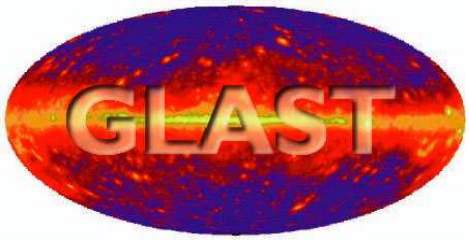

LAT Flight Software

GRB Manual

Type: User Manual
Version: V0-0-1
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Created: 28 February 2007
Updated: 16 March 2007
Printed: 16 March 2007

Manual for the GRB Algorithm Framework Package

Contents

0 Introduction

The GRB package software consists of a framework of function callbacks that allows an external application to drive the GRB detection algorithm. The package is also intended to house any number of implementations of the GRB detection algorithm.

0.0 Overview

The function of the GRB package is to define a driver framework in which to execute the GRB detection algorithm. There are several classes of routines that the GRB algorithm requires to report communication detection status, coordinate information, and event data summaries. The GRB algorithm processes GRB photon candidate events, as well as GBM burst alert telecommand data.

1 Package Description

This section describes the CMX package layout for GRB.

1.0 Shareables

GRB exports the following shareable libraries.

Module	Description
libgrb.o	Default GRB detection algorithm

1.1 Dependencies

GRB is dependent on the following FSW packages:

Package	Description
MSG	Message reporting
FBS	File basic services
EDS	Event delivery services
EDS_DB	Event delivery database
PBS	Package basic OS services
VXW	Operating system
GRB_DB	GRB database
CDM	Database services
EFC	Event filter code

2 Implementation

This section provides an overview of the GRB software implementation.

2.0 Task Descriptions

The GRB framework and algorithm software executes in the context of the calling task. This task is currently provided by the LPA package, which instantiates the GRB framework, and facilitates communication between the algorithm, other FSW packages, the GBM, and the spacecraft.

A portion of the GRB detection algorithm executes on the EPUs, as an “afterburner” to the gamma filter. The product of this post-processor is exported to the SIU, and intercepted by the GRB algorithm software.

The primary functions of the GRB package are:

- Define the framework for communication with the GRB algorithm
- Process GRB photon candidate summary messages from EPUs
- Resolve attitude coordinates and timing information of candidate photon events
- Populate GRB alert messages for delivery to external clients
- Formulate spacecraft repointing requests

GRB filter software executes in the context of the LCBD event task on each EPU and performs the following primary actions:

- Post process events passed in from event handlers
- Identify GRB photon candidates
- Create GRB summary messages for delivery to the GRB algorithm executing on the SIU

2.1 GRB Framework

The GRB framework consists of a set of function callbacks that allow communications between the GRB algorithm and a driver application. In this instance, the driving application is LPA, the LAT physics acquisition software.

2.1.0 GRB Callback Classes

The following types of callback routines are required by the GRB framework.

- GRB Alerts
- Attitude Transformations
- Event Time Resolution

2.2 GRB Event Handler

The GRB event handler executing on the EPUs acts as a post-processor for event handlers. It is a specialized handler installed by LPA, and operates as an output processor in the EDS framework. If an event handler posts an event to the GRB output stream, the GRB event handler will evaluate the event and decide whether or not it should be nominated as a GRB photon event. When this occurs, the event content is summarized and placed into a summary structure that is periodically delivered to the GRB algorithm on the SIU.

2.2.0 GRB Event Summary Messages

Upon encountering a GRB photon candidate, the GRB event handler summarizes the following event information:

Name	Description
Node	CPU node ID originating the event
ID	The event ID
Instance	The event instance
PPS	The GEM 1-PPS timestamp associated with the event
TRG	Event timestamp
CX	Event X coordinate
CY	Event Y coordinate
CZ	Event Z coordinate
Energy	Event energy

This information is buffered for a configurable amount of events, and forwarded to the GRB algorithm on the SIU. The GRB algorithm uses this data to resolve the disposition and location of a GRB.

2.3 GRB Simulations

To aid in diagnostics and testing of LAT, SC, and GBM interfaces, a few GRB simulations have been implemented. As a default, all LAT detected GRBs use the same GRB coordinates in alert telemetry and GBM telecommand messages. All time values represent the time at which the message was constructed. Remaining fixed values are specified in the table below.

