NASA Heliophysics Division Calibration and Measurement Algorithms Document Template

Calibration and Measurement Algorithms Document Template

1. Template Instructions
   1.1. The Calibration and Measurement Algorithms Document (CMAD) is the interface document between NASA, the mission systems, and the instrument teams that describes the overall concept for calibrating a specific instrument. This document describes how the mission will conduct preflight and inflight calibrations and details the algorithms for converting instrument signals to scientific measurements. The CMAD will also provide a summary of the scientific goals of the investigation and describe the instrumentation
   1.2. The CMAD shall be developed and available according to the same timeline for the Project Data Management Plan (PDMP), or at the discretion of the Program Scientist. Typically, the CMAD will be available in draft form at the time of Preliminary Design Review for the mission and signed at the time of the Operational Readiness Review. The CMAD may be revised at the Flight Readiness Review/Mission Readiness Review as well as the next Senior Review or at the discretion of the Program Scientist.
   1.3. This template contains representative tables with example content.

2. Calibration and Measurement Algorithms Document Title Page
3. Signature Page

[*Project Name*] Calibration and Measurement Algorithms Document
[*short title or acronym*]

Project Manager	Date
Project Scientist <*for Directed missions*>	Date
Principal Investigator <*for each instrument*>	Date
Instrument Scientist <*if applicable*>	Date

By signing this document, signatories are certifying that the content herein is acceptable direction for managing the project's data and that they will ensure its implementation by those over whom they have authority.

Copy to: HQ Program Scientist
Archive Project Scientist

4. Change History Log

Revision	Effective Date	Description of Changes
Baseline	mm/dd/yyyy	Original
Revision 1	mm/dd/yyyy	<<Include brief overview of any changes made from 'Original version' to this version by section.>>

5. Calibration and Measurement Algorithms Document Content

[Project Name] CALIBRATION AND MEASUREMENT ALGORITHMS DOCUMENT
[short title or acronym]

1. Scope

This section provides a brief description of the specific aspects of instrument calibration covered by this plan

2. Related Documentations

2.1 Applicable Documents

This section identifies (in tabular format) any other project/mission documentation with higher-level guiding requirements or that provide more detail or context. See example below:

Title	Document Number	Publication Date
EVE Science Requirements Document	EVE-T-11001	18 Nov 2005
EVE Systems Requirements Document	VE-T-11002	16 Jun 2006
EVE Science Data Processing Requirements Document	EVE-S-11314	27 April 2006 [Baseline] 15 Jun 2007 [Revision 1]
EVE Performance Verification Plan	EVE-T-13010	
EVE Solar Emission Line Measurement List	EVE-T-11004	
…		

3. Overview and Background Information

This section briefly summarizes the instrument and its objectives to provide its role and importance within the context of the SMD portfolio.

3.1 Science Objectives

This section describes the science objective(s) of the mission.

3.2 <Instrument name> Instrument Description

3.2.1 Measurement Concept

This subsection summarizes the instrument parameters and associated requirements that must be fulfilled to attain mission success. The types of measurements or observations made as well as how the instrument executes those measurements are described. A table like the example below may be included.

Parameter	Minimum Success Requirements	Comprehensive Success Criteria	Design Goals
λ Range	6 or more emissions to specify the chromosphere, TR, and corona, plus the He II 30.4 nm emission	0.1-105 nm	0.1-105 nm
Δλ Resolution	0.2 nm for these lines	0.1 nm for 18 or more emissions to specify the chromosphere, TR, and corona, and 5 nm or better elsewhere	0.1 nm
Time Cadence	60 sec	< 20 sec	10 sec
Accuracy	35% for 5 nm intervals and daily average	25% for 5 nm intervals and daily average	20% for brighter emissions
Mission Life	3 years	5 years	5 years, long enough to sample low and high solar activity

3.2.2 Instrument Subsystem Descriptions

3.2.2.1 <Subsystem name>

This section (and any necessary subsections) provides details on the susbsystems or components responsible for directly obtaining the measurements or observations pertinent to the instrument. Details on the layout and design of the subsystem, examples of expected measurements, and interactions with any other subsystems should be provided.

3.2.3 <Instrument name> Heritage

3.2.3.1 Instrument Heritage

This section summarizes any heritage from past missions for the instrument and its subsystems or components (e.g., detectors, cameras, signal processing electronics).

3.2.3.2 Algorithm and Calibration Heritage

This section identifies any heritage from past missions for the algorithms used to process/convert detector signals into the measurable quantities needed to meet the science requirements.

4. <Instrument name> Calibration Plan

4.1 Overall Calibration Scheme

This section summarizes the calibration philosophy and identifies any heritage tied to the calibration schemes of related missions and instruments.

4.2 Pre-flight Calibration Plans

This section details how unit level (e.g., individual detectors) and system level (e.g., instrument subsystem) are tested and calibrated to verify that they will meet the expected performance parameters prior to placement (i.e., launch) into the relevant operational environment.

4.2.1 <Subsystem name> Pre-flight Calibrations

This subsection describes the specific testing and examination methods used to characterize the build and performance of each subsystem or component (e.g., diffraction gratings, CCDs)

4.2.2 Instrument Description

This subsection describes the primary scientific objectives of the instrument, its hardware, physical configuration, etc. This subsection lists the major elements of the instrument and provides a schematic of the conceptual design. Known issues due to external factors that could impact any long-term comparison or analysis (e.g., optical distortion due to gradual radiation degradation) should be captured.

4.3 In-flight Tracking of Short-Term Changes

This section identifies any potential factors in the operational environment (e.g., radiation, temperature fluctuations, exposure-related degradation) that could eventually result in off-nominal changes in the instrument's measurements. The methods used to identify and track these changes are also described.

4.4 Long-term Absolute Calibration Tracking (Re-Calibration)

This section identifies any periodic re-calibration to absolute standards to be used over the course of the mission.

4.5 Validation

This describes the use of any other measurements (via complementary instruments) or models to validate the instrument's measurements.

5. <Instrument name> Measurement Algorithm Description

5.1 Theoretical basis

This section provides context and background information for the quantity or phenomenon being detected. The algorithms and techniques used are described, with pertinent equations and references included. Logical groupings (i.e., separate subsections) may be used for clarity of the concepts introduced.

5.2 Conversion of Instrument Signals to <Measurable units>

5.2.1 Measurement Equations

This subsection (one for each subsystem) describes the equations used to derive measurable quantities from raw instrument signals.

5.3 Signal Estimates and Error Analyses for Subsystems

5.3.1 <Subsystem name> Signal Estimates and Error Analysis

This subsection (one for each subsystem) provides details on the expected signal values for the instrument subsystem. This can be expressed graphically. A table summarizing the "acceptable" values—that is, the minimum values that would meet mission requirements and be deemed still usable to meet the mission's science objectives—as well as the estimated uncertainty in the measured values and the error budget allowable for each parameter may be included. The equations for determining the uncertainties should be included.

5.4 Preflight Calibration Algorithms

This section describes the process for calibrating the instrument prior to shipment and/or installation. It may refer back to measurement equations detailed earlier in the document and identify the specific variables being solved for in order to determine proper calibration.

Appendix A. List of Variable Definitions