmost to southernmost, in the Sounder's 9-cycle FOV.
193–194	SSFLN	The number of the southernmost visible detector scan line in the current frame. Inclusive values of 4 – 1582 correspond to detector lines, northernmost to southernmost, in the Sounder's 9-cycle FOV.
195–196	SMDPX	The number of the visible pixel corresponding to an instrument azimuth of 0°. Nominal value, ½ full range, is 879. This value is a constant per instrument.
197–198	SMDLN	The number of the scan line corresponding to an instrument elevation of 0°. Nominal value, ½ full range, is 791. This value is a constant per instrument.
199–200	SMDCT	The number of the output scan corresponding to an instrument elevation of 0°. Nominal value, ½ full range, is 198. This value is a constant per instrument.
The following four terms, words 201–214, are computed using the current O&A set. If IMC is on, the terms reflect the reference position subsatellite point. If IMC is off, the terms reflect the actual subsatellite point.		
201–202	SGVLN	The number of the visible detector scan line intersecting the subsatellite point.
203–204	SGVPX	The number of the visible pixel intersecting the subsatellite point.
205–206		Spares–not used
207–210	SUBLA2	The subsatellite latitude, a floating point number with units of degrees.
211–214	SUBLO2	The subsatellite longitude, a floating point number with units of degrees.
215–226		Spares–not used
227–230	SDBER	Current raw data BER, a floating point number denoting the most recent BER measure with nominal values on the order of 1.0E–6.
231–234	RANGE2	Most recently computed range, a floating point value denoting number of 50-MHz clock counts for signal transmission from satellite to ground.
235–238	GPATH2	Most recent range calibration ground path delay, a floating value denoting the number of 50-MHz clock counts that the GVAR signal takes to transit through CDA station equipment.

239–242	XMSNE2	The collimation tower range calibration value, a floating point value denoting the GVAR signal delay through the ground station's antenna feed and the spacecraft's Processed Data Relay (PDR) transponder in 50-MHz clock counts.
243–250	TGPAT2	GPATH measurement CDA TOD, in the same format as words 59–66.
251–258	TXMSN2	XMSNE measurement CDA TOD, in the same format as words 59–66.
259–260		Spares–not used
261	SFRAM	Current frame counter, an integer ranging from 0 – 255 identifying current frame. Rolls over to 0 following 255.
262	SMODE	Current sounding mode. Integer value, as follows: 1 = routine 2 = rapid scan operation 3 = super rapid scan operation 4 = checkout or special short-term operation 0,5 = 255 (undefined, not used)
The following 16 words, 263–278, contain frame-coordinate floating point values in units of degrees, with off-Earth coordinates indicated by a value of 999999.		
263–266	SFNW1	Current frame's northwest corner latitude
267–270	SFNW2	Current frame's northwest corner longitude
271–274	SFSE1	Current frame's southeast corner latitude
275–278	SFSE2	Current frame's southeast corner longitude
279	SG2TN	Second-order gain interpolation table index number with integer values of 1, 2, or 3 denoting which of three possible tables are reported in SG2IT words 4567–5718.
280	SSCP2	**Repeat of SSCP1 (see word 53)
281–282	SSCA2	**Repeat of SSCAN (see words 31–32)
283-290	CSFST	Current Sounder Frame Start Time. CDA time tag - 8 words formatted in same manner as defined for words 59-178.
290–305		Spares–not used
306	PXOR7	Longitudinal parity (XOR) of words 1–305
The O&A partition contains the Sounder O&A parameters being used. The format and engineering units of each variable are denoted in parentheses. The partition is sized to hold the largest expected O&A set. In general, the actual number of parameters in effect is less than the maximum and vary over time. The numeric parameters, words 563–566 and 687–690, denote the number of active terms employed for the roll attitude angle. In a similar fashion, each of the remaining four angles modeled by the O&A set is denoted by numeric parameters defining the number of active terms. Inactive terms are not compressed out of the O&A set; their places are occupied by zeroed data words.		
307–310	IMCID2	IMC Identifier (4 ASCII characters)
311–322		Spares–not used
323–326	REFLO2	Reference Longitude (positive East, R*4, radians)
327–330	REFRA2	Reference radial distance from nominal (R*4, km)
331–334	REFLA2	Reference Latitude (positive North, R*4, radians)
335–338	REFOR2	Reference Orbit yaw (R*4, radians)
339–342	REROL2	Reference Attitude: Roll (R*4, radians)

343–346	REPIT2	Reference Attitude: Pitch (R*4, radians)
347–350	REYAW2	Reference Attitude: Yaw (R*4, radians)
351–358	EPODT2	Epoch Date and Time: Standard BCD format
359–362	IMCSET2	IMC set enable time from epoch (R*4, minutes)
363–366	COROL2	Spacecraft compensation: Roll (R*4, radians)
367–370	COPIT2	Spacecraft compensation: Pitch (R*4, radians)
371–374	COYAW2	Spacecraft compensation: Yaw (R*4, radians)
375–426	CHLON2	Change in longitude from ref. (13 at R*4, radians)
427–470	CHRAD2	Change in radial distance from ref. (11 at R*4, km)
471–506	SINLA2	Sine geocentric latitude, total (9 at R*4, no units)
507–542	SIYAW2	Sine orbit yaw, total (9 at R*4, no units)
543–546	DAYSO2	Daily Solar Rate (R*4, radians per minute)
547–550	START2	Exponential Start time from epoch (R*4, minutes)
The following words, 551–770, apply to the roll attitude angle:		
551–554	EXMAGR2	Exponential Magnitude (R*4, radians)
555–558	EXTICR2	Exponential Time Constant (R*4, minutes)
559–562	MATANR2	Constant, mean attitude angle (R*4, radians)
563–566	SINANR2	Number of Sinusoids/Angles (I*4, none)
567–570	MAG1SR2	Magnitude of first-order sinusoid (R*4, radians)
571–574	PA1SDR2	Phase angle of first-order sinusoid (R*4, radians)
575–686	**	**Repeat 567–574 for second-order through 15th-order sinusoids (R*4, radians) MAG#SR2, # = 2 through 9, PA#SDR2, # = 2 through 9, MA##SR2, ## = 10 through 15, PA##SR2, ## = 10 through 15.
687–690	NUMMSR2	Number of monomial sinusoids (I*4, no units)
691–694	OAPS1R2	Order of applicable sinusoid (I*4, no units)
695–698	O1MSDR2	Order of first monomial sinusoid (I*4, no units)
699–702	MMSD1R2	Magnitude of monomial sinusoid (R*4, radians)
703–706	PAMS1R2	Phase angle of monomial sinusoid (R*4, radians)
707–710	AEMZ1R2	Angle from epoch where monomial is zero (R*4, radians)
711–770	**	**Repeat 691–710 for second – fourth monomials OAPS#R2, # = 2 through 4 O#MSDR2, # = 2 through 4 MMSD#R2, # = 2 through 4 PAMS#R2, # = 2 through 4 AMEZ#R2, # = 2 through 4

771–990	**	**Repeat 551–770 for Pitch attitude angle EXMAGP2 EXTICP2 MATANP2 SINANP2 MAG#SP2, where # = 1 through 9 PA#SDP2, where # = 1 through 9 MA##SP2, where ## = 10 through 15 PA##SP2, where ## = 10 through 15 NUMMSP2 OAPS#P2, where # = 1 through 4 O#MSDP2, where # = 1 through 4 MMSD#P2, where # = 1 through 4 PAMS#P2, where # = 1 through 4 AMEZ#P2, where # = 1 through 4
991–1210	**	**Repeat 551–770 for Yaw attitude angle EXMAGY2 EXTICY2 MATANY2 SINANY2 MAG#SY2, where # = 1 through 9 PA#SDY2, where # = 1 through 9 MA##SY2, where ## = 10 through 15 PA##SY2, where ## = 10 through 15 NUMMSY2 OAPS#Y2, where # = 1 through 4 O#MSDY2, where # = 1 through 4 MMSD#Y2, where # = 1 through 4 PAMS#Y2, where # = 1 through 4 AMEZ#Y2, where # = 1 through 4
1211–1430	**	**Repeat 551–770 for Roll Misalignment angle EXMAGRM2 EXTICRM2 MATANRM2 SINANRM2 MAG#SRM2, where # = 1 through 9 PA#SDRM2, where # = 1 through 9 MA##SRM2, where ## = 10 through 15 PA##SRM2, where ## = 10 through 15 NUMMSRM2 OAPS#RM2, where # = 1 through 4 O#MSDRM2, where # = 1 through 4 MMSD#RM2, where # = 1 through 4 PAMS#RM2, where # = 1 through 4 AMEZ#RM2, where # = 1 through 4

1431–1650	**	**Repeat 551–770 for Pitch Misalignment angle EXMAGPM2 EXTICPM2 MATANPM2 SINANPM2 MAG#SPM2, where # = 1 through 9 PA#SDPM2, where # = 1 through 9 MA##SPM2, where ## = 10 through 15 PA##SPM2, where ## = 10 through 15 NUMMSPM2 OAPS#PM2, where # = 1 through 4 O#MSDPM2, where # = 1 through 4 MMSD#PM2, where # = 1 through 4 PAMS#PM2, where # = 1 through 4 AMEZ#RM2, where # = 1 through 4
1651–1652	SSCA3	**Repeat of SSCAN (see words 31–32)
1653	SSCP3	**Repeat of SSCP1 (see word 53)
1654–1717		Spares–not used
1718	PXOR8	Longitudinal parity (XOR) of words 307–1717
1719–2994		Unused – zeroes
2995–3002	SPSSATTIM	Satellite database modified time (BCD time)
3003–3004	SPSSATVER	Satellite database version number
The factory parameters partition contains the values of various Sounder coefficients and parameters measured prior to launch. For the most part, these values serve as an historical reference useful in evaluating the current condition of the detectors. In a few instances, the values are used throughout the life of the instrument as part of the normal calibration functions. The nadir location of the instrument is measured in terms of cycles and increments in the N-S and E-W directions (see Section 3.4). Cycles are expressed as 8-bit integers ranging from 0 – 127. Increments are expressed as 16-bit integers ranging from 0 – 2804.		
3005	SOFNC	Instrument nadir, top-bottom cycles
3006	SOFEC	Instrument nadir, right-left cycles
3007–3008	SOFNI	Instrument nadir, top-bottom increments
3009–3010	SOFEI	Instrument nadir, right-left increments
For each of the 16 sounding detectors (4 visible, 12 IR), two 16-bit integer values are provided to denote the X (right-left) and Y (top-bottom) µradian offset of the detector from the instrument's optical axis. Negative values employ two's complement notation. Values can range from –32,768 to +32,767.		
3011–3012	XOVDA	X-offset Visible detector 1 (A)
3013–3014	XOVDB	X-offset Visible detector 2 (B)
3015–3016	XOVDC	X-offset Visible detector 3 (C)
3017-3018	XOVDD	X-offset Visible detector 4 (D)
3019–3020	XOLIA	X-offset Longwave IR detector 1 (A)
3021–3022	XOLIB	X-offset Longwave IR detector 2 (B)
3023–3024	XOLIC	X-offset Longwave IR detector 3 (C)
3025–3026	XOLID	X-offset Longwave IR detector 4 (D)
3027–3028	XOMIA	X-offset Midwave IR detector 1 (A)

3029–3030	XOMIB	X-offset Midwave IR detector 2 (B)
3031–3032	XOMIC	X-offset Midwave IR detector 3 (C)
3033–3034	XOMID	X-offset Midwave IR detector 4 (D)
3035–3036	XOSIA	X-offset Shortwave IR detector 1 (A)
3037–3038	XOSIB	X-offset Shortwave IR detector 2 (B)
3039–3040	XOSIC	X-offset Shortwave IR detector 3 (C)
3041–3042	XOSID	X-offset Shortwave IR detector 4 (D)
3043–3044	YOVDA	Y-offset Visible detector 1 (A)
3045–3046	YOVDB	Y-offset Visible detector 2 (B)
3047–3048	YOVDC	Y-offset Visible detector 3 (C)
3049-3050	YOVDD	Y-offset Visible detector 4 (D)
3051–3052	YOLIA	Y-offset Longwave IR detector 1 (A)
3053–3054	YOLIB	Y-offset Longwave IR detector 2 (B)
3055–3056	YOLIC	Y-offset Longwave IR detector 3 (C)
3057–3058	YOLID	Y-offset Longwave IR detector 4 (D)
3059–3060	YOMIA	Y-offset Midwave IR detector 1 (A)
3061–3062	YOMIB	Y-offset Midwave IR detector 2 (B)
3063–3064	YOMIC	Y-offset Midwave IR detector 3 (C)
3065–3066	YOMID	Y-offset Midwave IR detector 4 (D)
3067–3068	YOSIA	Y-offset Shortwave IR detector 1 (A)
3069–3070	YOSIB	Y-offset Shortwave IR detector 2 (B)
3071–3072	YOSIC	Y-offset Shortwave IR detector 3 (C)
3073–3074	YOSID	Y-offset Shortwave IR detector 4 (D)
A set of characteristic response coefficients is provided for each of the 19 channels, containing the initial calibration coefficients associated with the detectors. The scaling factors are used to generate a 16-bit value from each calibrated IR pixel. All entries are single-precision floating point numbers. Each of the following three arrays contain four elements, one element for each 10-km visible detector. Within each array, the elements are ordered one, two, three, and four, where the numbers have the same top-to-bottom sense indicated in Figure 3-15.		
3075–3090	SVCRB*	Visible detector characteristic response bias coefficients array. SVCRB_P0 - P3
3091–3106	SVCR1*	Visible detector characteristic response first-order gain coefficients array. SVCR1_P0 - P3
3107–3122	SVCR2*	Visible detector characteristic response second-order gain coefficients array. SVCR2_P0 - P3
3123–3126	SVRAL	Visible detector radiance-to-albedo conversion factor. Single value for detectors 1 - 4.
Each of the following five arrays contains 72 elements, sequentially divided into 18 groups of four elements. The first four-element group is assigned to channel 1 and the next to channel 2. This pattern continues for all groups until the last group is assigned to channel 18. Within each group, the four elements are sequentially assigned in a top-to-bottom sense to detectors 1 – 4.		

3127–3414	SICRB*	IR detector characteristic response bias coefficients array. SICRB_P0 - P71
3415–3702	SICR1*	IR detector characteristic response first-order gain coefficients array. SICR1_P0 - P71
3703–3990	SICR2*	IR detector characteristic response second-order gain coefficients array. SICR2_P0 - P71
3991–4278	SISFB*	IR detector scale factor bias coefficients array. SISFB_P0 - P71
4279–4566	SISF1*	IR detector scale factor first-order gain coefficients array. SISF1_P0 - P71
4567–5718	SG2IT*	IR detector second-order gain interpolation table containing 288 elements. The elements are sequentially arranged as 72 groups, four elements per group. The first four elements are assigned to Channel 1-Detector 1 with the next four to Channel 1-Detector 2, and so on until the last group of four, which is assigned to Channel 18-Detector 4. SG2IT_P0 - P287
5719–5734	SG2BP*	IR detector second-order gain baseplate temperature interpolation pivot points. Four baseplate temperatures at which SG2IT gains were measured for each IR detector. Access this table with baseplate temperature to determine interpolation factors to use within SG2IT. SG2BP_P0 - P3
5735–6886	SBBTR*	BB temperature-to-target radiance conversion coefficients array. Array of 288 elements, four elements for each of 72 IR CDET. Elements are ordered in the same manner as described for SG2IT. SBBTR_P0 - P287
6887–6910	SPRNG*	Patch temperature control ranges, an array of six elements. Two elements comprise each of the three patch temperature control ranges. Each pair of elements defines the lower and upper temperature limits assigned to a patch control point. SPRNG_P0 - P5
6911–6912	SADCP	A constant to correct the positive analog count values for the discontinuity at zero caused by the A–D converter.
6913–6914	SADCN	A constant to correct the negative analog count values for the discontinuity at zero caused by the A–D converter.
6915–7342		Spares–not used
The following words contain conversion coefficients for each telemetry point whose engineering units value is used for calibration or alarm monitoring functions by the SPS. Conversion factors for unused telemetry points may be ascertained from reference document SJ-572022.		
7343–7346	SCHTA	Sounder Cooler Housing PRT coefficients. The final letter of the term name (A – F) denotes the type. To convert raw counts to engineering units: Temp = A + BX + CX^2 + DX^3 The last two terms (E-F) are set equal to zero.
7347–7350	SCHTB	Refer to 7343–7346 description.
7351–7354	SCHTC	Refer to 7343–7346 description.
7355–7358	SCHTD	Refer to 7343–7346 description.
7359–7362	SCHTE	Refer to 7343–7346 description.
7363–7366	SCHTF	Refer to 7343–7346 description.

7367–7370	SEL1A	Sounder Electronics #1 Thermistor coefficients. The final letter of the term name (A – F) denotes the type. See Eq 3.6-5 and 3.6-6 for usage.
7371–7374	SEL1B	Refer to 7367–7390 description.
7375–7378	SEL1C	Refer to 7367–7390 description.
7379–7382	SEL1D	Refer to 7367–7390 description.
7383–7386	SEL1E	Refer to 7367–7390 description.
7387–7390	SEL1F	Refer to 7367–7390 description.
The A–F naming convention used above with SEL1_ is also used for the following thermistor terms:		
The A–F naming convention used above with SCHT_ is also used for the following thermistor terms:		
7391–7414	SEL2*	Sounder Electronics Side No. 2 thermistor terms SEL2A – F
7415–7438	SBP1*	Baseplate thermistor No. 1 terms SBP1A – F
7439–7462	SBP2*	Baseplate thermistor No. 2 terms SBP2A – F
7463–7486	SBP3*	Baseplate thermistor No. 3 terms SB3A – F
7487–7510	SBP4*	Baseplate thermistor No. 4 terms SBP4A – F
7511–7534	SBP5*	Baseplate thermistor No. 5 terms SBP5A – F
7535–7558	SBP6*	Baseplate thermistor No. 6 terms SBP6A – F
7559–7582	SBB1*	BB thermistor No. 1 terms SBB1A – F
7583–7606	SBB2*	BB thermistor No. 2 terms SBB2A – F
7607–7630	SBB3*	BB thermistor No. 3 terms SBB3A – F
7631–7654	SBB4*	BB thermistor No. 4 terms SBB4A – F
7655–7678	SBB5*	BB thermistor No. 5 terms SBB5A – F
7679–7702	SBB6*	BB thermistor No. 6 terms SBB6A – F
7703–7726	SBB7*	BB thermistor No. 7 terms SBB7A – F
7727–7750	SBB8*	BB thermistor No. 8 terms SBB8A – F
7751–7774	SOP1*	Scan Mirror thermistor terms SOP1A – F
7775–7798	SOP2*	Primary Mirror thermistor terms SOP2A – F

7799–7822	SOP3*	Secondary Mirror thermistor No. 1 terms SOP3A - F
7823–7846	SOP4*	Secondary Mirror thermistor No. 2 terms SOP4A – F
7847–7870	SOP5*	Baffle thermistor No. 1 terms SOP5A – F
7871–7894	SOP6*	Baffle thermistor No. 2 terms SOP6A – F
7895–7918	SOP7*	Aft optics thermistor terms SOP7A – F
The next four telemetry points use the following mapping to convert raw counts to engineering units: Temp = A + BX + CX^2 + DX^3		
7919–7942	SOP8*	Cooler radiator PRT terms SOP8A - F The last two terms (E-F) are set equal to zero.
7943–7966	SOP9*	Wide range IR detector PRT terms SOP9A – F
7967–7990	SOPA*	Narrow range IR detector PRT terms SOPAA – F
7991–8014	SOPB*	Filter wheel housing PRT terms SOPBA – F
The remaining three telemetry points use a simple linear gain and bias mapping to convert raw counts to engineering units, as follows:		
8015–8022	SFVGB*	Filter wheel heater gain or bias terms SFVGB_P0 - P1
8023–8030	SPVGB*	Patch control voltage gain or bias terms SPVGB_P0 - P1
8031–8038	SICGB*	Instrument current gain or bias terms SICGB_P0 - P1
8039		Spare–not used
8040	PXOR9	Longitudinal parity (XOR) of words 3005–8039

3.3.7.3 Sounder Scan Data

Sounder data is buffered within SPS memory until an entire scan line of downlinked, raw Sounder data blocks has been acquired. The number of raw blocks acquired can range from five (for a 0.016° dwell 1 scan) to 4788 (for a 19.2° dwell 4 scan). Each raw block contains all of the data acquired at one aim point, including a sample from each of the 76 CDET. Each CDET output is treated as if it were a separate scan line.

Radiometrically corrected, hereafter termed calibrated, versions of these detector scan lines are then created. The creation process uses all of the calibration coefficient sets that were applicable during the course of the Sounder scan. The set applied to a given pixel is determined by comparing the time tag of the pixels' raw data block (see Section 3.3.7.3.1) with the time tag(s) of the available calibration coefficient sets (see Section 3.3.7.9). The set(s) applicable at the start and end of the Sounder scan are directly identified in the documentation block (see Table 3-10, words 83–98).

Following this creation, the resulting 76 scan lines and the raw data scan blocks are each divided into segments, 11 samples in length in a W-E order. The segments are then organized into a number of groups from 1–436. Each group consists of a string of 11 raw Sounder data blocks and an associated 11-pixel subset for each of the 76 calibrated scan lines. A scan line and pixel identifier data structure is then created for each group to cross-reference the grouped information for display functions. Finally, a SAD ID is attached to complete the transformation of each group into a Sounder Scan Data Block 11 format.

The SAD ID links multiple Block 11s together to form a complete output scan. The final Block 11 in an output scan is likely to be only partially filled with 1 – 10 samples. Partially filled Block 11s also occur as a result of line breaks. A line break in the scan is caused by a loss of raw signal synchronization, which causes the loss of one or more raw downlink data blocks. The Block 11 where the line break starts is partially filled with samples acquired up to the break. The next sequential Block 11 is then initiated with samples acquired upon restoration of synchronization. The actual number of samples in a Block 11 is indicated by the associated SAD ID record count (see Table 3-8, word 9).

Physically, the layout of the Sounder Scan Data Block 11 format is always the same, with permanent space allocations for a full 11 sample segment. The data section which results is summarized below and diagramed in Figure 3-14. The SAD ID is defined in the preceding section. The remaining components of each segment are covered in the following sections:

Data Section Component	Words	Bits	Documented in Section
SAD ID	30	240	3.3.7.1
Instrument Data Records	5984	47872	3.3.7.3.1
Line and Pixel Indexes	354	2832	3.3.7.3.2
Detector Data Arrays	1672	13376	3.3.7.3.3

P/N SYNCH CODE	**(10,032 bits)**
HEADER	**(720 bits)**
SAD ID	**(240 bits)**
SOUNDER DATA RECORDS **11 Records at 4352 bits Each**	**(47,872 bits)**
LINE and PIXEL LOCATORS	**(2,832 bits)**
DETECTOR DATA ARRAYS **76 Lines of Calibrated Pixels @ 11 Pixels per Line**	**(13,376 bits)**

Figure 3-14. Sounder Scan Data Block 11 Format

3.3.7.3.1 Sounder Data Records

Each Sounder data record in a Block 11 is 544 eight-bit words, 4352 bits, in length. The first 500 words contain a modified raw downlink Sounder data block. The modifications are performed automatically by the SPS's Sensor Data Interface (SDI) software processes. These modifications include replacing of the leading 8-word (64-bit) block synchronization code with a time tag, and adjusting the format of the remaining 492 words (see Section 3.5.5). The time tag denotes when the synchronization code was received by the SPS. The Sounder scan data time tag is used to select the calibration coefficient set to be used for the data record during the scan line creation sequence.

The last 44 words are appended to each raw block by the SPS and provide status and Earth location information. The status data denotes a number of conditions registered by the SDI software processes when the raw block was received. The Earth location data provides the latitude and longitude on the Earth's surface of the aim point used by the Sounder during the collection of the raw data contained within the record, and the Earth locations associated with the four channel 8 detectors. Table 3-11 defines the contents of the 544-word instrument data record constructed by the SPS. Up to 11 of these records are packed into a Block 11 as follows:

Words	Contents
1–30	SAD ID
31–574	Record 1 (westernmost record in the Block 11)
575–1118	Record 2
1119–4926	Records 3–9
4927–5470	Record 10
5471–6014	Record 11 (easternmost record in the Block 11)

3.3.7.3.2 Line and Pixel Index Arrays

The aim point employed by the Sounder corresponds to its optical axis, approximately the geometric center of the FOV of the scanning detectors. The general form of the relationship is illustrated in Figure 3-15. The instrument operates by settling at a selected aim point, sampling each of the 76 channel-detectors, and then stepping E-W to the next aim point. The resultant raw block generated for each sampling contains pixels asymmetrically distributed with respect to the aim point. When constructing the detector data arrays the SPS "slides" the 76 calibrated scan lines by one another such that the transmitted GVAR Sounder scan data blocks contain calibrated pixel data, which is aligned in Earth location with the downlink data blocks (see Section 3.3.7.3.3). As a result, the 76 scan line segments are aligned in lines of longitude with each other and ready for preliminary display purposes.

The detector lines and pixel locators are provided for the scan line segments to assist the display effort. Table 3-12 defines the format of the information. Note that the scan line and pixel locations are provided in absolute terms (not relative to start-of-frame location). In addition to the line and pixel locators, two (f) flags are provided to indicate the presence of a line break start or end condition.

A line break start indicates one or more raw downlink data blocks are missing from the scan. The last raw block acquired before the onset of the break is included in the Block 11. The remaining raw block slots, 0 – 10, will be unoccupied, as will the associated detector data array locations. The next sequential Block 11 of the scan begins with the scan data acquired when the line break ended, a condition normally associated with the reestablishment of signal synchronization by the SPS.

Table 3-11. Sounder Data Records Block 11

Words	Name	Description
1–500	RSDBC*	The 250, 16-bit words contained in a raw Sounder data block, with each 16-bit raw data word occupying two sequential 8-bit words. The first four of these 250 data words contain the SPS raw data block arrival time tag, which the SPS substituted for the four word raw data block synchronization code. The raw data block content is defined in Space Systems/Loral (SS/L) Specification SJ-572022.
501–504	RSDBC*	Raw Sounder data interface status words, two 16-bit words generated at end of each raw block by the receiving hardware providing configuration and data status. The contents are as follows: **Word** / **Bits** / **Description** 1 / 0–7 / Synchronization code error count 8 / Bit slip sign (1 = negative) 9 / Not used 10–11 / Input channel 12 / Data loss 13 / Clock loss 14 / Sync fault 15 / First frame after synch loss flag 2 / 0–7 / Bit slip magnitude 8–15 / Parity error count
The remaining 40 words provide the Earth locations in degrees of five reference points in floating point format. If a reference point does not intersect the Earth, 999999.0 is used for both latitude and longitude.		
505–508	APLAT*	Aim Point Latitude
509–512	APLON*	Aim Point Longitude
513–516	DALAT*	Channel 8 Detector 1 (A) (Northwest) Latitude
517–520	DALON*	Channel 8 Detector 1 (A) Longitude
521–524	DBLAT*	Channel 8 Detector 2 (B) Latitude
525–528	DBLON*	Channel 8 Detector 2 (B) Longitude
529–532	DCLAT*	Channel 8 Detector 3 (C) Latitude
533–536	DCLON*	Channel 8 Detector 3 (C) Longitude
537–540	DDLAT*	Channel 8 Detector 4 (D) (Southeast) Latitude
541–544	DDLON*	Channel 8 Detector 4 (D) Longitude

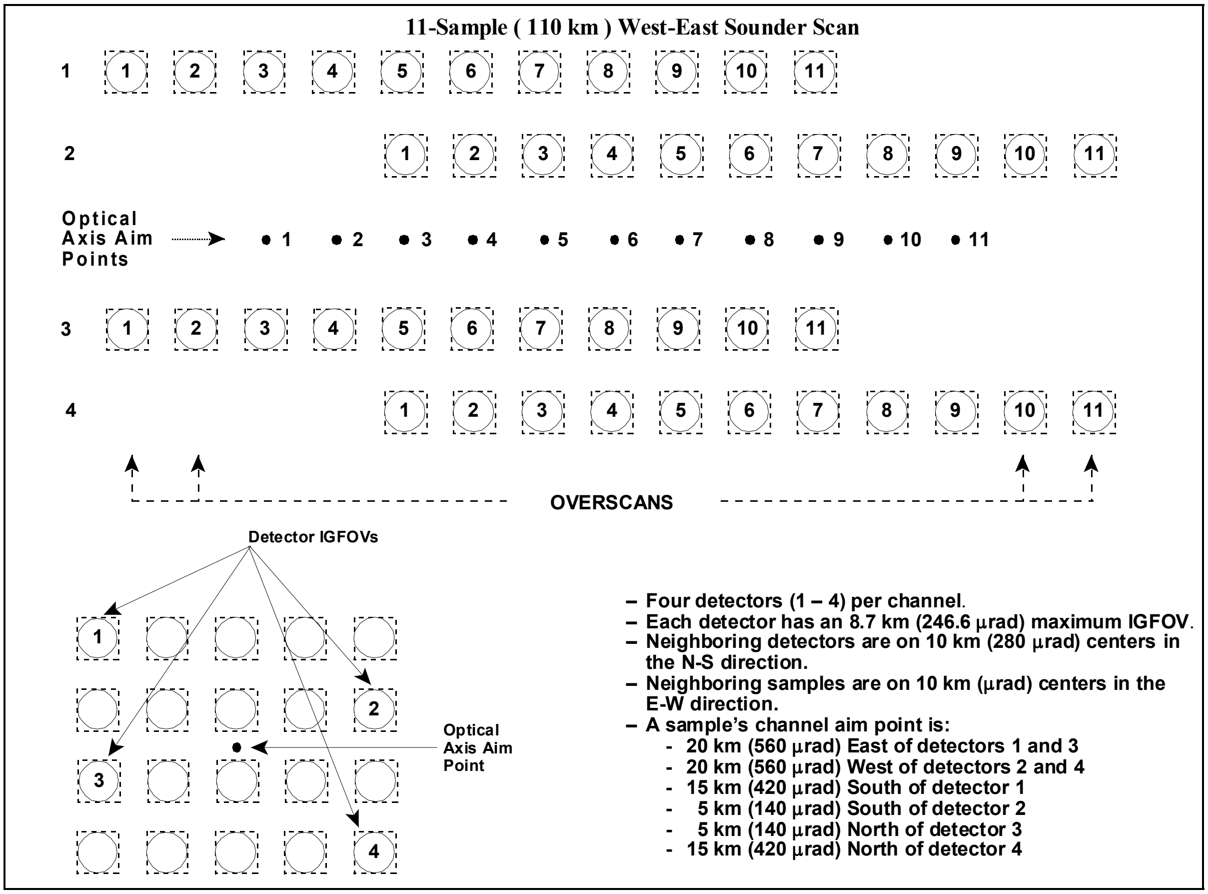


Figure 3-15. Sounder Detector FOV vs. Aim Point

Table 3-12. Sounder Detector Line and Pixel Locator Block 11

Word	Contents	Description
6015–6016	ALINENO	16-bit binary number denoting the detector 1 scan line number. The value provides a vertical display reference and ranges from 1 – 1577.
6017–6018	BLINENO	16-bit detector 2 scan line number
6019–6020	CLINENO	16-bit detector 3 scan line number
6021–6022	DLINENO	16-bit detector 4 scan line number
6023–6044	PIXLNO*	Eleven pixel numbers, each 16-bits (two words) in length. Each number specifies the instrument relative west-to-east aim point associated with one of the 11 pixels of a single detector data array. The value, ranging from 1 – 1758, is used to provide a horizontal reference for displays. Sequential pixels from multiple dwells will have the same number. PIXLNO_P0 - P10
6045	SLOSS	Flag denoting synchronization loss has occurred in this Block 11. Set to zero in case of no loss. Set to 255 (all bits set to 1) if synch has been lost.
6046	SRESTORE	Flag denoting whether synch has been restored in this Block 11. All bits set to 1 (=255) if restore present; else all bits are zero.

6047–6368		Not used – zeroes

To access the raw data associated with a calibrated pixel, satellite orientation (normal or yaw-flipped) must be considered because it affects the relationship of the physical detectors 1–4 to the logical detectors A–D. In the normal satellite orientation, the relationship is as follows:

Physical Detector		**Logical Detector**
1	=	A (northwest)
2	=	B
3	=	C
4	=	D (southeast)

In the yaw-flipped mode, the relationship is as follows:

Physical Detector		**Logical Detector**
4	=	A (northwest)
3	=	B
2	=	C
1	=	D (southeast)

Hence, the calibrated pixel arrays are always ordered north-to-south and west-to-east, regardless of the satellite orientation. A yaw-flip indicator is provided in the SAD ID as well as in word 57 of the Sounder documentation block.

It is important to note that ITT Industries, Defense Products and Services Segment, Aerospace/ Communication Unit (ITT) numbers the Sounder detectors differently than SPS does in GVAR. In ITT documentation, detector numbering begins with the bottom right detector as number one and the top left detector as number four.

In addition, the positional alignment discussed previously causes a misalignment with respect to time between the calibrated pixel information and the downlink data blocks. The time aligned raw data associated with the k^{th} calibrated pixel can be located in the i^{th} downlink data block as follows:

a. For detectors “1” and “2”, i = k + 2 * dmode
b. For detectors “2” and “4,” i = k – 2 * dmode

where *k* ranges from 1 – 11 and *dmode* is either 1, 2, or 4 according to the current dwell mode. If *i* exceeds 11, the desired downlink block is in the next sequential SAD block. If *i* is less than 1, the desired downlink data is located in the previous SAD block.

Figure 3-15 depicts a west-to-east scan of 110 km as provided by Sounder channel *n*. The aim points 1 – 11 are each bracketed by a distinct set of four FOVs corresponding to each of the four detectors in a channel. Note that aim point number 3 is the first aim point for which detectors 2 and 4 have data available, while detectors 1 and 3 have no data available after aim point 9.

Figure 3-16 represents the Sounder scan data block resulting from the 110 km scan of Figure 3-15. The relationships between the 11 downlink sensor data blocks and the resultant calibrated detector scan lines is depicted. A scan length of 110 km (11 raw data blocks) was selected to illustrate the boundary conditions at the start and end of a line of pixels using only one Block 11. For longer width scans, the non-present (zero) pixels depicted in Figure 3-16 would occur in only the first (detectors 2 and 4) and last (detectors 1 and 3) Block 11s of the scan sequence.

SOUNDER DATA RECORD No. 1 Earth Location Aim Point 1 k = 1 544 8-bit words (see Table 3-12)
• Raw data blocks are ordered by Earth location W-E, such that sample *n* is always either collocated or west of sample *n*+ 1 •
SOUNDER DATA RECORD 11 Earth Location Aim Point 11 k = 11

Display Data (Table 3-13)

1 lines	2 lines	3 lines	4 lines	Line numbers denote absolute scan lines (1–1580) for all channel-detectors 1–4.						
AP No. 1	2	3	4	5	6	7	8	9	10	11

Values denote absolute instrument pixel numbers (1–1758).

Calibrated Sounder Pixel Data (Table 3-14)

CHANNEL	k = 1	2	3	4	5	6	7	8	9	10	11
01	1 (3)	1 (4)	1 (5)	1 (6)	1 (7)	1 (8)	1 (9)	1 (10)	1 (11)	0	0
	0	0	2 (1)	2 (2)	2 (3)	2 (4)	2 (5)	2 (6)	2 (7)	2 (8)	2 (9)
	3 (3)	3 (4)	3 (5)	3 (6)	3 (7)	3 (8)	3 (9)	3 (10)	3 (11)	0	0
	0	0	4 (1)	4 (2)	4 (3)	4 (4)	4 (5)	4 (6)	4 (7)	4 (8)	4 (9)
02 • • 19	1 (3) • • 0	Four Channel 01 arrays are repeated for each of the 18 remaining channels								• • 4 (9)	

Figure 3-16. Sounder Raw and Block 11 Data for the Sample 110-km Scan

3.3.7.3.3 Detector Data Arrays

There are 72 calibrated IR detector data arrays and four normalized visible detector data arrays contained in a Sounder sensor data block, for a total of 76 detector data arrays. Each array is 11 pixels in length. Each calibrated IR pixel is 16 bits wide, occupying two sequential 8-bit words. Each normalized visible pixel (from channel 19 detectors) is 13 bits wide, left-adjusted and zero-filled within the 16-bit field. The source raw data pixels have 13-bit precision. Part of the calibration process employed involves a scaling operation to provide 16 bits of precision. Pixels whose raw data contain a parity error are assigned a value of zero. A value of zero is also assigned to the two non-present pixels at the start (detectors 2 and 4) and end (detectors 1 and 3) of a scan.

The 76 detector data arrays are allocated space within the Block 11 Sounder Channel-Detector array indicated in Table 3-13. Labeling of detectors with numbers 1, 2, 3, and 4 is done in the same north-to-south sense indicated in Figure 3-15.

Table 3-13. Block 11 Sounder Channel-Detector Array Assignments

Sounder Channel	Detector			
	1	2	3	4
01	6369–6390	6391–6412	6413–6434	6435–6456
02	6457–6478	6479–6500	6501–6522	6523–6544
03	6545–6566	6567–6588	6589–6610	6611–6632
04	6633–6654	6655–6676	6677–6698	6699–6720
05	6721–6742	6743–6764	6765–6786	6787–6808
06	6809–6830	6831–6852	6853–6874	6875–6896
07	6897–6918	6919–6940	6941–6962	6963–6984
08	6985–7006	7007–7028	7029–7050	7051–7072
09	7073–7094	7095–7116	7117–7138	7139–7160
10	7161–7182	7183–7204	7205–7226	7227–7248
11	7249–7270	7271–7292	7293–7314	7315–7336
12	7337–7358	7359–7380	7381–7402	7403–7424
13	7425–7446	7447–7468	7469–7490	7491–7512
14	7513–7534	7535–7556	7557–7578	7579–7600
15	7601–7622	7623–7644	7645–7666	7667–7688
16	7689–7710	7711–7732	7733–7754	7755–7776
17	7777–7798	7799–7820	7821–7842	7843–7864
18	7865–7886	7887–7908	7909–7930	7931–7952
19	7953–7974	7975–7996	7997–8018	8019–8040

Each of the 76 arrays is aligned with one another such that the k^{th} element of each array corresponds to the same Earth-located line of longitude. The associated aim point coordinates, latitude and longitude, can be obtained by accessing the k^{th} downlink data block.