Description	Value
First Location RA	213.9 degrees
First Location DEC	19.2 degrees
First Error RA	0.8333 degrees = 50 arcmin
First Error DEC	1.1667 degrees = 70 arcmin
GRB Classification	1 - GRB Candidate. Closeout messages resulting from LPASTOP or timeout use 0 – GRB Not a candidate.
Gamma count 0	0xfafa
Gamma count 1	0xfbfb, except when running FES simulation, then count of events in EPU summary which triggered alert.
Gamma count 2	0xfcfc
Gamma count 3	0xfdfd
Trigger Parameters 0 -9	1 – 10, repsectively

2.3.0 Commanded LAT GRB Detection

A simulated LAT detected GRB can be initiated by issuing the LPASETGRB telecommand with the simulation parameters set. 60 seconds after an LPASTART telecommand is successfully processed, the GRB simulation will start. There are 2 detection simulation modes available. For Mode 0, the simulation will declare a suspected GRB 60 seconds after the start of a physics run. At fixed intervals, GRB will issue alert telecommand and telemetry packets and transition from GRB suspect, to GRB confirm, and finally to GRB closeout. For Mode 1, GRB suspected is entered, followed by a GRB closeout.

During a LAT detected GRB simulation, GBM telecommands are acknowledged, but any repoint requests are not honored. If an LPASTOP command is issued, a GRB closeout action will be immediately executed.

Here are a few key points concerning this simulation:

- If the simulation mode is enabled, a LAT detected GRB will be initiated 60 seconds after the LPASTART successfully completes.

- Each LPASETGRB command will activate a single LAT detected GRB simulation ONLY for the subsequent physics run. All remaining physics runs will have the simulation disabled.
- While in simulation mode, all GBM telecommands will be ignored by the GRB software. Note that LIM will still issue acknowledgement of receipt of any such commands.
- While in simulation mode, all EPU GRB summary packets will be discarded, regardless of the enable setting.
- Issuing the LPASTOP command will immediately end the active LAT detected GRB simulation by executing GRB closeout.

GRB Mode 1 Simulation

Action	Description
GRB Suspect	Occurs 60 seconds after LPASTART completion. ALRTTRG telemetry 0x341 is issued, and GFSWLATTRIGGER is send to the GBM. LIM enters ARR mode GRB0 state.
GRB Update	10 ALRTUPDATE telemetry packets are issued at configurable fixed intervals.
GRB Confirm	GRB detection is confirmed, a repoint request issued to SC, via LIM, with a configurable dwell time. The repoint request can be disabled by using repoint dwell value of 0. LIM transitions to GRB1 state.
GRB Closeout	At a fixed interval after GRB confirm is executed, GRB detection is closed out. ALRTCLOSE 0x343 telemetry issued, GFSWLATCLOSEOUT telecommand is sent to the GBM, and LIM transitions to GRB2 state. At the completion of the repoint dwell, LIM will transition for ARR to Normal Physics.

GRB Mode 2 Simulation

Action	Description
GRB Suspect	Occurs 60 seconds after LPASTART completion. ALRTTRG telemetry 0x341 is issued, and GFSWLATTRIGGER is send to the GBM. LIM enters ARR mode GRB0 state.
GRB Closeout	At a fixed interval after GRB confirm is executed, GRB detection is closed out. ALRTCLOSE 0x343 telemetry issued, GFSWLATCLOSEOUT telecommand is sent to the GBM, and LIM transitions to GRB2 state. At the completion of the repoint dwell, LIM will transition from ARR to Normal Physics.

2.3.0.0 LPASETGRB Parameter Settings

This command enables or disables LPA forwarding of messages from the EPU and the GBM, to the GRB detection algorithm. A value of 0 indicates a DISABLED forwarding state, and a value of 1 indicates an ENABLED forwarding state.

The LPAGRBGBMSTATE parameter controls forwarding of GBM telecommands received by the LPA master task on the SIU, to the GRB detection algorithm.

The LPAGRBEPUSTATE parameter controls forwarding of EPU event summary packets received by the LPA master task on the SIU, to the GRB detection algorithm.

The remaining parameters configure a LAT detected GRB simulation. This feature is used for GRB interface diagnostics and testing.

