

# Cross-track Infrared Sounder (CrIS) Level 1B Quality Flags Description Document

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University of Wisconsin-Madison Space Science and Engineering Center

Version 2.11

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## Revision History

Document Version	Software Version	Date	Comment
Draft		2016-02-18	Creation of document
0.1	Beta3	2016-03-24	Consistent with Beta 3 implementation
1.0 Draft 1	1.0RC	2016-07-10	Updated for proposed V1.0 implementation
1.0 Draft 2	1.0RC	2016-07-22	Added threshold value tables and updated dependency trees
1.0 Draft 3	1.0RC	2016-07-25	Added threshold values
1.0 Draft 4	1.0RC	2016-07-29	Added preliminary threshold values for "Invalid Instrument Temperature" and "Excess Thermal Drift"
1.0 Draft 5	1.0RC	2016-08-01	Removed redundant check of ICT and DS window sizes from L1b Quality Invalid; removed ES Mag Spectrum Check; removed Met Laser Quality Flag; added ISA Degraded QF.
1.0 Draft 6	1.0RC1	2016-08-12	Added information on band specific inputs and outputs (color coded dependency trees); fixed error in rad cal quality flag = 1 (degraded) dependency tree; added l1a fill to rad cal quality flag = 2 (invalid) dependency tree.
1.0 Draft 7	1.0RC3	2016-08-24	Upped Excess Thermal Drift Threshold to 1.0K
1.0 Draft 8	1.0RC6	2016-10-15	Removed section with detail of RDR/SDR/GEO IDPS QFs; added caveat on known error in false positives for rad_qual and qual flags.

<b>Document Version</b>	<b>Software Version</b>	<b>Date</b>	<b>Comment</b>
1.0 Draft 9	1.0RC7	2016-11-07	Updated lunar intrusion info and rolling window threshold information. Added CrIS L1B reference documents.
1.0	1.0RC8	2017-03-09	Changed rolling average nominal and threshold to be consistent with rc8; document reviewed for release.
2.0 Draft 1	2.0.15	2018-01-25	Restructuring of QF fields and variable(s) for v2; addition of top-level (0,1,2 valued) QC summary variables
2.0	2.0.15	2018-02-27	Editorial revisions; Geo QF info added
2.11	2.1.3	2018-12-21	Editorial revisions. No changes to content.

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## 1 Overview

This document describes the quality information contained in the Version 2.11 NASA CrIS Level 1B (L1B) product. It is intended to supplement the more general description of the product that is found in the CrIS L1B Product Users' Guide, Version 2.11.

Quality information includes top-level Quality Control variables as well as Quality Flag variables.

## 2 Reference Documents

1. CrIS L1B Product Users' Guide, Version 2.11
2. NASA SNPP Cross Track Infrared Sounder (CrIS) Level 1B Delta Algorithm Theoretical Basis Document (ATBD), Version 2.11
3. CrIS L1B Software Users' Guide, Version 2.1
4. Cross Track Infrared Sounder (CrIS) Sensor Data Record (SDR) User's Guide, Version 1.0, NOAA Technical Report NESDIS 143
5. Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for Cross-track Infrared Sounder (CrIS) Sensor Data Record (SDR) Software, Revision F, Joint Polar Satellite System (JPSS) Ground Project Code 474 474-00071
6. Joint Polar Satellite System (JPSS) Algorithm Specification Volume I: Software Requirement Specification (SRS) for the CrIS RDR/SDR, Block 2.0.0, Joint Polar Satellite System (JPSS) Ground Project Code 474 474-00448-01-03-B0200
7. Joint Polar Satellite System (JPSS) Algorithm Specification Volume II: Data Dictionary for the CrIS RDR/SDR, Block 2.0.0, Joint Polar Satellite System (JPSS) Ground Project Code 474 474-00448-02-03-B0200
8. Joint Polar Satellite System (JPSS) Cross Track Infrared Sounder (CrIS) Sensor Data Records (SDR) Algorithm Theoretical Basis Document (ATBD), Revision C, Joint Polar Satellite System (JPSS) Ground Project Code 474 474-00032



### 3 Top-Level Quality Control Variables

For the v2.0 release, three top-level Quality Control (QC) variables were added (rad\_lw\_qc, rad\_mw\_qc, rad\_sw\_qc). These variables are valued 0, 1, or 2 and summarize the quality of the calibrated radiance product for each detector band, with one value per observation.

**Table 1: L1b QC values and description.**

0	No L1B quality issues
1	L1B quality 'Good'. Minor quality issues detected, product may be slightly degraded but is likely of acceptable quality to end users. Refer to L1a, geo, L1b quality flags for more information
2	L1B quality 'Invalid'. Refer to L1a, geo, L1b quality flags for more information

The values in each QC variable are obtained directly from the L1B summary flag in the calibration quality flag variable for the corresponding band. For information on how those values are determined, refer to Section 5.10 L1B Quality.

### 4 Quality Flag Variables

Quality Flag (QF) variables are bit-fields providing information on specific issues that affect the calibration or geolocation quality.

The individual flags that make up QF variables can be broken out by applying bit-masks. These flags may be one or more bits in length. For each flag, a value of 0 indicates no issues, and a non-zero value indicates issues were encountered.

Users who are not interested in breaking out individual flags to get detailed information about specific issues should use the top-level Quality Control variables described in Section 3. Alternatively, they can treat the quality flag variables as integers, where a value of 0 indicates no issues were encountered, and a non-zero value indicates issues were encountered.

The Quality Flag variables and their derivation are described in the following sections. Note that the flags and their meanings are also fully described by variable attributes in compliance with the Climate and Forecast (CF) standard. For information on using these attributes to interpret QF values, refer to the CF documentation.

### 5 Calibration Quality Flag Variables

For the v2.0 release, the L1b calibration quality flags were regrouped from a single 64-bit bit-encoded variable to four 32-bit bit-encoded variables (Table 2 - Table 5). The cal\_qualflag variable contains quality flag information that is detector band independent. The cal\_lw\_qualflag, cal\_mw\_qualflag, and cal\_sw\_qualflag contain quality flag information that is detector band dependent, and each of these 3 variables have identical bit encoding and

information format for the LW, MW, and SW bands, respectively. No new quality flags were added, but the QF logic was adjusted where necessary for the change in the definition of a QF value of 1 to 'good' from 'degraded' for {0,1,2} valued QFs.