3.3.7.4 Compensation and Servo Error Terms

Both the Imager and the Sounder employ two-degree of freedom scan mirrors for which active positioning involves the use of compensation terms. These terms correct for motions caused by cyclical variations in the spacecraft's orbit and attitude as well as short-term variations caused by movement of the other instrument. The total compensation employed by each instrument is split into a N-S and an E-W component associated with the two servo-controlled mirror axes. These component compensations, and the associated servo positioning errors, are reported by each of the instruments in the raw downlink data stream containing the imaging data. Samples of the compensation terms, servo errors, instrument location, time, and instrument status are buffered by the SPS for each instrument. As these sampling buffers fill, the SPS places them in an appropriate Block 11 format and transmits them through the GVAR uplink to a PM at the SOCC. The PM, on acquiring the compensation term Block 11, transmits the associated data to the OATS for use in monitoring each instrument's IMC and MMC component terms.

Samples are buffered by the SPS on a per instrument basis. Each instrument buffer is 64 samples in length and transmitted when either of the following conditions occur:

a. Buffer fills (64th sample acquired).
b. More than 120 seconds of non-productive instrument activity (e.g., Imager off) has elapsed.

Each 22-word group is made up of 11 pairs of 8-bit words corresponding to the 11 pixel locations for the indicated channels and detectors.

The second condition listed above can result in partial buffer transmissions. The number of samples contained in a block is indicated by the RECORD COUNT field of the SAD ID (see Table 3-8). The Block 11 format employed for the Imager and Sounder compensation terms uses the record format detailed in Table 3-14.

The Instrument Compensation and Servo Errors (ICSE) records are generated at a constant rate of 15 samples per second, whether a data function is active or not. These functions are always prefaced by a header block in the raw downlink data stream and include frame scans (normal and priority), calibration events (spacelook and BB), and star senses. For these functions, sampling starts on the first downlink data block following a header block and continues at every 364^{th} data block thereafter. Compensation and servo error terms are acquired directly from the downlinked wideband data blocks. The associated sample time and instrument location are calculated after the fact by interpolation between the header and trailer block end-points.

There are two special conditions to be considered. The first of these is related to the ICSE records generated for a star sense data set. The compensation and servo error terms in these records are the averaged values computed from the sums generated by the Imager SDI software processes. This summation is an unavoidable artifact of the star sense processing by the hardware.

The second special condition concerns the records generated for the intervals in which a data function is not active, that is, when the Imager is generating reversal sequences in the wideband data stream. Imager reversal sequences are generated at a nominal rate of five per second. They occur under a number of conditions, including idle, slew, and settling (at a star sense address, at the BB address, or at a frame start address).

3.3.7.5 Telemetry Statistics

Telemetry data statistics are reported for each instrument through the Block 11 format defined in Table 3-15. Critical alarm and warning flags associated with the statistics are defined in Tables 3-16 and 3-17, respectively. The instrument telemetry points included in the statistics are listed in Tables 3-18 and 3-19 for the Imager and Sounder, respectively.

In general, all telemetry points associated with the quality of the calibration functions are included in the statistics computations. The interval over which the statistics are accumulated is defined by the SPS time of data clock for the Imager, with every two-minute mark denoting a completion point. For the Sounder, the telemetry statistics are accumulated between spacelook events, nominally, every two minutes. The occurrence of a spacelook calibration event terminates the current telemetry statistics accumulation period, while concurrently initiating a new accumulation set.

Table 3-14. Instrument Compensation Term Records Block 11

Words	Name	Description
1–2	ISSRF*	Instrument status for Sounder record as follows: **Bit** — **Meaning (If Set)** 1 Spacelook in progress 2 ECAL in progress 3 BB-Cal in progress 4 Normal frame in progress 5 Priority 1 frame in progress 6 Priority 2 frame in progress 7 E-W scan 8 S-N frame 9 IMC active 10 Dwell mode = 4 11 Dwell mode = 2 12 Dwell mode = 1 13 N-S step mode = double 14 Side 2 electronics active 15 Star Sense in progress 16 Instrument Slew in progress
1–2	ISIRF*	Instrument status for Imager record as follows: **Bit** — **Meaning (If Set)** 1 Spacelook in progress 2 Preclamp scan in progress 3 BB-Cal in progress 4 Normal frame in progress 5 Priority 1 frame in progress 6 Priority 2 frame in progress 7 E-W scan 8 S-N frame 9 IMC active# 10 Scan Clamp Mode active 11 Fast Space Clamp Mode active (9.2 seconds) 12 Slow Space Clamp Mode active (36.6 seconds) 13 Reversal Data 14 Side 2 electronics active# 15 Star Sense in progress 16 Instrument Slew in progress
3–10	TTASI	CDA time tag associated with sample, formatted as described in Table 3-6 for words 23–110.

Note: # Bits 9 and 14 in word 2 are determined from SPS configuration flags. All other remaining bits are determined directly from the raw downlinked data.		
11–12	ILEWC	Instrument location: E-W cycles
13–14	ILEWI	E-W increments
15–16	ILNSC	N-S cycles
17–18	ILNSI	N-S increments
19–20	NSCTI	N-S compensation term for instrument
21–22	EWCTI	E-W compensation term for instrument
23–24	NSSEI	N-S servo error term for instrument
25–26	ESSEI	E-W servo error term for instrument

Notes:

1. The last eight terms, words 11 – 26, are each 16-bits in length. The corresponding instrument values are right-adjusted and zero-filled within the 16 bits.

2. Up to 64 compensation term records are transmitted in a GVAR Block 11 format, with the actual number of records indicated in the RECORD COUNT field of the SAD ID (see Table 3-8, word 9). Each record is 26 8-bit words long, as above. Unused data space within the Block 11 is zero-filled.

3. If a record is generated and no compensation or servo error data is available, the corresponding terms in the record are set to zero, such as parity errors in Sounder or dead zones in Imager reversals.

4. If an Imager record is generated and the time tag is estimated by the SPS, the flywheel bit of the record is set.

5. Every reversal data sequence yields three ICSE records. The time and mirror positions of the first of these records is the trailer data block, while the compensation and servo error terms are acquired from the data block immediately following the trailer. The remaining two records generated for an Imager reversal sequence are assigned interpolated time tags and mirror positions. The servo error and compensation terms for these two records are set to zero since there are no corresponding samples available in the wideband data stream.

6. The Sounder compensation and servo error records are much easier to explain. First, the sampling rate associated with the Sounder is 10 samples per second. Every raw downlink data block generates a compensation and servo error record while the SPS is operational. The record's time tag is taken as the time tag of the associated raw data block, while the mirror position is as reported in the block. The E-W compensation terms are taken directly from words 187 and 191 of the raw data block. The E-W servo error terms are obtained directly from words 181 and 192 of the same raw data block.

Table 3-15. Instrument Telemetry Block 11 Format

Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	TFTSSI	CDA time of first telemetry sample set (imager)
39–46	TCLSI	CDA time of current limits set (imager)
47–54	TLTSSI	CDA time of last telemetry sample set (imager)
55–70	TCAFI*	(4 x 4) Telemetry Critical Alarm Flags (see Table 3-16) TCAFI_P#_P where # = 1 - 3 TCAFI_P#_P## where # = 1 -3 and where ## = 0 - P25
71–198	TWFI*	(2 x 64) Telemetry Warning Flags (see Table 3-17) TWFI_P#_P where # = 0 - 28 TWFI_P#_P## where # = 0 - 28 and where ## = 0 – 9
199–220		Unassigned
221	EIEIO	Electronics Side active: 0 = Side 1, 255 = Side 2
222	PXOR10	Longitudinal parity (XOR) of words 1–221
Instrument Telemetry Statistics		
223–350	TSSI*	(2 x 64) Total sample size TSSI_P0 - 28
351–478	FSSI*	(2 x 64) Filtered sample size FSSI_P0 - 28
479–606	UMNCI*	(2 x 64) Unfiltered minimum value – counts UMNCI_P0 - P28
607–734	FMNCI*	(2 x 64) Filtered minimum value – counts FMNCI_P0 - P28
735–862	UMXCI*	(2 x 64) Unfiltered maximum value – counts UMXCI_P0 - P28
863–990	FMXCI*	(2 x 64) Filtered maximum value – counts FMXCI_P0 - P28
991–1246	UMECI*	(4 x 64) Unfiltered mean value – counts UMECI_P0 - P28
1247–1502	FMECI*	(4 x 64) Filtered mean value – counts FMECI_P0 - P28
1503–1758	USDCI*	(4 x 64) Unfiltered σ – counts USDCI_P0 - P28
1759–2014	FSDCI*	(4 x 64) Filtered σ – counts FSDCI_P0 - P28
2015–2270	FMNEI*	(4 x 64) Filtered minimum – engineering units FMNEI_P0 - P28
2271–2526	FMXEI*	(4 x 64) Filtered maximum – engineering units FMXEI_P0 - P28
2527–2782	FMEEI*	(4 x 64) Filtered mean – engineering units FMEEI_P0 - P28
2783–3038	FSDEI*	(4 x 64) Filtered σ – engineering units FSDEI_P0 - P28

Instrument Telemetry Statistics		
3039	PXOR11	Longitudinal parity (XOR) of words 223–3038
3040–8040		Spares–not used

Notes:

1. Telemetry flag definitions are provided in Tables 3-16 and 3-17. Temperature-critical alarm flag definitions are provided in Tables 3-30 and 3-31 for the Imager and the Sounder, respectively. Telemetry point assignments are provided in Tables 3-18 and 3-19 for the Imager and Sounder.
2. Arrays are sized to handle up to 64 telemetry points. Each of the *N* x 64 arrays above is defined in a parallel fashion, in that the K^{th} entry refers to the same telemetry point in all arrays.
3. With the exception of the flag words, the elements of all 2 x 64 arrays are 16-bit positive integer values, right-adjusted and zero-filled within the allocated bit space.
4. The elements of all 4 x 64 arrays are single precision floating point values whose format is described in Section 3.5.

Table 3-16. Instrument Telemetry Critical Alarm Flag Definitions

Words	Name	Associated Critical Alarm Condition
There are four critical alarm flag structures defined for the telemetry points of each instrument as follows:		
55–58	TCAFI_P0*	Insufficient filtered sample size TCAFI_P0_P0 - P25
59–62	TCAFI_P1*	Filtered mean below low critical limit TCAFI_P1_P0 - P25
63–66	TCAFI_P2*	Filtered mean exceeds high critical limit TCAFI_P2_P0 - P25
67–70	TCAFI_P3*	Filtered σ exceeds critical limits TCAFI_P3_P0 - P25
Flag	**Telemetry Points**	
Each of the four-word critical alarm flag structures has 32 flag bits, numbered 1 – 32, where bit 1 is the MSB of the first word and 32 is the LSB of the fourth word. Each flag bit is set to one if the associated condition is true and reset to zero if the condition is false. The flags are defined in a parallel fashion within these structures in that the k^{th} entry in each structure refers to the same telemetry point. The assignment of flag bits to telemetry points is as follows:		
1	Electronics Temperature No. 1	
2	Electronics Temperature No. 2	
3	Sensor Assy Baseplate Temperature No. 1	
4	Sensor Assy Baseplate Temperature No. 2	
5	Sensor Assy Baseplate Temperature No. 3	
6	Sensor Assy Baseplate Temperature No. 4	
7	Sensor Assy Baseplate Temperature No. 5	
8	Sensor Assy Baseplate Temperature No. 6	
9	BB Target Temperature No. 1	
10	BB Target Temperature No. 2	
11	BB Target Temperature No. 3	
12	BB Target Temperature No. 4	
13	BB Target Temperature No. 5	
14	BB Target Temperature No. 6	
15	BB Target Temperature No. 7	
16	BB Target Temperature No. 8	
17	Scan Mirror Temperature	
18	Telescope Primary Temperature	
19	Telescope Secondary Temperature No. 1	
20	Telescope Secondary Temperature No. 2	
21	Telescope Baffle Temperature No. 1	
22	Telescope Baffle Temperature No. 2	
23	Aft Optics Temperature	

24	Cooler Radiator Temperature
25	Wide Range IR Detector Temperature
26	Narrow Range IR Detector Temperature
27	Filter Wheel Housing Temperature (Sounder only)
28–32	Unassigned –always zero
Note: The critical alarm flags in words 59–70 are determined by the engineering unit value of each point.	

Table 3-17. Instrument Telemetry Warning Flag Definitions

Flag	Telemetry Points
Each of the two-word telemetry warning flag structures has 16 flag bits numbered 1 – 16, where bit 1 is the MSB of the first word and bit 16 is the LSB of the second. Each flag bit is set to 1 if the associated condition is true and reset to 0 if the associated condition is false. Flag bits for which no conditions are defined are always 0, as are flag words for which no telemetry point is assigned. The flag bits in each warning flag structure are defined in a parallel fashion in that the k^{th} bit always refers to the same condition, regardless of which telemetry point is referenced. (The telemetry points are each assigned a warning flag structure; Tables 3-18 and 3-19 provide a telemetry point or warning flag cross-reference for the Imager and the Sounder, respectively.) The flag-bits definitions for each of the warning flag structures is as follows:	
1	Unassigned – always zero
2	Unassigned – always zero
3	Unassigned – always zero
4	Unassigned – always zero
5	Unassigned – always zero
6	Unassigned – always zero
7	Filtered sample size too small
8	Unfiltered mean value (counts) below low limit
9	Filtered mean value (counts) below low limit
10	Unfiltered mean value (counts) exceeds high limit
11	Filtered mean value (counts) exceeds high limit
12	Unfiltered σ value (counts) exceeds limit
13	Filtered σ value (counts) exceeds limit
14	Filtered mean value (engineering units) low
15	Filtered mean value (engineering units) high
16	Filtered σ value (engineering units) high

Table 3-18. Imager Telemetry Point Assignments

Array Entry No.	Name	Warning Flags	Telemetry Point Description
1	TWFI_P0*	[71–72]	Electronics Temperature No. 1 TWFI_P0_P0 - P9
2	TWFI_P1*	[73–74]	Electronics Temperature No. 2 TWFI_P1_P0 - P9
3	TWFI_P2*	[75–76]	Sensor Assy Baseplate Temperature No. 1 TWFI_P2_P0 - P9
4	TWFI_P3*	[77–78]	Sensor Assy Baseplate Temperature No. 2 TWFI_P3_P0 - P9
5	TWFI_P4*	[79–80]	Sensor Assy Baseplate Temperature No. 3 TWFI_P4_P0 - P9
6	TWFI_P5*	[81–82]	Sensor Assy Baseplate Temperature No. 4 TWFI_P5_P0 - P9
7	TWFI_P6*	[83–84]	Sensor Assy Baseplate Temperature No. 5 TWFI_P6_P0 - P9
8	TWFI_P7*	[85–86]	Sensor Assy Baseplate Temperature No. 6 TWFI_P7_P0 - P9
9	TWFI_P8*	[87–88]	BB Target Temperature No. 1 TWFI_P8_P0 - P9
10	TWFI_P9*	[89–90]	BB Target Temperature No. 2 TWFI_P9_P0 - P9
11	TWFI_P10*	[91–92]	BB Target Temperature No. 3 TWFI_P10_P0 - P9
12	TWFI_P11*	[93–94]	BB Target Temperature No. 4 TWFI_P11_P0 - P9
13	TWFI_P12*	[95–96]	BB Target Temperature No. 5 TWFI_P12_P0 - P9
14	TWFI_P13*	[97–98]	BB Target Temperature No. 6 TWFI_P13_P0 - P9
15	TWFI_P14*	[99–100]	BB Target Temperature No. 7 TWFI_P14_P0 - P9
16	TWFI_P15*	[101–102]	BB Target Temperature No. 8 TWFI_P15_P0 - P9
17	TWFI_P16*	[103–104]	Scan Mirror Temperature TWFI_P16_P0 - P9
18	TWFI_P17*	[105–106]	Telescope Primary Temperature TWFI_P17_P0 - P9
19	TWFI_P18*	[107–108]	Telescope Secondary Temperature No. 1 TWFI_P18_P0 - P9
20	TWFI_P19*	[109–110]	Telescope Secondary Temperature No. 2 TWFI_P19_P0 - P9
21	TWFI_P20*	[111–112]	Telescope Baffle Temperature No. 1 TWFI_P20_P0 - P9

22	TWFI_P21*	[113–114]	Telescope Baffle Temperature No. 2 TWFI_P21_P0 - P9
23	TWFI_P22*	[115–116]	Aft Optics Temperature TWFI_P22_P0 - P9
24	TWFI_P23*	[117–118]	Cooler Radiator Temperature TWFI_P23_P0 - P9
25	TWFI_P24*	[119–120]	Wide Range IR Detector Temperature TWFI_P24_P0 - P9
26	TWFI_P25*	[121–122]	Narrow Range IR Detector Temperature TWFI_P25_P0 - P9
27	TWFI_P26*	[123–124]	Patch Control Voltage TWFI_P26_P0 - P9
28	TWFI_P27*	[125–126]	Instrument Current TWFI_P27_P0 - P9
29	TWFI_P28*	[127–128]	Cooler-Housing Temperature TWFI_P28_P0 - P9
30–64		[129–198]	Unassigned–zeros
Note: Square-bracketed numbers denote the warning flag words associated with that point. The definition of the flag bits within the warning flag words is provided in Table 3-17.			

Table 3-19. Sounder Telemetry Point Assignments

Array Entry No.	Name	Warning Flags	Telemetry Point Description
1	TWFS_P0*	[71–72]	Electronics Temperature No. 1 TWFS_P0_P0 - 9
2	TWFS_P1*	[73–74]	Electronics Temperature No. 2 TWFS_P1_P0 - 9
3	TWFS_P2*	[75–76]	Sensor Assy Baseplate Temperature No. 1 TWFS_P2_P0 - 9
4	TWFS_P3*	[77–78]	Sensor Assy Baseplate Temperature No. 2 TWFS_P3_P0 - 9
5	TWFS_P4*	[79–80]	Sensor Assy Baseplate Temperature No. 3 TWFS_P4_P0 - 9
6	TWFS_P5*	[81–82]	Sensor Assy Baseplate Temperature No. 4 TWFS_P5_P0 - 9
7	TWFS_P6*	[83–84]	Sensor Assy Baseplate Temperature No. 5 TWFS_P6_P0 - 9
8	TWFS_P7*	[85–86]	Sensor Assy Baseplate Temperature No. 6 TWFS_P7_P0 - 9
9	TWFS_P8*	[87–88]	BB Target Temperature No. 1 TWFS_P8_P0 - 9
10	TWFS_P9*	[89–90]	BB Target Temperature No. 2 TWFS_P9_P0 - 9
11	TWFS_P10*	[91–92]	BB Target Temperature No. 3 TWFS_P10_P0 - 9
12	TWFS_P11*	[93–94]	BB Target Temperature No. 4 TWFS_P11_P0 - 9
13	TWFS_P12*	[95–96]	BB Target Temperature No. 5 TWFS_P12_P0 - 9
14	TWFS_P13*	[97–98]	BB Target Temperature No. 6 TWFS_P13_P0 - 9
15	TWFS_P14*	[99–100]	BB Target Temperature No. 7 TWFS_P14_P0 - 9
16	TWFS_P15*	[101–102]	BB Target Temperature No. 8 TWFS_P15_P0 - 9
17	TWFS_P16*	[103–104]	Scan Mirror Temperature TWFS_P16_P0 - 9
18	TWFS_P17*	[105–106]	Telescope Primary Temperature TWFS_P17_P0 - 9
19	TWFS_P18*	[107–108]	Telescope Secondary Temperature No. 1 TWFS_P18_P0 - 9
20	TWFS_P19*	[109–110]	Telescope Secondary Temperature No. 2 TWFS_P19_P0 - 9
21	TWFS_P20*	[111–112]	Telescope Baffle Temperature No. 1 TWFS_P20_P0 - 9
22	TWFS_P21*	[113–114]	Telescope Baffle Temperature No. 2 TWFS_P21_P0 - 9

23	TWFS_P22*	[115–116]	Aft Optics Temperature TWFS_P22_P0 - 9
24	TWFS_P23*	[117–118]	Cooler Radiator Temperature TWFS_P23_P0 - 9
25	TWFS_P24*	[119–120]	Wide Range IR Detector Temperature TWFS_P24_P0 - 9
26	TWFS_P25*	[121–122]	Narrow Range IR Detector Temperature TWFS_P25_P0 - 9
27	TWFS_P26*	[123–124]	Filter Wheel Housing Temperature TWFS_P26_P0 - 9
28	TWFS_P27*	[125–126]	Filter Wheel Control Heater Voltage TWFS_P27_P0 - 9
29	TWFS_P28*	[127–128]	Patch Control Voltage TWFS_P28_P0 - 9
30	TWFS_P29*	[129–130]	Instrument Current TWFS_P29_P0 - 9
31	TWFS_P30*	[131–132]	Cooler Housing Temperature TWFS_P30_P0 - 9
32–64		[133–198]	Unassigned–zeros
Note: Square-bracketed numbers denote the warning flag words associated with the telemetry point. The definition of the flag bits within the warning flag words is provided in Table 3-17.			

The final statistics are computed and formatted for output at the end of accumulation periods. The final statistics include raw value (counts), and engineering unit quantities. The total unfiltered sample size is provided along with the filtered sample size remaining after high or low limit checking has been performed. Raw value statistics include the minimum, maximum, mean, and standard deviation (σ) in both the unfiltered and filtered states. Engineering unit value statistics are provided for the filtered minimum, maximum, mean, and standard deviations.

Two categories of alarm conditions are provided with the statistics. The warning alarm flags are of lower importance and serve to indicate the existence of outliers within the data. The critical alarm flags are more important because they are used to indicate the existence of a condition that can preclude a successful calibration of the IR detectors.

3.3.7.6 Electronic Calibration Statistics and Data

Each instrument periodically performs an ECAL to measure the performance of the signal processing circuitry associated with each radiometric detector. The ECAL applies a known input level to each circuit (at the point where the detector signal would normally be received) and records the resulting output counts. A total of 16 different input levels (or steps) are sequentially employed to span the full range of the signal processing circuitry. The resulting set of measured output counts are analyzed on the ground to determine the stability and linearity of the processing circuitry. The results of the analysis, as well as the associated raw data, are packaged in Block 11 formats for transmission within the GVAR data stream. Table 3-20 defines the Block 11 formats (two for **GOES I-N**, three for **GOES O-P**) required for the Imager ECAL data stream. Table 3-21 defines the three Block 11 formats required for the Sounder ECAL data stream.

Table 3-20. Imager ECAL Block 11 Format

Block 1 Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	FHDFEI	CDA time of first header block following ECAL data
39–46	TSCLSI	CDA time of current limits set
47–54		Unassigned
55–84	IFSSFI*	(2 x 15) Insufficient filtered samples or step flags††† IFSSFI_P#_P where # = 0 - 14 IFSSFI_P#_P## where # = 0 - 14, and ## = 0 – 15 GOES O-P 8th IR det @ block#3 wd#223
85–86	ERRWI*	(2 x 1) Excessive Root Mean Square (RMS) of residuals warning flags† ERRWI_P0 - P14 GOES O-P 8th IR det @ block#3 wd#225
87–220		Spares–not used
221	SAMNI	Electronics side active: 0 = Side 1, 255 = Side 2
222	PXOR14	Longitudinal parity (XOR) of words 1–221
Imager ECAL Statistics Records		
223–1566	SIRDRI*	Seven IR detector records at 192 words** GOES O-P 8th IR det @ block#3 wd#231
1567–3102	EDDRI*	Eight visible detector records at 192 words**
3103	PXOR15	Longitudinal parity (XOR) of words 223–3102
3104–3198		Spares–not used
Imager ECAL Raw Data Records		
3199–5438	SIRRDI*	Seven 320-word IR detector raw data records†† GOES O-P 8th IR det @ block#3 wd#423
5439–5478		Spares–not used
5479–8038	SVDRDI*	Visible detectors 1–2, 1280 words of raw data for each††
8039-8040		Spares–not used
Block 2 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
31–221		Spares–not used
222	PXOR16	Longitudinal parity (XOR) of words 1–221
Imager ECAL Raw Data Records		
223–7902	TVDRDI*	Visible detectors 3–8, raw data at 1280 words each††
Block 2 Words	**Name**	**Description**
7903–8040		Spares–not used
Block 3 Words	**Name**	**Description**

Block 3 is only provided for GOES O and beyond.		
1-30	**	**SAD ID (see Section 3.3.7.1)
31-221		Spares–not used
222-222	PXOR61	Longitudinal parity (XOR) of words 1-221
223-224	IFSSFI*	(2 x 1) Insufficient filtered samples/step flags††† GOES I-N IR dets 1-7 @ block#1 wd#55
225-225	ERRWI*	Excessive RMS of residuals warning flags for 8th IR detector † (0 or 1) GOES I-N IR dets 1-7 @ block#1 wd#85
226-230		Spares–not used
231-422	SIRDRI*	Eighth IR detector records at 192 words** GOES I-N IR dets 1-7 @ block#1 wd#223)
423-742	SIRRDI*	Eighth IR detector 320-word raw data records†† GOES I-N IR dets 1-7 @ block#1 wd#3199)
743-8040		Spares–not used

Notes:

† The RMS of residuals flag structure employs bits 1 – 7 for the IR detectors and bits 8 – 15 for the visible detectors (see words 85–86). Word 225 in Block 3 corresponds to the 8th IR detector introduced in **GOES-O**. Bit 1 is the MSB of word 85 and bit 16 is the LSB of word 86. Each bit is set to true when the RMS of the residuals over the entire 16-step ECAL exceeds a warning limit for the associated detector; otherwise, it is zero. Bit 16, the LSB of word 86, is not used and is always zero. Word 225 in block3 is set when the RMS of the residuals over the entire 16-step ECAL exceeds a warning limit for the 8th detector.

** Each of the detector-statistics records has the following layout in which all elements in (4 x *N*) arrays are in floating point format (see words 223–3102, and Block 3 words 231-742 [**GOES-O** and Beyond, only]):

Word	Description
1–16	(1 x 16) Total sample size each step
17–32	(1 x 16) Filtered sample size each step
33–96	(4 x 16) Mean Filtered Value each step
97–100	(4 x 1) Least Squares line slope
101–104	(4 x 1) Least Squares line intercept
105–168	(4 x 16) Residuals, each step
169–172	(4 x 1) RMS of residuals
173–192	Spares–not used

†† Each IR detector raw data record contains 160 samples (10 samples per step) in ascending order from step 1 samples through step 16 samples (see words 3199-5438, Block 1; words 423-742, Block 3). Each 10-bit sample is right-adjusted and zero-filled within the 16-bit space provided. Each visible detector raw data record contains 640 samples, 40 samples per step, ordered in the same step 1 through step 16 sequence employed in the IR detector records. Each 10-bit visible sample occupies two sequential 8-bit words, packed in the same right-adjusted zero-filled manner as the IR detector data values. Note that all of the ECAL raw data samples are pure data, in that no calibration or normalization is present. Also note that, as a result of electronic filter delays, one or more starting samples may be invalid at each step for each channel. The number of leading invalid samples is provided in Table 3-28, words 4387–4430.

††† Each of the two-word flag structures contains 16 bits (see words 55–84, Block 1; words 223-224, block 3). Each of the 16-step warning flags is assigned to an active detector. In Block 1, Elements 1 – 7 correspond to IR detectors 1–7, respectively. Elements 8 – 15 correspond to visible detectors 1 – 8, respectively. The words in Block 3 correspond to the 8th IR detector introduced in **GOES-O**. The 16 bits of each 2-word step warning flag are sequentially assigned to each ECAL step, with bit 1 to step 1 and bit 16 to step 16. Flag bits are set to true if too few filtered samples are acquired per given detector at a particular ECAL step; otherwise, they are set to zero.

Table 3-21. Sounder ECAL Block 11 Format

Block 1 Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	TFECALS	CDA time of first ECAL data block
39–46	TCLMSS	CDA time of current limits set
47–58		Spares–not used
59–90	IFSSFS*	(2 x 16) Insufficient filtered samples per step flags†† IFSSFS_P#_P where # = 0 - 15 IFSSFS_P#_P0 - P15 where # = 0 - 15
91–92	RRRWFS*	(2 x 1) Excessive RMS of Residuals warning flags†† RRRWFS_P0 - P15
93–108	CNUEDS*	(16 x 1) For each of 16 detectors, channel No. used CNUEDS_P0 - P15
109–220		Spares–not used
221	WHFSDC	Electronics Side active: 0 = Side 1, 255 = Side 2
222	PXOR17	Longitudinal parity (XOR) of words 1–221
Sounder ECAL Statistics Records		
223–990	FVCDRS*	Four visible CDET records at 192 words
991–1758	FLIDRS*	Four long-wave IR detector records at 192 words†
1759–2526	FMIDRS*	Four mid-wave IR detector records at 192 words†
2527-3294	FSIDRS*	Four short-wave IR detector records at 192 words†
3295	PXOR62	Longitudinal parity (XOR) of words 223–3294
3296–8040		Spares–not used

Notes:

† Each of the 16 detector-statistics records has the following layout, where all 4 x *N* array elements are in floating point format (see words 223 – 3294):

Word	Description
1–16	(1 x 16) Total sample size each step
17–32	(1 x 16) Filtered sample size each step
33–96	(4 x 16) Filtered Value each step
97–100	(4 x 1) Least Squares line slope
101–104	(4 x 1) Least Squares line intercept
105–168	(4 x 16) Residuals, each step
169–172	(4 x 1) RMS of residuals
173–192	Spares–not used

†† Each of the 17 two-word flag structures contains 16 bits (see words 59 – 92). See Block 1 notes for assignments.

Block 2 Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
Sounder ECAL Raw Data Records		
31–574	SLDAS1*	ECAL step 1 Sounder data block
575–1118	SLDAS2*	ECAL step 2 Sounder data block
1119–1662	SLDAS3*	ECAL step 3 Sounder data block

1663–2206	SLDAS4*	ECAL step 4 Sounder data block
2207–2750	SLDAS5*	ECAL step 5 Sounder data block
2751–3294	SLDAS6*	ECAL step 6 Sounder data block
3295–3838	SLDAS7*	ECAL step 7 Sounder data block
3839–4382	SLDAS8*	ECAL step 8 Sounder data block
4383–4926	SLDAS9*	ECAL step 9 Sounder data block
4927–5470	SLDAS10*	ECAL step 10 Sounder data block
5471–6014	SLDAS11*	ECAL step 11 Sounder data block
6015–8040		Spares–not used
Block 3 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
Sounder ECAL Raw Data Records		
31–574	SLDAS12*	ECAL step 12 Sounder data block
575–1118	SLDAS13*	ECAL step 13 Sounder data block
1119–1662	SLDAS14*	ECAL step 14 Sounder data block
1663–2206	SLDAS15*	ECAL step 15 Sounder data block
2207–2750	SLDAS16*	ECAL step 16 Sounder data block
2751–8040		Spares–not used

Notes:

1. Each of the Block 1, step-warning flags is assigned to an active detector as follows (see Sounder ECAL Block 1 words 59 – 90):
   Elements 1 – 4 are assigned to visible CDET 1 – 4
   Elements 5 – 8 are assigned to IR longwave CDET 1 – 4
   Elements 9 – 12 are assigned to IR mid wave CDET 1 – 4
   Elements 13 – 16 are assigned to IR short wave CDET 1 – 4

2. The 16 bits of each two-word step warning flag are sequentially assigned to each ECAL step, with bit 1 to step 1 and bit 16 to step 16. The flag bits are set to true if the associated conditions occur for a given detector at a particular ECAL step; otherwise, they are reset to zero.

3. The 16 bits of the RMS of residuals flag are sequentially assigned to each of the 16 CDET (see Sounder ECAL Block 1 words 91–92). The assignments are in the same 1 – 16 order denoted for the step warning flags. Each bit is set to true if the RMS of the residuals over the entire 16-step ECAL exceeds a warning limit for the associated detector; otherwise, it is zero.

An Imager ECAL is performed, on average, once 30 minutes just prior to a BB-Cal sequence. At each of the 16 step levels, 40 samples are acquired from each of the eight visible detector circuits. Concurrently, 10 samples are acquired at each step level from each of the active IR detector circuits.

A number of leading samples are automatically excluded from the analysis at each step level. The number of samples discarded varies according to the channel involved (see Table 3-28). The discarding of samples is a function of the time delay associated with the signal processing circuitry. The samples remaining in each step are filtered using high and low limits specified in Table 3-28 to discard outliers from the analysis. The resulting filtered sample sets are individually averaged at each step level. For each detector circuit, the 16 step averages are fitted with a linear least squares line. The residuals are computed as the difference between each step level average and the step level calculated using the least squares line. The RMS value of the 16 residuals is then computed for each detector.

In the case of the Sounder, an ECAL is performed on average every 20 minutes, again just prior to a BB-Cal sequence. Stability and linearity statistics are computed for the 16 10-km detectors representing the four spectral bands (visible, shortwave IR, medium wave IR, and long wave IR). The eight star sensing detectors are ignored. Only one channel is used as the data source for each of the 16 detectors.

The available channels associated with each detector are as follows:

Spectrum	Channel No.
4 detectors – visible	19
4 detectors – shortwave IR	13 – 18
4 detectors – medium wave IR	8 – 12
4 detectors – long wave IR	1 – 7

The actual channel used as the data source for each detector is specified in words 93–108 of ECAL Block 1 (see Table 3-21). The sample at each step level is filtered using high and low limits specified in Table 3-29 to discard outliers. For each detector a linear least squares curve is computed for the 16 step samples. The residual differences between the curve and the input step level averages is computed, and an RMS of the residuals is calculated for each detector.

3.3.7.7 Spacelook Calibration Statistics and Data

Each instrument performs a spacelook calibration sequence at frequent intervals. The spacelook calibration positions the scanning mirror at an extreme E-W coordinate permitting a view of space. Samples acquired from the imaging detectors while space is being viewed provide the measurements required to compute a new value for the bias term associated with each IR detector. The statistics developed from a spacelook sequence, as well as the underlying raw data, are packaged in Block 11 formats. The remainder of this section presents the spacelook calibration sequence, instrument peculiarities, and calibration bias adjustment specifics. Section 3.6 should be referenced for further information concerning the calibration algorithms.

The Imager performs a spacelook calibration sequence at rates based on the current activity of the instrument. The rates can vary from once every second (narrow scan clamp frame) to once every 36.6 seconds (priority 1 space clamp frame). Regardless of the rate, each spacelook has the following three stages:

a. Preclamp – provides up to 400 raw data blocks.
b. Clamp – provides no data.
c. Postclamp – provides up to 400 raw data blocks.

During the preclamp stage, space is viewed by the instrument while samples from the imaging detectors are being generated. The IR detectors use these samples to compute the drift bias. The drift bias is used with the previous postclamp bias to compute the bias rate of the detector since the last clamp event.

The clamp operation generates no directly observable samples. Electronic in nature, the clamp dynamically adjusts the low-level output of each detector to the common background level represented by space.

The postclamp stage occurs immediately following the clamping operation. Data from the postclamp set is used to compute a new bias term for each IR detector. A separate but identical data analysis is performed on both the preclamp and the postclamp samples. The minimum, maximum, mean, and standard deviation of the spacelook values, both filtered and unfiltered, are computed for each detector. Various warning flags are generated if predefined limits for the various statistics are exceeded.

With the conclusion of the spacelook data set analysis, a check is performed to determine if a 2-minute interval has expired since the last GVAR Block 11 report was generated. If one has, a new set of Block 11 spacelook data is constructed and queued for output in GVAR. This format includes one full set of preclamp and postclamp information (statistics and raw data) and summary statistics for all of the intervening clamp events since the last 2-minute report. The six Block 11s used to transport this information are defined in Table 3-22. The warning flags included with the statistics are defined in Table 3-23.

At the same time, computation of the updated calibration bias terms for the IR detectors may be performed using the filtered mean values generated by the spacelook data analysis. If, as a result of filtering, too few samples are included in a detector's mean value, no calibration bias term update is performed for that detector. Results of the calibration are reported in the Block 11 format described in Section 3.3.7.9.

