Hiberband modem

Key features

- Compact, ultra low-power SMT module design
- HiberBand RF signal and baseband processing
- GNSS-based satellite tracking algorithm
- Serial UART-based host processor interface
- On-board HiberBand antenna connector

Functional description

The Hiberband modem is a highly integrated, low-power communications front-end designed for global delivery of sensor data through Hiber's satellite-based HiberBand Low-Power Global Area Network (LPGAN). Designed as a compact, solderable SMT module, it is straightforward to integrate in IoT devices. The application host processor of the IoT device interacts with the Hiberband modem through a UART-based serial interface using a command-response protocol.

The Hiberband modem operates in one of several modes, each with their own distinctive power consumption pattern:

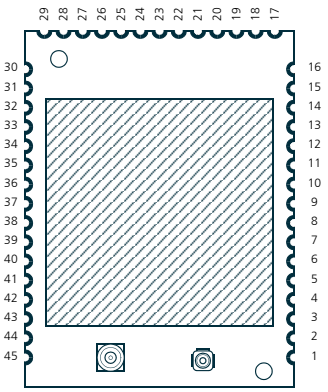
- **Hibernation Mode**: the Hiberband modem will be in this mode most the time; with exception of its internal real-time clock, all systems are shut off.
- **Host Communication Mode**: the Hiberband modem has activated the minimal set of functions needed to receive instructions (e.g. to submit sensor data for transmission) from the application host processor.
- **Geo-location Mode**: the Hiberband modem will autonomously activate its GPS receiver to re-determine its current location to stay synchronized with the HiberBand network of orbiting satellites.
- **HiberBand Listen Mode**: the Hiberband modem has activated its receiver in anticipation of a satellite passing overhead.
- **HiberBand Transmission Mode**: the Hiberband modem has activated its HiberBand transmitter to send sensor data to a satellite in range.

The highly energy-efficient operation of the Hiberband modem is supported by an advanced orbit prediction algorithm that allows it to remain in hibernation mode until one of the HiberBand satellites becomes 'visible' to the LPGAN-enabled IoT device. The optimal communication window is determined by the current geographic location of the device; to keep track of the actual location, the Hiberband modem is equipped with its own GPS receiver. This geo-position information acquired by the Hiberband modem is also available to the IoT device application through the host processor interface.

For the integration details of the Hiberband modem in your IoT device, please refer to the Hiber System Integration Manual.

The information on the internal GPS receiver of the Hiberband modem is provided for reference purposes only; this functionality has been discontinued. The application developer must provide current the geo-location by other means to the modem.

1 Hiberband modem pin-assignment



The pin numbering scheme of the Hiberband modem is shown in figure 1. The module pins are implemented as so-called castellations that allow soldering onto a printed circuit board (PCB) using standard reflow manufacturing techniques.

The Hiberband modem provides one or two on-board antenna connectors (depending on the modem version), one for the HiberBand satellite communication, and one for the GPS antenna (for modem versions with integrated GPS receiver). The antenna details are described in section 2.8.

The pin function assignment is given in table 1.

Figure 1: Hiberband modem pin numbering scheme

Function	Pin name	I/O	Description	Hiberband modem pin numbers
Power	VCC	I	Supply voltage	12, 13, 14, 15, 16, 40, 41, 42
	GND	n/a	Ground	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 23, 26, 29, 43, 44, 45
	VREF	n/a	I/O reference voltage	19
System	SYS_RXD	I	System UART receive	18
	SYS_TXD	O	System UART transmit	17
	WKUP	I	System wake-up	25
	RESET	I	System reset	24
Debug	DBG_RXD	I	Debug UART receive	28
	DBG_TXD	O	Debug UART transmit	27
Reserved	-	n/a	Reserved for internal or future use. Leave unconnected!	11, 21, 22, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39

Table 1: Hiberband modem pin assignment overview

2 Product specifications

Stressing the Hiberband modem above one or more of the ratings listed in the Absolute Maximum Ratings section may cause permanent damage. These are stress ratings only. Operating the Hiberband modem at these or at any conditions other than those specified in the Operating Conditions sections of the specification should be avoided. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Operating conditions ranges define those limits within which the functionality of the device is guaranteed.

Where application information is given, it is advisory only and does not form part of the specification.

Unless otherwise specified, all operating conditions are valid at an ambient operating temperature of +25 °C.

2.1 Absolute maximum ratings

The absolute maximum ratings of the Hiberband modem given in table 2 apply over the operating temperature range (for reasons of brevity the acronym HB is used for 'HiberBand').