**Table 2: cal\_qualflag bit assignments; this bit-encoded variable contains quality flag information that is detector band independent.**

Name	Bit Assignment	Initial Release	Section
Geo Quality	B0	Version 1	Section 5.1
Invalid Instrument Temperature	B1	Version 1	Section 5.2
Excess Thermal Drift	B2	Version 1	Section 5.3
FCE Detected (Reserved)	B3		Section 5.4
FCE Correction Failed (Reserved)	B4		Section 5.5
Neon Calibration Quality	B5	Version 1	Section 5.6
ISA Degraded	B6	Version 1	Section 5.7
Bit Trim Mismatch*	B7	Beta 3	Section 5.8
Scan Line Missing 8 Sec Sci *	B8	Beta 3	Section 5.9
Unassigned	B9-31		

**Table 3: cal\_lw\_qualflag bit assignments.**

Name	Bit Assignment	Initial Release	Section
LW L1B Quality	B0 – B1	Beta 3	Section 5.10
LW Radiometric Calibration Quality	B2 – B3	Version 1	Section 5.11
LW Spectral Calibration Quality	B4 – B5	Version 1	Section 5.12
LW Imaginary Radiance Anomaly	B6	Beta 3	Section 5.13
LW Lunar Intrusion Detected	B7	Version 1	Section 5.14
LW L1a ES Missing *	B8	Beta 3	Section 5.15
Unassigned	B9 -31		

\* replicated from ES/l1a\_qual

**Table 4: cal\_mw\_qualflag bit assignments.**

Name	Bit Assignment	Initial Release	Section
MW L1B Quality	B0 – B1	Beta 3	Section 5.10
MW Radiometric Calibration Quality	B2 – B3	Version 1	Section 5.11
MW Spectral Calibration Quality	B4 – B5	Version 1	Section 5.12
MW Imaginary Radiance Anomaly	B6	Beta 3	Section 5.13
MW Lunar Intrusion Detected	B7	Version 1	Section 5.14
MW L1a ES Missing *	B8	Beta 3	Section 5.15
Unassigned	B9 -31		

\* replicated from ES/l1a\_qual

Table 5: cal\_sw\_qualflag bit assignments.

<b>Name</b>	<b>Bit Assignment</b>	<b>Initial Release</b>	<b>Section</b>
SW L1B Quality	B0 – B1	Beta 3	Section 5.10
SW Radiometric Calibration Quality	B2 – B3	Version 1	Section 5.11
SW Spectral Calibration Quality	B4 – B5	Version 1	Section 5.12
SW Imaginary Radiance Anomaly	B6	Beta 3	Section 5.13
SW Lunar Intrusion Detected	B7	Version 1	Section 5.14
SW L1a ES Missing *	B8	Beta 3	Section 5.15
Unassigned	B9 -31		

\* replicated from ES/l1a\_qual

The following sections describe the meanings of the individual flags that make up the calibration quality flag variables.

For flags that are set based on multiple inputs, the criteria for promoting from the default value of 0 (no issues) to successively larger values are shown in dependency tree logic diagrams.

## 5.1 Geo Quality

This is a summary flag of the overall geolocation quality with value range 0 – 1. The bit assignment within cal\_qualflag is defined in Table 2.

Table 6: Geo Quality inputs.

Input	Input Type	Reference	Version 2
obs-time-missing	Quality Flag	Geo QF	Yes
servo-errors-missing	Quality Flag	Geo QF	Yes
spacecraft-diary-missing	Quality Flag	Geo QF	Yes
stale-utcpole	Quality Flag	Geo QF	Yes

Table 7: Geo Quality values and description.

Value	Description
0	No geolocation quality issues
1	Geolocation quality issues. Refer to geo_qualflag for more information.

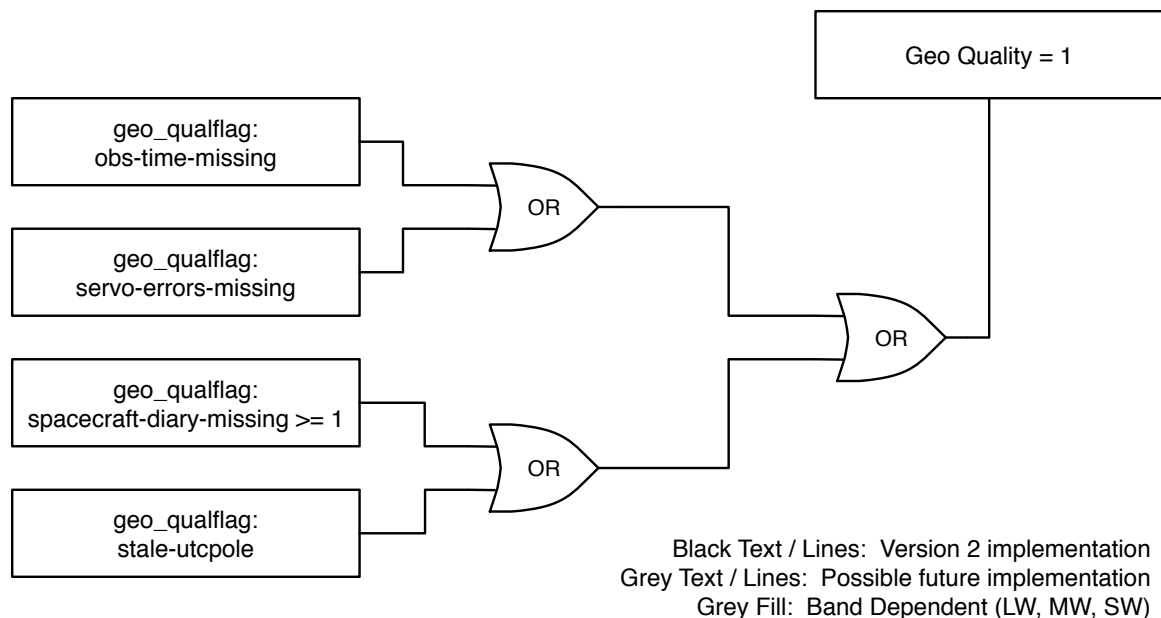


Figure 1: Geo Quality dependency tree.

## 5.2 Invalid Instrument Temperature

The Invalid Instrument Temperature flag is intended to identify the situation when the measured temperatures of certain instrument components are out of allowable ranges. These temperature measurements are used to compute the contributions of the instrument components to the ICT radiometric model. This flag has a range of 0 – 1, and the cal\_qualflag bit assignment is defined in Table 2.