Table 3-22. Imager Spacelook Block 11 Format

Block 1 Words	Name	Description
1-30	**	**SAD ID (see Section 3.3.7.1)
31-38	FTTSHBI	CDA formatted time tag of spacelook header block
39-46	CTCLSI	CDA time of current limits set
47-50 47-48 49-50	PCSLNUM PCWPNUM	(2 x 2) Preclamp scan line and western pixel number
51–54 51-52 53-54	PSSLNUM PSWPNUM	(2 x 2) Postclamp scan line and western pixel number
55–84	SLWFI*	(2 x 15) Spacelook warning flags (see Table 3-23). See Block 7, words 223-224 for flags for the 8th IR detector (**GOES-O** and beyond). SLWFI_P#_P0 - P8 where # = 0 - 6 SLWFI_P#_P0 - P6 where # = 7 - 14
85–114	PCWFI*	(2 x 15) Preclamp warning flags (see notes) See Block 7, words 225-226 for flags for the 8th IR detector (**GOES-O** and beyond). PCWFI _P#_P0 - P8 where # = 0 - 6 PCWFI _P#_P0 - P6 where # = 7 - 14
115–117	SLCAFI*	Spacelook critical alarm flags (see notes) See Block 7, word 227 for flags for the 8th IR detector (**GOES-O** and beyond). SLCAFI_P0 - P21
118		Spare–not used
119–126	TTPRCD	CDA time tag for preclamp data
127–134	TTPOCD	CDA time tag for postclamp data
135–220		Spares–not used
221	ANOTHER	Electronics Side active: 0 = Side 1, 255 = Side 2
222	PXOR18	Longitudinal parity (XOR) of words 1–221
Imager Preclamp Statistics		
223–252	TSSDOH*	(2 x 15) Total sample size TSSDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#231
253–282	FSSDOH*	(2 x 15) Filtered sample size FSSDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#233
283–312	UMINDOH*	(2 x 15) Unfiltered minimum value – counts UMINDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#235
313–342	FMINDOH*	(2 x 15) Filtered minimum value – counts FMINDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#237
343–372	UMXDOH*	(2 x 15) Unfiltered maximum value – counts UMXDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#239
373–402	FMXDOH*	(2 x 15) Filtered maximum value – counts FMXDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#241
403–462	UMNDOH*	(4 x 15) Unfiltered mean value – counts UMNDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#243
463–522	FMNDOH*	(4 x 15) Filtered mean value – counts FMNDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#247

523–582	USDDOH*	(4 x 15) Unfiltered σ – counts USDDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#251
583–642	FSCDOH*	(4 x 15) Filtered σ – counts FSCDOH_P0 - P14. GOES O-P 8th IR det @ block#7 wd#255
643–670	FSRDOH*	(4 x 7) Filtered σ – radiance (IR only) FSRDOH_P0 - P6. GOES O-P 8th IR det @ block#7 wd#259
671–698	FSTDOH*	(4 x 7) Filtered σ – temperature (IR only) FSTDOH_P7 - P13. GOES O-P 8th IR det @ block#7 wd#263
699–701		Spares–not used
702	PXOR19	Longitudinal parity (XOR) of words 223–701
Imager Postclamp Statistics		
703–732	TSSODD*	(2 x 15) Total sample size TSSODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#267
733–762	FSSODD*	(2 x 15) Filtered sample size FSSODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#269
763–792	UMINODD*	(2 x 15) Unfiltered minimum value – counts UMINODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#271
793–822	FMINODD*	(2 x 15) Filtered minimum value – counts FMINODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#273
823–852	UMXODD*	(2 x 15) Unfiltered maximum value – counts UMXODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#275
853–882	FMXODD*	(2 x 15) Filtered maximum value – counts FMXODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#277
883–942	UMNODD*	(4 x 15) Unfiltered mean value – counts UMNODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#279
943–1002	FMNODD*	(4 x 15) Filtered mean value – counts FMNODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#283
1003–1062	USDODD*	(4 x 15) Unfiltered σ – counts USDODD _P0 - P14. GOES O-P 8th IR det @ block#7 wd#287
1063–1122	FSCODD*	(4 x 15) Filtered σ – counts FSCODD_P0 - P14. GOES O-P 8th IR det @ block#7 wd#291
1123–1150	FSRODD*	(4 x 7) Filtered σ – radiance (IR only) FSRODD _P0 - P6. GOES O-P 8th IR det @ block#7 wd#295
1151–1178	FSTODD*	(4 x 7) Filtered σ – temperature (IR only) FSTODD _P7 - P13. GOES O-P 8th IR det @ block#7 wd#299
1179–1181		Spares–not used
1182	PXOR20	Longitudinal parity (XOR) of words 703–1181
Imager Accrued IR Activity		
1183–1662	IDPRM1	(4 x 120) IR detector 1 preclamp filtered mean – counts
1663–2142	IDPRM2	(4 x 120) IR detector 2 preclamp filtered mean – counts
2143–2622	IDPRM3	(4 x 120) IR detector 3 preclamp filtered mean – counts
2623–3102	IDPRM4	(4 x 120) IR detector 4 preclamp filtered mean – counts
3103–3582	IDPRM5	(4 x 120) IR detector 5 preclamp filtered mean – counts

3583–4062	IDPRM6	(4 x 120) IR detector 6 preclamp filtered mean – counts
4063–4542	IDPRM7	(4 x 120) IR detector 7 preclamp filtered mean – counts. GOES O-P 8th IR det @ block#7 wd#303
4543–5022	IDPOM1	(4 x 120) IR detector 1 postclamp filtered mean – counts
5023–5502	IDPOM2	(4 x 120) IR detector 2 postclamp filtered mean – counts
5503–5982	IDPOM3	(4 x 120) IR detector 3 postclamp filtered mean – counts
5983–6462	IDPOM4	(4 x 120) IR detector 4 postclamp filtered mean – counts
6463–6942	IDPOM5	(4 x 120) IR detector 5 postclamp filtered mean – counts
6943–7422	IDPOM6	(4 x 120) IR detector 6 postclamp filtered mean – counts
7423–7902	IDPOM7	(4 x 120) IR detector 7 postclamp filtered mean – counts GOES O-P 8th IR det @ block#7 wd#783
7903–7905		Spares–not used
7906	PXOR21	Longitudinal parity (XOR) of words 1183–7902
7907–8040		Spares–not used
Block 2 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
31–221		Spares – not used
222	PXOR22	Longitudinal parity (XOR) of words 1–221
Imager Accrued IR Activity		
223–702	IDPRS1	(4 x 120) IR detector 1 preclamp filtered σ – counts
703–1182	IDPRS2	(4 x 120) IR detector 2 preclamp filtered σ – counts
1183–1662	IDPRS3	(4 x 120) IR detector 3 preclamp filtered σ – counts
1663–2142	IDPRS4	(4 x 120) IR detector 4 preclamp filtered σ – counts
2143–2622	IDPRS5	(4 x 120) IR detector 5 preclamp filtered σ – counts
2623–3102	IDPRS6	(4 x 120) IR detector 6 preclamp filtered σ – counts
3103–3582	IDPRS7	(4 x 120) IR detector 7 preclamp filtered σ – counts GOES O-P 8th IR det @ block#7 wd#1263
3583–4062	IDPOS1	(4 x 120) IR detector 1 postclamp filtered σ – counts
4063–4542	IDPOS2	(4 x 120) IR detector 2 postclamp filtered σ – counts
4543–5022	IDPOS3	(4 x 120) IR detector 3 postclamp filtered σ – counts
5023–5502	IDPOS4	(4 x 120) IR detector 4 postclamp filtered σ – counts
5503–5982	IDPOS5	(4 x 120) IR detector 5 postclamp filtered σ – counts
5983–6462	IDPOS6	(4 x 120) IR detector 6 postclamp filtered σ – counts
Imager Accrued IR Activity Cont.		
6463–6942	IDPOS7	(4 x 120) IR detector 7 postclamp filtered σ – counts GOES O-P 8th IR det @ block#7 wd#1743
6943–6945		Spares–not used
6946	PXOR23	Longitudinal parity (XOR) of words 223–6942
6947–8040		Spares–not used

Block 3 Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–221		Spares–not used
222	PXOR24	Longitudinal parity (XOR) of words 1–221
223–462	IDPRP1	(2 x 120) IR 1 preclamp filtered point count
463–702	IDPRP2	(2 x 120) IR 2 preclamp filtered point count
703–942	IDPRP3	(2 x 120) IR 3 preclamp filtered point count
943–1182	IDPRP4	(2 x 120) IR 4 preclamp filtered point count
1183–1422	IDPRP5	(2 x 120) IR 5 preclamp filtered point count
1423–1662	IDPRP6	(2 x 120) IR 6 preclamp filtered point count
1663–1902	IDPRP7	(2 x 120) IR 7 preclamp filtered point count GOES O-P 8th IR det @ block#7 wd#2223
1903–2142	IDPOP1	(2 x 120) IR 1 postclamp filtered point count
2143–2382	IDPOP2	(2 x 120) IR 2 postclamp filtered point count
2383–2622	IDPOP3	(2 x 120) IR 3 postclamp filtered point count
2623–2862	IDPOP4	(2 x 120) IR 4 postclamp filtered point count
2863–3102	IDPOP5	(2 x 120) IR 5 postclamp filtered point count
3103–3342	IDPOP6	(2 x 120) IR 6 postclamp filtered point count
3343–3582	IDPOP7	(2 x 120) IR 7 postclamp filtered point count GOES O-P 8th IR det @ block#7 wd#2463
3583–3822	PRCET	(2 x 120) preclamp event times
3823–4062	POCET	(2 x 120) postclamp event times
4063–4542	CMASFI*	(4 x 120) clamp mode and status flags Note: Status flags for 8th IR detector are in Block 7 words 2703-2822. CMASFI_MODE CMASFI_P0 - P19
4543	TOONCE	Number of clamp events (1–120)
4544–4545		Spares–not used
4546	PXOR25	Longitudinal parity (XOR) of words 223–4545
Imager IR Preclamp Raw Data Values		
4547–5346	IDPRR1	(2 x 400) IR detector 1 – counts
5347–6146	IDPRR2	(2 x 400) IR detector 2 – counts
6147–6946	IDPRR3	(2 x 400) IR detector 3 – counts
6947–7746	IDPRR4	(2 x 400) IR detector 4 – counts
7747–8040		Spares–not used
Block 4 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
31–221		Spares–not used
222	PXOR26	Longitudinal parity (XOR) of words 1–221
Imager IR Preclamp Raw Data Values		

223–1022	IDPRR5	(2 x 400) IR detector 5 – counts
1023–1822	IDPRR6	(2 x 400) IR detector 6 – counts
1823–2622	IDPRR7	(2 x 400) IR detector 7 – counts GOES O-P 8th IR det @ block#7 wd#2823
Imager IR Postclamp Raw Data Values		
2623–3422	IDPOR1	(2 x 400) IR detector 1 – counts
3423–4222	IDPOR2	(2 x 400) IR detector 2 – counts
4223–5022	IDPOR3	(2 x 400) IR detector 3 – counts
5023–5822	IDPOR4	(2 x 400) IR detector 4 – counts
5823–6622	IDPOR5	(2 x 400) IR detector 5 – counts
6623–7422	IDPOR6	(2 x 400) IR detector 6 – counts
7423–8040		Spares–not used
Block 5 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
31–221		Spares–not used
222	PXOR27	Longitudinal parity (XOR) of words 1–221
Imager IR Postclamp Raw Data Values		
223–1022	IDPOR7	(2 x 400) IR detector 7 – counts GOES O-P 8th IR det @ block#7 wd#3623
Imager Visible Preclamp Data Values		
1023–1822	VDPRR1	(2 x 400) Visible detector 1 – counts
1823–2622	VDPRR2	(2 x 400) Visible detector 2 – counts
2623–3422	VDPRR3	(2 x 400) Visible detector 3 – counts
3423–4222	VDPRR4	(2 x 400) Visible detector 4 – counts
4223–5022	VDPRR5	(2 x 400) Visible detector 5 – counts
5023–5822	VDPRR6	(2 x 400) Visible detector 6 – counts
5823–6622	VDPRR7	(2 x 400) Visible detector 7 – counts
6623–7422	VDPRR8	(2 x 400) Visible detector 8 – counts
7423–8040		Spares–not used
Block 6 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
31–221		Spares–not used
222	PXOR28	Longitudinal parity (XOR) of words 1–221
Imager Visible Postclamp Data Values		
223–1022	VDPOR1	(2 x 400) Visible detector 1 – counts
1023–1822	VDPOR2	(2 x 400) Visible detector 2 – counts
1823–2622	VDPOR3	(2 x 400) Visible detector 3 – counts
2623–3422	VDPOR4	(2 x 400) Visible detector 4 – counts
3423–4222	VDPOR5	(2 x 400) Visible detector 5 – counts

4223–5022	VDPOR6	(2 x 400) Visible detector 6 – counts
5023–5822	VDPOR7	(2 x 400) Visible detector 7 – counts
5823–6622	VDPOR8	(2 x 400) Visible detector 8 – counts
6623–8040		Spares–not used
Block 7 Words	**Name**	**Description**
Block 7 is used for GOES-O and Beyond.		
1-30	**	**SAD ID (see Section 3.3.7.1)
31-221		SPARE
222-222	PXOR63	Longitudinal parity for words 1-221
223-224	SLWFI*	(2 x 1) Spacelook warning flags for 8th IR detector (see Table 3-23). See Block 1, words 55-84 for warning flags for other detectors. SLWFI_P7_P# where # = 0 - 8
225-226	PCWFI*	(2 x 1) Preclamp warning flags for 8th IR detector (see notes). See Block 1, words 85-114 for warning flags for other detectors. PCWFI _P7_P# where # = 0 - 8
227-227	SLCAFI*	Spacelook critical alarm flags for 8th IR detector (see notes). See Block 1, words 115-117 for critical alarm flags for other detectors. SLCAFI_P22 - P23
228–230		Spares-not used
Imager Preclamp Statistics for 8th IR Detector		
231-232	TSSDOH_P15	(2 x 1) Total sample size. GOES I-N IR dets 1-7 block#1 wd#223
233-234	FSSDOH_P15	(2 x 1) Filtered sample size. GOES I-N IR dets 1-7 block#1 wd#253
235-236	UMINDOH_P15	(2 x 1) Unfiltered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#283
237-238	FMINDOH_P15	(2 x 1) Filtered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#313
239-240	UMXDOH_P15	(2 x 1) Unfiltered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#343
241-242	FMXDOH_P15	(2 x 1) Filtered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#373
243-246	UMNDOH_P15	(4 x 1) Unfiltered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#403
247-250	FMNDOH_P15	(4 x 1) Filtered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#463
251-254	USDDOH_P15	(4 x 1) Unfiltered σ – counts. GOES I-N IR dets 1-7 block#1 wd#523
255-258	FSCDOH_P15	(4 x 1) Filtered σ – counts. GOES I-N IR dets 1-7 block#1 wd#583
Block 7 Words	**Name**	**Description**
259-262	FSRDOH_P7	(4 x 1) Filtered σ – radiance. GOES I-N IR dets 1-7 block#1 wd#643
263-266	FSTDOH_P14	(4 x 1) Filtered σ – temperature. GOES I-N IR dets 1-7 block#1 wd#671
Imager Postclamp Statistics for8th IR Detector		
267-268	TSSODD_P15	(2 x 1) Total sample size. GOES I-N IR dets 1-7 block#1 wd#703
269-270	FSSODD_P15	(2 x 1) Filtered sample size. GOES I-N IR dets 1-7 block#1 wd#733
271-272	UMINODD_P15	(2 x 1) Unfiltered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#763

273-274	FMINODD_P15	(2 x 1) Filtered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#793
275-276	UMXODD_P15	(2 x 1) Unfiltered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#823
277-278	FMXODD_P15	(2 x 1) Filtered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#853
279-282	UMNODD_P15	(4 x 1) Unfiltered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#883
283-286	FMNODD_P15	(4 x 1) Filtered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#943
287-290	USDODD_P15	(4 x 1) Unfiltered σ – counts. GOES I-N IR dets 1-7 block#1 wd#1003
291-294	FSCODD_P15	(4 x 1) Filtered σ – counts. GOES I-N IR dets 1-7 block#1 wd#1063
295-298	FSRODD_P7	(4 x 1) Filtered σ – radiance. GOES I-N IR dets 1-7 block#1 wd#1123
299-302	FSTODD_P14	(4 x 1) Filtered σ – temperature. GOES I-N IR dets 1-7 block#1 wd#1151
Imager Accrued IR Activity for 8th IR Detector		
303-782	IDPRM8	(4 x 120) 8th IR detector preclamp filtered mean – counts. GOES I-N IR dets 1-7 block#1 wd#1183
783-1262	IDPOM8	(4 x 120) 8th IR detector postclamp filtered mean – counts. GOES I-N IR dets 1-7 block#1 wd#4543
1263-1742	IDPRS8	(4 x 120) 8th IR detector preclamp filtered σ – counts GOES I-N IR dets 1-7 block#2 wd#223
1743-2222	IDPOS8	(4 x 120) 8th IR detector postclamp filtered σ – counts. GOES I-N IR dets 1-7 block#2 wd#3583
2223-2462	IDPRP8	(2 x 120) 8th IR preclamp filtered point count. GOES I-N IR dets 1-7 block#3 wd#223
2463-2702	IDPOP8	(2 x 120) 8th IR postclamp filtered point count. GOES I-N IR dets 1-7 block#3 wd#1903
2703-2822	CMASFI*	(1 x 120) Clamp Status Flags for 8th IR detector. CMASFI_P20 – P21 Flags for other detectors are in Block 3 words 4063-4542. Meaning of flags is as follows: **Bit** **True Condition** 00 Unassigned (always zero) 01 invalid calibration condition for 8th IR detector (channel 6 det 2) (no statistics) 02 excessive drift rate alarm for 8th IR detector (channel 6 det 2) 03-07 Unassigned (always zero)
Imager Raw Counts for 8th IR Detector		
2823-3622	IDPRR8	(2 x 400) 8th IR detector preclamp – counts. GOES I-N IR dets 1-7 block#3 wd#4547
3623-4422	IDPOR8	(2 x 400) 8th IR detector postclamp – counts. GOES I-N IR dets 1-7 block#4 wd#2623
4423-8040		Spares–not used

Notes:

1. Warning flags for pre-clamp data, Block 1 words 85 – 114, and Block 7 words 225-226, are parallel to the spacelook definitions provided in Table 3-23.

Notes Continued:

2. Critical Alarm flags, Block 1 words 115 – 117, and Block 7 word 227 are duplicated from Table 3-28, words 57 – 59, and word 7411 to simplify message logic in the PMs.
3. The event times provided in Block 3 (see words 3583 – 4062) are 16-bit positive integers having units of 10 msec (a value of 23 denotes 230 msec). The time denotes the interval from the preceding 2-minute mark of the preclamp or postclamp.
4. The clamp mode and status flags listed in Block 3, words 4063–4542, are defined the same as the scan documentation Block 0, words 5967–5970 and 6231–6234 (see Table 3-6).
5. With four exceptions, all Block 1 statistics arrays are 15 entries in length. The first seven entries in each of these arrays are sequentially assigned to the first seven active IR detectors. The last eight entries of each array are assigned to the eight visible detectors. The four exceptions are each seven entries in length, with each entry sequentially assigned to the first seven IR detectors. Starting with **GOES-O**, there is an 8th IR detector, and its statistics appear in the new Block 7.

6. Arrays sized as 2 x *N* whose units are in counts contain a right-adjusted 10-bit value. The most significant 6 bits of each two-word entry are zeroes. Arrays sized as 4 x *N* are floating point value arrays, each entry occupying four sequential words.

Table 3-23. Imager Spacelook and Blackbody Warning Flag Definitions

Words	Description
55–56, Block 1	IR detector 1 warning flags
57–58, Block 1	IR detector 2 warning flags
59–60, Block 1	IR detector 3 warning flags
61–62, Block 1	IR detector 4 warning flags
63–64, Block 1	IR detector 5 warning flags
65–66, Block 1	IR detector 6 warning flags
67–68, Block 1	IR detector 7 warning flags
69–70, Block 1	Visible detector 1 warning flags
71–72, Block 1	Visible detector 2 warning flags
73–74, Block 1	Visible detector 3 warning flags
75–76, Block 1	Visible detector 4 warning flags
77–78, Block 1	Visible detector 5 warning flags
79–80, Block 1	Visible detector 6 warning flags
81–82, Block 1	Visible detector 7 warning flags
83–84, Block 1	Visible detector 8 warning flags
223-224, Block 7 for Spacelook blk and Block 3 for Blackbody blk	IR detector 8 warning flags

Notes:

1. Visible detector flag, words 69-84 are used only for spacelook calibration.
2. Each of the two-word structures has 16 bits numbered 1-16, where bit 1 is the MSB of the first word and bit 16 is the LSB of the second word. Each flag bit is set to one if the associated condition is true; otherwise, the flag is zero. Warning flags are defined as follows:

<u>Flag</u>	<u>Set True (1) For Condition</u>
1	Unassigned (always 0)
2	Unassigned (always 0)
3	Unassigned (always 0)
4	Unassigned (always 0)
5	Unassigned (always 0)
6	Unassigned (always 0)
7	Filtered sample size too small
8	Unfiltered mean value (counts) below low limit

Notes Continued:

9	Filtered mean value (counts) below low limit
10	Unfiltered mean value (counts) exceeds high limit
11	Filtered mean value (counts) exceeds high limit
12	Unfiltered σ value (counts) exceeds limit
13	Filtered σ value (counts) exceeds limit
14	Unassigned (always 0)
15	Filtered IR σ value (radiance) exceeds limit
16	Filtered IR σ value (temperature) exceeds limit

3. Flags 15 and 16 are not applicable for the visible detectors.

The Sounder performs a spacelook calibration sequence at a fixed nominal rate every 2 minutes. During a Sounder spacelook calibration, 40 raw Sounder data blocks are acquired at the spacelook coordinates. Unlike the Imager, the Sounder has no defined preclamp or clamp activity. Each raw Sounder data block yields a single spacelook sample for each of the 76 CDET.

A data analysis is also performed for the Sounder spacelook data. The resulting statistics, warning flags, and raw data are packaged in five Sounder Block 11 formats, described in Table 3-24; and, the associated warning flags are defined in Table 3-25.

Table 3-24. Sounder Spacelook Block 11 Format

Block 1 Words	Name	Description
1-30	**	**SAD ID (see Section 3.3.7.1)
31–38	TTFSDS	CDA time tag of first spacelook data block
39–46	DODAD	CDA time of current limits set
47–48	PRSPLN	Prespacelook scan position line number
49–50	PRSPPN	Prespacelook scan position pixel number
51–52	SLSPLN	Spacelook scan position line number
53–54	SLSPPN	Spacelook scan position pixel number
55–206	SLWFS*	(2 x 76) Spacelook warning flags (see Table 3-25) SLWFS_P#_P## where # = 0 - 71, and where ## = 0 - 8 SLWFS_P#_P## where # = 72 - 75, and ## = 0 - 6
207–216	SLCAFS*	Spacelook Critical Alarm flags (see notes) SLCAFS_P# where # = 0 - 75
217–219		Spares–not used
220	SALSA	Spacelook side active: 0 = west, 255 = east
221	CURSES	Electronics Side active: 0 = Side 1, 255 = Side 2
222	PXOR29	Longitudinal parity (XOR) of words 1–221
Sounder Spacelook Statistics		
223–374	SAMMY*	(2 x 76) Total sample size SAMMY_P# where # = 0 - 75
375–526	SIBBY*	(2 x 76) Filtered sample size SIBBY_P# where # = 0 - 75
527–678	UFMNV*	(2 x 76) Unfiltered minimum value – counts UFMNV_P# where # = 0 - 75
679–830	FMNV*	(2 x 76) Filtered minimum value – counts FMNV_P# where # = 0 - 75
831–982	UFMXV*	(2 x 76) Unfiltered maximum value – counts UFMXV_P# where # = 0 - 75
983–1134	FMXV*	(2 x 76) Filtered maximum value – counts FMXV_P# where # = 0 - 75
1135–1438	UFMEV*	(4 x 76) Unfiltered mean value – counts UFMEV_P# where # = 0 - 75

1439–1742	FMEV*	(4 x 76) Filtered mean value – counts FMEV_P# where # = 0 - 75
1743–2046	UFSDV*	(4 x 76) Unfiltered σ – counts UFSDV_P# where # = 0 - 75
2047–2350	FSDV*	(4 x 76) Filtered σ– counts FSDV_P# where # = 0 - 75
2351–2638	FSRV*	(4 x 72) Filtered σ – radiance (IR only) FSRV_P# where # = 0 - 71
2639–2926	FSTV*	(4 x 72) Filtered σ – temperature (IR only) FSTV_P# where # = 0 - 71
2927	PXOR30	Longitudinal parity (XOR) of words 223–2926
2928–8040		Spares–not used
Block 2 Words	**Name**	**Description**
1–30	**	**SAD ID (Section 3.3.7.1)
Sounder Raw Data Records		
31–574	SLDAB1*	Spacelook data block 1
575–1118	SLDAB2*	Spacelook data block 2
1119–1662	SLDAB3*	Spacelook data block 3
1663–2206	SLDAB4*	Spacelook data block 4
2207–2750	SLDAB5*	Spacelook data block 5
2751–3294	SLDAB6*	Spacelook data block 6
3295–3838	SLDAB7*	Spacelook data block 7
3839–4382	SLDAB8*	Spacelook data block 8
4383–4926	SLDAB9*	Spacelook data block 9
4927–5470	SLDAB10*	Spacelook data block 10
5471–6014	SLDAB11*	Spacelook data block 11
6015–8040		Spares–not used
Block 3, [4] Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
Sounder Raw Data Records		
31–574	SLDAB12*	Spacelook data block 12, [23]
575–1118	SLDAB13*	Spacelook data block 13, [24]
1119–1662	SLDAB14*	Spacelook data block 14, [25]
1663–2206	SLDAB15*	Spacelook data block 15, [26]
2207–2750	SLDAB16*	Spacelook data block 16, [27]
2751–3294	SLDAB17*	Spacelook data block 17, [28]
3295–3838	SDAB18*	Spacelook data block 18, [29]
3839–4382	SLDAB19*	Spacelook data block 19, [30]
4383–4926	SLDAB20*	Spacelook data block 20, [31]
4927–5470	SLDAB21*	Spacelook data block 21, [32]

5471–6014	SLDAB22*	Spacelook data block 22, [33]
6015–8040		Spares–not used
Block 5 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
Sounder Raw Data Records		
31–574	SLDAB34*	Spacelook data block 34
575–1118	SLDAB35*	Spacelook data block 35
1119–1662	SLDAB36*	Spacelook data block 36
1663–2206	SLDAB37*	Spacelook data block 37
2207–2750	SLDAB38*	Spacelook data block 38
2751–3294	SLDAB39*	Spacelook data block 39
3295–3838	SLDAB40*	Spacelook data block 40
3039–8040		Spares–not used

Notes:

1. Spacelook critical alarm flags, Block 1, words 207–216, are duplicates of Table 3-29, words 63 – 72. The alarm flags are provided here to simplify the message logic in the PMs.
2. All arrays sized 2 x 76 in the statistics section of Block 1 contain positive integer values, right-adjusted and zero-filled. The 4 x *N* arrays contain floating point values.
3. Blocks 3 and 4 have the same format. The Block 4 contents are indicated by the numbers in brackets.
4. The format of the raw data spacelook records, 1 – 40, contained in the second through fifth Block 11s is defined in Table 3-11.

Table 3-25. Sounder Spacelook and Blackbody Warning Flag Definitions

Words	Description
55–56	Channel 1 detector 1 warning flags
57–58	Channel 1 detector 2 warning flags
59–60	Channel 1 detector 3 warning flags
61–62	Channel 1 detector 4 warning flags
63–70	Channel 2 detector 1 – 4 warning flags
71–78	Channel 3 detector 1 – 4 warning flags
79–86	Channel 4 detector 1 – 4 warning flags
87–94	Channel 5 detector 1 – 4 warning flags
95–102	Channel 6 detector 1 – 4 warning flags
103–110	Channel 7 detector 1 – 4 warning flags
111–118	Channel 8 detector 1 – 4 warning flags
119–126	Channel 9 detector 1 – 4 warning flags
127–206	Channels 10 – 19 detector 1 – 4 warning flags

Notes:

1. Each of the 76, two-word structures above, has 16-flag bits numbered 1-16, where bit 1 is the MSB of the first word and bit 16 is the LSB of the second. Each flag bit is set to one if the associated condition is true. Warning flags are defines as follows:

Flag	Set True (1) For Condition
1	Unassigned (always 0)
2	Unassigned (always 0)
3	Unassigned (always 0)
4	Unassigned (always 0)
5	Unassigned (always 0)
6	Unassigned (always 0)
7	Filtered sample size too small
8	Unfiltered mean value (counts) below low limit
9	Filtered mean value (counts) below low limit
10	Unfiltered mean value (counts) exceeds high limit
11	Filtered mean value (counts) exceeds high limit
12	Unfiltered σ value (counts) exceeds limit
13	Filtered σ value (counts) exceeds limit
14	Unassigned (always 0)
15	Filtered IR σ value (radiance) exceeds limit
16	Filtered IR σ value (temperature) exceeds limit

2. Flags 15 and 16 are not applicable for the four channel 19 visible detectors, words 199-206, during a spacelook report. During a BB report, none of the visible detector flags apply and words 199-206 will always be zero.

3.3.7.8 Blackbody Calibration Statistics and Data

A BB-Cal sequence is initiated every 30 minutes for the Imager and every 20 minutes for the Sounder. During a BB-Cal sequence, the scanning mirror is rotated in the N-S direction through an angle of approximately 180 mechanical degrees to present a view of the BB surface to the imaging detectors. The BB surface is actively maintained in thermal equilibrium at a nominal temperature of 290° Kelvin. The surface is instrumented with eight, temperature-measuring thermistors. The purpose in viewing a known, relatively high temperature scene is to provide a means of computing the first-order gain coefficients associated with the IR detectors.

Once the scanning mirror has settled on the blackbody, for **GOES I-M**, the Imager dwells for 2 milliseconds, generating slightly more than 1000 raw data blocks of imaging data. The first 1000 are used, providing 1000 pixels for each IR detector. The analysis proceeds in the same fashion described for the space look data analysis. Minimum, maximum, mean, and standard deviation of the BB values, both filtered and unfiltered, are computed for each IR detector. In addition, warning flags are generated if predefined limits for the various statistics are exceeded. The resulting statistics, warning flags, and raw data are packaged into two Block 11s for inclusion in the GVAR data stream. Table 3-26 provides the Block 11 format definitions employed. The warning flags for the Imager BB-Cal are defined in Table 3-23.

For **GOES N-P**, the Imager blackbody dwell period is extended to 2 seconds, resulting in over 10,000 raw data blocks (up to an instrument maximum of 11,003) and the same number of pixels per detector. A subset of these pixels is used to calculate the statistics as above. Words 143-146 in the first Imager Blackbody Block 11 (Table 3-26) define the first pixel used. Words 147-150 define how many pixels are used in a sequence beginning with the first pixel. By default, all pixels in a dwell will be used, but GOES operations can choose to use a subset if this provides more accuracy. The Imager Blackbody block 11 only provides space for 1,000 raw pixels per detector, so a limited selection of the 10,000-plus raw pixels per detector will be recorded here (sent in Block 1 words 1075-7874, and Block 2 words 223-7422, and starting with **GOES-O**, block 3 words 351-2350). The selection provided in GVAR is defined by Words 151-158. Words 151-154 define the first sample recorded. Words 155-158 define a sample interval. The default of 0 and 10 for these values means "The very first sample, and every 10th after that, until 1,000 samples are recorded". For **GOES O-P**, in addition to the longer Blackbody (BB) scan in GOES N, there is also an additional IR detector. The data for the 8th detector is found in the third Imager Blackbody Block 11, which is only transmitted in GVAR for **GOES O-P**.

During a Sounder BB-Cal, 40 raw Sounder data blocks are acquired after the scanning mirror has settled on the BB scene. Each raw Sounder data block yields a single BB sample for each of the 72 IR CDET.

A data analysis similar to that performed for the Imager BB data is provided for the Sounder data. The resulting statistics, warning flags, and raw data, are packaged in Block 11 formats for inclusion in the GVAR output data stream. The formats employed for the five Block 11s used to transport the Sounder BB information are delineated in Table 3-27. The warning flags employed for a Sounder BB are defined in Table 3-25.

Table 3-26. Imager Blackbody Block 11 Format

Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	FTTBHBI	CDA formatted time tag of BB header block
39–46	TCLSBI	CDA time of current limits set
47–48	PBSPLNI	Preblackbody scan position line number
49–50	PBSPPNI	Preblackbody scan position pixel number
51–52	BSPSCNI	BB scan position scan count number
53–54	BSPPXNI	BB scan position pixel number
55–68	BBWFI*	(2 x 7) BB warning flags (see Table 3-23) BBWFI_P#_P where # = 0 - 6 BBWFI_P#_P0 - P8 where # = 0 - 6 GOES O-P 8th IR det @ block#3 wd#223
69–114		Spares–not used
115–117	BBCAFI*	BB critical alarm flags (see notes) BBCAFI_P0 – P13 GOES O-P 8th IR det @ block#7 wd#225
118		Spare–not used
119–126	TPRBPOC	CDA time of preblackbody postclamp data
127–134	TBBD	CDA time of BB data
135–142	TPOBBSV	CDA time of postblackbody spacelook data
143-146	CALSELECT_0	Selector for BB Cal computations – Starting sample number (0 = 1st sample) GOES I-M: value fixed at 0 GOES N-P: Default value is 0
147-150	CALSELECT_1	Selector for BB Cal computations – Number of samples used GOES I-M: value fixed at 1000 GOES N-P: Default is all (>10,000)
151-154	OUTSELECT_0	Selector for raw data in GVAR (words 1075-7874 in this block and in block 2 and block 3 below.) and in archive - First sample recorded GOES I-M: value fixed at 0 GOES N-P: Default value is 0
155-158	OUTSELECT_1	Selector for raw data in GVAR (words 1075-7874 in this block and in block 2 words and block 3 words below.) and in archive - Sampling interval GOES I-M: value fixed at 1 GOES N-P: Default value is 10
159–220		Spares–not used
221	HMMNOT	Electronics side active: 0 = Side 1, 255 = Side 2
222	PXOR31	Longitudinal parity (XOR) of words 1–221
Imager Pre BB Postclamp Statistics		
223–236	TSSPRB*	(2 x 7) Total sample size TSSPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#231
237–250	FSSPRB*	(2 x 7) Filtered sample size FSSPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#233
251–264	UMINPRB*	(2 x 7) Unfiltered minimum value – counts UMINPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#235

265–278	FMINPRB*	(2 x 7) Filtered minimum value – counts FMINPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#237
Block 1 Words	**Name**	**Description**
279–292	UMXPRB*	(2 x 7) Unfiltered maximum value – counts UMXPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#239
293–306	FMXPRB*	(2 x 7) Filtered maximum value – counts FMXPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#241
307–334	UMNPRB*	(4 x 7) Unfiltered mean value – counts UMNPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#243
335–362	FMNPRB*	(4 x 7) Filtered mean value – counts FMNPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#247
363–390	USDPRB*	(4 x 7) Unfiltered σ – counts USDPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#251
391–418	FSCPRB*	(4 x 7) Filtered σ – counts FSCPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#255
419–446	FSRPRB*	(4 x 7) Filtered σ – radiance FSRPRB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#259
447–474	FSTPRB*	(4 x 7) Filtered σ – temperature FSTPRB_P7 - P13 GOES O-P 8th IR det @ block#3 wd#263
475–505		Spares–not used
506	PXOR32	Longitudinal parity (XOR) of words 223–505
Imager BB Statistics		
507–520	TSSBBS*	(2 x 7) Total sample size TSSBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#271
521–534	FSSBBS*	(2 x 7) Filtered sample size FSSBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#273
535–548	UMINBBS*	(2 x 7) Unfiltered minimum value – counts UMINBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#275
549–562	FMINBBS*	(2 x 7) Filtered minimum value – counts FMINBBS_P0 – P6 GOES O-P 8th IR det @ block#3 wd#277
563–576	UMXBBS*	(2 x 7) Unfiltered maximum value – counts UMXBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#279

577–590	FMXBBS*	(2 x 7) Filtered maximum value – counts FMXBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#281
591–618	UMNBBS*	(4 x 7) Unfiltered mean value – counts UMNBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#283
619–646	FMNBBS*	(4 x 7) Filtered mean value – counts FMNBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#287
647–674	USDBBS*	(4 x 7) Unfiltered σ – counts USDBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#291
675–702	FSCBBS*	(4 x 7) Filtered σ – counts FSCBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#295
703–730	FSRBBS*	(4 x 7) Filtered σ – radiance FSRBBS_P0 - P6 GOES O-P 8th IR det @ block#3 wd#299
731–758	FSTBBS*	(4 x 7) Filtered σ – temperature FSTBBS_P7 - P13 GOES O-P 8th IR det @ block#3 wd#303
Block 1 Words	**Name**	**Description**
Imager BB Statistics Cont.		
759–786	IPSLBBS*	(4 x 7) Interpolated spacelevel at BB – counts IPSLBBS_P7 - P13 GOES O-P 8th IR det @ block#3 wd#307
787–789		Spares–not used
Block 1 Words	**Name**	**Description**
790	PXOR33	Longitudinal parity (XOR) of words 507–789
Imager Post BB Spacelook Statistics		
791–804	TSSPOB*	(2 x 7) Total sample size TSSPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#315
805–818	FSSPOB*	(2 x 7) Filtered sample size FSSPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#317
819–832	UMINPOB*	(2 x 7) Unfiltered minimum value – counts UMINPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#319
833–846	FMINPOB*	(2 x 7) Filtered minimum value – counts FMINPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#321
847–860	UMXPOB*	(2 x 7) Unfiltered maximum value – counts UMXPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#323

861–874	FMXPOB*	(2 x 7) Filtered maximum value – counts FMXPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#325
875–902	UMNPOB*	(4 x 7) Unfiltered mean value – counts UMNPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#327
903–930	FMNPOB*	(4 x 7) Filtered mean value – counts FMNPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#331
Imager Post BB Spacelook Statistics		
931–958	USDPOB*	(4 x 7) Unfiltered σ – counts USDPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#335
959–986	FSCPOB*	(4 x 7) Filtered σ – counts FSCPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#339
987–1014	FSRPOB*	(4 x 7) Filtered σ – radiance FSRPOB_P0 - P6 GOES O-P 8th IR det @ block#3 wd#343
1015–1042	FSTPOB*	(4 x 7) Filtered σ – temperature FSTPOB_P7 - P13 GOES O-P 8th IR det @ block#3 wd#347
1043–1073		Spares–not used
1074	PXOR34	Longitudinal parity (XOR) of words 791–1073
Imager BB Raw Data Values (see Imager Blackbody block 1 words 151-158 for data range)		
1075–3074	IRD1RDB	(2 x 1000) IR detector 1 raw data – counts
3075–5074	IRD2RDB	(2 x 1000) IR detector 2 raw data – counts
5075–7074	IRD3RDB	(2 x 1000) IR detector 3 raw data – counts
7075–7874	IRD4RDB1	(2 x 400) IR detector 4 raw data – counts
7875–8040		Spares–not used
Block 2 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
31–221		Spares–not used
222	PXOR35	Longitudinal parity (XOR) of words 1–221
Imager BB Raw Data Values (see Imager Blackbody block 1 words 151-158 for data range)		
223–1422	IRD4RDB2	(2 x 600) IR detector 4 raw data – counts
1423–3422	IRD5RDB	(2 x 1000) IR detector 5 raw data – counts
3423–5422	IRD6RDB	(2 x 1000) IR detector 6 raw data – counts
5423–7422	IRD7RDB	(2 x 1000) IR detector 7 raw data – counts GOES O-P 8th IR det @ block#3 wd#351
7423–8040		Spares–not used
Block 3 Words	**Name**	**Description**

Block 3 Words are provided for GOES-O and Beyond.		
1-30	**	**SAD ID (see Section 3.3.7.1)
31-221		Spares
222-222	PXOR35	Longitudinal parity (XOR) of words 1-221
223-224	BBWFI*	(2 x 1) BB warning flags for 8th IR detector (see Table 3-23) BBWFI_P7_P BBWFI_P7_P0 - P8 GOES I-N IR dets 1-7 block#1 wd#55-68
225-225	BBCAFI*	BB critical alarm flags (see notes) BBCAFI_P14 – P15 GOES I-N IR dets 1-7 block#1 wd#115-117
226-230		Spares
Imager Pre BB Postclamp Statistics for 8th IR Detector		
231-232	TSSPRB_P7	(2 x 1) Total sample size. GOES I-N IR dets 1-7 block#1 wd#223
233-234	FSSPRB_P7	(2 x 1) Filtered sample size. GOES I-N IR dets 1-7 block#1 wd#237
235-236	UMINPRB_P7	(2 x 1) Unfiltered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#251
237-238	FMINPRB_P7	(2 x 1) Filtered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#265
239-240	UMXPRB_P7	(2 x 1) Unfiltered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#279
241-242	FMXPRB_P7	(2 x 1) Filtered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#293
243-246	UMNPRB_P7	(4 x 1) Unfiltered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#307
247-250	FMNPRB_P7	(4 x 1) Filtered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#335
251-254	USDPRB_P7	(4 x 1) Unfiltered σ – counts. GOES I-N IR dets 1-7 block#1 wd#363
255-258	FSCPRB_P7	(4 x 1) Filtered σ – counts. GOES I-N IR dets 1-7 block#1 wd#391
259-262	FSRPRB_P7	(4 x 1) Filtered σ – radiance. GOES I-N IR dets 1-7 block#1 wd#419
263-266	FSTPRB_P14	(4 x 1) Filtered σ – temperature. GOES I-N IR dets 1-7 block#1 wd#447
267-270		Spares
Imager BB Statistics for 8th IR Detector		
271-272	TSSBBS_P7	(2 x 1) Total sample size. GOES I-N IR dets 1-7 block#1 wd#507
273-274	FSSBBS_P7	(2 x 1) Filtered sample size. GOES I-N IR dets 1-7 block#1 wd#521
275-276	UMINBBS_P7	(2 x 1) Unfiltered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#535
277-278	FMINBBS_P7	(2 x 1) Filtered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#549
279-280	UMXBBS_P7	(2 x 1) Unfiltered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#563
281-282	FMXBBS_P7	(2 x 1) Filtered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#577
Block 3 Words	**Name**	**Description**
Imager BB Statistics for 8th IR Detector Cont.		