Parameter	Description	Condition	Min	Max	Unit
VCC	Supply voltage	DC voltage at VCC pins	-0.15	6.0	V
VREF	Reference voltage	DC voltage at VREF pin	-0.15	6.0	V
WKUP	WKUP input voltage	DC voltage at WKUP pin	-0.15	6.0	V
RESET	RESET input voltage	DC voltage at RESET pin	-0.15	6.0	V
UART	UART input voltages	DC voltage at RXD pins	-0.15	6.0	V
GPS antenna power		Input RF power at GPS antenna		-8	dBm
HB antenna power		Input RF power at HB antenna		-8	dBm
HB antenna ruggedness		Output RF load mismatch at HB antenna		20:1	VSWR
$T_{storage}$	Storage temperature		-40	+125	°C

Table 2: Absolute maximum ratings

The Hiberband modem is not protected against overvoltages or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification as given in the table above must be limited to values within the specified boundaries by using appropriate protection measures.

2.2 Operating temperature ranges

The following temperature ranges are defined for operation of the Hiberband modem:

- **Normal operating temperature**: the Hiberband modem is fully functional and meets all its product specifications across the specified temperature range.
- **Extended operating temperature**: the Hiberband modem is fully functional but RF performance may be degraded.

The environmental operating ranges of the Hiberband modem are defined in table 3.

Parameter	Description	Min	Typ	Max	Unit
$T_{operating}$	Typical operating temperature		+25		°C
	Normal operating temperature	-30		+70	°C
	Extended operating temperature	-40		+85	°C

Table 3: Environmental conditions

2.3 Maximum ESD ratings

The maximum ESD ratings of the Hiberband modem are specified in table 4.

Parameter	Max	Unit	Remarks
ESD sensitivity for all pins except GPS and HB antenna	1000	V	Human Body Model according to JESD22-A114
ESD sensitivity for GPS and HB antenna	1000	V	Human Body Model according to JESD22-A114
ESD immunity for GPS and HB antenna	4000	V	Contact Discharge according to IEC 61000-4-2
	8000	V	Air Discharge according to IEC 61000-4-2

Table 4: ESD ratings

The Hiberband modem is an Electrostatic Sensitive Device (ESD) and requires appropriate precautions when handling.

2.4 Power supply

The power supply characteristics of the Hiberband modem are specified in table 5.

Parameter	Description	Min	Typ	Max	Unit
VCC	Module supply voltage	3.2	3.3	3.9	V
ICC_{peak}	Module peak current consumption through all VCC pins, during transmit burst at maximum power level, with a matched antenna			1.8	A
	Module peak current consumption through all VCC pins, during transmit burst at maximum power level, with a mismatched antenna			2.2	A
VREF	VREF supply voltage (all ranges)	2.7	3.3	4.5	V
I_{REF}	Current consumption for voltage reference		3.0		µA

Table 5: Power supply specifications

2.5 Current consumption

The current consumption figures of the Hiberband modem are specified in table 6.

Mode	Condition	Min	Typ	Max	Unit
Hibernation Mode	VCC = 3.3V; VREF = 3.0V	0.5	5	20	µA
Host Communication Mode	VCC = 3.3V; VREF = 3.0V	10	20	25	mA
Geo-location Mode	VCC = 3.3V; VREF = 3.0V	40	100	120	mA
HiberBand Listen Mode	VCC = 3.3V; VREF = 3.0V; max. receive sensitivity	20	23	30	mA
HiberBand Transmission Mode	VCC = 3.3V; VREF = 3.0V; max. receive sensitivity and output power	100	1250	1500	mA

Table 6: Hiberband modem current consumption

When designing the application power supply, attention must be paid to the transient behaviour of the Hiberband modem current consumption when the transmitter power amplifier is turned on. In particular, the Hiberband transmission burst current consumption (figure 2) pattern needs to be taken into account. For comparison purposes, the current consumption for transmission of a continuous wave is shown in figure 3.