**Table 8: Invalid Instrument Temperature Quality Flag values and description.**

Value	Description
0	All instrument temperatures within respective thresholds
1	Instrument temperature outside of respective threshold

**Table 9: Valid ranges for instrument temperatures (TBR: To Be Reviewed for next release).**

Temperature	Min Value	Max Value
T_PRT1	270 (TBR)	290 (TBR)
T_PRT2	270 (TBR)	290 (TBR)
OMA_structure_input_1	270 (TBR)	290 (TBR)
OMA_structure_input_2	270 (TBR)	290 (TBR)
SSM_scan_mirror	270 (TBR)	290 (TBR)
beamsplitter_1	270 (TBR)	290 (TBR)
SSM_scan_mirror_baffle	270 (TBR)	290 (TBR)

### 5.3 Excess Thermal Drift

The Excess Thermal Drift flag is intended to identify the situation when the measured temperature of any instrument components has drifted greater than the allowable limit within the period of a single granule. These temperature measurements are used to compute the contributions of the instrument components to the ICT radiometric model. This flag has a range of 0 – 1, and the cal\_qualflag bit assignment is defined in Table 2.

**Table 10: Excess Thermal Drift Quality Flag values and description.**

Value	Description
0	No excess thermal drift of instrument temperatures
1	Thermal drift between measurements exceeds respective threshold

**Table 11: Excess Thermal Drift Threshold.**

Temperature	Threshold
T_PRT1	+/- 1.0 (TBR)
T_PRT2	+/- 1.0 (TBR)
OMA_structure_input_1	+/- 1.0 (TBR)
OMA_structure_input_2	+/- 1.0 (TBR)
SSM_scan_mirror	+/- 1.0 (TBR)
beamsplitter_1	+/- 1.0 (TBR)
SSM_scan_mirror_baffle	+/- 1.0 (TBR)

### 5.4 FCE Detected (Reserved)

The FCE (Fringe Count Error) Detected flag has a range of 0 – 1, and the cal\_qualflag bit assignment is defined in Table 2. This flag is not currently implemented and will always be set to 0.

**Table 12: FCE Detected Quality Flag values and description.**

Value	Description
0	No fringe count error detected
1	Fringe count error detected

### 5.5 FCE Correction Failed (Reserved)

This flag has a range of 0 – 1, and the cal\_qualflag bit assignment is defined in Table 2. This flag is not currently implemented and will always be set to 0.

**Table 13: FCE Correction Failed Quality Flag values and description.**

Value	Description
0	FCE correction successful
1	FCE correction failed

### 5.6 Neon Calibration Quality

This flag has a range of 0 – 1, and the cal\_qualflag bit assignment is defined in Table 2.

**Table 14: Neon Calibration Quality Flag values and description.**

Value	Description
0	Less than 25% of the neon calibration dataset varied from the mean by greater than the 28ppm threshold
1	25% or greater of the neon calibration dataset varied from the mean by greater than the 28ppm threshold

### 5.7 ISA Degraded

The ISA Degraded flag is intended to identify the situation when the inverse self-apodization matrices that are used in the self-apodization correction were generated for a metrology laser wavenumber that differs from the current metrology laser wavenumber by more than a pre-defined threshold (15 ppm). This flag has a range of 0 – 1, and the cal\_qualflag bit assignment is defined in Table 2.

**Table 15: ISA Degraded Quality Flag values and description.**

Value	Description
0	Current laser wavenumber value differs by less than 15 ppm with respect to the laser wavenumber used to calculate the ISA matrices
1	Current laser wavenumber value differs by 15 ppm or greater with respect to the laser wavenumber used to calculate the ISA matrices

### 5.8 Bit Trim Mismatch

This flag has a range of 0 – 1, is propagated from the corresponding ES/l1a\_qual flag, and the cal\_qualflag bit assignment is defined in Table 2.

**Table 16: Bit Trim Mismatch Quality Flag values and description.**

Value	Description
0	Bit trim succeeded
1	Bit trim failed, too much or too little packed interferogram data

### **5.9 Scan Line Missing 8 Sec Sci**

This flag has a range of 0 - 1, is propagated from the corresponding ES/l1a\_qual flag, and the cal\_qualflag bit assignment is defined in Table 2.

**Table 17: Scan Line Missing 8 Sec Sci Quality Flag values and description.**

Value	Description
0	8-sec science packet available for this scan line
1	8-sec science packet unavailable for this scan line

## 5.10 L1B Quality

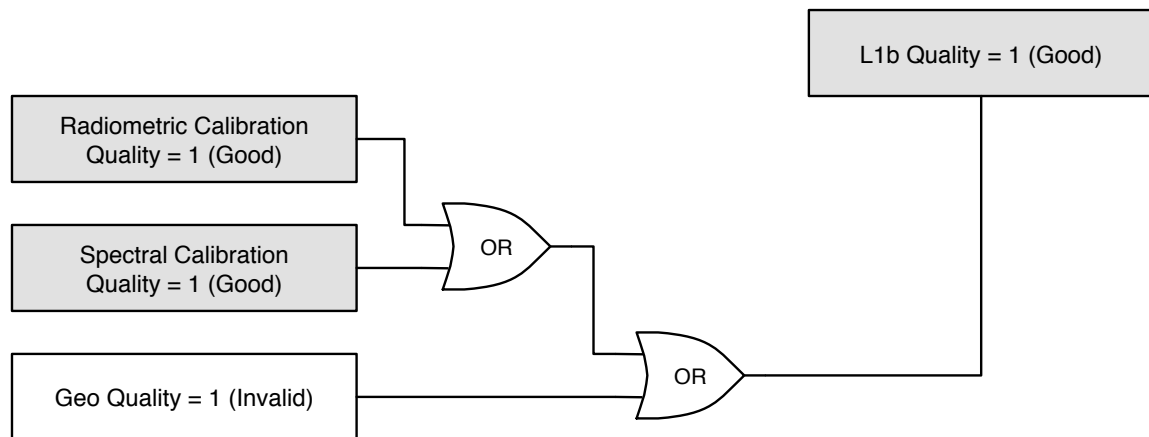
These are summary flags (LW, MW, SW) with value range 0 – 2. The dependency trees are shown in Figure 2 (L1B Quality = 1) and Figure 3 (L1B Quality = 2), with the inputs summarized in Table 18. L1b Quality Flag Values are summarized in Table 19 and band-specific QF bit assignments are defined in Table 3, Table 4, and Table 5. The top-level Quality Control (QC) variables described in Section 3 are set directly from the L1b Quality Flags (LW, MW, SW).