283-286	UMNBBS_P7	(4 x 1) Unfiltered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#591
287-290	FMNBBS_P7	(4 x 1) Filtered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#619
291-294	USDBBS_P7	(4 x 1) Unfiltered σ – counts. GOES I-N IR dets 1-7 block#1 wd#647
295-298	FSCBBS_P7	(4 x 1) Filtered σ – counts. GOES I-N IR dets 1-7 block#1 wd#675
299-302	FSRBBS_P7	(4 x 1) Filtered σ – radiance. GOES I-N IR dets 1-7 block#1 wd#703
303-306	FSTBBS_P14	(4 x 1) Filtered σ – temperature. GOES I-N IR dets 1-7 block#1 wd#731
307-310	IPSLBBS_P14	(4 x 1) Interpolated spacelevel at BB – counts. GOES I-N IR dets 1-7 block#1 wd#759
311-314		Spares
Imager Post BB Spacelook Statistics for 8th IR Detector		
315-316	TSSPOB_P7	(2 x 1) Total sample size. GOES I-N IR dets 1-7 block#1 wd#791
317-318	FSSPOB_P7	(2 x 1) Filtered sample size. GOES I-N IR dets 1-7 block#1 wd#805
319-320	UMINPOB_P7	(2 x 1) Unfiltered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#819
321-322	FMINPOB_P7	(2 x 1) Filtered minimum value – counts. GOES I-N IR dets 1-7 block#1 wd#833
323-324	UMXPOB_P7	(2 x 1) Unfiltered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#847
325-326	FMXPOB_P7	(2 x 1) Filtered maximum value – counts. GOES I-N IR dets 1-7 block#1 wd#861
327-330	UMNPOB_P7	(4 x 1) Unfiltered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#875
331-334	FMNPOB_P7	(4 x 1) Filtered mean value – counts. GOES I-N IR dets 1-7 block#1 wd#903
335-338	USDPOB_P7	(4 x 1) Unfiltered σ – counts. GOES I-N IR dets 1-7 block#1 wd#931
339-342	FSCPOB_P7	(4 x 1) Filtered σ – counts. GOES I-N IR dets 1-7 block#1 wd#959
343-346	FSRPOB_P7	(4 x 1) Filtered σ – radiance. GOES I-N IR dets 1-7 block#1 wd#987
347-350	FSTPOB_P14	(4 x 1) Filtered σ – temperature. GOES I-N IR dets 1-7 block#1 wd#1015
Imager BB Raw Data Values for 8th IR Detector (see Imager Blackbody block 1 words 151-158 for data range)		
351-2350	IRD8RDB	(2 x 1000) IR detector 8 raw data – counts. GOES I-N IR dets 1-7 block#1 wd#1075
2351-8040		Spares-not used

Notes:

1. Format and array layouts parallel the definitions provided in Table 3-22 for Imager spacelook data; except, only IR detectors are processed during a BB-Cal.

2. Critical Alarm flags are duplicates of Table 3-28, words 60–62, to simplify message logic in the RPMs (see words 115–117).

Table 3-27. Sounder Blackbody Block 11 Format

Block 1 Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	FTTBHBS	(2 x 1) BB warning flags (see Table 3-23)
39–46	TCLSBS	CDA time of current limits set
47–48	PBSPLNS	Preblackbody scan position line number
49–50	PBSPPNS	Preblackbody scan position pixel number
51–52	BSPSCNS	BB scan position line number
53–54	BSPPXNS	BB scan position pixel number
55–198	BBWFS*	(2 x 72) BB warning flags (see Table 3-25) BBWFS_P#_P## where # = 0 - 71, and where ## = P0 - P8
199–206		Spares–not used
207-216	BBCAFS*	BB critical alarm flags (see notes) BBCAFS_P0 - P71
217 –220		Spares–not used
221	PBTPBT	Electronics side active: 0 = Side 1, 255 = Side 2
222	PXOR36	Longitudinal parity (XOR) of words 1–221
Sounder BB Statistics		
223–366	DSAMMY*	(2 x 72) Total sample size DSAMMY_P0 - P71
367–510	DSIBBY*	(2 x 72) Filtered sample size DSIBBY_P0 - P71
511–654	DUFMNV*	(2 x 72) Unfiltered minimum value – counts DUFMNV_P0 - P71
655–798	DFMNV*	(2 x 72) Filtered minimum value – counts DFMNV_P0 - P71
799–942	DUFMXV*	(2 x 72) Unfiltered maximum value – counts DUFMXV_P0 -P71
943–1086	DFMXV*	(2 x 72) Filtered maximum value – counts DFMXV_P0 – P71
1087–1374	DUFMEV*	(4 x 72) Unfiltered mean value – counts DUFMEV_P0 - P71
1375–1662	DFMEV*	(4 x 72) Filtered mean value – counts DFMEV_P - P71
1663–1950	DUFSDV*	(4 x 72) Unfiltered σ – counts DUFSDV_P0 - P71
1951–2238	DFSDV*	(4 x 72) Filtered σ – counts DFSDV_P0 - P71
2239–2526	DFSRV*	(4 x 72) Filtered σ – radiance DFSRV_P0 - P71
2527–2814	DFSTV*	(4 x 72) Filtered σ – temperature DFSTV_P0 - P71
2815	PXOR37	Longitudinal parity (XOR) of words 223–2814

2816–8040		Spares–not used
Block 2 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
Sounder Raw Data Records		
31–574	BBDAB1*	BB data block 1 BBDAB1_P0 - P1 BBDAB1_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB1_P2_P0 - P8 BBDAB1_P3 - P12
575–1118	BBDAB2*	BB data block 2 BBDAB2_P0 - P1 BBDAB2_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB2_P2_P0 - P8 BBDAB2_P3 - P12
1119–1662	BBDAB3*	BB data block 3 BBDAB3_P0 - P1 BBDAB3_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB3_P2_P0 - P8 BBDAB3_P3 - P12
1663–2206	BBDAB4*	BB data block 4 BBDAB4_P0 - P1 BBDAB4_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB4_P2_P0 - P8 BBDAB4_P3 - P12
2207–2750	BBDAB5*	BB data block 5 BBDAB5_P0 - P1 BBDAB5_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB5_P2_P0 - P8 BBDAB5_P3 - P12
2751–3294	BBDAB6*	BB data block 6 BBDAB6_P0 - P1 BBDAB6_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB6_P2_P0 - P8 BBDAB6_P3 - P12
3295–3838	BBDAB7*	BB data block 7 BBDAB7_P0 - P1 BBDAB7_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB7_P2_P0 - P8 BBDAB7_P3 - P12
3839–4382	BBDAB8*	BB data block 8 BBDAB8_P0 - P1 BBDAB8_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB8_P2_P0 - P8 BBDAB8_P3 - P12
4383–4926	BBDAB9*	BB data block 9 BBDAB9_P0 - P1 BBDAB9_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB9_P2_P0 - P8 BBDAB9_P3 - P12
4927–5470	BBDAB10*	BB data block 10 BBDAB10_P0 - P1 BBDAB10_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB10_P2_P0 - P8 BBDAB10_P3 - P12

Block 2 Words	Name	Description
5471–6014	BBDAB11*	BB data block 11 BBDAB11_P0 - P1 BBDAB11_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB11_P2_P0 - P8 BBDAB11_P3 - P12
6015–8040		Spares–not used
Block 3, [4] Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
Sounder Raw Data Records		
31–574	BBDAB12*	BB data block 12, [23] BBDAB12_P0 - P1 BBDAB12_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB12_P2_P0 - P8 BBDAB12_P3 - P12
575–1118	BBDAB13*	BB data block 13, [24] BBDAB13_P0 - P1 BBDAB13_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB13_P2_P0 - P8 BBDAB13_P3 - P12
1119–1662	BBDAB14*	BB data block 14, [25] BBDAB14_P0 - P1 BBDAB14_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB14_P2_P0 - P8 BBDAB14_P3 - P12
1663–2206	BBDAB15*	BB data block 15, [26] BBDAB15_P0 - P1 BBDAB15_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB15_P2_P0 - P8 BBDAB15_P3 - P12
2207–2750	BBDAB16*	BB data block 16, [27] BBDAB16_P0 - P1 BBDAB16_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB16_P2_P0 - P8 BBDAB16_P3 - P12
2751–3294	BBDAB17*	BB data block 17, [28] BBDAB17_P0 - P1 BBDAB17_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB17_P2_P0 - P8 BBDAB17_P3 - P12
3295–3838	BBDAB18*	BB data block 18, [29] BBDAB18_P0 - P1 BBDAB18_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB18_P2_P0 - P8 BBDAB18_P3 - P12
3839–4382	BBDAB19*	BB data block 19, [30] BBDAB19_P0 - P1 BBDAB19_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB19_P2_P0 - P8 BBDAB19_P3 - P12
Block 3, [4] Words	**Name**	**Description**

4383–4926	BBDAB20*	BB data block 20, [31] BBDAB20_P0 - P1 BBDAB20_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB20_P2_P0 - P8 BBDAB20_P3 - P12
4927–5470	BBDAB21*	BB data block 21, [32] BBDAB21_P0 - P1 BBDAB21_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB21_P2_P0 - P8 BBDAB21_P3 - P12
5471–6014	BBDAB22*	BB data block 22, [33] BBDAB22_P0 - P1 BBDAB22_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB22_P2_P0 - P8 BBDAB22_P3 - P12
6015–8040		Spares–not used
Block 5 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
Sounder Raw Data Records		
31–574	BBDAB34*	BB data block 34 BBDAB34_P0 - P1 BBDAB34_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB34_P2_P0 - P8 BBDAB34_P3 - P12
575–1118	BBDAB35*	BB data block 35 BBDAB35_P0 - P1 BBDAB35_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB35_P2_P0 - P8 BBDAB35_P3 - P12
1119–1662	BBDAB36*	BB data block 36 BBDAB36_P0 - P1 BBDAB36_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB36_P2_P0 - P8 BBDAB36_P3 - P12
1663–2206	BBDAB37*	BB data block 37 BBDAB37_P0 - P1 BBDAB37_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB37_P2_P0 - P8 BBDAB37_P3 - P12
2207–2750	BBDAB38*	BB data block 38 BBDAB38_P0 - P1 BBDAB38_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB38_P2_P0 - P8 BBDAB38_P3 - P12
2751–3294	BBDAB39*	BB data block 39 BBDAB39_P0 - P1 BBDAB39_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB39_P2_P0 - P8 BBDAB39_P3 - P12
Block 5 Words	**Name**	**Description**
3295–3838	BBDAB40*	BB data block 40 BBDAB40_P0 - P1 BBDAB40_P1_C#D1 - C#D4, where # = 1 - 19 BBDAB40_P2_P0 - P8 BBDAB40_P3 - P12
3839–8040		Spares–not used

Notes:

1. BB critical alarm flags, Block 1, words 207 – 216, are duplicates of Table 3-29, words 73 – 82. The alarm flags are provided here to simplify the message logic in the PMs.
2. All arrays sized 2 x 72 in the statistics section of Block 1 contain positive integer values, right-adjusted, and zero-filled. The 4 x 72 arrays contain floating point values.
3. The format of the raw data BB records 1 – 40 contained in the second through fifth Block 11s, is defined in Table 3-11.

3.3.7.9 IR Calibration Coefficients and Limits Format

The IR calibration coefficients employed for each instrument are updated following each spacelook and BB-Cal event. The updated coefficients are reported in the Block 11 formats defined in Tables 3-28 and 3-29 for the Imager and Sounders, respectively. Included in these formats are the warning and critical alarm limits associated with each instrument for the four statistics computation sequences, telemetry statistics, ECAL, spacelook calibration, and BB-Cal.

The IR calibration coefficients are identified as a specific set through the use of a CDA time tag reflecting the time they were calculated and subsequently implemented within the SPS. This time tag is included in the documentation associated with each instrument's scan data to permit positive identification of the calibration coefficients employed to generate the pixel imagery. In a similar sense, the warning and critical alarm limits are uniquely identified by a CDA time tag indicating when the last update was made to the limits set in use. This time tag accompanies each of the reports made for the statistics computation sequences so that the limits employed in their generation can be ascertained.

Table 3-28. Imager Calibration and Limits Block 11 Format

Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	TIRCOC	CDA time IR coefficients calculated
39–46	TCLSCI	CDA time of current limits set
47–54	TCVNCI	CDA time current visible NLUTs created
55–56		Spares–not used
57–59	SLCCCAFI*	Spacelook Data Critical Alarm Flags (see Table 3-30) SLCCCAFI_P0 - P21 GOES O-P 8th IR det @ wd#7411
60–62	BBCCCAFI*	BB Data Critical Alarm Flags (see Table 3-30) BBCCCAFI_P0 - P13 GOES O-P 8th IR det @ wd#7412
63–64	TDCAFCCI*	Temperature Data Critical Alarm Flags (see Table 3-30) TDCAFCCI_P0 - P9
65–71	IDMGAFCCI*	IR detector M Gain Alarm Flags (see Table 3-30) IDMGAFCCI_P#_P where # = 0 - 6 IDMGAFCCI_P#_P0 - P4 where # = 0 – 6 GOES O-P 8th IR det @ wd#7413

72	BBTGAFCCI	BB temperature gradient alarm flag (= x ‘FF’ if σ of 8 BB temperatures is excessive)
73	SMTCCI	Scan mirror temperature out-of-range at BB-Cal (= 255 if true)
74–209		Spares – not used
210	TRIGEVI	Triggering event: 0 = spacelook, 255 = BB
211–218	TTRIGEI	CDA time of triggering event (see notes)
219–220		Spares–not used
221	LOTSOFEM	Electronics side active 0 = Side 1, 255 = Side 2
222	PXOR38	Longitudinal parity (XOR) of words 1–221
Imager Calibration Data		
223–250	CIDBCCI*	(4 x 7) Current IR detector biases CIDBCCI_P0 - P6 GOES O-P 8th IR det @ wd#7415
251–278	CID1CCI*	(4 x 7) Current IR detector first-order gains CID1CCI_P0 - P6 GOES O-P 8th IR det @ wd#7419
279–306	CID2CCI*	(4 x 7) Current IR detector second-order gains (q’s) CID2CCI_P0 - P6 GOES O-P 8th IR det @ wd#7423
307–310	CWBBTI	(4 x 1) Current weighted mean BB temperature
311–314	CWBPTI	(4 x 1) Current weighted mean baseplate temperature
315–318	CSPTCCI	(4 x 1) Current smoothed patch temperature
319–322	CS8BBTI	(4 x 1) Current σ of 8 BB temperatures
323–326	CST8BBTI	(4 x 1) Current σ tolerance for 8 BB temperatures
327–350	BPTWFI	(4 x 6) Baseplate thermistor weighting factors BPTWFI_P0 - P5
351–382	BBTWFI	(4 x 8) BB thermistor weighting factors BBTWFI_P0 - P7
383–386	CWMHFA	(4 x 1) Current A weight for M-history file
387–390	CWMHFB	(4 x 1) Current B weight for M-history file
391–394	CWMHFC	(4 x 1) Current C weight for M-history file
395–398	CWMHFD	(4 x 1) Current D weight for M-history file
399–414	BBTFSSI*	(2 x 8) BB thermistor filtered sample size BBTFSSI_P0 - P7
415	BBTWSI	BB thermistor window size N
416	CPTCLI	Current patch temperature control level {1:7} (see Note 6)
417	IRCALBM	IR Calibration B (bias) Mode 1
418	IRCALMM	IR Calibration M (first-order gain) Mode {1:7}
Imager Calibration Data (Cont.)		
419	IRCALQM	IR Calibration Q (second-order gain) Mode {1:3}
420	VRNDCCI	Visible reference normalization detector
421	MHWWHI	M-history window width in hours {1–24}

422	MHWDDI	M-history window depth in days {1–10}
423–448	MHROSI	(1 x 26) M-history regression optical selectors
449		Spare–not used
450	EWCED	E-W correction enabled/disabled (0 = disabled, 255 = enabled)
451–454	SMTBBC	(4 x 1) Scan mirror temperature at BB-Cal
455–470	CAECOEF*	(4 x 4) Current a emissivity coefficients (intercept) CAECOEF_P0 - P3
471–486	CBECOEF*	(4 x 4) Current b emissivity coefficients (first-order) CBECOEF_P0 - P3
487–502	CCECOEF*	(4 x 4) Current c emissivity coefficients (second-order) CCECOEF_P0 - P3
503-516	IMBCC*	MBCC status for 7 IR detectors. 0 for MBCC set off, 1 for MBCC set on but regression slope not used, 2 for MBCC set on and regression slope used IMBCC_P1 - P7 GOES O-P 8^{th} IR det @ wd#7695
517-530	IMBCG1ML*	MBCC IR calibration for 7 detectors (first-order gain) Mode {1:14} IMBCG1ML_P1 - P7 GOES O-P 8^{th} IR det @ wd#7697
531–733		Not used (set to zeros)
734	PXOR39	Longitudinal parity (XOR) of words 223–733
Imager Telemetry Warning Limits		
735–862	MFSSL*	(2 x 64) Minimum filtered sample size limits MFSSL_P0 - P28
863–990	LPFLCCI*	(2 x 64) Low pass filter limit – counts LPFLCCI_P0 - P28
991–1118	HPFLCCI*	(2 x 64) High pass filter limit – counts HPFLCCI_P0 - P28
1119–1374	UFMELLI*	(4 x 64) Unfiltered mean low limit – counts UFMELLI_P0 - P28
1375–1630	FMELLI*	(4 x 64) Filtered mean low limit – counts FMELLI_P0 - P28
1631–1886	UFMEHLI*	(4 x 64) Unfiltered mean high limit – counts UFMEHLI_P0 - P28
1887–2142	FMEHLI*	(4 x 64) Filtered mean high limit – counts FMEHLI_P0 - P28
2143–2398	UFSGHLI*	(4 x 64) Unfiltered σ high limit – counts UFSGHLI_P0 - P28
2399–2654	FSGHLI*	(4 x 64) Filtered σ high limit – counts FSGHLI_P0 - P28
Imager Telemetry Warning Limits (Cont.)		
2655–2910	FMELLEU*	(4 x 64) Filtered mean low limit – engineering units FMELLEU_P0 - P28
2911–3166	FMEHLEU*	(4 x 64) Filtered mean high limit – engineering units FMEHLEU_P0 - P28

3167–3422	FSGHLEU*	(4 x 64) Filtered σ high limit – engineering units FSGHLEU_P0 - P28
Imager Telemetry Critical Alarm Limits		
3423–3486	MNFSS*	(2 x 32) Minimum filtered sample size limits MNFSS_P0 - P25
3487–3614	FMELLSEU*	(4 x 32) Filtered mean low limits – engineering units FMELLSEU_P0 - P25
3615–3742	FMEHLSEU*	(4 x 32) Filtered mean high limits – engineering units FSGLSEU_P0 - P25
3743–3870	FSGLSEU*	(4 x 32) Filtered σ limits – engineering units FSGLSEU _P0 - P25
3871–4061		Spares–not used
4062	PXOR40	Longitudinal parity (XOR) of words 735–4061
Imager ECAL Warning Limits		
4063–4066	EXRRL	(4 x 1) Excessive residual RMS limit (all detectors)
4067–4098	CH1LLI*	(2 x 16) Channel 1 low filter limits/step – counts CH1LLI_P0 - P15
4099–4130	CH2LLI*	(2 x 16) Channel 2 low filter limits/step – counts CH2LLI_P0 - P15
4131–4162	CH3LLI*	(2 x 16) Channel 3 low filter limits/step – counts CH3LLI_P0 - P15
4163–4194	CH4LLI*	(2 x 16) Channel 4 low filter limits/step – counts CH4LLI_P0 - P15
4195–4226	CH6LLI*	(2 x 16) Channel 5 low filter limits/step – counts CH6LLI_P0 - P15
4227–4258	CH1HLI*	(2 x 16) Channel 1 high filter limits/step – counts CH1HLI_P0 - P15
4259–4290	CH2HLI*	(2 x 16) Channel 2 high filter limits/step – counts CH2HLI_P0 - P15
4291–4322	CH3HLI*	(2 x 16) Channel 3 high filter limits/step – counts CH3HLI_P0 - P15
4323–4354	CH4HLI*	(2 x 16) Channel 4 high filter limits/step – counts CH4HLI_P0 - P15
4355–4386	CH6HLI*	(2 x 16) Channel 5 high filter limits/step – counts CH6HLI_P0 - P15
4387–4430	LSDCI*	(2 x 22) Leading sample discard count/detector LSDCI_P0 - P21 GOES O-P 8th IR det @ wd#7427
Imager ECAL Warning Limits (Cont.)		
4431–4474	MNFSLI*	(2 x 22) Minimum filtered samples limit/detector MNFSLI_P0 - P21 GOES O-P 8th IR det @ wd#7431
4475–4573		Spares–not used
4574	PXOR41	Longitudinal parity (XOR) of words 4063–4573

Imager Spacelook Warning Limits		
4575–4618	MNFSSLSLI*	(2 x 22) Minimum filtered sample size limits MNFSSLSLI_P0 - P21 GOES O-P 8th IR det @ wd#7435
4619–4662	LFLSLII*	(2 x 22) Low filter limit – counts LFLSLII_P0 - P21 GOES O-P 8th IR det @ wd#7439
4663–4706	HFLSLI*	(2 x 22) High filter limit – counts HFLSLI_P0 - P21 GOES O-P 8th IR det @ wd#7443
4707–4794	UFMELLSLI*	(4 x 22) Unfiltered mean low limit – counts UFMELLSLI_P0 - P21 GOES O-P 8th IR det @ wd#7447
4795–4882	FMELLSLI*	(4 x 22) Filtered mean low limit – counts FMELLSLI_P0 - P21 GOES O-P 8th IR det @ wd#7455
4883–4970	UFMEHLSLI*	(4 x 22) Unfiltered mean high limit – counts UFMEHLSLI_P0 - P21 GOES O-P 8th IR det @ wd#7463
4971–5058	FMEHLSLI*	(4 x 22) Filtered mean high limit – counts FMEHLSLI_P0 - P21 GOES O-P 8th IR det @ wd#7471
5059–5146	UFSGHLSLI*	(4 x 22) Unfiltered σ high limit – counts UFSGHLSLI_P0 - P21 GOES O-P 8th IR det @ wd#7479
5147–5234	FSGHLSLI*	(4 x 22) Filtered σ high limit – counts FSGHLSLI_P0 - P21 GOES O-P 8th IR det @ wd#7487
5235–5322	FSGHLSLRI*	(4 x 22) Filtered σ high limit – radiance FSGHLSLRI_P0 - P21 GOES O-P 8th IR det @ wd#7495
5323–5410	FSGHLSLTI*	(4 x 22) Filtered σ high limit – temperature FSGHLSLTI_P0 - P21 GOES O-P 8th IR det @ wd#7503
Imager Spacelook Critical Limits		
5411–5454	MNFSSDSLI	(2 x 22) Minimum filtered sample size/detector MNFSSDSLI_P0 - P21 GOES O-P 8th IR det @ wd#7511
5455–5597		Spares–not used
5598	PXOR42	Longitudinal parity (XOR) of words 4575–5597
Imager Pre-clamp Warning Limits		
5599–5642	MNFSSLPRCI*	(2 x 22) Minimum filtered sample size limits MNFSSLPRCI_P0 - P21 GOES O-P 8th IR det @ wd#7515

5643–5686	LFLPRCII*	(2 x 22) Low filter limit – counts LFLPRCII_P0 - P21 GOES O-P 8th IR det @ wd#7519
5687–5730	HFLPRCI*	(2 x 22) High filter limit – counts HFLPRCI_P0 - P21 GOES O-P 8th IR det @ wd#7523
Imager Pre-clamp Warning Limits (Cont.)		
5731–5818	UFMELLPRCI*	(4 x 22) Unfiltered mean low limit – counts UFMELLPRCI_P0 - P21 GOES O-P 8th IR det @ wd#7527
5819–5906	FMELLPRCI*	(4 x 22) Filtered mean low limit – counts FMELLPRCI_P0 - P21 GOES O-P 8th IR det @ wd#7535
5907–5994	UFMEHLPRCI*	(4 x 22) Unfiltered mean high limit – counts UFMEHLPRCI_P0 - P21 GOES O-P 8th IR det @ wd#7543
5995–6082	FMEHLPRCI*	(4 x 22) Filtered mean high limit – counts FMEHLPRCI_P0 - P21 GOES O-P 8th IR det @ wd#7551
6083–6170	UFSGHLPRCI*	(4 x 22) Unfiltered σ high limit – counts UFSGHLPRCI_P0 - P21 GOES O-P 8th IR det @ wd#7559
6171–6258	FSGHLPRCI*	(4 x 22) Filtered σ high limit – counts FSGHLPRCI_P0 - P21 GOES O-P 8th IR det @ wd#7567
6259–6346	FSGHLPRCRI*	(4 x 22) Filtered σ high limit – radiance FSGHLPRCRI_P0 - P21 GOES O-P 8th IR det @ wd#7575
6347–6434	FSGHLPRCTI*	(4 x 22) Filtered σ high limit – temperature FSGHLPRCTI_P0 - P21 GOES O-P 8th IR det @ wd#7583
6435–6621		Spares–not used
6622	PXOR43	Longitudinal parity (XOR) of words 5599–6621
Imager BB Warning Limits		
6623–6650	MNFSSLBBI*	(2 x 14) Minimum filtered sample size limits MNFSSLBBI_P0 - P13 GOES O-P 8th IR det @ wd#7591
6651–6678	LFLBBII*	(2 x 14) Low filter limit – counts LFLBBII_P0 - P13 GOES O-P 8th IR det @ wd#7595
6679–6706	HFLBBI*	(2 x 14) High filter limit – counts HFLBBI_P0 - P13 GOES O-P 8th IR det @ wd#7599
6707–6762	UFMELLBBI*	(4 x 14) Unfiltered mean low limit – counts UFMELLBBI_P0 - P13 GOES O-P 8th IR det @ wd#7603

6763–6818	FMELLBBI*	(4 x 14) Filtered mean low limit – counts FMELLBBI_P0 - P13 GOES O-P 8th IR det @ wd#7611
6819–6874	UFMEHLBBI*	(4 x 14) Unfiltered mean high limit – counts UFMEHLBBI_P0 - P13 GOES O-P 8th IR det @ wd#7619
6875–6930	FMEHLBBI*	(4 x 14) Filtered mean high limit – counts FMEHLBBI_P0 - P13 GOES O-P 8th IR det @ wd#7627
6931–6986	UFSGHLBBI*	(4 x 14) Unfiltered σ high limit – counts UFSGHLBBI_P0 - P13 GOES O-P 8th IR det @ wd#7635
6987–7042	FSGHLBBI*	(4 x 14) Filtered σ high limit – counts FSGHLBBI_P0 - P13 GOES O-P 8th IR det @ wd#7643
7043–7098	FSGHLBBRI*	(4 x 14) Filtered σ high limit – radiance FSGHLBBRI_P0 - P13 GOES O-P 8th IR det @ wd#7651
7099–7154	FSGHLBBTI*	(4 x 14) Filtered σ high limit – temperature FSGHLBBTI_P0 - P13 GOES O-P 8th IR det @ wd#7659
Imager BB-Cal Critical Limits		
7155–7182	MNFSSDBBI*	(2 x 14) Minimum filtered sample size/detector MNFSSDBBI_P0 - P13 GOES O-P 8th IR det @ wd#7667
Imager Calibration Critical Limits		
7183–7186	MXBPTGL	(4 x 1) Maximum baseplate temperature for gain Lookup Table (LUT)
7187–7190	MNBPTGL	(4 x 1) Minimum baseplate temperature for gain LUT
7191–7192	MNFSSBT	(2 x 1) Minimum filtered sample size/BB thermistor
7193–7194		Unused – zeros
7195–7206	MXBII	(4 x 3) Maximum bias interpolation interval (msec)
7207–7234	MXSLR*	(4 x 7) Maximum space level rate/detector (counts/second) MXSLR_P0 - P6 GOES O-P 8th IR det @ wd#7671
7235–7262	MXMRM2*	(4 x 7) Maximum M (first order gain) rate in mode 2 (MBCC OFF) or 9 (MBCC ON) MXMRM2_P0 - P6 GOES O-P 8th IR det @ wd#7675
7263–7266	MXPOPM35	(4 x 1) Maximum percentage of outliers permitted in M modes 3&5 (MBCC OFF) or 10&12 (MBCC ON)
7267–7294	MXSEEALARM45*	(4 x 7) Maximum standard error of estimate (SEE) for M modes 4&5 (MBCC OFF) or 11&12 (MBCC ON) MXSEEALARM45_P0 - P6 GOES O-P 8th IR det @ wd#7679

7295–7322	MXSEEALARM67*	(4 x 7) Maximum Root Sum Squares (RSS) error for M modes 6&7 (MBCC OFF) or 13&14 (MBCC ON) MXSEEALARM67_P0 - P6 GOES O-P 8th IR det @ wd#7683
7323–7326	ALPHABET	(4 x 1) N-σ tolerance for M-history filtering
7327–7330	ITERATION	(4 x 1) Maximum number of iterations M-history filtering
7331–7334	MNMINBB	(4 x 1) Minimum minutes between BB-Cal
7335–7338	MRECOMP	(4 x 1) M recomputation interval (2-minute units)
7339–7342	HELPIMBORED	(4 x 1) Minimum delta patch temperature for M mode 2 (MBCC OFF) or 9 (MBCC ON)
7343–7370	WHATSWITHM	(4 x 7) Minimum delta gain for M mode 2 (MBCC OFF) or 9 (MBCC ON) GOES O-P 8th IR det @ wd#7687
7371–7398	WOWWEE	(4 x 7) Minimum rate (slope) in M mode 2 (MBCC OFF) or 9 (MBCC ON) GOES O-P 8th IR det @ wd#7691
7399–7401		Unused – zeros
7402	PXOR44	Longitudinal parity (XOR) of words 6623–7401
7403-7410		Unused – zeros
Note: 7411-7698 are only used for GOES-O and Beyond. Otherwise they are spare.		
7411-7411	SLCCCAFI*	Spacelook Data Critical Alarm Flags (see Table 3-30) SLCCCAFI_P22 – P23 GOES I-N IR dets 1-7 wd#57-59
7412-7412	BBCCCAFI*	BB Data Critical Alarm Flags (see Table 3-30) BBCCCAFI_P14 – P15 GOES I-N IR dets 1-7 wd#60-62
7413-7413	IDMGAFCCI*	8th IR detector M Gain Alarm Flags IDMGAFCCI_P7_P IDMGAFCCI_P7_P0 - P4 GOES I-N IR dets 1-7 wd#65-71
Imager Calibration Data for 8th IR Detector		
7414-7414		Spares not used.
7415-7418	CIDBCCI_P7	(4 x 1) Current 8th IR detector biases. GOES I-N IR dets 1-7 wd#223
7419-7422	CID1CCI_P7	(4 x 1) Current 8th IR detector first-order gains. GOES I-N IR dets 1-7 wd#251
7423-7426	CID2CCI_P7	(4 x 1) Current 8th IR detector second-order gains (q's). GOES I-N IR dets 1-7 wd#279
Imager ECAL Warning Limits for 8th IR Detector		
7427-7430	LSDCI*	(2 x 2) Leading sample discard count/detector LSDCI_P22 – P23 GOES I-N IR dets 1-7 wd#4387
7431-7434	MNFSLI*	(2 x 2) Minimum filtered samples limit/detector MNFSLI_P22 – P23 GOES I-N IR dets 1-7 wd#4431
Imager Spacelook Warning Limits for 8th IR Detector		

7435-7438	MNFSSLSLI*	(2 x 2) Minimum filtered sample size limits MNFSSLSLI_P22 - P23 GOES I-N IR dets 1-7 wd#4575
7439-7442	LFLSLII*	(2 x 2) Low filter limit – counts LFLSLII_P22 – P23 GOES I-N IR dets 1-7 wd#4619
7443-7446	HFLSLI*	(2 x 2) High filter limit – counts HFLSLI_P22 – P23 GOES I-N IR dets 1-7 wd#4663
7447-7454	UFMELLSLI*	(4 x 2) Unfiltered mean low limit – counts UFMELLSLI_P22 – P23 GOES I-N IR dets 1-7 wd#4707
7455-7462	FMELLSLI*	(4 x 2) Filtered mean low limit – counts FMELLSLI_P22 – P23 GOES I-N IR dets 1-7 wd#4795
7463-7470	UFMEHLSLI*	(4 x 2) Unfiltered mean high limit – counts UFMEHLSLI_P22 – P23 GOES I-N IR dets 1-7 wd#4883
7471-7478	FMEHLSLI*	(4 x 2) Filtered mean high limit – counts FMEHLSLI_P22 – P23 GOES I-N IR dets 1-7 wd#4971
7479-7486	UFSGHLSLI*	(4 x 2) Unfiltered σ high limit – counts UFSGHLSLI_P22 – P23 GOES I-N IR dets 1-7 wd#5059
7487-7494	FSGHLSLI*	(4 x 2) Filtered σ high limit – counts FSGHLSLI_P22 – P23 GOES I-N IR dets 1-7 wd#5147
7495-7502	FSGHLSLRI*	(4 x 2) Filtered σ high limit – radiance FSGHLSLRI_P22 – P23 GOES I-N IR dets 1-7 wd#5235
7503-7510	FSGHLSLTI*	(4 x 2) Filtered σ high limit – temperature FSGHLSLTI_P22 – P23 GOES I-N IR dets 1-7 wd#5323
Imager Spacelook Warning Limits for 8th IR Detector (Cont.)		
7511-7514	MNFSSDSLI	(2 x 2) Minimum filtered sample size/detector MNFSSDSLI_P22 – P23 GOES I-N IR dets 1-7 wd#5411
Imager Spacelook Critical Limits for 8th IR Detector		
7515-7518	MNFSSLPRCI*	(2 x 2) Minimum filtered sample size limits MNFSSLPRCI_P22 - P23 GOES I-N IR dets 1-7 wd#5599
Imager Pre-clamp Warning Limits for 8th IR Detector		
7519-7522	LFLPRCII*	(2 x 2) Low filter limit – counts LFLPRCII_P22 - P23 GOES I-N IR dets 1-7 wd#5643
7523-7526	HFLPRCI*	(2 x 2) High filter limit – counts HFLPRCI_P22 - P23 GOES I-N IR dets 1-7 wd#5687

7527-7534	UFMELLPRCI*	(4 x 2) Unfiltered mean low limit – counts UFMELLPRCI_P2 - P23 GOES I-N IR dets 1-7 wd#5731
7535-7542	FMELLPRCI*	(4 x 2) Filtered mean low limit – counts FMELLPRCI_P22 - P23 GOES I-N IR dets 1-7 wd#5819
7543-7550	UFMEHLPRCI*	(4 x 2) Unfiltered mean high limit – counts UFMEHLPRCI_P22 - P23 GOES I-N IR dets 1-7 wd#5907
7551-7558	FMEHLPRCI*	(4 x 2) Filtered mean high limit – counts FMEHLPRCI_P22 - P23 GOES I-N IR dets 1-7 wd#5995
7559-7566	UFSGHLPRCI*	(4 x 2) Unfiltered σ high limit – counts UFSGHLPRCI_P22 - P23 GOES I-N IR dets 1-7 wd#6083
7567-7574	FSGHLPRCI*	(4 x 2) Filtered σ high limit – counts FSGHLPRCI_P22 - P23 GOES I-N IR dets 1-7 wd#6171
7575-7582	FSGHLPRCRI*	(4 x 2) Filtered σ high limit – radiance FSGHLPRCRI_P22 - P23 GOES I-N IR dets 1-7 wd#6259
7583-7590	FSGHLPRCTI*	(4 x 2) Filtered σ high limit – temperature FSGHLPRCTI_P22 - P23 GOES I-N IR dets 1-7 wd#6347
Imager BB Warning Limits for 8th IR Detector		
7591-7594	MNFSSLBBI*	(2 x 2) Minimum filtered sample size limits MNFSSLBBI_P14 - P15 GOES I-N IR dets 1-7 wd#6623
7595-7598	LFLBBII*	(2 x 2) Low filter limit – counts LFLBBII_P14 - P15 GOES I-N IR dets 1-7 wd#6651
7599-7602	HFLBBI*	(2 x 2) High filter limit – counts HFLBBI_P14 - P15 GOES I-N IR dets 1-7 wd#6679
7603-7610	UFMELLBBI*	(4 x 2) Unfiltered mean low limit – counts UFMELLBBI_P14 - P15 GOES I-N IR dets 1-7 wd#6707
7611-7618	FMELLBBI*	(4 x 2) Filtered mean low limit – counts FMELLBBI_P14 - P15 GOES I-N IR dets 1-7 wd#6763
7619-7626	UFMEHLBBI*	(4 x 2) Unfiltered mean high limit – counts UFMEHLBBI_P14 - P15 GOES I-N IR dets 1-7 wd#6819
7627-7634	FMEHLBBI*	(4 x 2) Filtered mean high limit – counts FMEHLBBI_P14 - P15 GOES I-N IR dets 1-7 wd#6875

7635-7642	UFSGHLBBI*	(4 x 2) Unfiltered σ high limit – counts UFSGHLBBI_P14 - P15 GOES I-N IR dets 1-7 wd#6931
Imager BB Warning Limits for 8th IR Detector (Cont.)		
7643-7650	FSGHLBBI*	(4 x 2) Filtered σ high limit – counts FSGHLBBI_P14 - P15 GOES I-N IR dets 1-7 wd#6987
7651-7658	FSGHLBBRI*	(4 x 2) Filtered σ high limit – radiance FSGHLBBRI_P14 - P15 GOES I-N IR dets 1-7 wd#7043
7659-7666	FSGHLBBTI*	(4 x 2) Filtered σ high limit – temperature FSGHLBBTI_P14 - P15 GOES I-N IR dets 1-7 wd#7099
Imager BB-Cal Critical Limits for 8th IR Detector		
7667-7670	MNFSSDBBI*	(2 x 2) Minimum filtered sample size/detector MNFSSDBBI_P14 - P15 GOES I-N IR dets 1-7 wd#7155
Imager Calibration Critical Limits for 8th IR Detector		
7671-7674	MXMRM2_P7	(4 x 1) Maximum space level rate/detector (counts/second) GOES I-N IR dets 1-7 wd#7207
7675-7678	MXMRM2_P7	(4 x 1) Maximum M (first-order gain) rate in M mode 2 (MBCC OFF) or 9 (MBCC ON) GOES I-N IR dets 1-7 wd#7235
7679-7682	MXSEEALARM45_P7	(4 x 1) Maximum Standard Error of Estimate (SEE) for M modes 4&5 (MBCC OFF) or 11&12 (MBCC ON) GOES I-N IR dets 1-7 wd#7267
7683-7686	MXSEEALARM67_P7	(4 x 1) Maximum root sum square (RSS) error for M modes 6&7 (MBCC OFF) or 13&14 (MBCC ON) GOES I-N IR dets 1-7 wd#7295
7687-7690	WHATSWITHM2	(4 x 1) Minimum delta gain for M mode 2 (MBCC OFF) or 9 (MBCC ON) GOES I-N IR dets 1-7 wd#7343
7691-7694	WOWWEE2	(4 x 1) Minimum rate (slope) in M mode 2 (MBCC OFF) or 9 (MBCC ON) GOES I-N IR dets 1-7 wd#7371
7695-7696	IMBCC_P8	MBCC indicator for 8th detector: 0 = inactive, 1 = active but not used, 2 = active and used. GOES I-N IR dets 1-7 wd#503
7697-7698	IMBCG1ML_P8	MBCC IR calibration for 8th detector (first-order gain) Mode {1:14}. GOES I-N IR dets 1-7 wd#517
7699-8040		Unused-zeros

Notes:

1. This Block 11 format is produced following every spacelook and BB-Cal sequence. The trigger time in words 211–218 is the time associated with the raw data header block of the triggering event (spacelook or BB) identified in word 210.