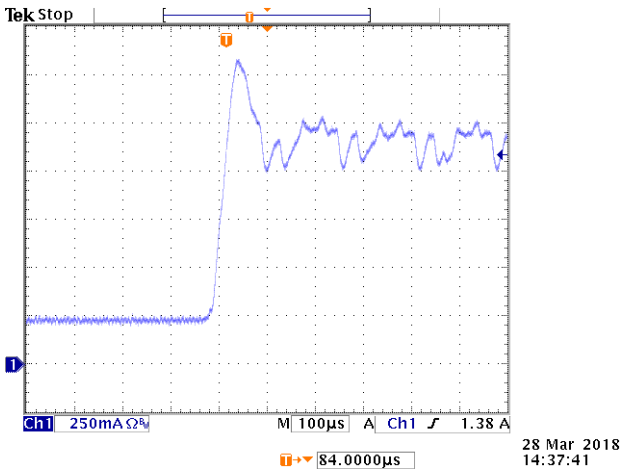


Figure 2: Hiberband transmission burst current consumption

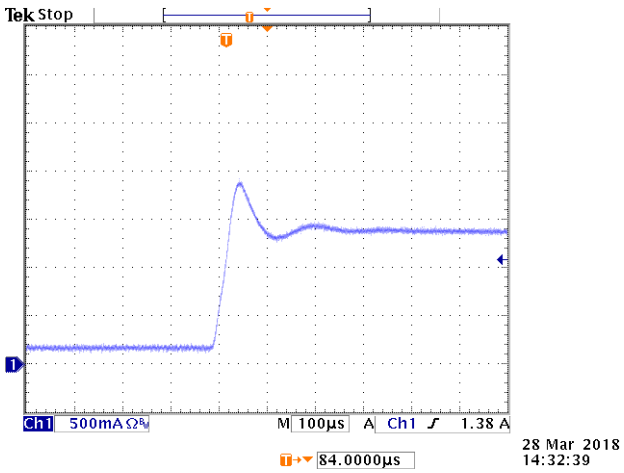


Figure 3: Hiberband modem transmitter current consumption (continuous wave)

Both patterns were measured with +30 dBm transmission power.

2.6 Dynamic performance

The dynamic performance figures of the Hiberband modem are given in table 7.

Parameter	Description	Min	Typ	Max	Unit
T_{GPS}	Duration for a GPS fix	20	30	50	s
T_{listen}	HiberBand listen period	360	420	480	s
$T_{transmit}$	HiberBand transmission burst duration	280	300	500	ms
$UART_{bitrate}$	Default UART bitrate (both UART interfaces)	-	115.2	-	kbps

Table 7: Hiberband modem dynamic performance

2.7 RF performance

The RF performance figures of the Hiberband modem are given in table 8.

Parameter		Min	Max	Unit	Remarks
HiberBand frequency range	Uplink	399.90	400.05	MHz	
	Downlink	400.15	401.00	MHz	Only for Hiberband network management
GPS frequency range	Downlink	1575.42	1575.42	MHz	Only GPS is supported

Table 8: Hiberband modem RF frequency bands

The RF performance figures of the Hiberband modem are given in table 9.

Parameter	Min	Typ	Max	Unit	Remarks
HiberBand receiver sensitivity	TBD	TBD	TBD	dBm	50Ω source
GPS receiver sensitivity	TBD	TBD	TBD	dBm	50Ω source

Table 9: Hiberband modem RF receiver sensitivity

The RF transmission output power figures of the Hiberband modem are given in table 10.

Parameter		Min	Typ	Unit	Remarks
HiberBand receiver transmit power	Normal	TBD	TBD	dBm	50Ω load
	Boost	20.0	31.7	dBm	50Ω load

Table 10: Hiberband modem RF output power

2.8 Mechanical dimensions

The mechanical drawing of the Hiberband modem is shown in figure 4.

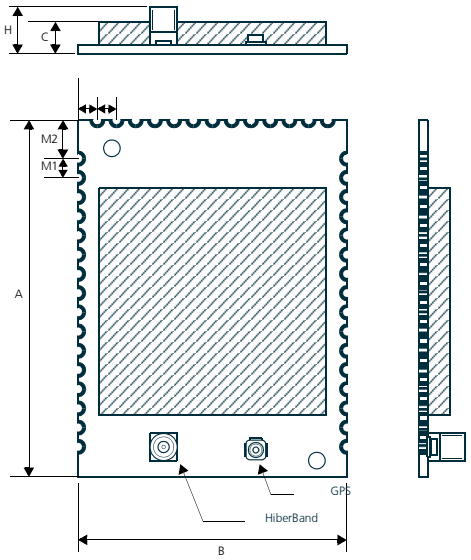


Figure 4: Mechanical drawing Hiberband modem

The pin numbers have been omitted from figure 4. Please refer to section for pin assignment information.

