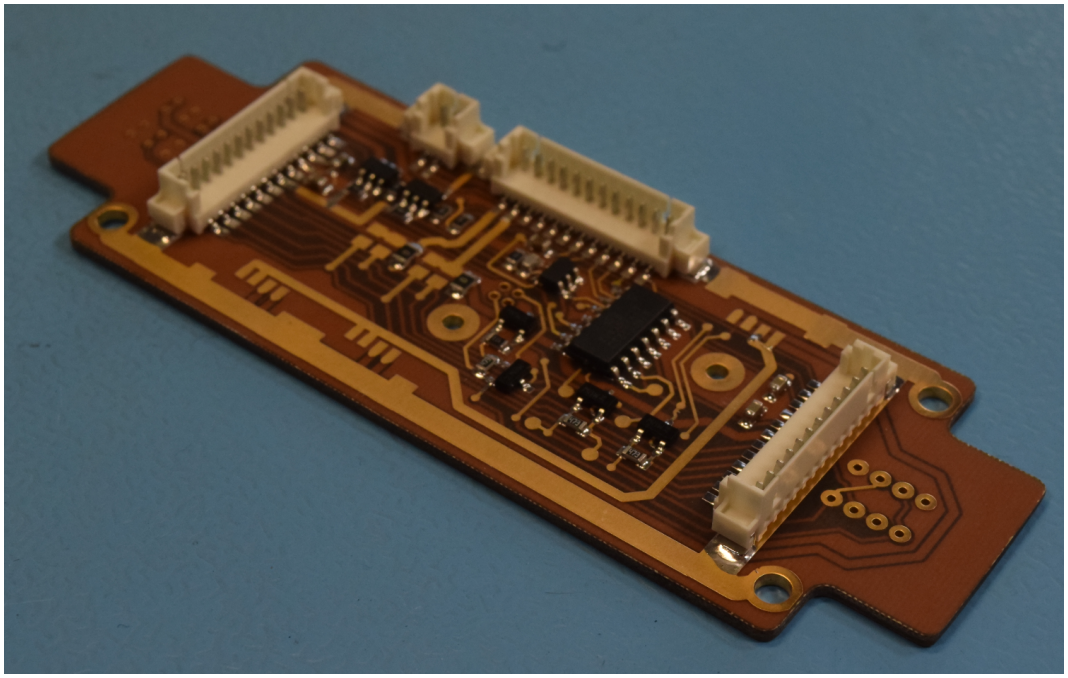

NanoUtil
Interstage GSSB

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Release 3.0.0

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Confidentiality Notice

Table of Contents

1. Introduction

The GSSB (GomSpace Sensor Bus) interstage is used for Antenna deployment and for reading sensors embedded on GomSpace solar panels. The interface for the interstage uses GSSB which makes it easy to connect multiple devices on the same bus as it supplies both power and data. The interstage also have support for mounting a GomSpace NanoSense FSS (Fine Sun Sensor) and a connector to give the FSS access to the GSSB bus.

2. Operation Guide

The following guide is intended to be used together with the libgssb software library. If you don't have libgssb you should still read the operation guide to understand how the interstage functions and you will need to implement the I2C commands as described in *Communication*.

2.1 Reading Sensors

When connected to a solar panel the interstage can measure panel temperature and read the coarse sun sensor with the command `rgssb interstage sensors`. (NOTE: if connected via gosh you can also use the gssb command instead of rgssb) The output looks like the example below

Sensor readings:

```
Panel Temperature: 26
Coarse Sunsensor: 11
```

The panel temperature is in degrees Celsius and the coarse sun sensor value is the voltage measured from the sensor.

2.2 Antenna Deployment System

The antenna deployment algorithm is responsible for deploying the antennas by switching on the thermal knifes thereby cutting the wire holding the antenna down. The interstages have two thermal knifes for redundancy but we only want one of them to cut at a time. This to avoid the wire detaching and drifting away from the satellite thereby creating unessesary space debris. All the logic for antenna deployment is handled by the interstage firmware, but it is important to have a basic understanding of how it works to be able to understand the configuration variables.