2. All arrays sized as 4 x *N* are floating point value arrays.

3. All arrays sized as 2 x *N* are integer value arrays.

4. All limit arrays sized as *N* x 22 contain data for all 22 imaging detectors as follows:
   1 – 8 – Visible detectors 1 – 8
   9 – 15 – Primary IR detectors 1 – 7
   16 – 22 – Redundant IR detectors 1 – 7

5. All limit arrays for BB-Cal, sized *N* x 14, contain data for the 14 IR detectors only, as follows:
   1 – 7 – Primary IR detectors 1 – 7
   8 – 14 – Redundant IR detectors 1 – 7

6. The value of word 416 is given by the following, based on the patch temperature:
   1 = less than Control point 1 lower limit
   2 = between Control point 1 lower and upper limits
   3 = between Control point 1 upper limit and Control point 2 lower limit
   4 = between Control point 2 lower and upper limits
   5 = between Control point 2 upper limit and Control point 3 lower limit
   6 = between Control point 3 lower and upper limits
   7 = beyond Control point 3 upper limit

Table 3-29. Sounder Calibration and Limits Block 11 Format

Block 1 Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	TIRCALCCS	CDA time IR calibration coefficients calculated
39–46	THETIME	CDA time of current limits set
47–54	TCVNCS	CDA time current visible NLUTs created
55–62	TLLREG	CDA time of latest linear regression
63–72	SPLDCAF*	Spacelook data critical alarm flags (See Table 3-31 for definitions of alarm flags in words 63–134) SPLDCAF_P0 - P75
73–82	BBDCAFS*	BB data critical alarm flags BBDCAFS_P0 - P71
83–84	TEMPCAFS*	Temperature critical alarm flags TEMPCAFS_P0 - P9
85–94	BSEEALARMCAF*	SEE critical alarm flags BSEEALARMCAF_P0 - P71
95–104	MRATCAF*	(2 x 5) IR detector M gain rate alarms MRATCAF_P0 - P71
105–114	MOUTCAF*	(2 x 5) IR detector M gain outlier alarms MOUTCAF_P0 - P113
115–124	MSEEALARMCAF*	(2 x 5) IR detector M gain SEE alarms MSEEALARMCAF_P0 - P123
125–134	MRSSCAF*	(2 x 5) IR detector M gain RSS alarms MRSSCAF_P1 - P71
135	FWPALA	Filter Wheel period alarm (= x ‘FF’ if a synch loss occurred since the last report)
136	BBTGAFS	BB temperature gradient alarm flag (= x ‘FF’ if excessive σ in 8 BB temperatures)
137–146	MRATLAF*	(2 x 5) IR detector M gain rate low alarms MRATLAF_P0 - P71
147	SCANMIR	Scan mirror temperature out-of-range at BB-Cal (= 255 if true)
148–209		Spares–not used
210	TRIGEVT	Triggering event: 0 = spacelook, 255 = BB
211–218	TIMETRIGGER	CDA time of triggering event (see notes)
219		Spares–not used
220	LEFTRIGHT	Spacelook side active: 0 = west, 255 = east
221	ELECSIDE	Electronics side active: 0 = Side 1, 255 = Side 2
222	PXOR45	Longitudinal parity (XOR) of words 1–221
Sounder Calibration Data		
223–510	IRDETBIA*	(4 x 72) IR detector biases IRDETBIA_P0 - P71
511–798	IRDET1OG*	(4 x 72) IR detector first-order gains IRDET1OG_P0 - P71

799–1086	IRDET2OG*	(4 x 72) IR detector second-order gains IRDET2OG_P0 - P71
1087–1374	IRDETBRS*	(4 x 72) IR detector bias regression slopes (ks) IRDETBRS_P0 - P71
1375–1662	IRDETBRI*	(4 x 72) IR detector bias regression intercepts (hs) IRDETBRI_P0 - P71
1663–1950	IRDETBSE*	(4 x 72) IR detector bias SEE IRDETBSE_P0 - P71
1951–1954	WMBBTS	(4 x 1) Weighted mean BB temperature
1955–1958	WMBPTS	(4 x 1) Weighted mean baseplate temperature
1959–1962	WMEOTS	(4 x 1) Weighted mean optics temperature
1963–1966	SMPATS	(4 x 1) Smoothed patch temperature
1967–1970	AVFWRS	(4 x 1) Average filter wheel rate (revolutions per second)
1971–1974	CSG8BBTS	(4 x 1) Current σ of 8 BB temperatures
1975–1978	CSGTBBS	(4 x 1) Current σ tolerance for BB
1979–2010	BBTWFS*	(4 x 8) BB thermistor weighting factors BBTWFS_P0 - P7
2011–2034	BPTWFS*	(4 x 6) Baseplate thermistor weighting factors BPTWFS_P0 - P5
2035–2062	OTWFS*	(4 x 7) Optics temperature weighting factors OTWFS_P0 - P6
2063–2066	CAWMHDS	(4 x 1) Current *a* weight for M-history data
2067–2070	CBWMHDS	(4 x 1) Current *b* weight for M-history data
2071–2074	CCWMHDS	(4 x 1) Current *c* weight for M-history data
2075–2078	CDWMHDS	(4 x 1) Current d weight for M-history data
2079–2094	BBTFSSS*	(2 x 8) BB thermistor filtered sample size BBTFSSS_P0 - P7
2095	BBTWSS	BB thermistor window size N
2096	CPTCLS	Current patch temperature control level [1:7] (See Note 6 for Table 2-28)
2097	IRCALBMS	IR calibration B (bias) mode [1:2]
2098	IRCALMMS	IR calibration M (first-order gain) mode [1:7]
2099	IRCALQMS	IR calibration Q (second-order gain) mode [1:3]
2100	VRNORMDS	Visible reference normalization detector
2101	MHWWHS	M-history window width; in hours [1:24]
2102	MHWDDS	M-history window depth; in days [1:10]
2103–2129	MHROCSS	M-history regression optical component selectors
2130	EWCEDS	E-W correction enabled or disabled (0 = disabled, 255 = enabled)
2131–2134	SMTMPBC	(4 x 1) Scan mirror temperature at BB-Cal
2135–2206	CAECACME*	(4 x 18) Current *a* emissivity coefficients (intercept) CAECACMEIR1 - 18
2207–2278	CBECACMEIR1*	(4 x 18) Current *b* emissivity coefficients (first-order) CBECACMEIR1 - 18

2279–2350	CCECACMEIR1*	(4 x 18) Current *c* emissivity coefficients (second-order) CCECACMEIR1 - 18
2351–2781		Not assigned (set to zeros)
2782	PXOR46	Longitudinal parity (XOR) of words 223–2781
Sounder Telemetry Warning Limits		
2783–2910	MFSSLS*	(2 x 64) Minimum filtered sample size limit MFSSLS_P0 - P30
2911–3038	P30P30 LPFLCCS*	(2 x 64) Low pass filter limit – counts LPFLCCS_P0 - P30
3039–3166	HPFLCCS*	(2 x 64) High pass filter limit – counts HPFLCCS_P0 - P30
3167–3422	UFMELLS*	(4 x 64) Unfiltered mean low limit – counts UFMELLS_P0 - P30
3423–3678	FMELLS*	(4 x 64) Filtered mean low limit – counts FMELLS_P0 - P30
3679–3934	UFMEHLS*	(4 x 64) Unfiltered mean high limit – counts UFMEHLS_P0 - P30
3935–4190	FMEHLS*	(4 x 64) Filtered mean high limit – counts FMEHLS_P0 - P30
4191–4446	UFSGHLS*	(4 x 64) Unfiltered σ high limit – counts UFSGHLS_P0 - P30
4447–4702	FSGHLS*	(4 x 64) Filtered σ high limit – counts FSGHLS_P0 - P30
4703–4958	FMELLEUS*	(4 x 64) Filtered mean low limit – engineering units FMELLEUS_P0 - P30
4959–5214	FMEHLEUS*	(4 x 64) Filtered mean high limit – engineering units FMEHLEUS_P0 - P30
5215–5470	FSGHLEUS*	(4 x 64) Filtered σ high limit – engineering units FSGHLEUS_P0 - P30
Sounder Telemetry Critical Alarm Limits		
5471–5534	MNFSSS*	(2 x 32) Minimum filtered sample size limits MNFSSS_P0 - P26
5535–5662	FMELLSEUS*	(4 x 32) Filtered mean low limits – engineering units FMELLSEUS_P0 - P26
5663–5790	FMEHLSEUS*	(4 x 32) Filtered mean high limits – engineering units FMEHLSEUS_P0 - P26
5791–5918	FSGLSEUS*	(4 x 32) Filtered σ limits – engineering units FSGLSEUS_P0 - P26
5919	PXOR47	Longitudinal parity (XOR) of words 2783–5918
5920–6110		Unused – zeroes
Sounder ECAL Warning Limits		
6111–6114	EXRRLS	(4 x 1) Excessive residual RMS limit (all detectors)
6115–6146	VISLLSS*	(2 x 16) Visible low limits/step – counts VISLLSS_P0 - P15
6147–6178	ILWLLSS*	(2 x 16) IR Long wave low limits/step – counts ILWLLSS_P0 - P15

6179–6210	IMWLLSS*	(2 x 16) IR Medium wave low limits/step – counts IMWLLSS_P0 - P15
6211–6242	ISWLLSS*	(2 x 16) IR Short wave low limits/step – counts ISWLLSS_P0 - P15
6243–6274	VISHLSS*	(2 x 16) Visible high limits/step – counts VISHLSS_P0 - P15
6275–6306	ILWHLSS*	(2 x 16) IR Long wave high limits/step – counts ILWHLSS_P0 - P15
6307–6338	IMWHLSS*	(2 x 16) IR Medium wave high limits/step – counts IMWHLSS_P0 - P15
6339–6370	ISWHLSS*	(2 x 16) IR Short wave high limits/step – counts ISWHLSS_P0 - P15
6371–6402	MNFSLDS*	(2 x 16) Minimum filtered samples limit or detector (equals 1) MNFSLDS_P0 - P15
6403–6418	CAADSDS*	(1x16) Channel assigned as data source or detector CAADSDS_P0- P15
6419	PXOR48	Longitudinal parity (XOR) of words 6111–6418
6420–8040		Unused – zeroes
Block 2 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	CDAIRCC	CDA time IR coefficients calculated
39–46	CDATCLS	CDA time of current limits set
47–54	CDACVNC	CDA time current visible NLUTs created
55–222		Spares–not used
Sounder Spacelook Warning Limits		
223–374	MNFSSLSL*	(2 x 76) Minimum filtered sample size limit MNFSSLSL_P0 - 75
375–526	LOWFILLIMSL*	(2 x 76) Low filter limit – counts LOWFILLIMSL_P0 - 75
527–678	HIFILISL*	(2 x 76) High filter limit – counts HIFILISL_P0 - 75
679–982	UNFIMELLSL*	(4 x 76) Unfiltered mean low limit – counts UNFIMELLSL_P0 - 75
983–1286	FIMELLSL*	(4 x 76) Filtered mean low limit – counts FIMELLSL_P0 - 75
1287–1590	UNFIMEHLSL*	(4 x 76) Unfiltered mean high limit – counts UNFIMEHLSL_P0 - 75
1591–1894	FIMEHLSL*	(4 x 76) Filtered mean high limit – counts FIMEHLSL_P0 - 75
1895–2198	UNFISGHLSL*	(4 x 76) Unfiltered σ high limit – counts UNFISGHLSL_P0 - 75
2199–2502	FISGHLSL*	(4 x 76) Filtered σ high limit – counts FISGHLSL_P0 - 75

2503–2790	FISGHLRSL*	(4 x 72) Filtered IR σ high limit – radiance FISGHLRSL_P0 - 71
2791-3078	FISGHLTSL*	(4 x 72) Filtered IR σ high limit – temperature FISGHLTSL_P0 - 71
Sounder Spacelook Critical Limits		
3079–3230	MNFILSSCSL*	(2 x 76) Minimum filtered sample size/detector MNFILSSCSL_P0 - 75
3231	PXOR49	Longitudinal parity (XOR) of words 223–3230
3232–3538		Unused – zeroes
Sounder BB Warning Limits		
3539–3682	MNFSSLBB*	(2 x 72) Minimum filtered sample size limits MNFSSLBB_P0 - 71
3683–3826	LOWFILLIMBB*	(2 x 72) Low filter limit – counts LOWFILLIMBB _P0-71
3827–3970	HIFILIBB *	(2 x 72) High filter limit – counts HIFILIBB P0-71
3971–4258	UNFIMELLBB*	(4 x 72) Unfiltered mean low limit – counts UNFIMELLBB_P0-71
4259–4546	FIMELLBB *	(4 x 72) Filtered mean low limit – counts FIMELLBB _P0-71
4547–4834	UNFIMEHLBB*	(4 x 72) Unfiltered mean high limit – counts UNFIMEHLBB_ P0-71
4835–5122	FIMEHLBB*	(4 x 72) Filtered mean high limit – counts FIMEHLBB _P0-71
5123–5410	UNFISGHLBB*	(4 x 72) Unfiltered σ high limit – counts FISGHLRBB_P0-71
5411–5698	FISGHLBB*	(4 x 72) Filtered σ high limit – counts FISGHLBB_P0-71
5699–5986	FISGHLRBB*	(4 x 72) Filtered σ high limit – radiance FISGHLRBB_P0-71
5987–6274	FISGHLTBB*	(4 x 72) Filtered σ high limit – temperature FISGHLTBB_P0-71
Sounder BB-Cal Critical Limits		
6275–6418	MNFILSSCBB*	(2 x 72) Minimum filtered sample size or CDET MNFILSSCBB_P0-71
Sounder Linear Regression Critical Limit		
6419–6422	MAXSEEALARMS	(4 x 1) Maximum SEE
Sounder Calibration Critical Limits		
6423–6426	MAXBPTGLS	(4 x 1) Maximum baseplate temperature for gain LUT
6427–6430	MINBPTGLS	(4 x 1) Minimum baseplate temperature for gain LUT
6431–6432	MINFSSBTS	(2 x 1) Minimum filtered sample size/BB thermistor
6433–6434		Unassigned – zeros

6435–6722	MAXRMM2*	(4 x 72) Maximum rate in M modes 2 MAXRMM2_P0-71
6723–6726	MAXPOMM35S	(4 x 1) Maximum percentage of outliers in M modes 3, 5
6727–7014	MAXSEM45S*	(4 x 72) Maximum standard error in M modes 4, 5 MAXSEM45S_P0-71
7015–7302	MAXRSSE67S*	(4 x 72) Maximum RSS error in modes 6, 7 MAXRSSE67S_P0-71
Sounder Calibration Critical Limits (Cont.)		
7303–7306	NSIG	(4 x 1) N-σ tolerance for M-history filtering
7307–7310	MAXHIST	(4 x 1) Maximum number of history data iterations
7311–7314	MINBBMIN	(4 x 1) Minimum number of minutes between BB-Cal
7315–7318	MVALUP	(4 x 1) M value update interval in 2-minute marks
7319–7322	MINDPATCH	(4 x 1) Minimum delta patch temperature for M modes 2
7323–7610	MINDELGAIN*	(4 x 72) Minimum delta gain for M mode 2 MINDELGAIN_P0-71
7611–7898	MINRATE*	(4 x 72) Minimum rate (slope) in M mode 2 MINRATE_P0-71
7899–7901		Unassigned – zeros
7902	PXOR50	Longitudinal parity (XOR) of words 3539–7901
7903–8040		Unused – zeroes

Notes:

1. This Block 11 format sequence is produced following every spacelook and BB-Cal sequence. The trigger time in words 211–218 is the time associated with the first raw data block of the triggering event, spacelook or BB.

2. All arrays of size 4 x *N* are floating point value arrays.

3. All arrays of size *N* x 72 apply to the IR CDET groups and are ordered channel 1, detector 1 to channel 18, detector 4, respectively. Arrays having a size of *N* x 76 include data for the channel 19, visible detectors 1–4.

4. Detector 1, as identified in GVAR , refers to the top left detector in the radiometric detector array (see Figure 3-6). Note that in ITT documentation detector 1 refers to the bottom-right detector and detector 4 refers to the top-left detector.

Included with each IR calibration coefficients set is a series of critical alarm flags. The flags are used to denote the occurrence of any condition which prohibits the normal calibration computation sequence for one or more detectors. These flags are defined in Tables 3-30 and 3-31 for the Imager and Sounder, respectively.

Table 3-30. Imager Calibration Critical Alarm Flag Definitions

Critical alarm flags for Imager spacelook, words 57–59, and BB-Cal, words 60–62, data are defined as follows:	
Bits	**Set True(1) if Critical Condition is Present**
1	Visible detector 1 insufficient samples
2	Visible detector 2 insufficient samples
3	Visible detector 3 insufficient samples
4	Visible detector 4 insufficient samples
5	Visible detector 5 insufficient samples
6	Visible detector 6 insufficient samples
7	Visible detector 7 insufficient samples
8	Visible detector 8 insufficient samples
9	Unassigned (always 0)
10	IR side 1 detector 1 insufficient samples
11	IR side 1 detector 2 insufficient samples
12	IR side 1 detector 3 insufficient samples
13	IR side 1 detector 4 insufficient samples
14	IR side 1 detector 5 insufficient samples
15	IR side 1 detector 6 insufficient samples
16	IR side 1 detector 7 insufficient samples
17	Unassigned (always 0)
18	IR side 2 detector 1 insufficient samples
19	IR side 2 detector 2 insufficient samples
20	IR side 2 detector 3 insufficient samples
21	IR side 2 detector 4 insufficient samples
22	IR side 2 detector 5 insufficient samples
23	IR side 2 detector 6 insufficient samples
24	IR side 2 detector 7 insufficient samples

Notes:

1. The flag bits are numbered 1 – 24, where bit 1 is the MSB of the first word and bit 24 is the LSB of the third word. Each flag bit is set to one if the associated condition is true; otherwise, it is set to zero.

2. Only one instrument side can be active at any one time, as indicated by Table 3-28, word 221. The inactive side flag bits above are always reset to zero.

3. A Block 11, formatted according to Table 3-28, can result from either a spacelook or a BB event, as indicated in word 210. If word 210 indicates a spacelook trigger, the BB critical alarm flags in words 60–62 are not used and are set to zeros. If word 210 indicates a BB event, the critical alarm flags in words 57–59 are not used and set to zeros.

4. Note that bits 1 – 8 are the visible detector flags, are not applicable for BB-Cal and are always set to zero (see words 60 – 62). Following is added for GOES-O 8th detector information

   Word 7411 and 7412 for Imager Calibration Limits Block11 (Table 3-28)
   Word 227 for Imager Spacelook Block11 Block#7 (Table 3-22)
   Word 225 for Imager Blackbody Blcok11 Block#3 (Table 3-26)

Bit	Set True (1) if critical condition is present
1	Unassigned (always 0)
2	Unassigned (always 0)
3	Unassigned (always 0)
4	Unassigned (always 0)
5	Unassigned (always 0)
6	Unassigned (always 0)
7	IR side2 detector 8 insufficient samples
8	IR side1 detector 8 insufficient samples

Critical alarm flags for Imager temperature values affect detector calibration and are defined as follows (see words 63–64):	
Bits	**Set True(1) if Critical Condition is Present**
1	BB Thermistor 1 insufficient samples
2	BB Thermistor 2 insufficient samples
3	BB Thermistor 3 insufficient samples
4	BB Thermistor 4 insufficient samples
5	BB Thermistor 5 insufficient samples
6	BB Thermistor 6 insufficient samples
7	BB Thermistor 7 insufficient samples
8	BB Thermistor 8 insufficient samples
9	Baseplate Temperature too low for LUT usage
10	Baseplate Temperature too high for LUT usage
11–16	Spares – not used

Notes:

1. Critical alarm-flag bits are numbered 1 – 16, with bit 1 the MSB of the first word and bit 16 the LSB of the second word. Each flag bit is set to one if the associated condition is true; otherwise, it is set to zero. Limits defined in Table 3-28, words 7183–7192, are employed in determining the above temperature alarms.

2. The BB thermistor flag bits are enabled only for a report triggered by a BB-Cal; they are always reset to zeros for reports triggered by a spacelook. The samples referenced by these bits are maintained in a moving window within the SPS and are not directly reported within the GVAR stream. The samples are evaluated at the occurrence of a BB-Cal sequence.

3. Baseplate temperature flag bits are enabled only for a report triggered by a spacelook calibration; they are always reset to zeros for reports triggered by a BB event. The baseplate temperature filtered mean values reported in the telemetry statistics Block 11 associated with the spacelook are used to form a weighted mean baseplate temperature. This weighted mean value is used in controlling the temperature flag bits.

Critical alarm flags for first-order gain computations, words 65–71, are defined as follows:

Bits	**Set True(1) if Critical Condition is Present**
1	Maximum gain rate exceeded, mode 2
2	Maximum percentage of outliers exceeded, modes 3, 5,
3	Maximum standard error exceeded, modes 4, 5,
4	Maximum RSS error exceeded, modes 6, 7,
5	Gain rate below minimum, mode 2
6-8	Unassigned – always zero

Notes:

1. The critical alarm flag bits are numbered 1 – 8, with bit 1 assigned to the MSB of the word and bit 8 to the LSB. Each flag bit is set to one if the associated condition is true; otherwise, it is set to zero.
2. The seven-flag words, 65 – 71, are sequentially assigned to the seven active IR detectors using the mapping defined in Figure 3-11.

Table 3-31. Sounder Calibration Critical Alarm Flag Definitions

Critical Alarm flags for Sounder spacelook, words 63–72, and BB data, words 73–82, are defined as follows:

Spacelook words 63–64, 65–66, 67–68, 69–70, 71–72
BB words 73–74, 75–76, 77–78, 79–80, 81–82

Flag	Set True (1) if an Insufficient Sample Condition is Present
1	1 detector – Channels 1, 5, 9, 13, 17
2	2 detector – Channels 1, 5, 9, 13, 17
3	3 detector – Channels 1, 5, 9, 13, 17
4	4 detector – Channels 1, 5, 9, 13, 17
5	1 detector – Channels 2, 6, 10, 14, 18
6	2 detector – Channels 2, 6, 10, 14, 18
7	3 detector – Channels 2, 6, 10, 14, 18
8	4 detector – Channels 2, 6, 10, 14, 18
9	1 detector – Channels 3, 7, 11, 15, 19
10	2 detector – Channels 3, 7, 11, 15, 19
11	3 detector – Channels 3, 7, 11, 15, 19
12	4 detector – Channels 3, 7, 11, 15, 19
13	1 detector – Channels 4, 8, 12, 16
14	2 detector – Channels 4, 8, 12, 16
15	3 detector – Channels 4, 8, 12, 16
16	4 detector – Channels 4, 8, 12, 16

Notes:

1. Detectors 1 – 4 for Channels 1, 2, 3, and 4 are assigned to flag bits 1 – 16 in words 63 and 64 for spacelook data and words 73 and 74 for BB data.
2. The four Channel 19 visible detectors are not included as part of the BB-Cal sequence. As a result, their flag bits, 9 – 12, are always zeroed for the BB case, words 81 and 82. Also, the last four flag bits, 13 – 16, in words 71, 72, 81 and 82, are not used and are always zero.

Temperature critical alarm flags, words 83–84, are defined as follows:

Flag	Set True (1) if Critical Condition is Present
1	BB Thermistor 1 insufficient samples
2	BB Thermistor 2 insufficient samples
3	BB Thermistor 3 insufficient samples
4	BB Thermistor 4 insufficient samples
5	BB Thermistor 5 insufficient samples
6	BB Thermistor 6 insufficient samples
7	BB Thermistor 7 insufficient samples
8	BB Thermistor 8 insufficient samples
9	Baseplate Temperature too low for LUT usage
10	Baseplate Temperature too high for LUT usage
11-16	Spares–not used

Note: The critical alarm flag bits are numbered 1 – 16, with bit 1 the MSB of the first word and bit 16 the LSB of the second word. Notes and comments associated with the Imager temperature critical alarm flags in Table 3-30 apply, except that the limits used in the temperature alarms are defined in Table 3-29, words 6423 – 6432.

Critical alarm flags for bias (B) and first-order gain (M) computations are defined as follows:

Alarm Condition	Words
B SEE	85–86, 87–88, 89–90, 91–92, 93–94
M rate	95–96, 97–98, 99–100, 101–102, 103–104
M outliers	105–106, 107–108, 109–110, 111–112, 113–114
M SEE	115–116, 117–118, 119–120, 121–122, 123–124
M RSS	125–126, 127–128, 129–130, 131–132, 133–134

Flag	Set True (1) if the see too High Condition is Present
1	Detector 1 – Channels 1, 5, 9, 13, 17
2	Detector 2 – Channels 1, 5, 9, 13, 17
3	Detector 3 – Channels 1, 5, 9, 13, 17
4	Detector 4 – Channels 1, 5, 9, 13, 17
5	Detector 1 – Channels 2, 6, 10, 14, 18
6	Detector 2 – Channels 2, 6, 10, 14, 18
7	Detector 3 – Channels 2, 6, 10, 14, 18
8	Detector 4 – Channels 2, 6, 10, 14, 18
9	Detector 1 – Channels 3, 7, 11, 15
10	Detector 2 – Channels 3, 7, 11 ,15
11	Detector 3 – Channels 3, 7, 11, 15
12	Detector 4 – Channels 3, 7, 11, 15
13	Detector 1 – Channels 4, 8, 12, 16
14	Detector 2 – Channels 4, 8, 12, 16
15	Detector 3 – Channels 4, 8, 12, 16
16	Detector 4 – Channels 4, 8, 12, 16

Note: The last eight flag bits, 9 – 16, assigned to each alarm condition, words 94, 104, 114, 124, and 134, are not used and are always zero.

3.3.7.10 Visible Detector NLUTs

Data from the Imager and Sounder visible detectors are converted to destriped pixel imagery by the SPS through the use of NLUTs. The NLUTs are generated in the PMs and transmitted to the SPSs on an as needed basis. The instrument NLUTs currently in use are broadcast in GVAR following every BB-Cal event. The Block 11 formats employed are defined in Tables 3-32 and 3-33 for the Imager and Sounder, respectively. The formats include CDA time tags denoting the NLUT creation time and the time at which the respective NLUT was enabled by the SPS. The creation time tag is reported in the scan documentation blocks to permit positive identification of the NLUT.

Table 3-32. Imager NLUT Block 11 Format

Block 1 Words	Name	Description
1–24	**	**SAD ID (see Section 3.3.7.1)
25		Unused – always zero
26–33	CDATIMEIRIM1	CDA time IR coefficients calculated
34–41	CDATIMEIRIM2	CDA time of current limits set
42–49	CDATIMEIRIM3	CDA time current visible NLUTs created
50–57	CDATIMEIRIM4	CDA time current visible NLUTs implemented
58	REFDETIDI	Reference detector ID (1 – 8)
59	DXOR1	Longitudinal parity (XOR) of detector 1 NLUT
60	DXOR2	Longitudinal parity (XOR) of detector 2 NLUT
61	DXOR3	Longitudinal parity (XOR) of detector 3 NLUT
62	DXOR4	Longitudinal parity (XOR) of detector 4 NLUT
63	DXOR52	Longitudinal parity (XOR) of words 1 - 62
64–1021		Spares–not used
1022–2045	DECT1NLUT	Detector 1 NLUT
2046–3069	DECT2NLUT	Detector 2 NLUT
3070–4093	DECT3NLUT	Detector 3 NLUT
4094–5117	DECT4NLUT	Detector 4 NLUT
5118–5125	OHDEAR1*	ASCII NLUT identification OHDEAR1_P0 - P7
5126–6432		Spares–not used
Block 2 Words	**Name**	**Description**
1-24	**	**SAD ID (see Section 3.3.7.1)
25		Unused – always zero
26–33	CDATIMEIRIM5	CDA time IR coefficients calculated
34–41	CDATIMEIRIM6	CDA time of current limits set
42–49	CDATIMEIRIM7	CDA time current visible NLUTs created
50–57	CDATIMEIRIM8	CDA time current visible NLUTs implemented

58	REFDETIDI2	Reference detector ID (1 – 8)
59	DXOR5	Longitudinal parity (XOR) of detector 5 NLUT
60	DXOR6	Longitudinal parity (XOR) of detector 6 NLUT
61	DXOR7	Longitudinal parity (XOR) of detector 7 NLUT
62	DXOR8	Longitudinal parity (XOR) of detector 8 NLUT
63	DXOR53	Longitudinal parity (XOR) of words 1 - 62
64–1021		Spares–not used
1022–2045	DECT5NLUT	Detector 5 NLUT
2046–3069	DECT6NLUT	Detector 6 NLUT
3070–4093	DECT7NLUT	Detector 7 NLUT
4094–5117	DECT8NLUT	Detector 8 NLUT
5118–5125	OHDEAR2*	ASCII NLUT identification OHDEAR2_P0 - P7
5126–6432		Spares–not used

Note: The Imager visible NLUTs use a 10-bit word length. They are broadcast in GVAR following every BB-Cal. The NLUTs are sequenced to follow the transmission of the BB-triggered calibration Block 11 (see Table 3-28).

Table 3-33. Sounder NLUT Block 11 Format

Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	CDATIMEIR_0	CDA time IR coefficients calculated
39–46	CDATIMELIMITS_0	CDA time of current limits set
47–54	CDATIMENLUT_0	CDA time current visible NLUTs created
55–62	LASTFORNOW_0	CDA time current visible NLUTs implemented
63	REFERENCE_0	Reference detector ID (1 – 4)
64	DETECXID_0	Detector X ID
65–66	DETECXWC_0	Detector X word count
67	DXORX_0	Longitudinal parity (XOR) of detector X NLUT
68	DETECYID_0	Detector Y ID
69–70	DETECYWC_0	Detector Y word count
71	DXORY_0	Longitudinal parity (XOR) of detector Y NLUT
72–73		Unused – zeroes
74	PXOR51_0	Longitudinal parity (XOR) of words 1 – 73

The Sounder visible detector NLUTs require 16,384 8-bit words of Block 11 transmission space for each detector. Between the four applicable detectors, a total of nine Block 11s are required to completely transfer the NLUTs. Words 1 – 74 of each of the nine blocks are defined above. Three of the required nine Block 11s contain portions of NLUTs for two detectors. The “X” ID in the header identifies the first detector (1, 2, or 3) along with a count of words. The “Y” ID identifies the second detector (2, 3, or 4) and also indicates the number of words. The longitudinal parity values are always computed over the entire 16,384 words of a detector’s NLUT. The nine Block 11s constituting the Sounder’s NLUTs are broadcast in GVAR following each Sounder BB-Cal.

Block 11 Sequence No.	Words	Name	Content Description
1	75–8040	D1NP1	Detector 1 NLUT words 1 – 7966
2	75–8040	D1NP2	Detector 1 NLUT words 7967 – 15932
3	75–526	D1NP3	Detector 1 NLUT words 15933 – 16384
3	527–8040	D2NP1	Detector 2 NLUT words 1 – 7514
4	75–8040	D2NP2	Detector 2 NLUT words 7515 – 15480
5	75–978	D2NP3	Detector 2 NLUT words 15481 – 16384
5	979–8040	D3NP1	Detector 3 NLUT words 1 – 7062
6	75–8040	D3NP2	Detector 3 NLUT words 7063 – 15028
7	75–1430	D3NP3	Detector 3 NLUT words 15029 – 16384
7	1431–8040	D4NP1	Detector 4 NLUT words 1 – 6610

Block 11 Sequence No.	Words	Name	Content Description
8	75–8040	D4NP2	Detector 4 NLUT words 6611 – 14576
9	75–1882	D4NP3	Detector 4 NLUT words 14577 – 16384
9	1883–1890	ASCIINIDS	ASCII NLUT ID
9	1891–8040		Spares–not used

3.3.7.11 Star Sense Statistics and Data

Under nominal conditions the Imager and Sounder each perform a star sensing operation at a rate ranging from two to six times an hour. During a star sense the instrument is left positioned at a predetermined coordinate through which a star is expected to pass as the satellite revolves. The passage of the known star through the FOV of one or more of the instrument's 1 km visible detectors at a particular time provides a measurement of the instrument's attitude.

