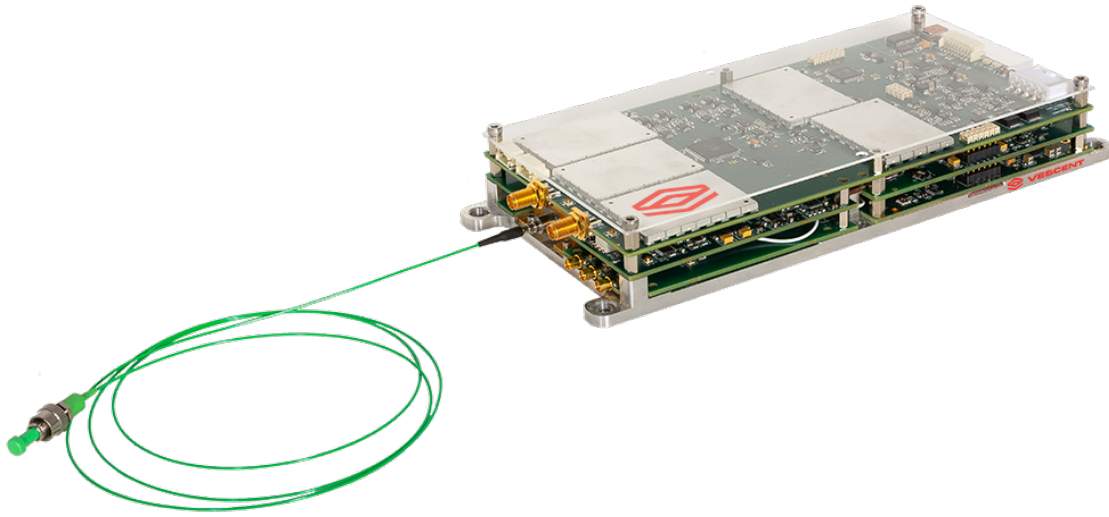


HAL System Specifications



1. System Description

The Heterodyne Agile Laser (HAL) system offers an atom-referenced, frequency-agile laser in a fiber-coupled butterfly package with integrated control electronics that enable a variety of quantum sensing applications. The electronics offer current sources, temperature controllers, and feedback control loops to enable high performance operation of this system with deterministic timing, and can be controlled with serial communications.

2. Performance Specifications

Parameter	Unit	Min.	Typ.	Max.	Comments
Optical Power Output	mW	5	6	12	
Center Wavelength	nm		780.241		Rubidium D2 transition at laser temperatures and injection currents specified by Certificate of Conformance.
Fractional Frequency Instability					Allan deviation of heterodyne beat against a similar system.
@ 1 s			3E-12	6E-12	
@ 10 s			8E-12	4E-11	
@ 100 s			1E-11	8E-11	
@ 1,000 s			3E-11	2E-10	
Laser Linewidth	kHz		450	650	
Slave Laser Frequency Tuning Range	GHz			±6.8	

Parameter	Unit	Min.	Typ.	Max.	Comments
Slave Laser Offset Frequency Tuning Time					
Frequency tuning < 1 GHz	μs		5	10	
Frequency tuning > 1 GHz & < 8.5 GHz	μs		40	100	
Polarization Extinction Ratio	dB			20	Linear polarization aligned to slow axis of PM780 output optical fiber
Relative Intensity Noise					
@ 10 Hz	dBc/Hz		-120	-110	
@ 100 Hz	dBc/Hz		-130	-120	
@ 1,000 Hz	dBc/Hz		-140	-125	
@ 10,000 Hz	dBc/Hz		-145	-135	Shot Noise dependent
System Operating Temperature Range	°C	26		40	HAL optics package temperature set point at 37 °C.
HAL Optics Package Operating Temperature Range	°C	23	37	40	Range over which Rb cell is maintained at 48 °C.
HAL Optics Package TEC Operating Current	mA			1,080	NOTE: Firmware reports a factor 2 lower current than actual (i.e. 540 mA).
Rb Gas Cell Operating Temperature	°C	40	46	48	
Gas Cell Heater Current	mA	150	220	350	
Laser Injection Current					
Master laser	mA		90	150	
Slave laser	mA		130	150	
Laser Temperature	°C	15	25	35	Master and Slave DBR lasers.
Laser TEC Current	mA		15	100	Master and Slave DBR lasers
SOA Injection Current	mA			1080	
SOA TEC current	mA			1000	