Parameter	Description	Typical	Tolerance
A	Module length	47.2 mm	+0.2/-0.2 mm
B	Module width	35.6 mm	+0.2/-0.2 mm
C	Module height (excl. antenna connectors)	4.2 mm	+0.3/-0.1 mm
H	HiberBand antennta connector height	6.2 mm	+0.3/-0.1 mm
M1	Pin-to-pin spacing	2.54 mm	+0.02/-0.02 mm
M2	Edge to pin 16/28 spacing	5.08 mm	+0.02/-0.02 mm
M3	Edge to pin 17/27 spacing	2.54 mm	+0.02/-0.02 mm
Weight	Module weight	< 30g	

Table 11:

The Hiberband modem has two antenna connectors: one MMCX-female for the HiberBand antenna and one U.FL-male for the GPS antenna.

3 Typical application ciruit

A typical interface between the application host processor, generally a microcontroller, and the Hiberband modem is shown in Figure 5.

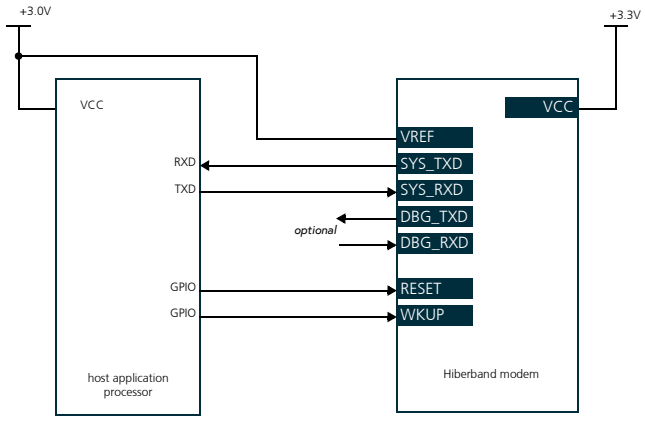


Figure 5: Typical integration of a Hiberband modem with an application host processor

In the example design shown above, the host application processor runs at 3.0V, while the Hiberband modem has a +3.3V supply voltage. The processor interfaces with the Hiberband modem through a UART interface for serial device-to-device communication. Optionally, the debug UART may be used in the application. Furthermore, two GPIO pins (configured as outputs) are used to drive the RESET and WKUP inputs of the Hiberband modem, both of which have active HIGH levels. The signal levels of the processor-modem UART interfaces is set by applying the appropriate voltage to the VREF input of the Hiberband modem. Other than ensuring that the power supply is able to deliver the necessary current within a sufficiently fast transient response time, this covers the integration of Hiber's LPGAN connectivity in an IoT device.

The host application processor must provide the actual geo-location of the device. Since the active version of the Hiberband modem does not have the internal GPS receiver anymore, non-stationary IoT devices must provide other means for determining its current position.

4 Hiberband modem design support

Hiber is strongly committed to providing good support to its partners. In addition to documentation, Hiber offers CAD libraries, reference schematics and board layout footprints, that can be obtained upon request. Please contact us at support@hiber.global for any assistance you may need.

5 Product ordering information

Please find the product ordering information in the table below.

Orderable device	Status	Description
HBR-18MDM001-001	End of life	Hiberband modem with internal GPS receiver
HBR-18MDM001-002	Mass production	Hiberband modem

Table 12: Hiberband modem product ordering codes

6 Revision history

Date	Revision	Changes
Feb 22, 2018	1	Initial release
March 29, 2018	1.1	Added current consumption patterns (figures 2 and 3).
April 18, 2018	1.2	Changed naming of RESETn to RESET to reflect active HIGH level.
May 9, 2018	1.3	Corrected the GPS antenna type.
July 2, 2018	1.4	Added remark on downlink usage to table 8.
Nov. 14, 2018	1.5	Updated RF performance figures in section 2.5.
Nov. 14, 2018	1.6	Changed product name to Hiberband modem Updated storage temperature range (table 2). Added product ordering information (section 5) Updated information related to discontinued GPS support
March 19, 2019	1.7	Updated notices

Table 13: Document revision history

IMPORTANT NOTICES – PLEASE READ CAREFULLY

FCC Interference Statement, Part 15.105(b): This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Part 15.21 Warning: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Part 15.19(a) Statement: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation."

FCC/ISED RF Exposure Guidance Statement: In order to comply with FCC/ISED RF Exposure requirements, this device must be installed to provide at least 30 cm separation from the human body at all times. Afin de respecter les exigences de la FCC/ISED concernant l'exposition aux fréquences radio, ce système doit être installé pour assurer une séparation d'au moins 30 cm du corps humain à tout instant.

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