The statistics associated with each star sense are passed to the OATS for use in updating the instrument's O&A estimates. As a diagnostic aid, the star sense statistics, supporting calculation data, and the associated raw detector data are transferred in GVAR to the PM by way of a sequence of Block 11s. The format of the Imager and Sounder star sense Block 11 sequences are defined in Table 3-34 and Table 3-35, respectively. Section 3.7 details the algorithm employed for the star crossing analysis, providing further information about the terms employed in Tables 3-34 and 3-35.

The star sense Block 11 formats also contain edge detection data for the Moon's rim. The edge of the full moon is "bright" in both the visible and IR channels, offering a fine target for measuring the E-W imaging detector misalignments. When moon-shot data is transmitted, the moon flag in word 1087 is non-zero. The channel flag, word 1088, is set to denote the radiometric channel being transmitted.

Table 3-34. Imager Star Sense Block 11 Format

Block 1 Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	CDASTARINT	CDA time star sense interval started
39–42	MILLISECONDS	Interval Duration (msec)
43–44	WHERENSC	Instrument Coordinates, N-S cycles
45–46	WHERENSI	Instrument Coordinates, N-S increments
47–48	WHEREEWC	Instrument Coordinates, E-W cycles
49–50	WHEREEWI	Instrument Coordinates, E-W increments
51–52	WSLAMW	W – Sample length of averaging moving window
53–54	FOURM	FOURM – number of raw pixels/SDI sample
Star Sense Controls, Statistics, and Results		
55–56	WTC	(2 x 1) window thresholding count (WTC)
57–58	ETC	(2 x 1) Event Thresholding Count (ETC)
59–74	DWT*	(2 x 8) Window Threshold Tolerance/Detector (DWT) DWT_P0-7
75–90	DMV*	(2 x 8) Interval Mean Value/Detector (DMV) DWV_P0-8
91–106	WTL*	(2 x 8) Window Threshold Level/Detector (WTL) WTL_P1-8
107–122	EVECOUNT*	(2 x 8) events counted/detector EVECOUNT_P1-8
123–124	NUMBERPIX	(2 x 1) number of pixels in each of Blocks 2–9
125–126	DATAFLAG	(2 x 1) data loss flag = 1 if break in star data
127–190	HIN*	(2 x 32) Hin – start of window raw data index HIN_P00-31
191–254	KIN*	(2 x 32) Kin – end of window raw data index KIN_ P00-31
255–318	WMV*	(2 x 32) Window Mean Value (WMV) WMV_P01-32
319–382	ETL	(2 x 32) Event Thresholding Level (ETL)
383–446	MIN	(2 x 32) Min – start of event raw data index
447–510	NIN	(2 x 32) Nin – end of event raw data index
511–574	EMV	(2 x 32) Event Mean Value (EMV)
575–638	NSSEEALARM	(2 x 32) N-S servo error at event
639–702	EWSEEALARM	(2 x 32) E-W servo error at event
703–766	TEVI*	(2 x 32) Star pixel event data index TEVI_P01-32
Star Sense Controls, Statistics, and Results (Cont.)		
767–1022	TEVCDA*	(8 x 32) TEVCDA – CDA time of event TEVCDA_P01-32

1023–1086	EVENTDUR*	(2 x 32) Event duration (msec) EVENTDUR_P01-32
1087	MOONFLAG	(1 x 1) MOONFLAG (0 = star sense, 255 = moon sense)
1088	MOONCHAN	(1 x 1) MOONCHAN (0 = star sense, 1 to 5 = moon sense)
1089–1090		Spares–not used
1091–1122	DWTF*	(4 x 8) DWT – in floating point format DWTF_P1-8
1123–1154	DMVF*	(4 x 8) DMV – in floating point format DMVF_P1-8
1155–1186	WTLF*	(4 x 8) WTL – in floating point format WTLF_P1-8
1187–1314	WMVF*	(4 x 32) WMV – in floating point format WMVF_P01-32
1315–1442	ETLF*	(4 x 32) ETL – in floating point format ETLF_P01-32
1443–1570	EMVF*	(4 x 32) EMV – in floating point format EMVF_P01-32
1571–1698	SDIMAX	(4 x 32) SDIMAX – maximum raw value
1699–1826	SDIFWHM	(4 x 32) SDIFWHM – full width half maximum value
1827	PXOR52	Longitudinal parity (XOR) of words 1 – 1826
1828–8040		Spares–not used
Blocks 2-9 Words	**Name**	**Description**
1–24	**	**SAD ID (see Section 3.3.7.1)
25–32	CDA_START_TIME*	CDA start time (from words 31 – 38 of block 1) CDA_START_TIME_1 - 8
33–6432	DET_STAR_PIXEL_DATA*	Detector [1–8] star pixel data DET_STAR_PIXEL_DATA_1 - 8

Notes:

1. Block 1 uses an 8-bit word format. With the exception of the CDA formatted time tags, all values in Block 1 are unsigned integers.

2. Blocks 2 – 9 use 10-bit word formats. Star pixel data in blocks 2 – 9 have 10 significant bits in the 10-bit words and are time-ordered with the oldest pixel first (word 33) in each array.

Table 3-35. Sounder Star Sense Block 11 Format

Block 1 Words	Name	Description
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	SCDASTARINT	CDA time star sense interval started
39–42	SMILLISECONDS	Interval duration (msec)
43–44	SWHERENSC	Instrument coordinates, N-S cycles
45–46	SWHERENSI	Instrument coordinates, N-S increments
47–48	SWHEREEWC	Instrument coordinates, E-W cycles
49–50	SWHEREEWI	Instrument coordinates, E-W increments
51–52	SWSLAMW	W – Sample length of averaging moving window
53–54		Unused - zeroes
Star Sense Controls, Statistics, and Results		
55–56	SWTC	(2 x 1) WTC
57–58	SETC	(2 x 1) ETC
59–74	SDWT*	(2 x 8) DWT SDWT_P0 - 7
75–90	SDMV*	(2 x 8) DMV SDMV_P0 - 7
91–106	SWTL*	(2 x 8) WTL SWTL_P0 - 7
107-122	SEVECOUNT*	(2 x 8) events counted/detector SEVECOUNT_P0 - 7
123-124	SNUMBERPIX	(2 x 1) number of pixels in each of blocks 2–9
125–126	SDATAFLAG	(2 x 1) data loss flag = 1 if break in star data
127–190	SHIN	(2 x 32) Hin – start of window raw data indice
191–254	SKIN	(2 x 32) Kin – end of window raw data indice
255–318	SWMV	(2 x 32) WMV
319–382	SETL	(2 x 32) ETL
383–446	SMIN	(2 x 32) Min – start of event raw data indice
447–510	SNIN	(2 x 32) Nin – end of event raw data indice
511–574	SEMV	(2 x 32) EMV
575–638	SNSSEEALARM	(2 x 32) N-S Servo Error at event
639–702	SEWSEEALARM	(2 x 32) E-W Servo Error at event
703–766	STEVI*	(2 x 32) TEVi – star pixel event data index STEVI_P01 - 32
767–1022	STEVCDA*	(8 x 32) TEVCDA – CDA time of event (TEV) STEVCDA_P01 - 32
1023–1086	SEVENTDUR*	(2 x 32) Event duration (msec) SEVENTDUR_P01 - 32
1087	SMOONFLAG	(1 x 1) MOONFLAG (0 = star sense, 255 = moon sense)

1088	SMOONCHAN	(1 x 1) MOONCHAN (0 = star sense, 1 to 20 = moon channel)
1089–1090		Spares–not used
1091–1122	SDWTF*	(4 x 8) DWT – in floating point format SDWT4_P0 - 7
1123–1154	SDMV4*	(4 x 8) DMV – in floating point format SDMV4_P0 - 7
1155–1186	SWTL4*	(4 x 8) WTL – in floating point format SWTL4_P0 - 7
1187–1314	SWMVF*	(4 x 32) WMV – in floating point format SWMVF_P01 - 32
1315–1442	SETLF*	(4 x 32) ETL – in floating point format SETLF_P01 - 32
1443–1570	SEMVF*	(4 x 32) EMV – in floating point format SEMVF_P01 - 32
1571–1698	SSDIMAX	(4 x 32) SDIMAX – maximum raw value
1699–1826	SSDIFWHM	(4 x 32) SDIFWHM – full width half maximum value
1827	PXOR53	Longitudinal parity (XOR) of words 1 – 1826
1828–8040		Spares–not used
Blocks 2-9 Words	**Name**	**Description**
1–30	**	**SAD ID (see Section 3.3.7.1)
31–38	CDA_START_TIME*	CDA start time from Block 1, words 31 – 38 CDA_START_TIME_S1 - 8
39–54		Spares–not used
55–5174	SPDFD*	Detector [1–8] star pixel data SPDFD1 - 8
5175–8040		Spares–not used

Note: All Sounder star sense Block 11s use an 8-bit word format. Star pixel data, Blocks 2 – 9, are ordered with oldest pixel first. Each star pixel has 13 significant bits, right-adjusted, and zero-filled within a two-word 16-bit field.

3.3.7.12 GIMTACS and SPS Text Message Format

A Block 11 format is also used for transmission of GIMTACS and SPS operator text messages to users. The format uses 8-bit words and the record format is straight 8-bit ASCII strings, one message per record. The record count in the SAD ID indicates the number of messages in the Block 11. Included at the beginning of each message is a 16-byte time tag formatted by the SPS as follows:

			1 1111	1	1
byteNo. :	1	2	3 4 567 89 0 1234	5	6
contents:	<CR>	<LF>	DDD:HH:MM:SS	<CR>	<LF>

where <CR> and <LF> indicate a carriage return and line feed character, respectively.

GIMTACS passes text messages to the SPS through a TCP/IP interface. GIMTACS text messages may be up to 11,866 characters in length, including the time tag. Large messages spanning more than one Block 11 are indicated by the first and last block flags and the block count in the SAD ID.

The SPS operator enters text messages through a keyboard using the SEND command. This command permits entry of messages that are up to 74 ASCII characters in length. The SPS normally sends the message by way of a Block 11 transfer as soon as entry is completed. The record length for SPS text messages is 90 characters, with the actual operator entered message (74 characters maximum) left-adjusted and blank filled following the 16-byte time tag. A limit of 10 SPS messages per Block 11 is observed.

Table 3-9 defines the SAD ID fields specifically related to the text message Block 11.

3.3.7.13 Fill Data Format

A fill data block is transmitted by the SPS whenever no other data blocks are ready for transmission. The fill data is nothing more then a block of 64,080 bits, each set to zero. This is packaged with an appropriate 240-bit SAD ID for transmission in the GVAR stream.

3.3.7.14 Imager Factory Coefficients

Starting with **GOES-M**, the block 11 format is used for the transmission of factory measured calibration coefficients for each of the imaging detectors along with the misalignments of the detectors with respect to the instruments optical axis. The coefficients required to convert raw telemetry counts to engineering units are provided for those points employed during formation of GVAR data. This data also appears in block 0 for **GOES M-N**. An Imager Factory Coefficients Block 11 will be sent at the start of the imager frame and at the lowest priority of all other block 11's but just before “fill data block”. The format of the Imager Factory Coefficients Block is defined in Table 3-36.

Table 3-36. Imager Factory Coefficients Block 11 Format (GOES-M and Beyond)

Word	Name	Description
1-30	**	**SAD ID
31-40		Spares–not used
41-41	F_IOFNC	Instrument nadir, north/south cycles
42-42	F_IOFEC	Instrument nadir, east/west cycles
43-44	F_IOFNI	Instrument nadir, north/south increments
45-46	F_IOFEI	Instrument nadir, east/west increments
47-48	F_VD1XO	Visible detector 1 x-offset
49-50	F_VD2XO	Visible detector 2 x-offset
51-52	F_VD3XO	Visible detector 3 x-offset
53-54	F_VD4XO	Visible detector 4 x-offset
55-56	F_VD5XO	Visible detector 5 x-offset
57-58	F_VD6XO	Visible detector 6 x-offset
59-60	F_VD7XO	Visible detector 7 x-offset
61-62	F_VD8XO	Visible detector 8 x-offset
63-64	F_PI1XO	Infrared detector 1 x-offset
65-66	F_PI2XO	Infrared detector 2 x-offset
67-68	F_PI3XO	Infrared detector 3 x-offset
69-70	F_PI4XO	Infrared detector 4 x-offset
71-72	F_PI5XO	Infrared detector 5 x-offset
73-74	F_PI6XO	Infrared detector 6 x-offset
75-76	F_PI7XO	Infrared detector 7 x-offset GOES O-P 8th IR det @1781
77-78	F_RI1XO	Redundant Infrared detector 1 x-offset
79-80	F_RI2XO	Redundant Infrared detector 2 x-offset
81-82	F_RI3XO	Redundant Infrared detector 3 x-offset
83-84	F_RI4XO	Redundant Infrared detector 4 x-offset
85-86	F_RI5XO	Redundant Infrared detector 5 x-offset
87-88	F_RI6XO	Redundant Infrared detector 6 x-offset
89-90	F_RI7XO	Redundant Infrared detector 7 x-offset GOES O-P 8th (Redundant) IR det @1783
91-92	F_VD1YO	Visible detector 1 y-offset
93-94	F_VD2YO	Visible detector 2 y-offset
95-96	F_VD3YO	Visible detector 3 y-offset
97-98	F_VD4YO	Visible detector 4 y-offset
99-100	F_VD5YO	Visible detector 5 y-offset
101-102	F_VD6YO	Visible detector 6 y-offset

103-104	F_VD7YO	Visible detector 7 y-offset
105-106	F_VD8YO	Visible detector 8 y-offset
Word	**Name**	**Description**
107-108	F_PI1YO	Infrared detector 1 y-offset
109-110	F_PI2YO	Infrared detector 2 y-offset
111-112	F_PI3YO	Infrared detector 3 y-offset
113-114	F_PI4YO	Infrared detector 4 y-offset
115-116	F_PI5YO	Infrared detector 5 y-offset
117-118	F_PI6YO	Infrared detector 6 y-offset
119-120	F_PI7YO	Infrared detector 7 y-offset GOES O-P 8th IR det @1785
121-122	F_RI1YO	Redundant Infrared detector 1 y-offset
123-124	F_RI2YO	Redundant Infrared detector 2 y-offset
125-126	F_RI3YO	Redundant Infrared detector 3 y-offset
127-128	F_RI4YO	Redundant Infrared detector 4 y-offset
129-130	F_RI5YO	Redundant Infrared detector 5 y-offset
131-132	F_RI6YO	Redundant Infrared detector 6 y-offset
133-134	F_RI7YO	Redundant Infrared detector 7 y-offset GOES O-P 8th (Redundant) IR det @1787
A set of characteristic response coefficients is provided for each of the 22 Imager detectors. The characteristic response coefficients are the initial calibration coefficients associated with the detectors. The scaling factors are used to generate a 10-bit value from each calibrated IR pixel. All entries are single precision floating point numbers. Each of the following arrays contains eight elements, one element per visible detector. The elements are ordered within each array in increasing physical detector number, with element 1 assigned to physical visible detector 1. This pattern continues for all the elements within each array.		
135-166	F_IVCRB*	Visible detectors characteristic response bias coefficients array. F_IVCRB_P0 - P7
167-198	F_IVCR1*	Visible detectors characteristic response first-order gain coefficients array. F_IVCR1_P0 - P7
199-230	F_IVCR2*	Visible detector characteristic response second-order gain coefficients array. F_IVCR2_P0 - P7
231-234	F_IVRAL	Visible detectors radiance-to-albedo conversion factor, one value for all eight detectors.
In the following arrays the first five each contains 14 elements, one element per IR detector for the first seven (7) pairs of detectors. The first seven elements in each array apply to the seven side 1 (primary) detectors; the last seven, to the side 2 (redundant) detectors. Within each group of seven, the elements are ordered in the same 1–7 sense as follows: 1 – channel 2 north 2 – channel 2 south 3 – channel 3 north 4 – channel 3 south 5 – channel 4 north 6 – channel 4 south 7 – channel 6 For GOES-O and beyond, the data for the 8th IR detector is found starting at word 1781		
235-290	F_IICRB*	Characteristic response bias coefficients F_IICRB_P0 - P13

		GOES O-P 8th IR det @1791
291-346	F_IICR1*	Characteristic response first-order gain coefficients F_IICR1_P0 - P13 GOES O-P 8th IR det @1799
347-402	F_IICR2*	Characteristic response second-order gain coefficients F_IICR2_P0 - P13 GOES O-P 8th IR det @1807
403-458	F_IISFB*	Scale factors bias coefficients F_IISFB_P0 - P13 GOES O-P 8th IR det @1815
459-514	F_IISF1*	Scale factors first-order gain coefficients F_IISF1_P0 - P13 GOES O-P 8th IR det @1823
515-738	F_IG2IT*	Second gain interpolation table. This array contains 56 elements, 4 elements for each of the first 14 IR detectors. The first 28 elements apply to the side 1 detectors, the last 28 to side 2. Within each group of 28, the elements are sequentially ordered (in groups of four) in the same 1–7 sense defined previously. F_IG2IT_P0 - P55 GOES O-P 8th IR det @1831
739-754	F_IG2BP*	Second gain baseplate temperature interpolation pivot points. Four baseplate temperatures at which IG2IT gains were measured. Access this table with baseplate temperature to determine linear interpolation factors to use within IG2IT. F_IG2BP_P0 - P3
755-978	F_IBBTR*	BB temperature-to-target radiance conversion coefficients. An array of 56 elements, 4 elements for each of the 14 IR detectors. Elements are ordered in the same manner as described for IG2IT. F_IBBTR_P0 - P55 GOES O-P 8th IR det @1863
979-1002	F_IPRNG*	Patch temperature control ranges. An array of six elements, two elements for each of the three patch temperature control ranges. Each pair of elements defines the lower and upper temperature limit assigned to a patch control point. F_IPRNG_P0 - P5
1003-1102		Spares–not used
In the following section, conversion coefficients are provided for each telemetry point whose engineering units value is used for calibration or alarm monitoring functions by the SPS. Conversion factors of unused telemetry points may be acquired from reference document SJ-572022.		
1103-1106	F_IEL1A	Imager Electronics Temperature side No. 1 coefficients. Final letter of term name (A–F) denotes type. See Eq 3.6-5 and 3.6-6 for usage.
1107-1110	F_IEL1B	See the above description.
1111-1114	F_IEL1C	See the above description.
1115-1118	F_IEL1D	See the above description.
1119-1122	F_IEL1E	See the above description.
1123-1126	F_IEL1F	See the above description.
The A-F naming convention used above with F_IEL1* is also used for the following thermistor terms:		
1127-1150	F_IEL2*	Imager electronics temp side 2 coefficients F_IEL2A-2F

1151-1174	F_IBP1*	Baseplate thermistor # 1 terms F_IBP1A-1F
1175-1198	F_IBP2*	Baseplate thermistor # 2 terms F_IBP2A-2F
1199-1222	F_IBP3*	Baseplate thermistor # 3 terms F_IBP3A-3F
1223-1246	F_IBP4*	Baseplate thermistor # 4 terms F_IBP4A-4F
1247-1270	F_IBP5*	Baseplate thermistor # 5 terms F_IBP5A-5F
1271-1294	F_IBP6*	Baseplate thermistor # 6 terms F_IBP6A-6F
1295-1318	F_IBB1*	Blackbody thermistor # 1 terms F_IBB1A-1F
1319-1342	F_IBB1*	Blackbody thermistor # 2 terms F_IBB2A-2F
1343-1366	F_IBB3*	Blackbody thermistor # 3 terms F_IBB3A-3F
1367-1390	F_IBB4*	Blackbody thermistor # 4 terms F_IBB4A-4F
1391-1414	F_IBB5*	Blackbody thermistor # 5 terms F_IBB5A-5F
1415-1438	F_IBB6*	Blackbody thermistor # 6 terms F_IBB6A-6F
1439-1462	F_IBB7*	Blackbody thermistor # 7 terms F_IBB7A-7F
1463-1486	F_IBB8*	Blackbody thermistor # 8 terms F_IBB8A-8F
1487-1510	F_IOP1*	Scan mirror thermistor terms F_IOP1A-1F
1511-1534	F_IOP2*	Primary mirror thermistor terms F_IOP2A-2F
1535-1558	F_IOP3*	Secondary mirror thermistor #1 terms F_IOP3A-3F
1559-1582	F_IOP4*	Secondary mirror thermistor #2 terms F_IOP4A-4F
1583-1606	F_IOP5*	Baffle thermistor #1 terms F_IOP5A-5F
1607-1630	F_IOP6*	Baffle thermistor #2 terms F_IOP6A-6F
1631-1654	F_IOP7*	Aft optics thermistor terms F_IOP7A-7F
The next four telemetry points use the following mapping to convert raw counts to engineering units: Temp = $A + BX + CX^2 + DX^3$		
1655-1678	F_IOP8*	Cooler radiator PRT terms F_IOP8A-8F The last two terms (E-F) are set equal to zero.

1679-1702	F_IOP9*	Wide range IR detector PRT terms F_IOP9A-9F
1703-1726	F_IOPA*	Narrow range IR detector PRT terms F_IOPAA-AF
1727-1750	F_ICHT*	Cooler housing PRT terms F_ICHTA-TF
The remaining two telemetry points use a simple linear, gain and bias, mapping to convert raw counts to engineering units.		
1751-1758	F_IPVGB*	Patch control voltage Gain/Bias terms F_IPVGB_P0 - P1
1759-1766	F_IICGB*	Instrument current Gain/Bias terms F_IICGB_P0 - P1
1767-1780		Spares–not used
1781-1894 are used for the 8th detector for GOES O and beyond ONLY. Otherwise they are spares.		
1781-1782	F_PI8XO	Infrared detector 8 x-offset (GOES–O and beyond, otherwise spare) GOES I-N IR dets 1-7 wd#63-76
1783-1784	F_RI8XO	Redundant Infrared detector 8 x-offset (GOES–O and beyond, otherwise spare). GOES I-N IR dets 1-7 wd#77-90
1785-1786	F_PI8YO	Infrared detector 8 y-offset (GOES–O and beyond, otherwise spare) GOES I-N IR dets 1-7 wd#107-120
1787-1788	F_RI8YO	Redundant Infrared detector 8 y-offset (GOES–O and beyond, otherwise spare). GOES I-N IR dets 1-7 wd#121-134
1789-1790		Spares–not used
1791-1798	F_IICRB*	Characteristic response bias coefficient for 8th IR detector (2 detectors [primary and redundant]) (GOES–O and beyond, otherwise spare) F_IICRB_P14 - P15. GOES I-N IR dets 1-7 wd#235-290
1799-1806	F_IICR1*	Characteristic response first-order gain coefficient for 8th IR detector (2 detectors [primary and redundant]) (GOES–O and beyond, otherwise spare) F_IICR1_P14 - P15. GOES I-N IR dets 1-7 wd#291-346
1807-1814	F_IICR2*	Characteristic response second-order gain coefficient for 8th IR detector (2 detectors [primary and redundant]) (GOES–O and beyond, otherwise spare) F_IICR2_P14 - P15. GOES I-N IR dets 1-7 wd#347-402
1815-1822	F_IISFB*	IR scaling bias for 8th IR Detector (GOES–O and beyond, otherwise spare) F_IISFB_P14 - P15. GOES I-N IR dets 1-7 wd#403-458
1823-1830	F_IISF1*	IR scaling gain (GOES–O and beyond, otherwise spare) FIISF1_P14 - P15. GOES I-N IR dets 1-7 wd#459-514
1831-1862	F_IG2IT*	IR 2nd order gains/temp table (GOES–O and beyond, otherwise spare) F_IG2IT_P56 - P71. GOES I-N IR dets 1-7 wd#515-738
1863-1894	F_IBBTR*	BB temp-to-rad conversions (GOES–O and beyond, otherwise spare) F_IBBTR_P56 - P71.

		GOES I-N IR dets 1-7 wd#755-978
1895-8040		Spares–not used

3.4 Coordinate Systems

The scan mirror positioning for both instruments is controlled by two servo motors, one for the N-S elevation angle, outer gimbal motor, and one for the E-W scanning azimuth angle, inner gimbal motor. Each servo motor has an associated inductosyn to measure the mechanical shaft rotation angle. The position of the scanning mirror, and hence, the coordinate system employed for the instrument, is measured in terms of the inductosyn outputs.

The inductosyn outputs are expressed in terms of cycles and increments. Cycles, denoted C_x for E-W and C_y for N-S, are coarse measures of the shaft rotation angles. One cycle equals 2.8125° of mechanical rotation, or 128 cycles for one full 360° mechanical shaft revolution. Increments, denoted I_x for E-W and I_y for N-S, are finer shaft rotation angle measures that are different for each instrument. Each Imager cycle contains 6136 increments and is equal to approximately 8.0 (actually 7.999899) µradians of mechanical rotation. Each Sounder cycle contains 2805 increments and is equal to approximately 17.5 (actually 17.499959) µrads of mechanical rotation.

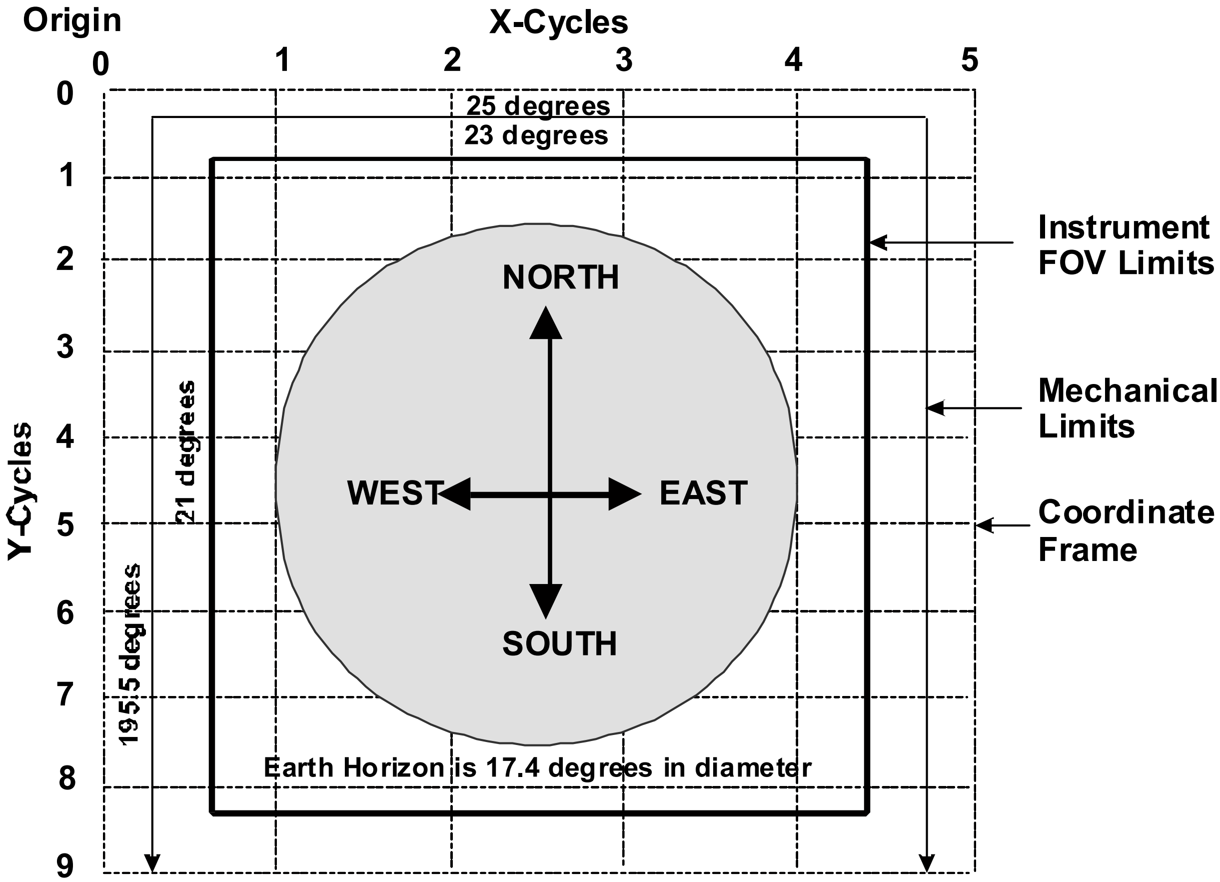
As a result of the manner in which the scanning mirrors have been gimbaled, the relationship between a given shaft mechanical angle and the corresponding image optical angle is not the same on both axes. In the N-S direction, the mechanical shaft angle is equal to the mirror's optical angle. Thus, a mechanical shaft rotation of one increment results in a one-increment change in the mirror's elevation angle. However in the E-W direction, a shaft angle change has a doubling effect upon the mirror's optical angle. This doubling effect means that a single increment of mechanical rotation causes a two-increment change in the scanning mirror's scan angle.

Figures 3-17a and 3-17b illustrates the mapping between cycles and increments for the Imager's FOV in the nominal and Yaw-Flipped configurations. The origin of the coordinate system, zero cycles, zero increments, is defined to be the northwest corner in the nominal configuration, or the southeast corner in the Yaw-Flipped configuration. At a geosynchronous O&A, the Earth is positioned in the frame as indicated in the figures. Under these conditions, instrument nadir corresponds to the subsatellite point and has the coordinates denoted in Figures 3-17a and 3-17b. The actual nadir coordinate values may vary somewhat according to the results of the factory alignment. The true values are reported in the factory parameters section of the scan documentation block (see Table 3-6 [**GOES I-N**] or Table 3-36 [**GOES M-P**]).

The Imager mechanical limits (shown for the west, north (south for yaw-flipped), and east sides) are enforced by the presence of physical stops. The north (south for yaw-flipped) and west (east for yaw-flipped) stops prevent the instrument from ever reaching the origin point. On the south (north for yaw-flipped) side, the scanning mirror is not constrained until 183° from nadir, permitting rotation of the mirror for BB viewing.

Figures 3-18a and 3-18b illustrates the mapping between cycles and increments and the Sounder's FOV. The origin of the coordinate system (zero cycles, zero increments) is defined as the southwest corner (nominal configuration) or northeast corner (yaw-flipped). At a geosynchronous O&A, the Earth is positioned in the frame as indicated in Figures 3-18a and 3-18b. Under these conditions instrument nadir corresponds to the subsatellite point and has the coordinates denoted in the figures. As with the Imager, the true nadir coordinates may differ slightly from those indicated according to the results of the factory alignment. The actual values are reported in the factory parameters section of the Sounder scan documentation block (see Table 3-10).

The Sounder mechanical limits, shown for the west, south (north for yaw-flipped), and east sides, are enforced by the presence of physical stops. The south (north for yaw-flipped) and west (east for yaw-flipped) stops prevent the instrument from ever reaching the origin point. On the north (south for yaw-flipped) side, the scanning mirror is not constrained until 183° from nadir, permitting rotation of the mirror for BB viewing.

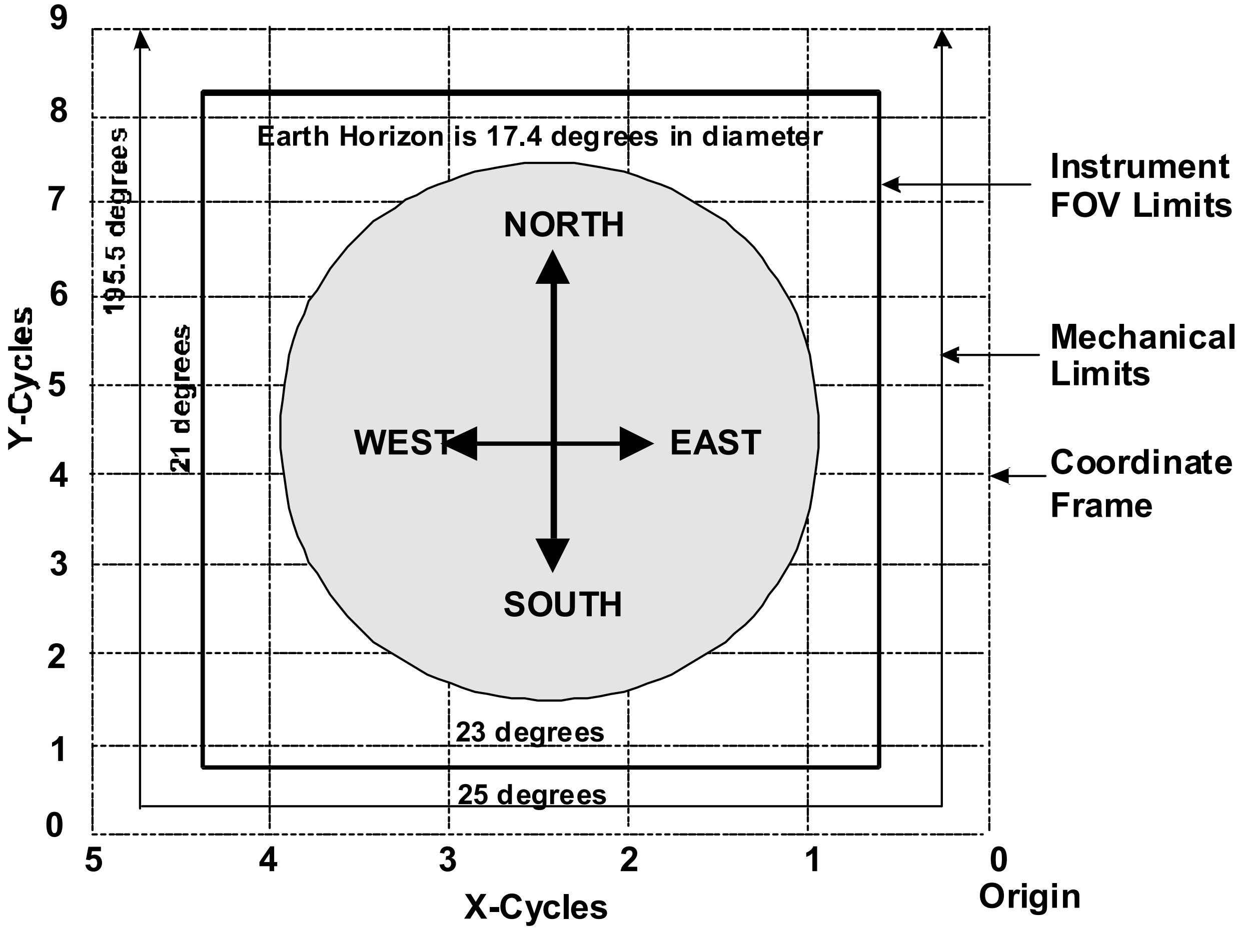


Imager Instrument Nadir

Offset from Origin	E/W	N/S
Mechanical Degrees	7.03125	12.65625
Cycles/Increments	2/3068	4/3068

Imager Increments/Cycle: 0 – 6135

Figure 3-17a. Imager Coordinate System (Nominal)

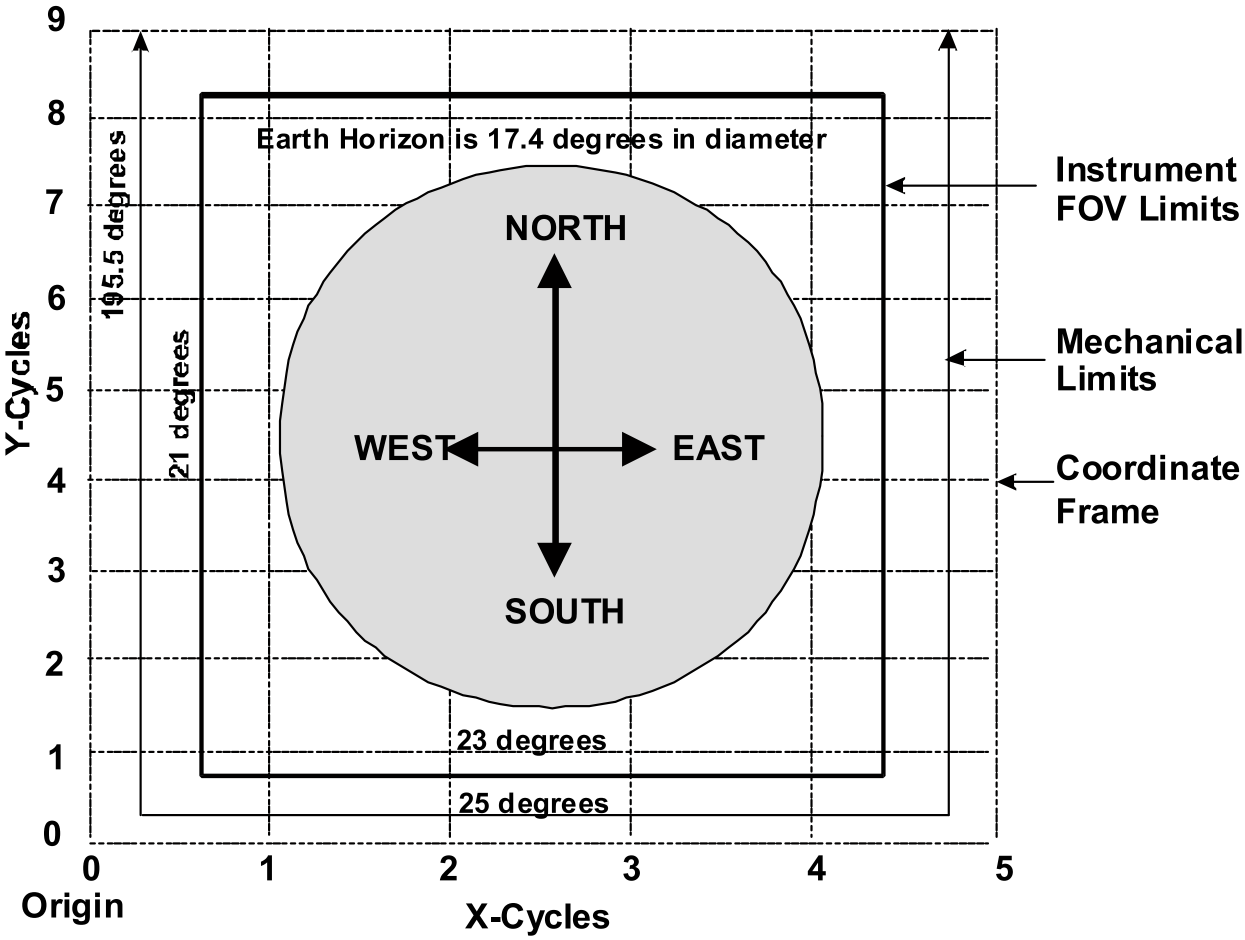


Imager Instrument Nadir

Offset from Origin	E/W	N/S
Mechanical Degrees	7.03125	12.65625
Cycles/Increments	2/3068	4/3068