**Table 18: Inputs to L1b Quality dependency tree.**

Input	Input Type	Reference	Version 2
Radiometric Calibration Quality	Quality Flag	Section 5.11	Yes
Spectral Calibration Quality	Quality Flag	Section 5.12	Yes
Geo Quality	Quality Flag	Section 5.1	Yes
Bit Trim Mismatch	Quality Flag	L1a QF	Yes
Scan Line Missing 8 Sec Sci	Quality Flag	L1a QF	Yes
L1a ES Missing	Quality Flag	L1a QF	Yes
Imaginary Radiance Anomaly	Quality Flag	Section 5.13	Yes
ES Spectrum	Value (test vs. threshold)	Table 20	NO (TBR)

**Table 19: L1b Quality values and description.**

Value	Description
0	No L1B quality issues
1	L1B quality 'Good' (minor quality issues detected). Refer to L1a, geo, L1b quality flags for more information
2	L1B quality 'Invalid'. Refer to L1a, geo, L1b quality flags for more information



Black Text / Lines: Version 2 implementation  
 Grey Text / Lines: Possible future implementation  
 Grey Fill: Band Dependent (LW, MW, SW)

**Figure 2: L1b Quality Flag dependency tree for L1b Quality = 1 ('Good', minor quality issues detected).**



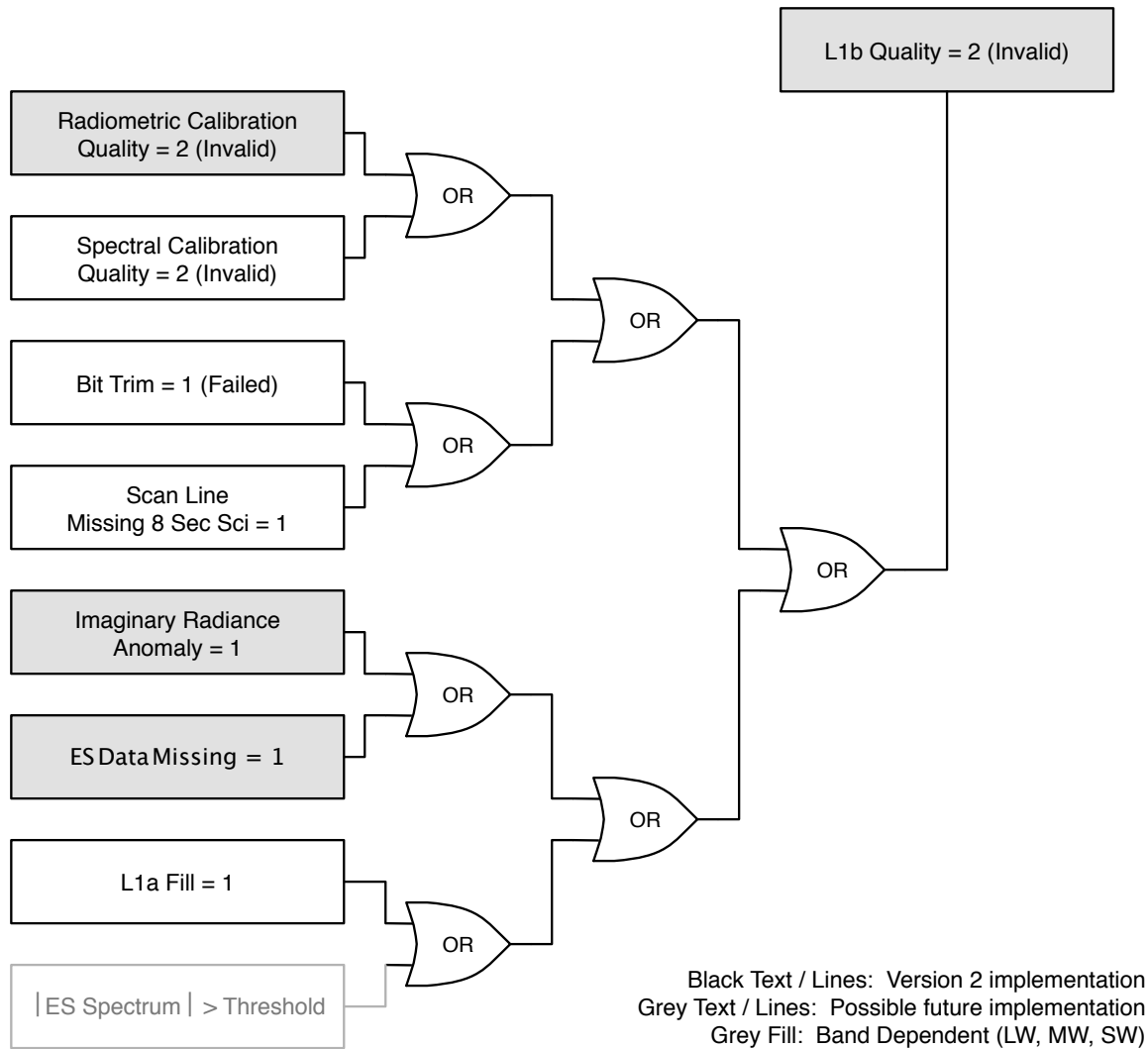


Figure 3: L1b Quality Flag dependency tree for L1b Quality = 2 (Invalid).

Table 20: Absolute ES Spectrum threshold values and wavenumber ranges (not currently implemented).

Band	Wavenumber Range for threshold check		Threshold Value
	Min (cm <sup>-1</sup> )	Max (cm <sup>-1</sup> )	
LW	779 (TBR)	960 (TBR)	TBD
MW	1455 (TBR)	1655 (TBR)	TBD
SW	2230 (TBR)	2330 (TBR)	TBD