In figure Fig.2.1 a state diagram of the interstage firmware is shown. On boot the interstage starts in the *init* state and then reads its configuration to see whether to enter the *not armed* state or *the armed for manual deploy* state. The configuration is described in *Auto deploy*. When in the *armed for auto deploy* state the interstage will check if the time since boot is greater than the value stored in the configuration variable *delay till deploy*. If this the case it will transition to the *deploying* state where it will try and cut the antenna hold-down wire with the thermal knives.

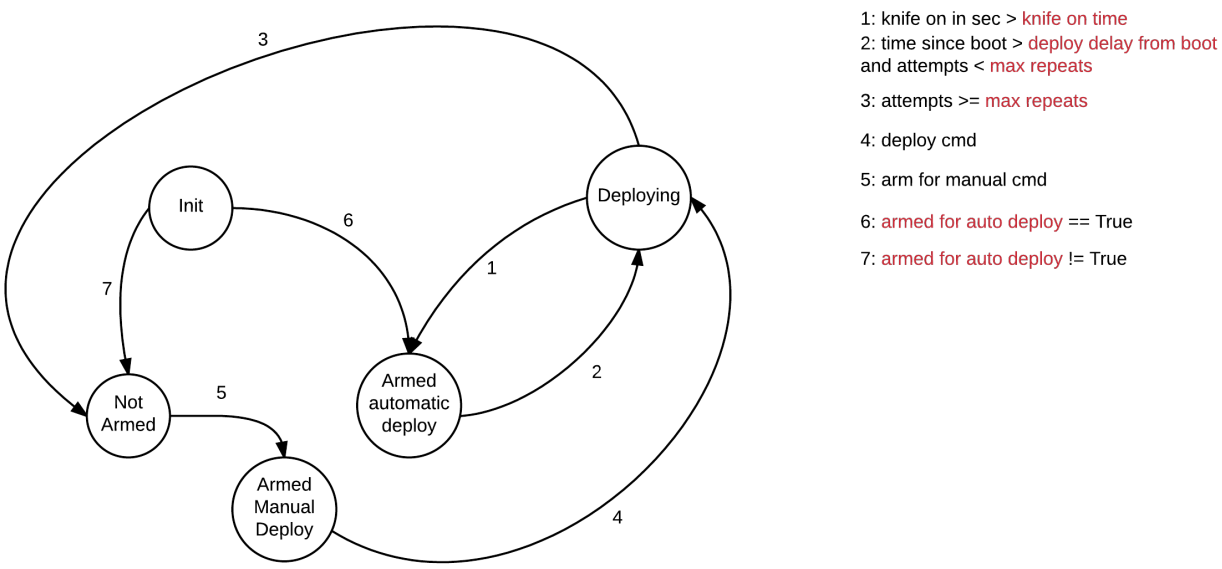

Fig. 2.1: State diagram of antenna deployment logic.

In the deploying state a number of parameters is used to configure e.g., how long to burn and whether multiple attempts with a variable delay between should be performed. The parameters are described in *Configuration*

2.2.1 Viewing the status

It is possible to verify the status of the interstage with the command `rgssb interstage status`. The normal response for this command looks like the example below.

status:

```
Current state:                          Not armed
Antenna state:                          Not released

Delay till deploy:                      2000 s
Number of attempts since boot:          0
Knife that will be use in next deploy:  1
Total deploy attempts                   0
Reboot deploy cnt:                      20
```

Current state This can be *Not armed*, *Armed for manual deploy*, *Armed for auto deploy* or *Deploying*.

Antenna state This can be *Not released* or *Released*.

Delay till deploy Number of seconds until the antenna is deployed in state *Armed for auto deploy* otherwise it displays the configured delay.

Number of attempts since boot Number of deploy attempts since boot.

Knife that will be used in next deploy Can be zero or one and alternates with each deployment attempt.

Total deploy attempts Total number of deployment attempts across reboots.

Reboot deploy cnt Number of reboots left before the deployment is done at power on.

2.2.2 Configuration

Warning: Setting configuration wrong can damage the resistors used on the thermal knifes.