Imager Increments/Cycle: 0 – 6135

Figure 3-17b. Imager Coordinate System (Yaw-Flipped)

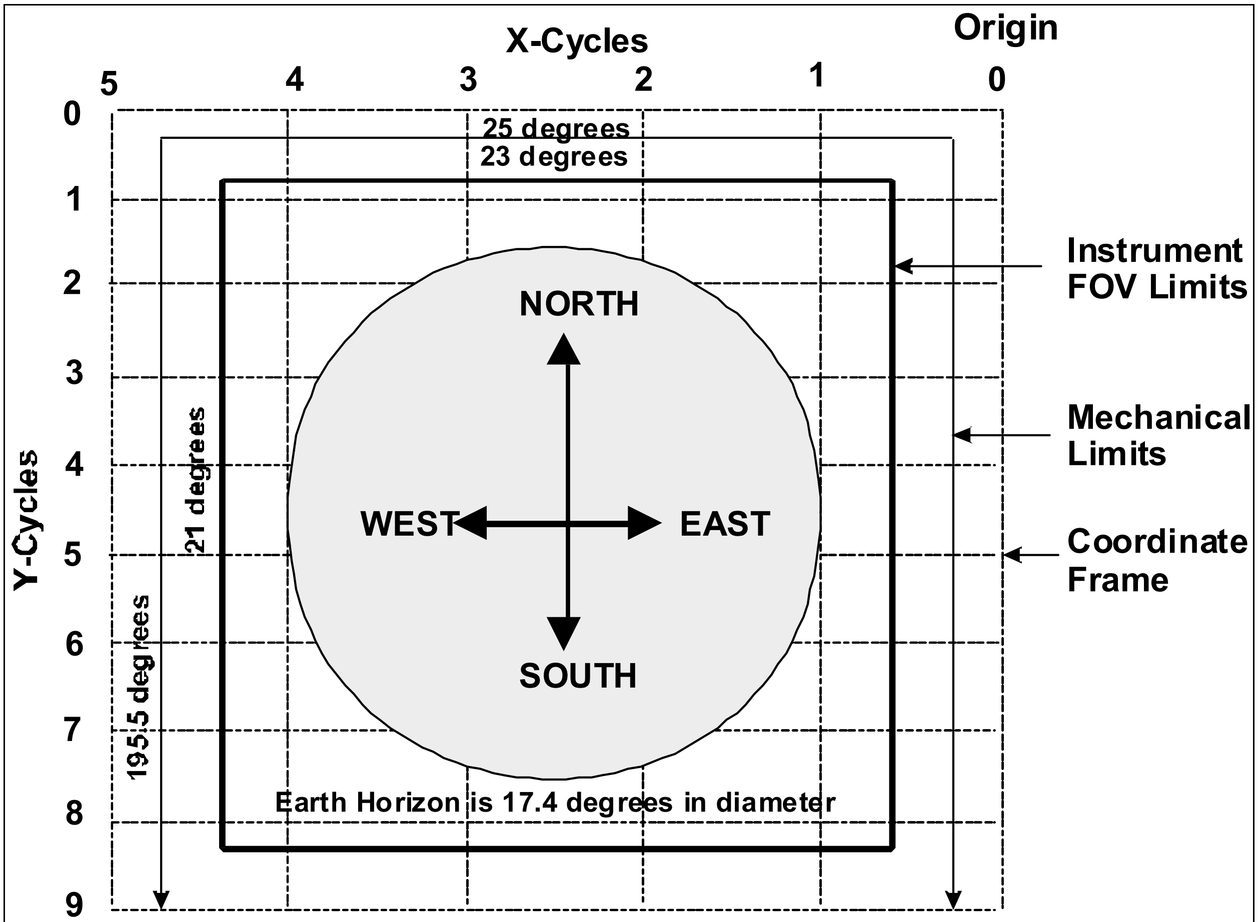


Sounder Instrument Nadir

Offset from Origin	E/W	N/S
Mechanical Degrees	7.03125	12.65625
Cycles/Increments	2/1402	4/1402

Sounder Increments/Cycle: 0 – 2804

Figure 3-18a. Sounder Coordinate System (Nominal)



Sounder Instrument Nadir

Offset from Origin	E/W	N/S
Mechanical Degrees	7.03125	12.65625
Cycles/Increments	2/1402	4/1402

Sounder Increments/Cycle: 0 – 2804

Figure 3-18b. Sounder Coordinate System (Yaw-Flipped)

3.5 Bits, Words, and Formats

3.5.1 Bit Transmission Order

Every GVAR block transmitted consists of a similar sequence of the following four basic components:

a. 10,032-bit synchronization code
b. 720-bit header section
c. *N*-bit information field
d. 16-bit information field CRC

The number of bits in the information field varies according to the type of GVAR block involved. Figure 3-19 illustrates the rules governing the order in which the bits of a GVAR block are transmitted, focusing on the bit sequence associated with a GVAR Block 11 header. The first 10,032 bits transmitted correspond to the block synchronization code. These are followed sequentially by the 720-bit header section, the 64,320-bit information field; and, finally, the 16-bit information field CRC. As shown, the 720-bit header section contains three, sequential 240-bit segments, each an identical copy of the 240-bit block header (see Figure 3-10 and Table 3-5).

In general, the transmission of any GVAR block segment always starts with the first word of the segment. The transmission proceeds in a sequential fashion through all of the words in the segment. For any given word, the left-most or MSB is transmitted first. Transmission of the word proceeds in a sequential fashion through the remainder of the bits, with the right-most or LSB transmitted last.

3.5.2 Longitudinal Parity (XOR) Words

Every transmitted GVAR block is terminated by a 16-bit CRC code that detects the presence of bit errors in the associated information field at the GVAR receiver (see Section 3.3.3). An additional level of error detection capability is provided for some GVAR block types in the form of embedded longitudinal parity words. The embedded longitudinal parity word is assigned to a portion or segment of the block's information field. If the block CRC denotes that an error is present in the received information field, the longitudinal parity words can be used to isolate the error(s) to a particular segment.

A longitudinal parity word may be either 6-, 8-, or 10-bits in length. The word length employed is the same as the word length used for the rest of the information data field. The word is formed by the cumulative XOR of all of the data words in the segment. The resulting XOR word is assigned a one or a zero in each bit position such that each bit position across all words in the segment has an even number of ones and zeros. Two examples are provided below showing the XOR word for a 4-word and a 5-word segment. An 8-bit word length is used for the 4-word segment and 10 bits for the 5-word segment.

Data words	1:	0 0 0 0 1 0 1 0	1:	1 0 0 0 0 0 1 1 0 1
	2:	0 0 1 0 0 1 1 0	2:	1 1 0 0 0 0 0 0 1 0
	3:	0 0 0 0 1 1 1 1	3:	1 1 1 0 0 0 1 0 0 0
	4:	0 0 0 1 1 1 1 1	4:	1 1 1 1 0 0 1 1 0 0
			5:	1 1 1 1 1 0 1 1 1 0
XOR word:		0 0 1 1 1 1 0 0		1 0 1 0 1 0 0 1 0 1

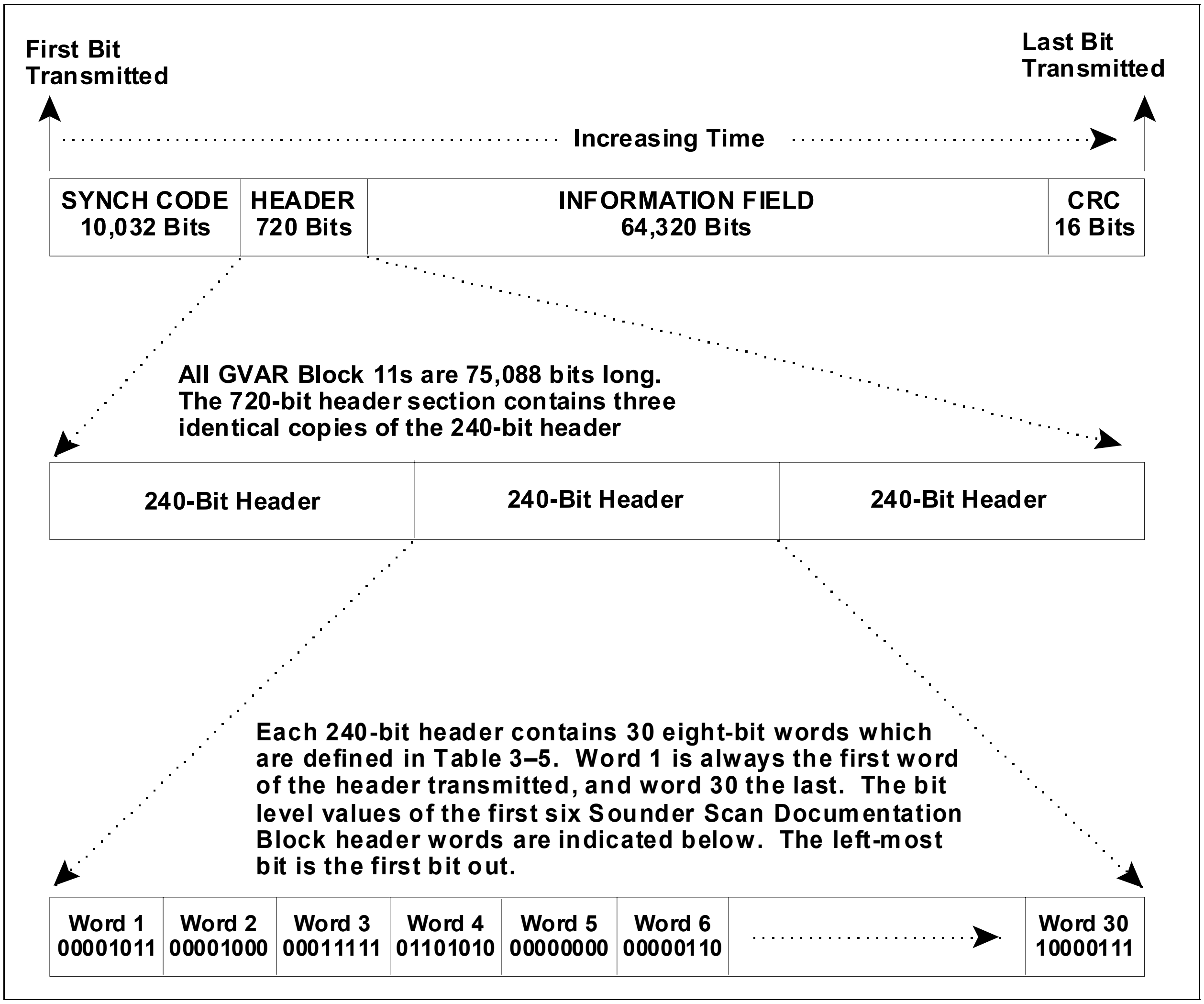


Figure 3-19. GVAR Block Bit Transmission Order

3.5.3 Integer Formats

All integer values transmitted in the GVAR format are right adjusted and zero filled within their allocated bit space. The size of the bit space for a particular integer value is generally a function of the word size used in the block information field and the expected range of the value. A total of seven different bit lengths are employed in the GVAR format for integer values. The following list denotes the range of values available for each bit length. It also provides a reference to an occurrence of their use in GVAR:

Length	Value Range	Where Used
6 bits	0 – 63	Table 3-8, word 9
8 bits	0 – 255	Table 3-10, word 261
8 bits	-128 – 127	Table 3-6, words 6235 – 6282
10 bits	0 – 1023	Table 3-7, word 3
16 bits	-32768 – 32767	Table 3-6, words 6311 – 6312
18 bits	0 – 262143	Table 3-8, words 6 – 8

Negative integer values in the GVAR format are formed using a twos complement notation and only permitted for the 8-, 16-, and 32-bit lengths. All other bit lengths always represent a zero or positive integer value. The only integer terms currently expected to indicate negative quantities include the co-registration correction terms for the Imager (see Table 3-6a, words 1631 – 1678 and 6235 – 6282), the Imager grid bias terms (see Table 3-6a, words 189 – 192) and the instrument detector offsets (Imager: see Table 3-6b, words 6311 – 6398; and Sounder: see Table 3-10, words 3011 – 3074).

Two special cases exist for 16-bit integer values that do not employ two's complement arithmetic. The first case involves the GVAR block header block sequence counter (see Table 3-5, words 13 – 14). The second case involves the Sounder detector data arrays defined in Section 3.3.7.3.3. In both of these cases, the 16-bit integers take on values ranging from 0 – 65,535.

3.5.4 Floating Point Format

All floating point numbers used in GVAR are 32 bits in length and transported by way of four sequential 8-bit words. Each is a single precision floating point value formatted for the Gould or SEL computer. This format employs a sign bit, a 7-bit exponent, and a 24-bit fractional mantissa, defined as follows:

```
word    1                2                3                4
bits    1            8   1            8   1            8   1            8
        - - - - - - - -  - - - - - - - -  - - - - - - - -  - - - - - - - -
        S E E E E E E E  MMMMMMM          MMMMMMM          MMMMMMM
                         M                M                M
                         MSB---------------  24-bit Mantissa  ----------------LSB
```

WORD	BIT	DESCRIPTION
1	1	**S**ign bit – set to 1 if negative quantity, set to 0 if positive. Negative quantities employ a two's complement notation for the entire 32 bits.
1	2–8	**E**xponent – is biased at 64 (*x* '40') for a null shift of the binary point. The binary point is shifted 1 hexadecimal digit (4 bits) for each exponent increment, right for positive increments (>*x* '40'), left for negative increments (<*x* '40').
2	1–8	**M**antissa – first 8 bits. Bit 1 is the MSB of the 24-bit mantissa. The Binary point is positioned to the left of bit 1.
3	1–8	**M**antissa – second 8 bits.
4	1–8	**M**antissa – last 8 bits. Bit 8 is the LSB of the 24-bit mantissa.

The following examples illustrate the relationship between a decimal value and associated floating point format:

Decimal Value	Floating Point Format Hexadecimal Value
–1.0	x 'BEF00000'
–0.1640625	x 'BFD60000'
0.0	x '00000000'
0.1640625	x '402A0000'
1.0	x '41100000'
100.1640625	x '42642A00'

3.5.5 Sounder Raw Data Word Format

The GOES I-M Sounders generate one raw data block every 100 msec. These raw data blocks each contain 250 16-bit words of information for a total block length of 4000 bits. The word formats and their arrangement in the blocks is defined in reference document SJ-572022. The SPS performs a number of operations on the received raw Sounder data blocks, including the following:

a. Replacing the first 64 bits (synchronization code) with a time tag.

b. Reformatting each of the remaining 246 16-bit words into 492 8-bit words (two 8-bit words for each original 16-bit word).

c. Appending Earth location information.

The final result of these operations is the Sounder data record transmitted in the GVAR stream. This record is defined in Table 3-11 and consists of 544 8-bit words. The first 500 words of this record correspond to the original raw data block generated by the Sounder.

The reformatting of the original 16-bit words into two 8-bit words includes the following, two primary operations:

a. The SPS changes the 16th bit of the original word, which is an odd parity bit, to a bad parity indicator. The bit is set to one if the parity of the original word is bad and zero if the parity is good.

b. The bad parity indicator bit is then moved from the LSB position to the MSB position of the word. The 15 remaining data bits are shifted right, one position, to accommodate the move.

Following these two operations, the SPS views the resulting 16-bit word as two sequential 8-bit words viewed for GVAR transmission purposes. The transformation described above is diagramed as follows for the M^{th} word of the original raw Sounder data block:

Original 16-bit word M

MSB															**LSB**
d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	O
0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	D
1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	D

SPS transformed 16-bit word M

MSB															**LSB**
B	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
D	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5

SPS transmitted 8-bit words

word (2*M – 1)								word (2*M)							
MSB							**LSB**	**MSB**							**LSB**
B	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
D	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5

3.6 Visible and Infrared Channel Calibration

The OGE performs relativization, normalization, and calibration of the Imager and Sounder detector data as well as monitors calibration and telemetry data. The monitoring functions provide extensive statistics computation on spacelook data, blackbody calibration data, and selected telemetry points. Monitoring also includes verification of the linearity of the detector electronics based on electronic calibration (ECAL) data received at each blackbody calibration occurrence. The following sections describe the relativization, normalization, calibration, and linearity verification functions in detail.

3.6.1 Visible Channel Processing

No calibration is applied to either the Imager and Sounder visible channel data. Instead, the visible detector data are subjected to two processes, termed relativization and normalization, described below.

3.6.1.1 Relativization

The SPS relativization process adjusts the outputs of each visible channel detector to the *difference* between the detector's output signal for the target and the detector's space (black) reference signal, rather than the *absolute* detector signals. The resultant signal is relative to space. The Imager's primary objective is to eliminate image banding caused by noise in the space clamps. The Sounder does not execute space clamps, and its primary objective is to eliminate the effects of drifts.

Relativization is applied to the counts from each pixel in a two-step process. First, the mean count value from the most recent spacelook is subtracted from the pixel counts. The Imager's spacelook data is from the postclamp following the preceding spacelook. (See Section 3.3.7.7 Spacelook Calibration Statistics and Data for a discussion of spacelooks.) Second, the constant BOOST is added. Without the second step, relativization would have two unfortunate consequences. First, when space itself is the target, the distribution of the data would be approximately Gaussian with a mean of zero. Half of the distribution would have count values less than zero and would be lost, since GVAR does not transmit negative integers. Second, the overall brightness of the image would change significantly between the relativization 'off' and relativization 'on' states.

The value of BOOST is set at 29 for all eight visible channel detectors of all Imagers. It is set to 920 for all four visible channel detectors of all Sounders. Since these are the nominal values for space in the absence of relativization, little change in overall image brightness will occur between the relativization off and on states. However, note that the two steps in the relativization process do not cancel each other out, because the mean space value and BOOST are not necessarily equal. The mean spacelook value varies from event to event, affected by noise in the case of the Imager and noise and drift in the case of the Sounder. BOOST, on the other hand, is invariant.

The SPS applies the two relativization steps in sequence, followed by normalization, for the Sounder. The SPS applies relativization and normalization in one operation for the Imager. The on or off relativization status and the values of BOOST are transmitted in GVAR in the Block 0s (see Tables 3-6 and 3-10).

3.6.1.2 Normalization

The SPS normalizes Imager and Sounder visible detector data to allow all the visible detectors of a single instrument to produce the same grey scale intensity when an area of uniform brightness on space or the Earth is viewed. The normalization operation, which occurs in real time in the SPS, consists of the application of normalization look-up tables (NLUTs) to the scan data. The NLUTs, whose dimensions are 8 (detectors) by 1024 (count intensity levels) for the Imager and 4 by 8192 for the Sounder, are generated in non-real time and off-line in the PM. Typically, an instrument's NLUT will be generated soon after launch and then updated infrequently, if ever.

Normalization can be applied to relativized or non-relativized image data. However, if an NLUT is optimal for relativized data, it will, in general, not be optimal for non-relativized data and vice-versa.

The approach used to generate an NLUT in the PM is a histogram matching technique. Details can be found in

> Weinreb, M.P., J.X. Johnson (nee R. Xie), J.H. Lienesch, and D.S Crosby, "Destriping GOES images by matching empirical distribution functions," *Remote Sens. Environ.*, 29, 185 (1989).

Normalization may be turned on and off via operator directive. When normalization is enabled, at the start of the next instrument scan, the NLUT will be used for the remainder of the current frame and for all subsequent frames until otherwise directed. The NLUTs in current use are sent to users in GVAR Block 11s after each blackbody calibration event (see Section 3.3.7.10).

ITT (factory) measured characteristic response coefficients for Imager and Sounder visible detectors are also provided in the Imager and Sounder Documentation blocks (GOES I-N) and/or Imager Factory Coefficients blocks (GOES-M and beyond). These coefficients are never actually applied to visible detector data by the OGE but are provided to the user for conversion of visible detector counts to radiance. Included in each instrument's documentation block is the conversion factor required to obtain the albedo from the visible radiance. Refer to Tables 3-6 and 3-10 for a detailed Documentation Block description for the Imager and Sounder, respectively.

3.6.2 IR Calibration

Imager and Sounder IR-channel calibration and application of the calibration equation to the raw scan data is a real-time process in the SPS. The calibration is the process of determining the coefficients of the calibration equation, which relates the count output from the view of a pixel to the intensity of the radiation (radiance) incident on the instrument. Details of the calibration can be found in Weinreb, M.P., M. Jamieson, N. Fulton, Y. Chen, J.X. Johnson, C. Smith, J. Bremer, and J. Baucom, 1997: Operational Calibration of GOES-8 and -9 Imagers and Sounders. *Applied Optics,* **36**, 6895-6904.

The calibration equation is a quadratic whose coefficients are generated from real-time, on-orbit observations of space and the instrument's onboard blackbody target, as well as the factory-measured instrument response characteristics, i.e.,

$$R = b + m\,C + q\,C^2 \qquad (3.6\text{-}1)$$

where R is radiance, C is the measured counts, b is the intercept (bias factor), m is the first-order gain (gain factor), and q is the coefficient of the quadratic (second-order) term. Nominal values of b, m, and q for each detector and detector-channel, computed from the spectral response function, are provided to the user in the documentation blocks. See Tables 3-6 (GOES I-N) or 3-36 (GOES M and beyond) for the Imager and Table 3-10 for the Sounder. The approximation in Eq. 3.6-1 is valid over the limited range of blackbody temperatures expected in orbit, typically 270 – 310K.

The calibration coefficients are expected to vary in flight for several reasons, including aging of components and temperature variations within the instruments. In addition, the Imager IR detectors are subject to a low frequency random drift. This phenomena is labeled 1/*f* drift, and it has a pronounced affect upon the bias terms (*b* terms) of the medium and longwave IR detectors of the Imager. The Sounder avoids these effects by high frequency clamping of the IR detectors to the filter wheel every 100 msec.

The OGE calibration algorithms allow for recomputation of the calibration coefficients (*b*, *m*, and *q*) from the instrument's observations of its on-board blackbody and space, and measurements of the temperature of the blackbody from thermistors embedded within it. In addition, Imager IR bias terms are dynamically adjusted for each pixel to account for the effects of the 1/*f* drift.

Every time a space or blackbody look occurs, a new calibration coefficient set is generated. The Sounder automatically transmits a new set in GVAR within a Calibration Coefficient and Limits Block 11 (see Section 3.3.7.9). The Imager transmits new sets for each output scan in the Scan Documentation Block (see Section 3.3.4.5). In addition, a Calibration Coefficient and Limits Block 11 is transmitted following each blackbody calibration event and each 2-minute interval spacelook event (see Section 3.3.7.9). Each calibration coefficient set includes the latest coefficients for all Imager detectors or Sounder detector-channel combination, along with a time tag. The time tag can be used to correlate the calibration coefficient set to the sensor data.

Scaling factors are applied to a new calibration coefficient set before the set is actually enabled within the SPS. Hence, the IR scan line data (radiances) transmitted in GVAR is also scaled. The scaling factors are used to expand calibrated data into a range of 0 – 1023 for the Imager and 0 – 65,535 for the Sounder to maximize the dynamic range of the retransmitted data. The scaling factors used are provided to the user in the Imager and Sounder Scan Documentation Blocks. With these factors included, the form of the equation relating input raw counts to retransmitted scaled radiance becomes the following:

$$SR = SB + SG\,(b + m\,C + q\,C^2) \qquad (3.6\text{-}2)$$

where *SR* is the scaled radiance, *SB* is the scaling bias, and *SG* is the scaling gain. The calibration coefficient sets transmitted in GVAR (the *b*, *m*, and *q* terms) are always in their unscaled forms.

The following sections describe distinct operator-selectable IR calibration modes. The different modes allow enough flexibility so that observation and analysis of detector response as related to instrument telemetry can be used to select the most useful algorithms for the IR calibration process.

3.6.2.1 Standard IR Calibration

In the standard algorithm, the second-order terms (q) of the calibration equations are not expected to change significantly; therefore, the factory measured values are used. The first-order gain (m) and bias (b) terms are expected to vary as detectors age and temperatures change. Therefore, the coefficients of those terms are recomputed based on in-flight space and blackbody measurements.

Data associated with the instrument's blackbody are of two types: First, there are the direct measurements of its bulk temperature from thermistors embedded in the blackbody. Second, there are the radiometric observations of the blackbody made periodically by the sensor itself, during which the detectors' outputs are downlinked.

A key quantity in the calibration of any channel is the average radiance of the blackbody in the passband of that channel. It is calculated from the thermistor measurements (made on orbit) of the blackbody's temperature and the spectral response function of the channel (measured before launch). An exact calculation would be to compute Planck radiances from the blackbody's temperature and then average the Planck radiances over the spectral response function of the channel. In the actual processing, the SPS uses an approximation, a cubic polynomial,

$$R(T) = R0 + a\,T + b\,T^2 + c\,T^3 \qquad (3.6\text{-}3)$$

where $R(T)$ is the calculated channel-averaged radiance of the blackbody, T is the blackbody's temperature in K, and $R0$, a, b and c are the polynomial coefficients determined from the spectral response function of the channel. These coefficients are provided to the user in the Imager and Sounder documentation blocks. See Table 3-6 (GOES I-N) or 3-36 (GOES M and beyond) for the Imager and Table 3-10 for the Sounder. This approximation holds only for the limited range of temperatures (270K - 310K) that the blackbody assumes in orbit.

Following the collection of blackbody calibration data in orbit, the determination of detector first-order gain and bias is carried out in several steps. First, a moving window's worth of the latest N (operator-adjustable) blackbody thermistor samples is quality-checked and averaged into one value for each thermistor. These individual thermistor values are converted to temperatures using factory measured polynomial coefficients relating measured thermistor output in counts to actual blackbody temperature. The polynomial is as follows:

$$(1/T) = A + B \ln X + C (\ln X)^3 \qquad (3.6\text{-}4)$$

where,

T	=	thermistor temperature in K
A, B, and C	=	thermistor characteristic terms
X	=	thermistor resistance computed as:

$$X = (D + E\,G) / (F + G) \qquad (3.6\text{-}5)$$

where,

D, E, F	=	amplifier characteristic terms
G	=	raw counts in base 10

The coefficients, A – F, above are provided in the Factory Parameters section of the Imager and Sounder documentation blocks. The temperature of the blackbody is calculated as the weighted mean of the all the thermistor values. (If, for any one thermistor, the number of samples that passed the quality-check filter is below a specified minimum and the affected thermistor's weighing factor is not zero, a critical alarm is reported and new IR calibration coefficients are not computed.)

A blackbody (target) radiance is then computed for each Imager detector or Sounder detector-channel combination from Eq. 3.6-3.

The next step utilizes the instrument's downlinked radiometric measurements of the blackbody. The SPS computes an average blackbody measurement in counts for each detector, or detector-channel combination, from the downlinked samples. For GOES-I-M, the Imagers take ~1000 samples when viewing the blackbody target. For GOES-N and beyond, the Imagers take >10,000 samples when viewing the blackbody. Which samples and the number of samples to use for the blackbody measurement are selectable by the operator. Because only 1000 samples can be downlinked in GVAR, the operator may also specify which samples will be contained in GVAR. The current values of the operator selectable parameters are transmitted in the Imager Blackbody Block 11 which is described in Table 3-26. For the Sounders, 40 samples are used for all spacecraft. The downlinked samples are first filtered using low and high-reasonableness limits to eliminate noise-induced outliers. Next, the filtered samples are averaged. If the number of samples passing the reasonableness limits is below a specified minimum for any detector, a critical alarm is reported and new IR calibration coefficients are not computed for that detector or detector-channel. First-order gain is then computed for each detector or detector-channel with the following equation:

$$m = \frac{R\,(T) - q\,(C_{bb}^{2} - C_{sp}^{2})}{(C_{bb} - C_{sp})} \tag{3.6-6}$$

where m is the first-order gain, q is the factory-measured second-order coefficient, C_{sp} and C_{bb} are the counts from the instruments view of space and its internal blackbody, respectively.

The Sounder uses the space level counts that are the filtered mean values acquired from the spacelook immediately preceding the blackbody event. A spacelook is performed prior to each blackbody calibration sequence, and the data samples are filtered and averaged as was described for blackbody data.

The SPS uses interpolated spacelevel values for the Imager. The Imager performs a spacelook associated with a clamping operation prior to blackbody events and a spacelook following the blackbody events. The filtered mean values acquired from these two operations serve as the end points between which the SPS computes a time-interpolated space count level.

A new bias factor is computed for each detector (detector-channel for Sounder) using the new first-order gains and the associated space levels. The equation is as follows:

$$b = -(\,q\,C_{sp}^{2} + m\,C_{sp}) \tag{3.6-7}$$

where b is the new bias, q is the factory-measured second-order coefficient, m is the newly computed first-order gain, and C_{sp} is the space-count value used to compute the first-order gain coefficient m.
The new bias factors, new gain factors, and second-order coefficients used for all the Imager detectors or Sounder detector-channel combinations constitute a new calibration coefficient set. The calibration coefficient set is time-tagged and transmitted in GVAR Block 11s along with the following information (see Section 3.3.7.9):

a. Weighted mean blackbody temperature
b. Blackbody thermistor weighting factors
b. Blackbody thermistor sample window size (*N*)
c. Q (quality or reasonableness limits)
d. Sample size minimums
e. Critical alarms (if any).

Spacelooks are performed at a higher frequency than blackbody calibration sequences. The bias coefficients are adjusted after each spacelook, using the spacelook data and the latest computed first-order gain from the most recent blackbody calibration. The equation is the same as the equation used for the bias computation following calculation of a new gain (3.6-7). The Sounder's new bias factors are automatically transmitted in a Calibration Coefficients and Limits Block 11 sequence along with all the unchanged information from the previous blackbody calibration.

The Imager's Block 11 sequence is generated every 2 minutes. However, any new sets being applied to a scan are reported in the Scan Documentation Block 0 preceding each scan. The bias coefficient applied to a raw Imager IR pixel is dynamically adjusted to compensate for the $1/f$ drift effects mentioned earlier. The adjustment performed relies upon the assumed linearity of the $1/f$ drift over short time intervals. A bias value coefficient $b0$ is first computed from postclamp spacelook measurements using the following:

$$b0 = -(q\, C_{sp}^{2} + m\, C_{sp}) \tag{3.6-8}$$

where q is the factory-measured second-order coefficient, m is the most recently computed first-order gain, and C_{sp} is the filtered mean postclamp spacelook count value. The computation results and the data from the scans that occur before the next spacelook event are held by the SPS. The preclamp spacelook data acquired from this next event are used to form the drifted spacelook filtered mean count level ($\mathrm{d}C_{sp}$). (See Section 3.3.7.7 for a discussion of spacelooks.) The following equation uses the $\mathrm{d}C_{sp}$ to compute the drift bias (bd) value:

$$bd = -(q\, \mathrm{d}C_{sp}^{2} + m\, \mathrm{d}C_{sp}) \tag{3.6-9}$$

The following equation uses the bias values, drift bias values, and the midpoint times of the two data sets to compute a bias rate (bias change per pixel) for each IR detector:

$$ibrate = \frac{(bd - b0)}{(td - t0)} * \frac{1}{prate} \tag{3.6-10}$$

In this equation, td and t0 are the midpoint times of the two spacelooks, and *prate* is a conversion coefficient nominally fixed at 5460 IR pixels per second. It is used to convert the bias rate from change per second to change per pixel.

If any intervening scans are being held by the SPS, the bias coefficients associated with the westernmost pixel in each scan, *bw*, are computed by linear interpolation between the postclamp bias values, *b0*, and the preclamp drift bias values, *bd*. The times, *tw,* of the westernmost pixels of each scan are used to establish the interpolation ratios, as follows:

$$bw = b0 + (bd - b0) * \frac{(tw - t0)}{(td - t0)} \qquad (3.6\text{-}11)$$

Using *bw* and *ibrate*, the bias coefficient *bn* for the nth IR pixel of a scan is computed from the following:

$$bn = bw + (n - 1)\ ibrate \cdot dir \qquad (3.6\text{-}12)$$

where *dir* is +1 for a W-E scan and –1 for an E-W scan. The calibration coefficients provided in the Imager Scan Documentation Block 0 include *bw*, *m*, *q*, and *ibrate · dir* for each IR detector. Also included in Block 0, are *t0*, *td*, *tw*, and the statistics associated with the postclamp and drift bias data sets.

Statistics are computed on detector spacelook data and transmitted with the raw data in GVAR Spacelook Block 11s as described in Section 3.3.7.7. Similarly, statistics are computed on detector blackbody calibration data and transmitted with the raw blackbody data in GVAR blackbody calibration Block 11s (see Section 3.3.7.8). Telemetry Statistics Block 11s are generated following each reported spacelook event (see Section 3.3.7.5).

3.6.2.2 Modifications to Correct for East-West Variation in Scan Mirror Reflectance

The standard IR calibration equations include a modification to account for the east-west scan-position variation in the reflectance of the Imager and Sounder scan mirrors. (See Weinreb, M.P., M. Jamieson, N. Fulton, Y. Chen, J.X. Johnson, C. Smith, J. Bremer, and J. Baucom, 1997: Operational Calibration of GOES-8 and -9 Imagers and Sounders. *Applied Optics,* **36**, 6895-6904.*) The standard calibration, referred to as mode 1, always includes this modification.*

The modified equations use the scan mirror temperature and emissivity as a function of instrument address. After each blackbody event, a table of emissivity, *ε,* verses instrument address, *θ,* is generated for each detector from a polynomial as follows:

$$\varepsilon(\theta) = a + b\theta + c\theta^2 \qquad (3.6\text{-}13)$$

The Imager table has 7670 values (of θ*)*, and the Sounder table has 1758 values. The coefficients *a*, *b*, and *c* are generated off-line by NOAA engineers shortly after launch and are updated infrequently, if ever. Their values are transmitted in GVAR in the Imager and Sounder Calibration and Limits Block 11s (see Tables 3-28 and 3-29).

The instrument address is related to the absolute increments number as follows:

$$\theta = (\, increments + 3\,)/4 \quad (Imager) \qquad (3.6\text{-}14)$$

and

$$\theta = (\, increments + 7\,)/8 \quad (Sounder) \qquad (3.6\text{-}15)$$

The basic calibration equation, 3.6-1, is modified to become the following:

$$R = \frac{\left\{ q\,C^2 + mC + b - \left(\varepsilon[\,\theta\,] - \varepsilon[\,sp\,] \right) R_M \right\}}{\left(1 - \varepsilon[\,\theta\,] \right)} \qquad (3.6\text{-}16)$$

where R is radiance, b is a bias coefficient (from eq. 3.6-7), m is the first-order gain (gain coefficient), q is the quadratic (second-order) coefficient, and C is the measured counts, as in equation 3.6-1. The variable $\varepsilon\ (\theta)$ is the emissivity at the address of the target; $\varepsilon\ (sp)$ is the emissivity at the address of the spacelook; and R_M is the radiance of the scan mirror, which is calculated from its temperature by equation 3.6-3.

Corresponding changes are made in the scaling equation 3.6-2. However, the user still derives radiances from GVAR counts exactly as before, by subtracting the scaling bias and dividing by the scaling gain.

Equation 3.6-6, the computation of gain, is replaced with the following:

$$m = \frac{\left[r_{bb} - q(c_{bb}^2 - c_{sp}^2) \right]}{c_{bb} - c_{sp}} \qquad (3.6\text{-}17)$$

where the subscripts bb and sp refer to blackbody and spacelook data, respectively. The quantity r_{bb} is given by the following:

$$r_{bb} = \left(1 - \varepsilon[\,bb\,] \right) R(T) + \left(\varepsilon[\,bb\,] - \varepsilon[\,sp\,] \right) R_{M,bb} \qquad (3.6\text{-}18)$$

where $R(T)$ is the radiance of the blackbody and is computed from its temperature as described in Sections 3.6.2.1 and 3.6.2.2. The quantity $R_{M,bb}$ is the radiance of the scan mirror computed with equation 3.6-3 from a window-average temperature at the time of the blackbody event. The window-average temperature of the scan mirror is computed in the same exact way as that of the blackbody's, as described in Section 3.6.2.1. The value of $R_{M,bb}$ is transmitted in GVAR in the Imager and Sounder Calibration and Limits Block 11s (see Tables 3-28 and 3-29). The quantities $\varepsilon[bb]$ and $\varepsilon[sp]$ are the scan mirror's emissivity at the blackbody and spacelook addresses, respectively.

Equation 3.6-7 remains unchanged, although it is understood that m is now computed as in Eq. 3.6-17.

With m and b computed as described above, the calibration is applied to the counts at each pixel address according to equation 3.6-16. In this equation, R_M is computed by equation 3.6-3 from the most recent 2-minute average temperature of the scan mirror. As before, the Imager drift correction time interpolates *b* between the spacelooks preceding and following the pixel. The value of *b*, for the Sounder, is the value computed at the spacelook preceding the pixel.

3.6.2.3 IR Calibration Extensions

There are sixteen extensions to the standard IR calibration algorithms. These extensions can be selected separately or in combination. The currently active calibration algorithms for the Imager are reported in the Calibration and Limits Block 11s in Table 3-28, words 417–419. The Sounder's active calibration algorithms are listed in Table 3-29, words 2097-2099. These words denote the currently active calibration mode for the computation of the three calibration coefficients b, *m*, and *q*. Each of these words is set to one in the standard algorithms defined in the preceding section. The following sections provide a description of each extended calibration mode.