Table 1. HAL Specifications

3. Hardware Interfaces

Item	Function	Signals / Pinout	Board Connector Specification
1	Electrical Power Input	1. +15 V _{DC} @ 1.85 A 2. -15 V _{DC} @ 0.12 A 3. +/- 15 V _{DC} Return (GND) 4. +5 V _{DC} @ 0.25 mA (when only lasers, no SOAs, running) 5. +5 V _{DC} Return (GND)	Molex P/N 0039014050
2	Computer Control	USB 2.0 (Serial Port Emulation)	Mini USB Type B
3	Slave laser RF Modulation Input	DO NOT USE – SYSTEM NOT FULLY DESIGNED FOR HIGH FREQUENCY RF	

Item	Function	Signals / Pinout	Board Connector Specification
4	Beat Note Monitor Output	0 to 5 GHz, 10 dBm typical output power. NOTE: The heterodyne beat note signal from the HAL optics module goes through a frequency divider (divide by 2) before being output to the user. The frequency divider has bandwidth limitations that can affect linewidth measurements.	SMP (male)
5	Reference Signal Input	10 to 300 MHz 0 dBm max input power	SMP (male)
6	SOA Injection Current Output (x2)	1 A max	SMA (male)
7	SOA Temperature Control	1. TEC (+) 2. TEC (-) 3. Thermistor (+) 4. Thermistor (-)	PHR-4 (JST)
8	Event Trigger Inputs	1. +3.3 V 2. GND 3. Serial TX 4. Serial RX 5. ADDR0 6. ADDR1 7. ADDR2 8. TRIGGER	PHR-8 (JST)
9	Optical Fiber Output		PM780 pigtail fiber (1 m) terminated with FC/APC connector

Table 2. HAL I/O Connections

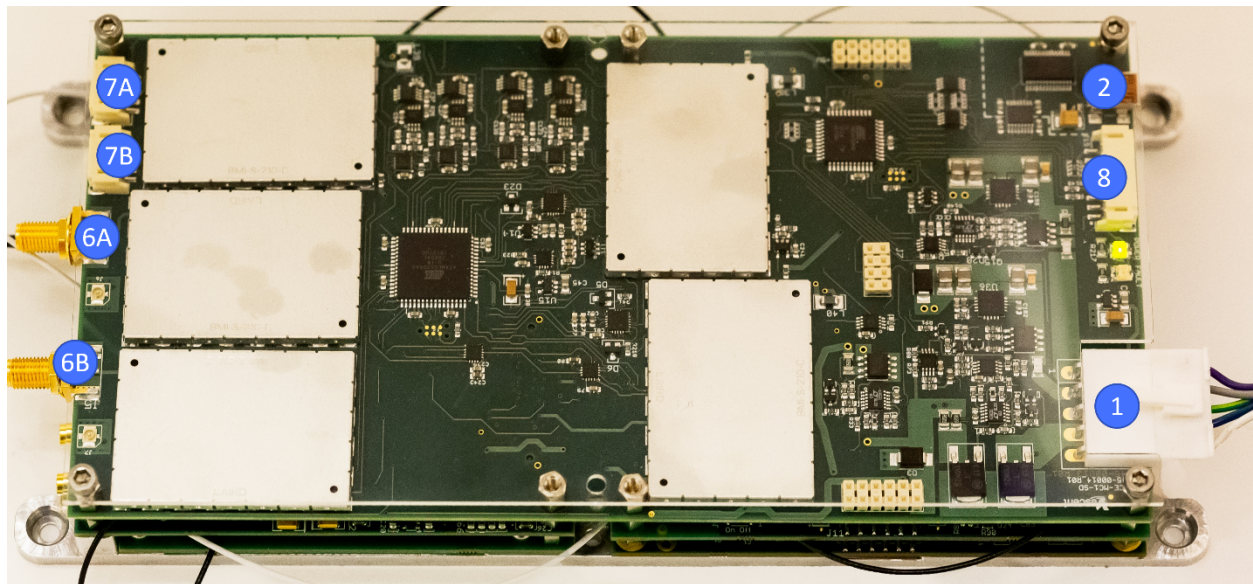


Figure 1. Top-down view of the HAL system. Labels correspond to the table in Section 3.