Parameter	Description
LPAGRBGBMSTATE	Enable state of GBM command forwarding
LPAGRBEPUSTATE	Enable state of EPU summary packet forwarding
LPAGRBSIMMODE	0: Mode 0- simulation is disabled. 1: Mode 1 - execute all available detection states: suspect->(update*10)->confirm->closeout. 2: Mode 2 - execute only suspect->closeout.
LPAGRBSIMINTV	time interval in seconds between the GRB detection states for the simulation mode
LPAGRBSIMRPTSEC	GRB repoint request in seconds for the simulation mode. A value of 0 will disable sending of a repoint request

2.3.1 Event Driven LAT GRB Detection

A counting simulation is available that tests the full communications path from the EPUs to the SIU GRB software. The simulation will accept events posted to the LPA GRB output stream which have energy values above the configurable threshold. These events are summarized, and sent to the SIU GRB simulation. The SIU GRB simulation will count the number of GRB summary packets and transition, in order, through the GRB detection states.

Event summary packet counts are reset at the start of each physics run. The rate at which the GRB state transition occurs is dependent on the FES trigger rate, and the event handler filter criteria.

This simulation is designed to be used only on the LAT testbed, in conjunction with the FES. This feature is only available in the default simulation implementation and will not be included in flight functionality.

Event Summary Count	Action	Description

Event Summary Count	Action	Description
0 - 63	GRB inactive	No action
64	GRB Suspect	GRB is suspected. ALRTTRG telemetry 0x341 is issued, and GFSWLATTRIGGER is send to the GBM. LIM enters ARR mode GRB0 state.
127 - 136	GRB Update	GRB is updated. ALRTUPDATE telemetry packets are issued.
138	GRB Confirm	GRB detection is confirmed, a repoint request issued to SC, via LIM, with the pre - configured dwell time. The repoint request can be disabled by using repoint dwell value of 0. LIM transitions to GRB1 state.
192	GRB Closeout	GRB detection is closed out. ALRTCLOSE 0x343 telemetry issued, GFSWLATCLOSEOUT telecommand is sent to the GBM, and LIM transitions to GRB2 state. At the completion of the repoint dwell, LIM will transition for ARR to Normal Physics.
192 - 256	GRB inactive	Simulation counter resets to 0 at 256.

2.3.2 GBM GRB Detection

Using the GBM interrupt signal, and the GBM burst alert telecommand sequence, the GRB simulation software will respond to a GBM detected GRB. If a LAT detected GRB is not in progress, the GRB software will transition through the GRB states, issuing the proper command and telemetry packets. LIM provides confirmation of each of the following steps in the LIM state telemetry packets.

This feature is only available in the default simulation implementation and will not be included in flight functionality.

Action	Description
GBM Interrupt Signal	LIM transitions to ARR mode, GRB0 state.

Action	Description
GBM LFSWCALCINFO Telecommand	If not already in GRB0 state, LIM transitions to GRB0 state.
GBM LFSWCREPREC Telecommand	GRB detection is confirmed. If the command requested a repoint, a repoint request is issued to SC, via LIM, with a configurable dwell time. The repoint request can be disabled by using repoint dwell value of 0. LIM transitions to GRB1 state.
GBM LFSWCLOSEOUT Telecommand	GRB detection is closed out. LIM transitions to GRB2 state. At the completion of the repoint dwell, LIM will transition from ARR to Normal Physics.

2.4 GRB Detection Algorithm

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2.5 GRB Alert Reporting

Upon encountering one of several GRB detection states, the GRB algorithm will issue alert messages destined for LPA, LIM, the spacecraft, or the GBM. The content of these messages is defined in the LAT to GBM ICD. The formatting of these messages is handled by the LPA software.

2.6 GBM Message Handling

Upon detection of a GRB by the GBM, a series of telecommand packets will be forwarded to the GRB detection algorithm. The algorithm will analyze the data contained in these packets, and decide on a course of action. If the GRB algorithm confirms that the GRB is genuine, it will proceed with the alert process. This could result in a LAT mode change, reconfiguration of event handling software, and issuing of a spacecraft repoint request.

3 Configuration

This section describes the process of configuration for the GRB package. GRB is configured by default at initialization by reading in CDM database files from the file system. Further configuration is accomplished by processing telecommands and applying the settings dynamically.

3.0 GRB_DB Configuration

The GRB configuration parameters are defined in a CDM database file. The schema for these files resides in the GRB_DB package. There can be multiple instances of the GRB_DB schema. The database instances are identified by their instance IDs. These instance IDs are to be used in telecommand parameters when accessing or updating the configuration values. Please refer to GRB_DB_schema.h in the GRB_DB package.