3.6.2.3.1 IR Calibration – Bias Mode 2 (B-MODE = 2) (Sounder Only)

For GOES Sounders, in the basic bias mode 1, biases are computed once every two minutes from spacelook data, as is described in sections 3.6.2.1 and 3.6.2.2. However, when on-board temperatures are changing rapidly, the biases change rapidly, and recalculating them every two minutes is insufficient to maintain the accuracy of the biases more than a few seconds after each spacelook. In addition, there is a substantial "banding," or intensity change, evident in frames at each two-minute boundary because of the large change made in the computed bias at those times. To avoid these problems, bias mode 2 was made available. In bias mode 2, the biases are updated every 1.1 sec by interpolation between the biases computed at successive spacelooks, as follows:

$$\mathbf{b(t+\Delta t) = b(t) + \Delta t * \{[b(t+Dt) - b(t)]/Dt\}} \tag{3.6-19}$$

$$\mathbf{\Delta t = 1.1, 2.2, 3.3, ... (seconds)} \tag{3.6-20}$$

Where **Dt** is the time span (nominally two minutes) between two space look events, the bias values, **b(t)** and **b(t+Dt)**, are computed by the standard method (Eq. 3.6-7), and **b(t+Δt)** is the bias value at any of the intervening times.

In the real-time GOES operation, the bias values for time lines between **t** and **t + Dt** cannot be computed until after the calibration event at **t + Dt** has occurred. As a result, all the raw sounder observations between times **t** and **t + Dt** are buffered in the SPS system. Consequently, the calibrated sounder data (radiances) sent in GVAR for observations occurring between times **t** and **t + Dt** have to wait until after **t + Dt,** meaning that there will be a delay as long as two minutes or more from the time a pixel is observed until its radiance value is transmitted in GVAR. Once the calibration event at **t + Dt** has occurred, the buffered scan data between each pair of space looks are converted to radiances with the interpolated biases and the gain from the preceding blackbody event.

In addition, bias mode 2 makes a slight change in how the slopes are used in the bias calculation for spacelooks associated with blackbody events. Each blackbody event consists of a space look followed approximately 28 seconds later by a blackbody view. Each blackbody event is preceded by a space look two minutes earlier and is followed by a space look two minutes later. Below is a time sequence showing a blackbody event and space look events before and after. Space look $\mathbf{SP}^{n+1}$ and the blackbody view together are considered a blackbody event. Usually space looks, including the one that is part of a blackbody event, occur every two minutes.

The diagram in Figure 3-20 describes a typical routine.

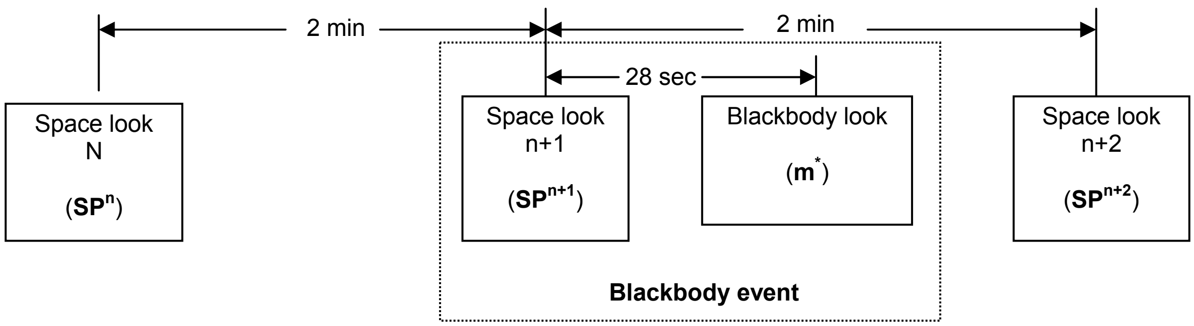


Figure 3-20. Timing of Sounder Space Looks and Blackbody Look

Under the basic bias mode 1, the biases, including that associated with the blackbody event, are computed from Eq. (3.6-7) with data from the space looks and the gain (**m**) from the *preceding* blackbody event.

Under bias mode 2 , the biases at space looks are still computed from the gain (**m**) associated with the previous blackbody event *except for the bias at space look* $\mathbf{SP}^{n+1}$, which is part of the blackbody event. The bias at spacelook $\mathbf{SP}^{n+1}$ is computed with the forthcoming gain (**m***).

The Sounder Bias Mode 2 algorithm will be improved further in the next SPS software release, as the preceding version (and bias mode 1) appears to be subject to image striping near some blackbody events. The new algorithm is different from the current operational only for the data processing in the two-minute interval beginning at $\mathbf{SP}^{n}$ and terminating at the blackbody event or $\mathbf{SP}^{n+1}$ (no scan data between space look $\mathbf{SP}^{n+1}$ and blackbody view). The new algorithm not only interpolates bias values between $\mathbf{SP}^{n}$ and $\mathbf{SP}^{n+1}$, it also interpolates the gain values (between **m** and **m***). The gain interpolation is only performed between $\mathbf{SP}^{n}$ and $\mathbf{SP}^{n+1}$.

3.6.2.3.2 First-Order Gain Extensions (M-MODEs 2 - 14)

It is believed that various factors, such as the temperatures of the optics components, INR sunshield, and diurnally varying 1/*f* noise, may affect the first-order gain for both the Imager and Sounder. To minimize the influence of these factors, fourteen different algorithms (M-modes) are available for the computation of the first-order gain coefficient.

All of these modes begin with the basic calculation of first-order gain coefficients after every blackbody calibration event, based on the latest spacelook and blackbody measurements. This standard computation is described below as first-order gain calibration M-mode 1.

M-mode 8 is the midnight blackbody calibration correction (MBCC), and is used as secondary standard mode. M-modes 2-7 are derived from M-mode 1, and equivalently, M-modes 9-14 are derived from M-mode 8. However, M-mode 12 is equal to M-mode 11 due to a limitation on data storage. Figure 3-21 shows the configuration of all the modes, and the following is a description of them.

a. Mode 1 — Standard algorithm (described in sections 3.6.2.1 and 3.6.2.2)
b. Mode 8 — Secondary standard algorithm (Midnight Blackbody Calibration Correction)
c. Modes 2 and 9 — Gain as a function of patch temperature
d. Modes 3 and 10 — Diurnally averaged gain
e. Modes 4, 11, and 12 — Gain as a function of optics temperatures
f. Modes 5 — Diurnally average gain, updated as a function of optics temperatures
g. Modes 6 and 13 — Gain as a function of time (linear)
h. Modes 7 and 14 — Gain as a function of time (quadratic).

Once a new first-order gain has been computed according to the selected mode, the same spacelook means and quadratic coefficients (from the previous spacelook calculations) are used, along with the new gain coefficients, to recompute the bias coefficients; the equation is the same as that used to compute the bias coefficients after a spacelook (described in Sections 3.6.2.1 and 3.6.2.2). The new gain and bias coefficients, along with the quadratic coefficients, are transmitted in the GVAR data stream and are applied to all subsequent image data.

3.6.2.3.2.1 Mode 8 - Midnight Blackbody Calibration Correction (MBCC) - Imager Only

During part of the year, the computed calibration first-order gains from M-mode 1 exhibit anomalous dips in the approximately eight hours centered on satellite midnight. It is believed that most of the anomaly is the result of radiation from hot INR sunshield being reflected by the imager's internal blackbody to its detectors during the blackbody event. Studies show that the effective temperature of the sunshield in the imager's scan cavity sometimes gets as high 350K, making it a very strong source of infrared radiation. Also, it is believed that some error may be introduced by scattered solar radiation, which contaminates the instrument space-look signal around midnight during the two annual eclipse seasons. Both midnight effects alter the first-order gain by as much as 4%, thus leading to an apparent temperature error of up to 1 K for a 300K target.

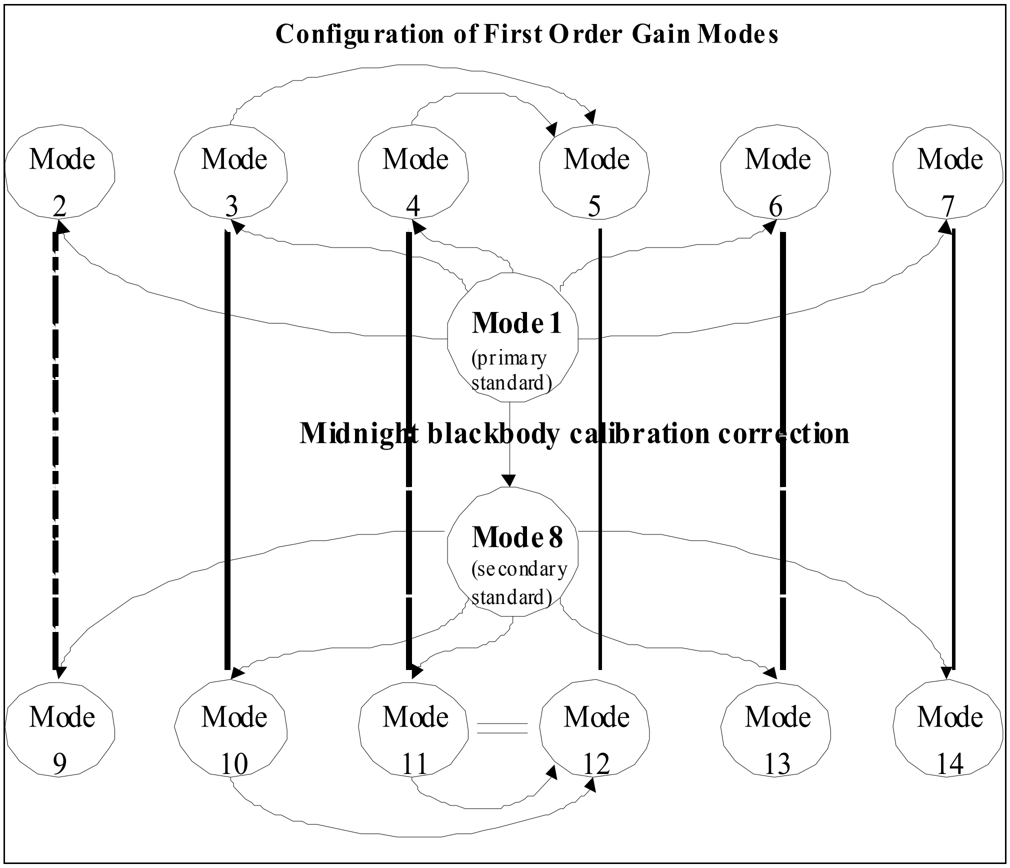


Figure 3-21. Configuration of All Modes

The midnight blackbody calibration correction (MBCC) is applied to the IR channels of the imager to correct for this error. MBCC can be switched on or off by operator directive, and is applied in addition to any other calibration enhancements.

MBCC can be expressed in the following steps:

a. The current responsivity, *r*, is computed for each detector during every blackbody event. (A channel/detector's responsivity is its output-count increment for a unit change in radiance.) The responsivity is a simple function of the first-order gain, *m*, i.e.,

$$r = (m + 2qC_b)^{-1} \qquad (3.6\text{-}21)$$

where *q* is the second-order coefficient, *m* is computed by M-mode 1, C_b is the mean raw count value registered by the IR detector while viewing the blackbody.

b. Historical responsivities and optics temperatures, *T*, are extracted for the previous D days outside of the midnight window. The duration of the midnight window (in hours) and the value of D are operator selectable integers, and T is one of 26 operator-selectable optics temperatures.

c. An estimated responsivity r_{est} is calculated by performing a quadratic regression on T, the chosen optics temperature. This regression is restricted to data from blackbody events outside of the midnight window. The optics temperature and the first-order gains (which are used to compute the responsivities at each blackbody event) in the regression are quality controlled. The temperature is discarded if it exceeds an operator-specified critical limit. Before doing the regression, the SPS computes the mean first-order gain μ, and standard deviation, σ, of all the first-order gains in the dependent sample. All first-order gains whose values are not between $\mu - M\sigma$ and $\mu + M\sigma$ are rejected from the dependent samples, where M is an operator-specified integer. The Standard Errors of Estimate (SEE) of the responsivity generated from the regression are used for quality control of the responsivities as described below.

d. The current responsivity, r, and the estimated responsivity, r_{est}, at each blackbody event are compared for each channel/detector. If the absolute value of their difference is less than or equal to $N*SEE$, where SEE was computed from previous step and N is an operator-selected integer, then the current first-order gain is used in further processing. But if the absolute value of this difference is greater than $N*SEE$, then the first-order gain associated with the estimated responsivity (m_{est}) is computed,

$$m_{est} = 1/r_{est} - 2qC_b \qquad (3.6\text{-}22)$$

and is used in all further processing.

3.6.2.3.2.2 M-Modes 2 and 9 - Gain as a Function of Patch Temperature

The M-mode 2 algorithm addresses the effects of narrow range IR patch temperature on the first-order gain of the calibration equation. In this mode, a linear function of gain versus patch temperature is computed based on data from two blackbody calibration events. The slope of the linear function is used to adjust the value of the first-order gain at 2-minute intervals, as a function of change in patch temperature, until the next blackbody calibration event. The specific steps used to accomplish these tasks are as follows.

After every blackbody calibration event:

a. Current mean patch temperature is computed as part of the 2-minute telemetry statistics calculations preceding this blackbody event.

b. First-order gain coefficients are computed based on the latest spacelook and blackbody measurements (as described in Sections 3.6.2.1 and 3.6.2.2).

c. The just-computed patch temperature and gain values are saved for use at this blackbody calibration event and at the next one.

d. The linear relationship of gain versus patch temperature is computed using the equation

$$S = (M_p - M_c)/T_p - T_c) \tag{3.6-23}$$

where S is the slope of the linear function, *M* is the first-order gain, *T* is the mean patch temperature, and subscripts p and c indicate the previous and current blackbody events, respectively.

At each 2-minute interval (or multiple thereof) after the blackbody event, the mean patch temperature (T) is again computed. The first-order gain coefficient (M) is recomputed as follows:

$$M = M_{bb} + S^*(T - T_{bb}) \tag{3.6-24}$$

where S, M_{bb}, and T_{bb} are the slope, first-order gain, and patch temperature, respectively, computed at the most recent blackbody calibration event.

Four operator-modifiable parameters are used for each instrument in this calibration:

a. The number of 2-minute intervals between first-order gain recomputations. If the number is set to 1, first-order gains are recomputed every time 2-minute calculations are performed. If set to greater than 1, the specified number of 2-minute intervals must pass before first-order gains are recomputed.

b. The minimum time, in minutes, between blackbody calibration events. If two blackbody calibration events occur in less than the minimum specified interval, only the data from the second of the two events will be used (along with data from the blackbody event preceding these two events) to compute the slope of the linear function relating gain to patch temperature.

c. The maximum acceptable value for the computed slope for each IR detector. If this value is exceeded, an alarm is generated in the event log and in GVAR, and the slope is forced to zero, thus disabling first-order gain recomputation until the next blackbody calibration event.

d. The minimum acceptable value for the computed slope for each IR detector. If the slope falls below this value, an alarm is generated in the event log and in GVAR, and the slope is forced to zero, disabling first-order gain recomputation until the next blackbody calibration event.

3.6.2.3.2.3 M-Modes 3 and 10 - Diurnally Averaged Gain

The M-mode 3 algorithm is designed to minimize any variation in the first-order gain caused by measurement noise. Using historical data, a filtered weighted average is computed of all the gains for a selected time interval over a selected number of days.

After every blackbody calibration event, the following specific steps are used to accomplish these tasks:

a. First-order gain coefficients are computed from the latest spacelook and blackbody measurements as described in Sections 3.6.2.1 and 3.6.2.2. These gains, along with the associated blackbody event time, are saved to a history file.

b. Data belonging to a specified interval, H hours, centered at the current blackbody event time T_0, for the previous D days, is extracted from the history file. H and D are operator specified.

c. A weight is computed for each extracted data point with the following equation:

$$w_i = ln(C_1 + C_2 * D_i) * ln(C_3 + C_4 * [T_i - T_0]) \tag{3.6-25}$$

where w_i, D_i, and T_i denote the weight, day, and time of the i^{th} data point; and C_{1-4} are specified in an operator-modifiable array. Nominal values are: $C_1 = e$, $C_2 = -0.1$, $C_3 = e$, $C_4 = -0.5$. (The notation "ln" represents the natural logarithm. The constant "e," the base of the natural logarithm, is approximately 2.71828.)

d. For each detector, the weighted average (M) first-order gain and standard error (S) of extracted data (x_i) is computed:

$$M = \sum_{i=1}^{N} (w_i * x_i) \Big/ \sum_{i=1}^{N} (w_i) \tag{3.6-26}$$

$$S^2 = \frac{N}{N-1} \left\{ \sum_{i=1}^{N} \left(w_i * x_i^2 \right) - M^2 * \sum_{i=1}^{N} (w_i) \right\} \tag{3.6-27}$$

e. The standard error (S) is used to remove outliers from the extracted history data. A data point (x_i) is considered an outlier if:

$$|x_i - M| > K * S / sqrt(w_i) \tag{3.6-28}$$

where K is an operator-specified integer. In the SPS database, K is represented by the constants IMNSIGMA for Imager and SMSIGMA for Sounder. It is expected to take a value between 1.0 and 5.0.

f. The last two steps (M, S computation and removal of outliers) are repeated until no more outliers can be detected, or the percentage of outliers exceeds a level specified by the operator, or finally if the maximum number of iterations is exceeded, as specified by the operator.

The final value obtained for M is the diurnally averaged gain, and it is used for subsequent IR data calibration until the next blackbody calibration sequence. In M-mode 3, no recomputation of the first-order gain occurs between blackbody calibration events.

3.6.2.3.2.4 M-Modes 4, 11 and 12 - Gain as a Function of Optics Temperatures

The M-mode 4 algorithm addresses the effects of the temperature of various optics components on the first-order gain. Once a day, a multilinear regression analysis is performed on the data in a history file to determine the relationship of gain to optics temperatures. The coefficients of the regression are subsequently used to update the first-order gain between blackbody events based on changes in the optics temperatures. The specific steps used to accomplish these tasks are described here.

After every blackbody calibration event, temperatures and gain coefficients are computed.

a. Current mean optics temperatures are computed as part of the 2-minute telemetry statistics calculations preceding this blackbody event.

b. First-order gain coefficients are computed based on the latest spacelook and blackbody measurements (as described in Sections 3.6.2.1 and 3.6.2.2). These gains, along with the associated blackbody event time and temperatures of the optics components, are saved in the history file.

At an operator-specified interval (nominally once each day), a multilinear regression analysis is performed:

a. The first-order gains and temperature of selected optics elements for the previous *D* days is extracted from the gain history file. *D* and optics elements are operator-specified.

b. A multilinear regression analysis of gains versus optics temperatures is performed for each detector:

$$M = B_0 + B_1T_1 + B_2T_2 + \dots + B_nT_n \qquad (3.6\text{-}29)$$

where M is the gain of the detector, n is the number of selected optics elements, T_K is the temperature of the K^{th} optics element ($K=1,\dots,n$), and $B_0, B_1, B_2,\dots,B_n$ are the coefficients of regression.

c. The coefficients of regression, their standard estimate of error (*SEE*), and the optics selector array are also saved in the history file. If the *SEE* exceeds operator-specified limits, an alarm is generated in the event log and in GVAR. Also, the coefficients of regression are discarded and previously computed coefficients of regression remain in use.

d. At each 2-minute interval (or multiple thereof) after the blackbody event, the mean temperatures T_K of the optics components are again computed. The first-order gain coefficient (M) is recomputed as follows:

$$M = M_{BB} + \sum_{K=1}^{n} \left\{ B_K * \left(T_K - T_{K_{BB}} \right) \right\} \tag{3.6-30}$$

where M_{BB} and $T_{K_{BB}}$ are the first-order gain and the temperature of the K^{th} optics element, computed at the preceding blackbody calibration event; and B_K is the coefficient of regression for the K^{th} optics element.

e. Operator-specified parameters define the number of 2-minute intervals between first-order gain recomputations. If set to 1, first-order gains are recomputed every time 2-minute calculations are performed (these 2-minute calculations are discussed in Section 2.2.5). If set to greater than 1, the specified number of 2-minute intervals must pass before first-order gains are recomputed.

3.6.2.3.2.5 M-Mode 5 - Diurnally Averaged Gain as a Function of Optics Temperatures

M-mode 5 is a combination of M-mode 3 and M-mode 4. The diurnally averaged gain is computed as described for Mode 3, and updated between blackbody events based on changes in the optics temperatures as in Mode 4. Note that Mode 12 is identical to Mode 11 due to data storage limitations.

3.6.2.3.2.6 M-Modes 6 and 13 - Gain as a Function of Time (Linear)

The M-mode 6 algorithm is designed to compute gain solely as a function of time. A weighted, least-squares fit is performed on the data in the history file to determine the linear relationship of gain to time. The coefficients of the fit are subsequently used to recompute the first-order gain coefficient between blackbody events as a function of time. The specific steps used to accomplish these tasks are given below.

After every blackbody calibration event, the following functions are performed:

a. First-order gain coefficients are computed based on the latest spacelook and blackbody measurements (as described in Sections 3.6.2.1 and 3.6.2.2). These gains, along with the associated blackbody event time, are saved in a history file.

b. Data belonging to a specified interval *(H)* centered at the current blackbody event time T_0, for the previous *D* days, are extracted from the gain history file. *H* and *D* are operator-specified parameters.

c. A weight is computed for each extracted data point by using the following equation:

$$w_i = ln(C_1 + C_2*D_i) * ln(C_3 + C_4*[T_i - T_0]) \quad (3.6\text{-}31)$$

where w_i, D_i, and T_i denote the weight, day, and time of the i^{th} data point; and $C_{1\text{-}4}$ are specified in an operator-modifiable array. Nominal values are: $C_1 = e$, $C_2 = -0.1$, $C_3 = e$, $C_4 = -0.5$. (The notation "ln" represents the natural logarithm. The constant "e," the base of the natural logarithm, is approximately 2.71828.)

d. A polynomial regression analysis of gains versus time of day is performed for each detector:

$$M = a_0 + a_i\, t \quad (3.6\text{-}32)$$

where M is the first-order gain, t is the Time of Day (TOD), and a_i are the coefficients of regression.

1. The residual sum squared (*RSS*) is computed and compared to operator-specified limits. If the *RSS* values exceed operator-specified limits, an alarm is generated in the event log and in GVAR. Also, the coefficients of regression are discarded, and previously computed coefficients of regression remain in use.

2. As a last step, the coefficients of regression are used to estimate the smoothed gain at the time of the blackbody event.

e. At each 2-minute interval (or multiple thereof) after the blackbody event, the coefficients of regression are used to predict the first-order gains:

$$M = a_0 + a_i\, (t - t_0) \quad (3.6\text{-}33)$$

where M is the predicted gain, t is the current time, and t_0 is the time at the preceding blackbody event.

The operator specifies the number of 2-minute intervals between first-order gain recomputations. If set to 1, first-order gains are recomputed every time 2-minute calculations are performed (these 2-minute calculations are discussed in Section 2.2.5). If set to greater than 1, the specified number of 2-minute intervals must pass before first-order gains are recomputed.

3.6.2.3.2.7 M-Modes 7 and 14 - Gain as a Function of Time (Quadratic)

Mode 7 is the same as Mode 6, but uses a quadratic fit instead of linear as follows:

$$M = a_0 + a_1\, t + a_2\, t^2 \quad (3.6\text{-}34)$$

All other aspects, including the database parameters and displays related to Mode 6 or 7 calibration, are identical to Mode 6.

3.6.2.3.3 Second-Order Gain Extensions

3.6.2.3.3.1 Second-Order Gain Versus Patch Temperature (Q-MODE = 2)

Q-mode 2 is available for both the Imager and Sounder and computes the IR second-order gain coefficients at 2-minute intervals as a function of patch temperature. The second-order gain coefficients are factory measurements taken for each IR detector at the three distinct patch temperatures available to each instrument (termed patch low, patch mid, and patch high). Tables of these coefficients and their associated narrow patch temperature ranges are available to the SPS. When Q-mode 2 is enabled, the SPS compares the current smoothed (averaged over 2 seconds) patch temperature to the three nominal narrow temperature ranges defined for the instrument. If a match is detected, the second-order gain coefficients are taken directly from the gain table. If the current patch temperature lies outside of the nominal ranges, the SPS performs a linear interpolation, or extrapolation, of a new second-order gain on the tabulated factory coefficients. The option selected by the SPS is denoted by the patch temperature control level reported in Table 3-28, word 416, or Table 3-29, word 2096, of the Calibration and Limits Block 11s.

3.6.2.3.3.2 Second-Order Gain Versus Baseplate Temp (Q-MODE = 3)

Q-mode 3, available for both the Imager and Sounder, uses the baseplate temperature to compute the IR second-order gain coefficients at 2-minute intervals. A Lookup Table (LUT) containing values of the second order gain (*q)* at different baseplate temperatures is defined for each IR detector. A separate table is provided for each of the three nominal patch temperatures defined for the instrument (patch low, patch mid, and patch high). The table values are derived from factory measurements and provided in the Imager and Sounder documentation blocks. An effective baseplate temperature is calculated at 2-minute intervals from telemetry as the weighted mean of the six baseplate thermistor temperatures. The current value of *q* is determined from the effective baseplate temperature by interpolation in the LUT. The current smoothed patch temperature determines which of the three available LUTs is used for this interpolation. If the current patch temperature lies outside the defined table ranges, the two nearest tables are accessed with the effective baseplate temperature to generate two intermediate values of *q*. An interpolation, or extrapolation, is then performed using these two values, the associated patch temperature ranges, and the current patch temperature value to generate the new value of *q*.

Regardless of the calibration mode, the current weighted mean baseplate temperature, smoothed patch temperature, and the thermistor weighting factors are reported in the Calibration and Limits Block 11s along with the new values of the second-order gains. A critical alarm is generated, and reported in the Block 11, if the effective baseplate temperature is out of the LUT's range. If the baseplate temperature is out of range, the values of *q* are extracted directly from the LUT by selection of the nearest entry corresponding to the effective baseplate temperature.

3.6.3 ECAL Linearity Verification

Each blackbody calibration sequence on the Imager and Sounder is prefaced by an ECAL to measure the performance of the signal processing circuitry associated with each detector. The resulting 16 steps of measured output counts are received at the SPS and analyzed as described in the following paragraph.

First, all ECAL data are passed through high and low-reasonableness filters. The filtered data are then averaged into one value per step per each of the Imager detectors (15 for GOES 8 – 13; 16 for GOES-O and beyond) or 16 Sounder detectors (distinction between Sounder channels is not required in this case). Linearity verification is performed for each detector by fitting the mean values at the 16 steps to a line using the method of least squares and then computing the 16 individual residuals and their RMS.

The results of the filtering and the least squares fit for each detector, the slope and intercept of each computed line, and the associated residuals and RMS are reported in the GVAR ECAL Block 11s (see Section 3.3.6.7). A warning is generated and reported in the ECAL Block 11s if the RMS exceeds a specified limit for any detector or there are insufficient filtered samples for a particular step. The RMS limits, sample or step minimums, and high or low filters are reported in the Calibration Coefficients and Limits Block 11s.

It is important to note that filter delays in the Imager data result in invalid samples being downlinked to the SPS preceding the valid ECAL data. These invalid samples are discarded. The number of samples discarded for each Imager detector is specified by the "leading sample discard count/detector" array in the Imager Calibration Coefficients and Limits Block 11s.

3.7 Star Sense Analysis Algorithm

3.7.1 Problem Description

At intervals determined by ground command, the scanning mirror slews to a coordinate through which a star is expected to pass. A space clamp is performed at this coordinate, and for the imager, the detector amplifier gains for each of the eight visible star sense detectors are increased from 108 – 432 (nominal). The scanning mirror settles at this location and waits 2 seconds for the start of the star sense data sequence.

The star passes through the detector's FOV by normal in-orbit rotation of the satellite (0.25° per minute). The star senses last from 1 – 64 seconds as commanded by the ground. While a star sense data sequence is underway, no corrections for image rotation are performed by the instrument. The instrument's optical system provides a diffraction-limited blur spot diameter of approximately 10–15 μrads in the visible spectrum of the sensing detectors. The point spread function associated with the blur spot intensity follows a *sin x/x* distribution.

At the conclusion of a star sense, the instrument slews back to the coordinate it occupied prior to the initiation of the star sense and continues the previously active operation. For the imager, the detector amplifier gains are restored to a value of 108, and the nominal space clamp value is reestablished.

3.7.2 Analysis

A detector is assumed to act as an integrator, providing an output proportional to the total incident illumination and intensity. As a result, the output of a detector for a *sin x/x* blur spot resembles a flattened pyramid whose base width is composed of the following three parts:

a. Up staircase
b. Plateau
c. Down staircase

The up and down staircases are generated as the blur spot enters and leaves the detector FOV. The step effects, caused by the *sin x/x* intensity lobes, will be unequal as the bulk of the incident energy is contained in the central lobe. The overall width of each staircase will be equal to the width of the incident blur spot divided by the rotation rate. The plateau begins when the bulk of the blur spot is incident on the detector. It represents the peak detector response. The plateau remains in effect as the spot traverses the face of the detector until, at the far edge, the spot staircases out of the FOV. The height of the plateau is a function of the intensity, wavelength, and apparent spot diameter of the target star and is not characterized further. The width of the plateau is a function of the blur spot diameter and detector width. The time characteristics associated with a star sensing use the following terms:

r = Earth's rotation rate = 0.25 degrees per minute = 72.722 μrad per second
w = detector width = 28 μrad
d = star blur spot diameter = 10 μrad (example)
t_1 = up staircase interval, in seconds
t_2 = plateau interval, in seconds
t_3 = down staircase interval, in seconds

The total time of a star crossing can be computed as the time required to sweep through the detector width and the star blur spot diameter as follows:

$$t_t = (w + d)/r = 38/72.722 = 0.5225 \text{ seconds} = t_1 + t_2 + t_3$$

Because of the symmetry of the *sin x/x* intensity function, the up and down staircases are equivalent and equal in time to the sweep rate applied to the blur spot diameter as follows:

$$t_1 = t_3 = d/r = 0.1375 \text{ seconds}$$

The resulting plateau time is the following:

t_2 = 0.5225 – 0.1375 – 0.1375 = 0.2475 seconds

The Sounder generates pixels at a rate of 40 pixels per second (10 frames per second x 4 pixels per frame) for the eight star sense detectors. Other than stripping this information from the original downlink data block and repacking it into eight time-ordered arrays, no preprocessing of this information occurs prior to the software analysis. Since the star sense interval can range from 4 – 64 seconds in duration, the number of pixels included in the analysis of each detector can range from 160 – 2560 pixels. The occurrence of a star crossing event involves approximately 21 pixels from a particular array, 10 of which will be registering a plateau while the remaining 11 are split between the up and down staircases.

The analysis performed on the Sounder star sense arrays is described using the terms defined in Table 3-37. In addition to the eight time-ordered sample arrays S_i, a ninth array of CDA time stamps T_i is provided as a primary input to the analysis. The time stamp for each raw Sounder data block is assigned to the first of the four associated star sense samples. The remaining three samples are stamped by the cumulative addition of 25-msec increments to the initial CDA time stamp. The remainder of this section presents an algorithm from the viewpoint of a single detector.

The star sense pixel array, P_i, is formed by the moving window averaging filter operating on the input sample array, S_i. An operator specified term, *W*, specifies the number of raw input samples to be included in the window and is constrained to be a positive integer. The number of star sense pixels generated by the moving window filter is a function of the input sample size, *N*, the window size, *W,* and is equal to $N - W + 1$. The intent of the moving window averaging filter is to improve the signal-to-noise ratio of the data prior to analysis. The resulting star sense pixel array, P_i, is employed in the remainder of the computations.

The mean value registered by the detector during the star sense interval *DMV* is computed as the average value of the detector pixel array, P_i. An operator specified constant, *DWT*, is added to the *DMV* to compute a window threshold level, *WTL*, for the detector. The value of *DWT* can be tailored for each of the eight detectors. Its primary function is to provide a first-order filtering of noise effects that may be present in the pixel data. The *WTL* is used to select the subset(s) or window(s) of pixels within array P_i that may contain star information.

The operator specified constant, *WTC*, denotes the number of pixels that must exceed the *WTL* before a star crossing has started. The *WTC* criteria is also applied in a reverse transit through the pixel array to determine the end location of the window(s).

Once a windowed set of pixels has been selected, the window mean value, *WMV*, of the pixels contained within the window is computed. Next, an *ETL* is computed as the level halfway between *WTL* and *WMV*. This level, in conjunction with the operator specified constant *ETC*, is used to locate the pixels at which the windowed event is defined to begin and end.

Table 3-37. Sounder Star Crossing Analysis Terms

Analysis Terms	Equation
input sample array (160 ≤ N ≤ 2560) expanded input time array	$S_i \Big\vert_1^N$ $T_i \Big\vert_1^N$
star sense pixel value (W is integer: {1,2,3,...})	$P_i = \frac{1}{W} \sum_{8}^{g+W-1} S_g \quad \Big\vert \begin{matrix} g = N - W + 1 \\ g = 1 \end{matrix}$
DMV (interval mean value or detector)	$DMV = \frac{1}{N - W + 1} \sum_{1}^{N-W+1} P_i$
DWT (window threshold tolerance/detector), separate value each detector	$\mathrm{DWT} = \mathrm{constant}_d$
WTL (Window Threshold Level/Detector)	$WTL = DMV + DWT$
WTC (Window Thresholding Count) used with WTL to locate the window start (h) and end (k) indexes	$WTC = \mathrm{constant}_1$
WMV (Window Mean Value)	$WMV = \frac{1}{k - h + 1} \sum_{h}^{k} P_i$
ETL (event thresholding level)	$ETL = WTL + \frac{WMV - WTL}{2}$
ETC (event thresholding count) used with ETL to locate event start (m) and end (n) indices	$ETC = \mathrm{constant}_2$
EMV (event mean value)	$EMV = \frac{1}{n - m + 1} \sum_{m}^{n} P_i$
TEV (time of event)	$TEV = T_m + \frac{T_n - T_m}{2}$

Table 3-38. Imager Star Crossing Analysis Terms

Analysis Terms	Equation
input sample array (100 ≤ N ≤ 6400) input time array	$S_i \Big\vert_1^N$ $T_i \Big\vert_1^N$
star sense pixel value (W is integer: {1,2,3,...}) (2 ≤ M ≤ 1024)	$P_i = \frac{1}{4MW} \sum_{8}^{g+W-1} S_g \Big\vert_{g=1}^{g=N-W+1}$
DMV (interval mean value or detector)	$DMV = \frac{1}{N-W+1} \sum_{1}^{N-W+1} P_i$
DWT (window threshold tolerance/detector), separate value each detector	$DWT = constant_d$
WTL (Window Threshold Level/Detector)	$WTL = DMV + DWT$
WTC (Window Thresholding Count) used with WTL to locate the window start (h) and end (k) indexes	$WTC = constant_3$
WMV (Window Mean Value)	$WMV = \frac{1}{k-h+1} \sum_{h}^{k} P_i$
ETL (event thresholding level)	$ETL = WTL + \frac{WMV - WTL}{2}$
ETC (event thresholding count) used with ETL to locate event start (m) and end (n) indices	$ETC = constant_4$
EMV (event mean value)	$EMV = \frac{1}{n-m+1} \sum_{m}^{n} P_i$
TEV (time of event)	$TEV = T_m + \frac{T_n - T_m}{2}$

The value of *ETC* specifies the number of sequential pixels with the values exceeding *ETL* that defines the edge of a star crossing event. The following two passes are made through each set of windowed pixels:

1. In the forward direction to locate the rising edge of the event.
2. In the reverse direction to locate the falling edge of the event.

In the forward pass, the last of the ETC pixels defines the start of the event; and, similarly, in the reverse pass, the last (i.e., the point in time when the detected signal starts to fall) of the *ETC* pixels defines the end of the event.

The CDA *TEV* is computed at the mid-point time of the inclusive pixel set. The above analysis is repeated for each windowed subset of pixels in the detector's array. The entire analysis is repeated for each of the remaining seven detector arrays.

With some variations, the preceding analysis described for the Sounder also applies to the Imager star sense data. The applicable Imager data analysis terms are defined in Table 3-38. The primary difference between the two analysis lies in the formation of the start sense pixel array, P_i.

The Imager generates 21,840 pixels per second from each of the eight star sense detectors and can perform a simple star sense up to 64 seconds in length. Extended star sense intervals exceeding 64 seconds can also be performed if the star sequence mode has been commanded. Thus, preprocessing of the Imager star sense data by the SPS's SDI software processes are required to reduce the volume of Imager data generated to a manageable size. To accomplish this reduction, the SDI software processes sum $4M$ raw pixels to generate each input sample, S_i. The summation is performed prior to entry of the sample into the SPS's memory. *M* is an operator-modifiable database constant that specifies the number of Imager data blocks to be included in the sum and is restricted to a range of 2-1024. The nominal value of *M* is 55, yielding an input sample timing resolution of 10.07 msec.

Each Imager raw data block provides four pixels from each of the eight star sensing detectors, corresponding to a pixels per sample sum between 8 - 4096 generated by the SDI software processes. For the default case of $M = 55$, the SDI software processes would generate about 99 input samples per second for each detector.

Assuming a 10-µrad blur spot star event, 51 samples would be involved with the event, 24 registering a plateau, and the remaining 27, split between the up and down staircases.

The Imager sample time array, T_i, contains the CDA time tags associated with the last raw block included in each sample sum generated by the SDI software processes. The star sense pixel array, P_i, for each visible detector is formed using a moving window averaging filter similar to the one described for the Sounder star sense. The difference between the two is that the Imager version includes the factor $1/4M$ in the averaging algorithm to compensate for the effects of the summing operation performed by the SDI software processes.