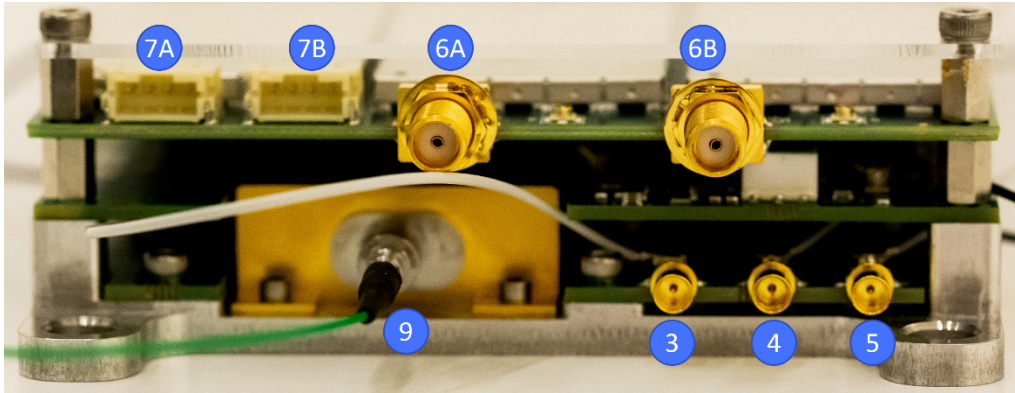
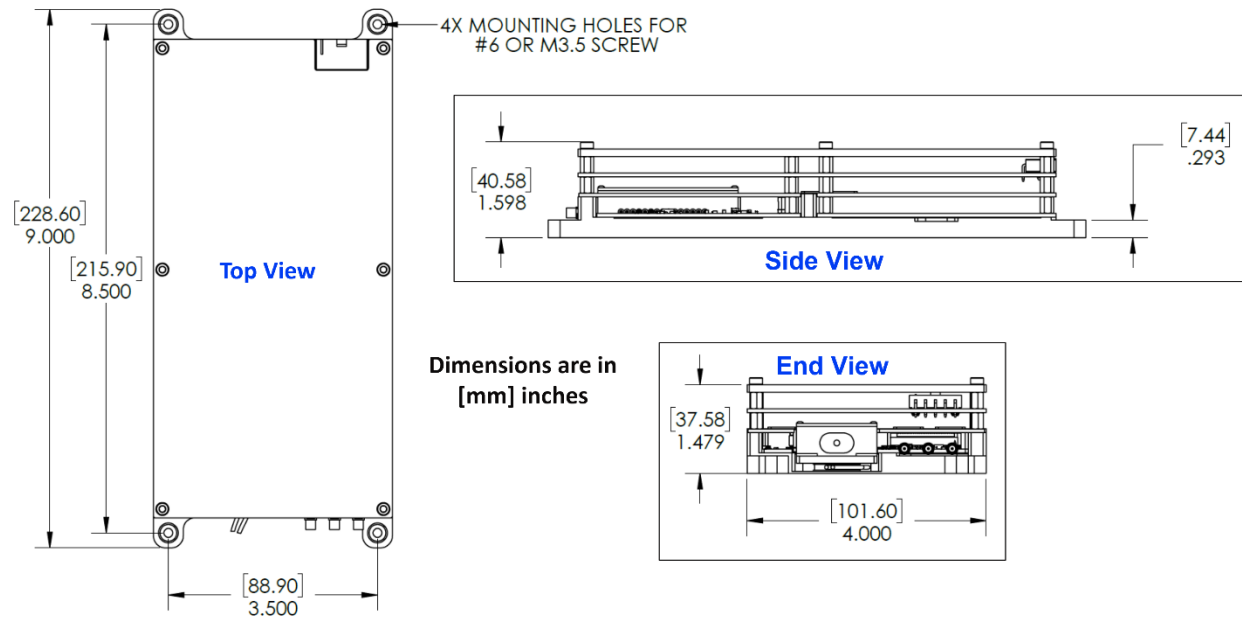


Figure 2. Side view of the HAL system. Labels correspond to the table in Section 3.

4. Mechanical dimensions



5. Software interface

API command list is available and can be provided. This allows full control of all laser system parameters.