Parameter	Description
repoint_time	The default GRB repoint request time in seconds. This is the default time requested by GRB to the spacecraft to remain in a repoint.
photon_cnt	GRB photon count threshold. TBD
photon_energy	GRB energy threshold in Mev. Photons with energies above this threshold will be evaluated as candidate events.
photon_timeout	GRB time window in seconds. TBD
close_timeout	The GRB inactivity timeout in seconds. Sets the elapsed time for which no GRB activity, after which the GRB closeout action is executed.
gbm_timeout	The GBM inactivity timeout in seconds. Sets the elapsed time for which no GBM telecommands, after which the GRB closeout action is executed.

4 Programming

The GRB package provides several public control interfaces that are used to initialize and start the software.

4.0 GRB Control Routines

The following callbacks are exported by the GRB packages for initialization and control of the GRB detection algorithm.

Callback	Description
GRB_sizeOfAlgCtl	Returns the size of a GRB algorithm control block
GRB_initAlgCtl	Initializes a pre-allocated GRB control block
GRB_registersCbs	Routine to seed the algorithm output callback routines
GRB_reset	Resets the GRB algoritm
GRB_handleEvent	Callback for processing EPU photon candidate event summaries
GRB_handleGbmInt	Callback for processing a GBM interrupt message from LIM
GRB_handleGbmCalc	Callback for handling a GBM GRB Calculations command
GRB_handleGbmRpt	Callback for handling a GBM GRB Repoint Recommendation command
GRB_handleGbmClose	Callback for handling a GBM GRB Closeout command

Refer to GRB.h for the full callback signature for each function

4.1 GRB Callback Routines

The following callbacks must be registered for processing and reporting of GRBs by the GRB algorithm

Callback	Description
GRB_suspectCb	Callback for notification of a suspected GRB
GRB_updateCb	Callback for updates to a suspected GRB
GRB_confirmCb	Callback for confirmation of a suspected GRB
GRB_closeoutCb	Callback for closeout of the confirmed GRB
GRB_attXformJCb	Callback for transformation of Cartesian vectors to J2000 vectors
GRB_attXformSCb	Callback for transformation of J2000 vectors to RA,DEC spherical coodinates
GRB_timeLookupCb	Callback to return wall clock time using GEM strobe and clock input

Refer to GRB.h for the full callback signature for each function

4.2 GRB Event Handler Processor

The following routines are exported for initialization and control of the GRB event handler processor by an LPA EPU slave.

Callback	Description
GRB_sizeOfWriteCtl	Returns the size of a GRB event processor control block
GRB_initWriteCtl	Initializes a pre-allocated a GRB event processor control block
GRB_initSummary	Initializes a pre-allocated GRB photon summary structure
GRB_getSummarySize	Returns the current size of a populated GRB photon summary structure
GRB_getPhotonCount	Returns the count of events in a GRB photon summary structure
GRB_writePhoton	Routine to analyze and write a photon to a summary block

5 Command and Telemetry

This section covers the command and telemetry interfaces of the GRB package.

5.0 GRB Telecommands

GRB generates command content defined for the GBM, and delivered by LPA. For details on structure and content of these packets, refer to the LAT Telecommand and Telemetry document, and the LAT GBM Interface Control document.

Command	APID	Function Code	Description
LFSWCALCINFO	0x660	1	GBM GRB Calculated Information
LFSWCREPREC	0x660	2	GBM GRB Candidate Repoint Recommendation
LFSWCLOSEOUT	0x660	3	GBM GRB Closeout
GFSWLATTRIGGER	0x6f1	1	LAT Detected GRB Alert
GFSWLATCLOSEOUT	0x6f1	3	LAT Detected GRB Closeout

5.1 Telemetry

This section describes the telemetry interface for the GRB package. GRB generates content for alert telemetry packets, which are delivered by LPA. For details on the size and structure of these packets, refer to the LAT Telecommand and Telemetry document, and the LAT GBM Interface Control document.

5.1.0 Packet Descriptions

Name	APID	Description
ALRTTRG	0x341	GRB Trigger Alert Telemetry
ALRTUPDATE	0x341	GRB Update Alert Telemetry
ALRTCLOSE	0x343	GRB Closeout Alert Telemetry