The interstages are configured with the command `rgssb interstage conf` and if no arguments are supplied the current configuration is fetched and displayed. Below is the command shown with the usage description.

```
rgssb interstage conf
usage: conf <knife ON [ms]> <increment [ms]> <auto deploy delay [s]> <max repeat [#]>
<repeat time [s]> <switch polarity> <deploy boot cnt>
```

Knife ON Thermal knife on time in ms. Default value is 1500 ms.

Increment For each deployment attempt the knife ON time will be increased by this value.

Auto deploy delay Delay in seconds from power-on before doing an antenna deployment in state *Armed for auto deploy*.

Max repeat Number of deployment attempts. When the antenna is detected as released no more attempts will be made.

Repeat time Number of seconds between deployment attempts.

Deploy boot cnt If *Armed for auto deploy* is set, deployment will be performed at boot time after this number of reboots.

When getting the configuration the output should look like the following.

configuration:

```
Deploy mode:              NOT ARMED
Deploy delay from boot:   2000 s

-------- Deploy algorithm config ----------
Knife on time:            1500 ms
Increment:                500 ms
Max repeats:              4
Repeat time:              10 s
Switch polarity:          0
Settings locked:          1
```

2.2.3 Auto deploy

When the deployment algoritm is correct configured the command `rgssb interstage arm` can be used to set the armed auto to true so the antennas will be deployed according to the configuration. As seen below the command will arm the interstage for deployment by running `rgssb interstage arm 1`. Replacing the `1` with `0` will disarm deployment.

```
rgssb interstage arm
usage: <1 = arm, 0 = disarm>
```

2.2.4 Manual Deploy

It is also possible to deploy the antenna manually by first arming the interstage for manual deployment by calling the command `rgssb interstage state` with `1` as argument. The current state of the interstage can be verified with the command `rgssb interstage status` and if it shows *Armed for manual deploy* the antennas can be deployed with the command `rgssb interstage deploy`

```
rgssb interstage state
usage: <State 0=NOT ARMED, 1=ARMED MANUAL>
```

3. Communication

The Interstage uses I2C as configuration and commanding interface and in the table below all commands for the interstage are listed.

Command name	Command	Description
SetI2CAddr	0x06	Give the interstage a new I2C addr
CommitI2CAddr	0x07	Store the current addr to persistant memory
GetVersion	0x08	Get firmware version
GetUUID	0x0D	Get UUID
GetReleaseStatus	0x09	Get release status
GetTemperature	0x0A	Get panel temperature
GetPanelSunSens	0x0C	Read coarse sun sensor on panel
ManualDeploy	0x0B	Manual deploy antenna
GetBurnSettings1	0x0E	Get configuration for deploy algorithm
GetBurnSettings2	0x0F	Get configuration for switch and arm
SetBurnSettings1	0x10	Set configuration for deploy algorithm
SetBurnSettings2	0x11	Set configuration for switch polarity
SetBurnSettings3	0x12	Set configuration for armed
GetCounters	0x15	Get status
UnlockSettings	0x14	Makes it possible to change critical configurations
Reboot	0x16	Reboots the interstage
ChangeState	0x17	Change the state. Can be used for manual deploy

3.1 Commands

In general all numbers that are more that one byte is send LSB first, but the endian is also noted in the comment describing the data.

- S = Start condition
- A = Device address
- W = Write
- R = Read
- RS = Repeated start
- P = Stop condition

3.1.1 SetI2CAddr

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x06	SetI2CAddr
W	New Addr	
W	0x00	
RS		
A+R	ADDR | R	
R	B1	Ignore
P		

3.1.2 CommitI2CAddr

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x07	CommitI2CAddr
W	0x33	
RS		
A+R	ADDR | R	
R	B1	Ignore
P		

3.1.3 GetVersion

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x08	GetVersion
RS		
A+R	ADDR | R	
R	B0	First char in version
R	B1	
R	B2	
R	B3	
R	B4	
R	B5	
R	B6	Last char in version
P		

3.1.4 GetUUID

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x0D	GetUUID
RS		
A+R	ADDR | R	
R	B1	MSB
R	B2	
R	B3	
R	B4	LSB
P		

3.1.5 GetReleaseStatus

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x09	GetReleaseStatus
RS		
A+R	ADDR | R	
R	B1	1 = released, 0 = not released
P		

3.1.6 GetTemperature

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x0A	GetTemperature
RS		
A+R	ADDR | R	
R	B1	LSB
R	B2	MSB
P		

signed 11 bit right aligned temperature, with an LSB equal to 0.25 C. Note that the result it not sign extended.