### 5.11 Radiometric Calibration Quality

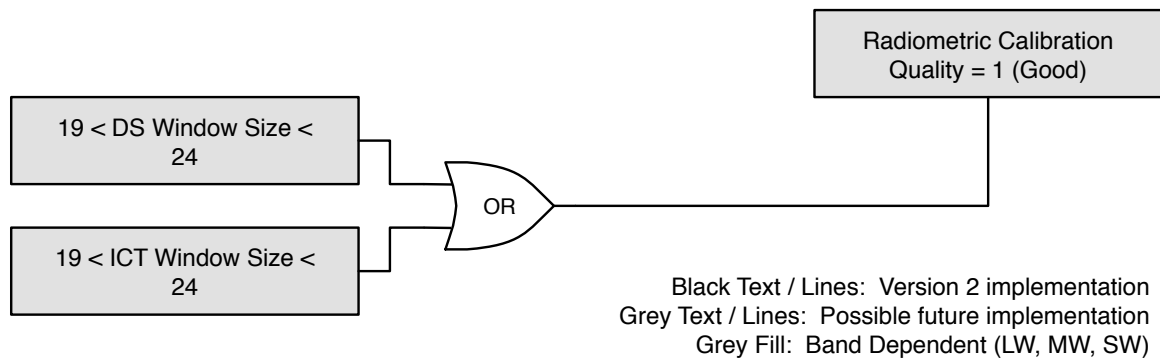
These are summary flags describing the overall radiometric calibration quality (LW, MW, SW) with value range 0 – 2. The dependency trees are shown in Figure 4 (Radiometric Calibration Quality = 1) and Figure 5 (Radiometric Calibration Quality = 2), with the inputs summarized in Table 21. Radiometric Calibration Quality Flag values are summarized in Table 22, and the band-specific QF bit assignments are defined in Table 3, Table 4, and Table 5. These flags are implemented at reduced functionality for the current version.

**Table 21: Inputs to Radiometric Calibration Quality dependency tree.**

Input	Input Type	Reference	Version 2
DS Window Size (WS)	Value (test vs. threshold) 0: $24 \leq \text{DS WS} < 29$ 1: $19 < \text{DS WS} < 24$	Figure 4 Figure 5	Yes
ICT Window Size (WS)	Value (test vs. threshold) 0: $24 \leq \text{DS WS} < 29$ 1: $19 < \text{DS WS} < 24$	Figure 4 Figure 5	Yes
ICT Temperature Stability	Value (test vs. threshold)	Section 5.11.1	Yes
ICT Temperature Consistency	Value (test vs. threshold)	Section 5.11.2	Yes
Number of Valid PRT Temperatures	Value (test vs. threshold)	Section 5.11.3	Yes (TBR)
ES Impulse Noise Count	Value (test vs. threshold)		No (TBR)
Excess Thermal Drift	Quality Flag	Section 5.3	Yes
Invalid Instrument Temperature	Quality Flag	Section 5.2	Yes

**Table 22: Radiometric Calibration Quality values and description.**

Value	Description
0	No quality issues detected
1	'Good' radiometric calibration (minor quality issues detected)
2	Invalid radiometric calibration



**Figure 4: Radiometric Calibration Quality Flag dependency tree for Rad Cal Quality = 1 (Good, minor quality issues detected).**

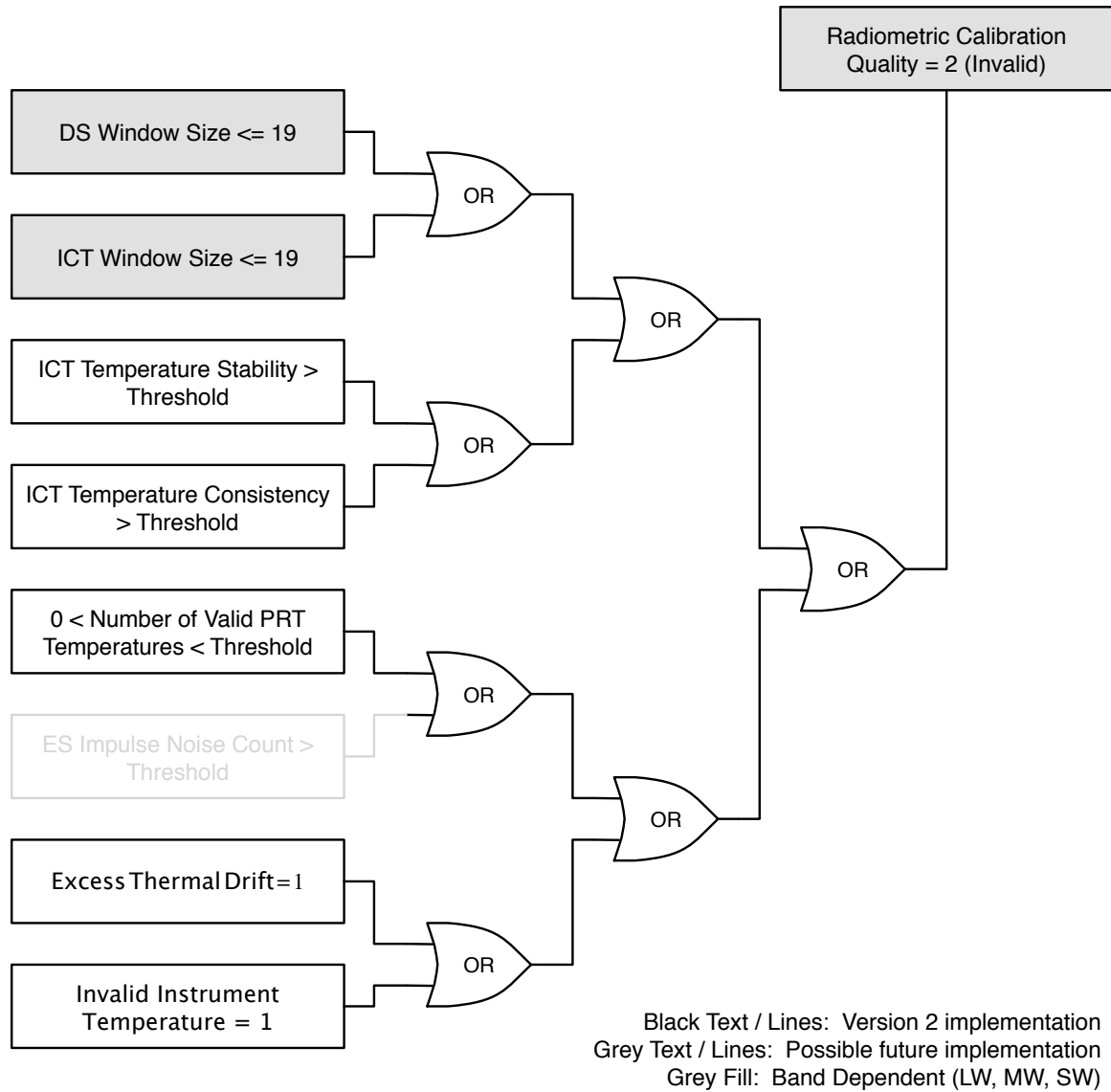


Figure 5: Radiometric Calibration Quality Flag dependency tree for Rad Cal Quality = 2 (Invalid). This flag condition is implemented with reduced functionality in the current version.