3.1.7 GetPanelSunSens

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x0C	GetPanelSunSens
RS		
A+R	ADDR | R	
R	B1	Ignore
R	B2	Ignore
R	B3	Voltage LSB
R	B4	Voltage MSB
P		

16 bit value.

3.1.8 ManualDeploy

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x0B	ManualDeploy
RS		
A+R	ADDR | R	
R	B1	Ignore
P		

3.1.9 GetBurnSettings1

Action	Data	Comment	Unit
S			
A+W	ADDR | W		
W	0x0E	GetBurnSettings1	
RS			
A+R	ADDR | R		
R	B1	Knife on time LSB	ms
R	B2	Knife on time MSB	
R	B3	Increment LSB	ms
R	B4	Increment MSB	
R	B5	Deploy delay LSB	s
R	B6	Deploy delay MSB	
R	B7	Max repeats	#
R	B8	Repeat delay	s
P			

3.1.10 GetBurnSettings2

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x0F	GetBurnSettings2
RS		
A+R	ADDR | R	
R	B1	Switch polarity
R	B2	Mode: 0 = NOT ARMED, 2 = ARMED AUTO
R	B3	Settings locked: 0 = no, 1 = yes
P		

3.1.11 SetBurnSettings1

Action	Data	Comment	Unit
S			
A+W	ADDR | W		
W	0x10	SetBurnSettings1	
W	B1	Knife on time LSB	ms
W	B2	Knife on time MSB	
W	B3	Increment LSB	ms
W	B4	Increment MSB	
W	B5	Deploy delay LSB	s
W	B6	Deploy delay MSB	
W	B7	Max repeats	#
W	B8	Repeat delay	s
RS			
A+R	ADDR | R		
R	B1	Ignore	
P			

3.1.12 SetBurnSettings2

Action	Data	Comment	Unit
S			
A+W	ADDR | W		
W	0x11	SetBurnSettings2	
W	B1	Switch polarity	
W	B2	Reboot deploy count	#
RS			
A+R	ADDR | R		
R	B1	Ignore	
P			

3.1.13 SetBurnSettings3

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x12	SetBurnSettings3
W	B1	0x55
W	B2	0x04 for ARMED AUTO and 0x08 for NOT ARMED
RS		
A+R	ADDR | R	
R	B1	Ignore
P		

3.1.14 GetCounters

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x15	GetCounters
RS		
A+R	ADDR | R	
R	B1	Delay till deploy LSB
R	B2	Delay till deploy MSB
R	B3	Number of burns since boot
R	B4	Knife for next burn
R	B5	State: 1 = Released, 0 = not released
R	B6	Total burns LSB
R	B7	Total burns MSB
R	B8	Reboot deploy cnt
P		

3.1.15 UnlockSettings

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x14	UnlockSettings
W	0x52	
W	0xA7	
W	0xFF	
RS		
A+R	ADDR | R	
R	B1	Ignore
P		

The settings can be locked again by sending any other data pattern that 0x52, 0xA7 and 0xFF in the write command. It is recommended to simply just reboot the interstage after any configuration changes.

3.1.16 Reboot

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x16	Reboot
W	0x5A	
RS		
A+R	ADDR | R	
R	B1	Ignore
P		

3.1.17 ChangeState

Action	Data	Comment
S		
A+W	ADDR | W	
W	0x17	ChangeState
W	B1	0 = NOT ARMED, 1 = ARMED MANUAL
RS		
A+R	ADDR | R	
R	B1	Ignore
P		

4. Disclaimer

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