### 5.11.1 ICT Temperature Stability

Threshold Value: 1.0 (TBR) ictTempStabilityThreshold

From the SDR User's Guide [REF1]:

*ICT\_TemperatureStability* measures the stability of the two PRT measurements of the ICT. This variable is calculated using the following equation:

$$ICTTS = \sqrt{\sum_{i=1}^{ICTWS} \left[ \bar{T}(i) - \frac{1}{ICTWS} \sum_{j=1}^{ICTWS} \bar{T}(j) \right]^2} / (ICTWS - 1) \quad (1.1)$$

where  $ICTWS$  is the ICT Window Size,  $\bar{T}(i) = \frac{1}{N} \sum_{k=1}^N T(i,k)$   $\bar{T}(i) = \frac{1}{N} \sum_{k=1}^N T(i,k)$ , where  $T(i,k)$  is the converted PRT temperature in the validated  $k^{th}$  epoch, represents the average ICT temperature measured from a PRT for the  $i^{th}$  scan. This variable is set separately for the two PRTs.

### 5.11.2 ICT Temperature Consistency

Threshold Value: 1.0 (TBR) ictTempConsistencyThreshold

From the SDR User's Guide [REF1]:

*ICT\_TemperatureConsistency* measures the consistency between the two PRT measurements of the ICT. This variable is calculated using the following equation:

$$ICTTC = \frac{1}{ICTWS} \sum_{i=1}^{ICTWS} \bar{T}_1(i) - \frac{1}{ICTWS} \sum_{i=1}^{ICTWS} \bar{T}_2(i) \quad (1.2)$$

The nomenclature is similar to the *ICT\_TemperatureStability* variable except that the subscripts 1 and 2 denote the two PRTs, respectively.

### 5.11.3 Number of Valid PRT Temperatures

The threshold value from the IDPS/ADL configuration (PCT) binary file is noted below.

Threshold Value: 15 (numOfValidPRTTempThreshold)

From the SDR User's Guide [REF1]:

*numberOfValidPRTTemperatures* represents the number of PRT temperatures that have been validated using the procedure described below. The mean and standard deviation of the PRT temperatures is calculated to identify any outliers, which are defined as being different from the mean by an amount of more than 3-sigma (standard deviation). The outliers do not enter subsequent processing.

### 5.11.4 ES Impulse Noise Count

The threshold value from the IDPS/ADL configuration (PCT) binary file is noted below. This test is not currently implemented.

Threshold Value: 2 (impulseNoiseCountThreshold)

## 5.12 Spectral Calibration Quality

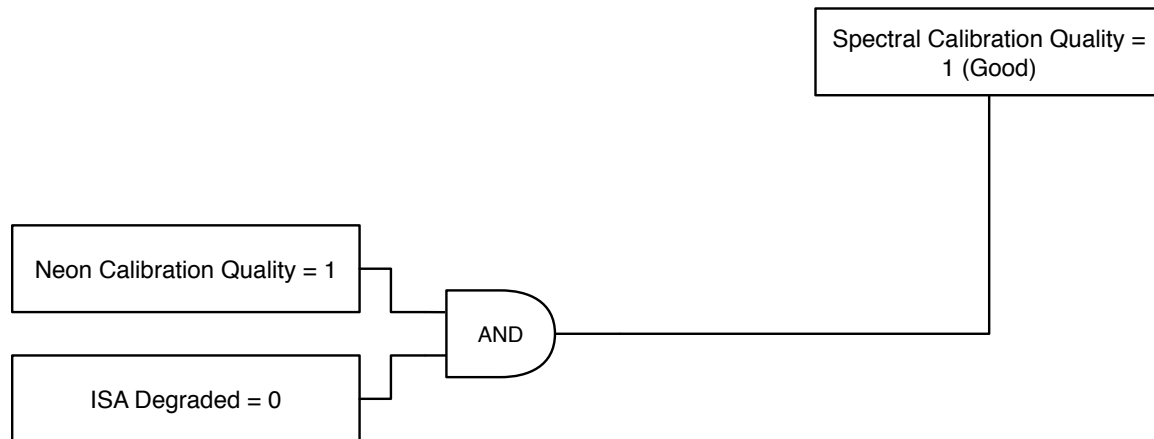
These are summary flags (LW, MW, SW) describing the overall spectral calibration quality with value range 0 - 2 where the dependency trees are shown in Figure 6 (Spectral Calibration Quality = 1) and Figure 7 (Spectral Calibration Quality = 2), with the inputs summarized in Table 23. Quality Flag values are summarized in Table 24, and the band-specific QF bit assignments are defined in Table 3, Table 4, and Table 5. These flags are implemented at a reduced functionality for the current version. The usage of “FCE Detected”, “FCE Correction Failed”, and “Met Laser Monitored” has been omitted from the current version.

**Table 23: Inputs to Spectral Calibration Quality dependency tree.**

Input	Input Type	Reference	Version 2
FCE Detected	Quality Flag	Section 5.4	NO
FCE Correction Failed	Quality Flag	Section 5.5	NO
Neon Calibration Quality	Quality Flag	Section 5.6	Yes
ISA Degraded	Quality Flag	Section 5.7	Yes
Met Laser Monitored	TBD		NO

**Table 24: Spectral Calibration Quality values and description.**

Value	Description
0	No quality issues detected
1	‘Good’ spectral calibration (minor quality issues detected)
2	Invalid spectral calibration



Black Text / Lines: Version 2 implementation  
 Grey Text / Lines: Possible future implementation  
 Grey Fill: Band Dependent (LW, MW, SW)

**Figure 6: Spectral Calibration Quality Flag dependency tree for Spectral Cal Quality = 1 (Good, minor quality issues detected). This flag condition is implemented with reduced functionality in the current version.**

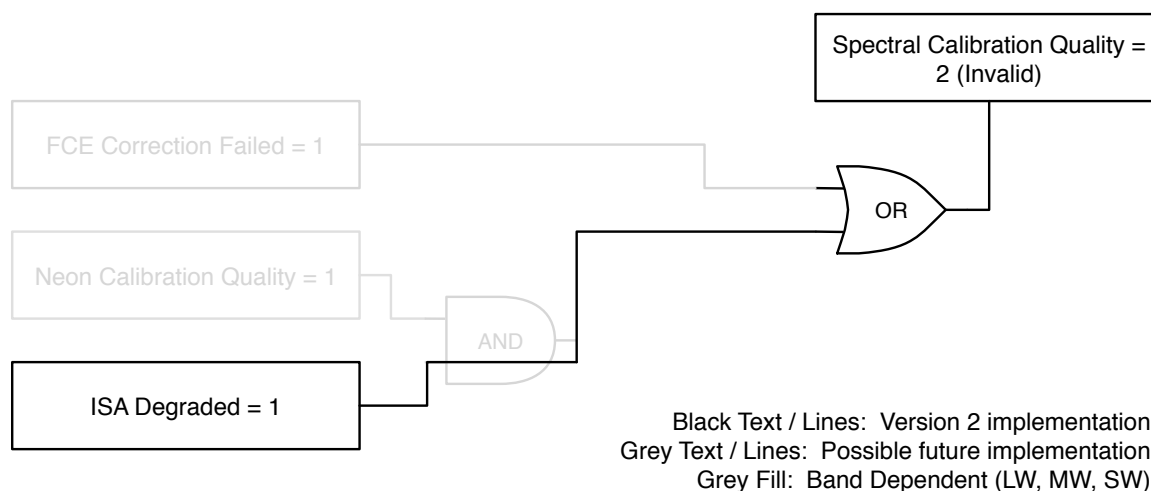


Figure 7: Spectral Calibration Quality Flag dependency tree for Spectral Cal Quality = 2 (Invalid). This flag condition is implemented with reduced functionality in the current version.

### 5.13 Imaginary Radiance Anomaly

A large imaginary component of the calibrated radiance is an indication of poor quality of the calibrated radiance. These flags (LW, MW, SW) indicate whether the imaginary component of the calibrated radiance exceeds the defined thresholds, with value range 0 – 1. Band-specific QF bit assignments are defined in Table 3, Table 4, and Table 5.

Table 25: Imaginary Radiance Anomaly values and description.

Value	Description
0	Imaginary component of the calibrated radiance is within the threshold value
1	Imaginary component of the calibrated radiance exceeds the threshold value

Table 26: Imaginary Radiance Anomaly threshold values and wavenumber ranges.

Band	Wavenumber Range for threshold check		Threshold Value
	Min (Index)	Max (Index)	
LW	779	960	+/- 1.5
MW	1455	1655	+/- 0.88*
SW	2230	2330	+/- 0.05**

\* multiplied by  $\sqrt{2}$  for FSR data

\*\* multiplied by 2 for FSR data

### 5.14 Lunar Intrusion Detected

The Lunar Intrusion Detected flags indicate that a lunar intrusion has been detected in the deep space reference spectra within the moving average window span. If lunar intrusion is detected, the DS spectrum is marked as invalid and excluded from the moving window average. This results in a reduced number of DS spectra in the sliding window average used in the calibration of the current observation. These flags have a range of 0 – 1, and the band-specific QF bit assignment is defined in Table 3.

**Table 27: Lunar Intrusion Detected Quality Flag values and description.**

Value	Description
0	No DS views affected by lunar intrusion
1	At least one DS view is affected by moon within the moving window

### 5.15 L1a ES Missing

This flag has a range of 0 – 1, is propagated from the corresponding ES/l1a\_qual flag, and the band-specific QF bit assignment is defined in Table 3.

**Table 28: L1a ES Missing Quality Flag values and description.**

Value	Description
0	Complete ES interferogram packet
1	Interferogram packet was not received

## 6 Geolocation Quality Flag Variable

The geo\_qualflag variable contains quality information regarding the calculation of observation earth location and related fields. Table 29: geo\_qualflag bit assignments and the sections that follow provide a summary of the geo\_qualflag fields and their meanings.

**Table 29: geo\_qualflag bit assignments.**

Name	Bit Assignment	Initial Release	Reference
Observation Time Missing	B0	Version 1	Section 6.1
Servo Error Missing	B1	Version 1	Section 6.1
Spacecraft Diary Gap	B2-B3	Version 1	Section 6.1
Stale Earth Orientation Data	B4	Version 1	Section 6.2

### 6.1 Missing Geolocation Inputs

The first three fields in Table 29: geo\_qualflag bit assignments signal that input data from the instrument data stream essential to geolocation is unavailable.

Observation times and scan mirror servo error angles (along- and across-track) must be provided for every observation for geolocation to succeed.

Spacecraft diary refers to spacecraft position, velocity, and attitude information which is available once per second in the instrument data and interpolated to the observation times by the geolocation software. The Spacecraft Diary Gap field can be set to one of three nonzero values to indicate missing diary information. Binary values 01, 10, and 11 are used to respectively signify small, medium, or large gaps. All versions of the geolocation module released thus far mark all gaps as small, but this may change in a future release.

## 6.2 Stale Earth Orientation Data

The CrIS L1B geolocation software requires an ancillary file containing earth rotation angle and polar motion values tabulated over time. The corresponding bit in `geo_qualflag` will be set if this file does not have data covering the time of observation.

## 7 Caveats and Known Issues

Further refinement of the lunar intrusion check algorithm is still desirable. The current algorithm is based on the IDPS method but has been modified to account for the issues identified in that method, and incorporates tighter thresholds than used in the IDPS software.

The LW, MW, and SW L1b Quality Flags (and corresponding QC variables `rad_lw_qc`, `rad_mw_qc`, `rad_sw_qc`) are currently set to a value of 1 ('Good'), when the Rad Cal Quality Flag is set to 1 (Good), **OR** Spectral Cal Quality Flag is set to 1 (Good), **OR** Geo Quality Flag is set to 1 (Invalid Geo). For future releases this logic should be reviewed as it is not clear that a radiance should be considered to be 'Good' without good geolocation. It is expected that there are very few instances where the Rad Cal Quality Flag and/or the Spectral Cal Quality Flag will be set to 1 (Good) while the Geo Quality Flag is set to 1.

The Geo QF 'spacecraft-dairy-missing' is a 2-bit QF (no gap, small gap, medium gap, large gap detected), but only uses single bit functionality in software release v2.1.3 (0=no gap detected or 1=gap detected).

A false positive for Imaginary Radiance Anomaly may be indicated for extremely hot scenes. Threshold values and algorithm optimization will be reviewed prior to the v3.0 release.

Spectral Calibration Quality currently is set to 1 (Good) for the case in which the ISA Degraded flag is clear, but the Neon Cal Quality Flag is set. It is expected that there are very few instances for which this combination occurs, but this logical test will be reviewed prior to the v3.0 release.



## 8 L1B to SDR Quality Flag Comparison

Table 30: L1B to SDR quality flag comparison, sorted by SDR Quality Flag.

RDR/SDR/GEO		L1B	
Quality Flag	Quality Variable (Bit)	Quality Flag (# of bits)	Init Rel
Data Gap	QF1_SCAN_CRISDR (B0)	LW ES Missing (1) * MW ES Missing (1) * SW ES Missing (1) *	B3
Timing Sequence Error	QF1_SCAN_CRISDR (B1)	Not currently implemented	
Lambda Monitored Quality	QF1_SCAN_CRISDR (B2)	Not currently implemented	
Invalid Instrument Temperature	QF1_SCAN_CRISDR (B3)	Invalid Instrument Temperature (1)	V1
Excess Thermal Drift	QF1_SCAN_CRISDR (B4)	Excess Thermal Drift (1)	V1
Suspect Neon Calibration	QF1_SCAN_CRISDR (B5)	Neon Calibration Quality (1)	V1
Lunar Intrusion Forward	QF2_CRISDR (B0)	LW Lunar Intrusion Detected (1) MW Lunar Intrusion Detected (1) SW Lunar Intrusion Detected (1)	V1
Lunar Intrusion Reverse	QF2_CRISDR (B1)		
SDR Overall Quality	QF3_CRISDR (B0-B1)	LW L1B Quality (2) MW L1B Quality (2) SW L1B Quality (2)	B3
Invalid Geolocation	QF3_CRISDR (B2)	Geo Quality (1) (TBD)	B3
Invalid Radiometric Calibration	QF3_CRISDR (B3-B4)	LW Radiometric Calibration Quality (2) MW Radiometric Calibration Quality (2) SW Radiometric Calibration Quality (2)	V1
Invalid Spectral Calibration	QF3_CRISDR (B5-B6)	LW Spectral Calibration Quality (2) MW Spectral Calibration Quality (2) SW Spectral Calibration Quality (2)	V1
SDR FCE Correction Failed	QF3_CRISDR (B7)	FCE Correction Failed (1) Not currently implemented	
Day/Night Indicator	QF4_CRISDR (B0)	Not currently implemented	
Invalid RDR	QF4_CRISDR (B1)	N/A	
FCE Detected	QF4_CRISDR (B2)	FCE Detected (1) Not currently implemented	
Bit Trim Failed	QF4_CRISDR (B3)	Bit Trim (1) *	B3
Imaginary Radiance Anomaly	QF4_CRISDR (B4)	LW Imaginary Radiance Anomaly (1) MW Imaginary Radiance Anomaly (1)	B3

		SW Imaginary Radiance Anomaly (1)	
Attitude and Ephemeris availability	QF1_CRISDRGEO (B0-B1)	Spacecraft Diary Gap (2)**	V1
		Scan Line Missing 8 Sec Sci (1) *	B3
		ISA Degraded (1)	V1
		Observation Time Missing (1)**	V1
		Servo Errors Missing (1)**	V1
		Stale Earth Orientation Data (1)**	V1

\* replicated from ES/11a\_qual

\*\* geolocation flag (in geo\_qualflag variable)

**Table 31: L1B to SDR quality flag comparison, sorted by L1B Quality Flag.**

<b>L1B</b>		<b>RDR/SDR/GEO</b>	
<b>Quality Flag (# of bits)</b>	<b>Init Rel</b>	<b>Quality Flag</b>	<b>Quality Variable (Bit Address)</b>
Geo Quality (1)	Beta 3	Invalid Geolocation	QF3_CRISDR (B2)
Invalid Instrument Temperature (1)	V1	Invalid Instrument Temperature	QF1_SCAN_CRISDR (B3)
Excess Thermal Drift (1)	V1	Excess Thermal Drift	QF1_SCAN_CRISDR (B4)
FCE Detected (1) Not currently implemented		FCE Detected	QF4_CRISDR (B2)
FCE Correction Failed (1) Not currently implemented		SDR FCE Correction Failed	QF3_CRISDR (B7)
Neon Calibration Quality (1)	V1	Suspect Neon Calibration	QF1_SCAN_CRISDR (B5)
ISA Degraded (1)	V1	N/A	N/A
Bit Trim (1) *	Beta 3	Bit Trim Failed	QF4_CRISDR (B3)
Scan Line Missing 8 Sec Sci (1) *	Beta 3		
LW L1B Quality (2) MW L1B Quality (2) SW L1B Quality (2)	Beta 3	SDR Overall Quality	QF3_CRISDR (B0-B1)
LW Radiometric Calibration Quality (2) MW Radiometric Calibration Quality (2) SW Radiometric Calibration Quality (2)	V1	Invalid Radiometric Calibration	QF3_CRISDR (B3-B4)
LW Spectral Calibration Quality (2) MW Spectral Calibration Quality (2) SW Spectral Calibration Quality (2)	V1	Invalid Spectral Calibration	QF3_CRISDR (B5-B6)
LW Imaginary Radiance Anomaly (1) MW Imaginary Radiance Anomaly (1) SW Imaginary Radiance Anomaly (1)	Beta 3	Imaginary Radiance Anomaly	QF4_CRISDR (B4)
LW Lunar Intrusion Detected (1) MW Lunar Intrusion Detected (1) SW Lunar Intrusion Detected (1)	V1	Lunar Intrusion Forward	QF2_CRISDR (B0)
		Lunar Intrusion Reverse	QF2_CRISDR (B1)
Not currently implemented		Lambda Monitored Quality	QF1_SCAN_CRISDR (B2)
Not currently implemented		Timing Sequence Error	QF1_SCAN_CRISDR (B1)
LW ES Missing (1) * MW ES Missing (1) * SW ES Missing (1) *	Beta 3	Data Gap	QF1_SCAN_CRISDR (B0)
N/A		Invalid RDR	QF4_CRISDR (B1)
Not currently implemented		Day/Night Indicator	QF4_CRISDR (B0)

\* replicated from ES/l1a\_qual

**Table 32: L1B geolocation to SDR quality flag comparison.**

<b>L1B</b>		<b>RDR/SDR/GEO</b>	
<b>Quality Flag (# of bits)</b>	<b>Init Rel</b>	<b>Quality Flag</b>	<b>Quality Variable (Bit Address)</b>
Observation Time Missing (1)	V1	N/A	N/A
Servo Errors Missing (1)	V1	N/A	N/A
Spacecraft Diary Gap (2)	V1	Attitude and Ephemeris availability	QF1_CRISSDRGeo (B0-B1)
Stale Earth Orientation Data (1)	V1	N/A	N/A