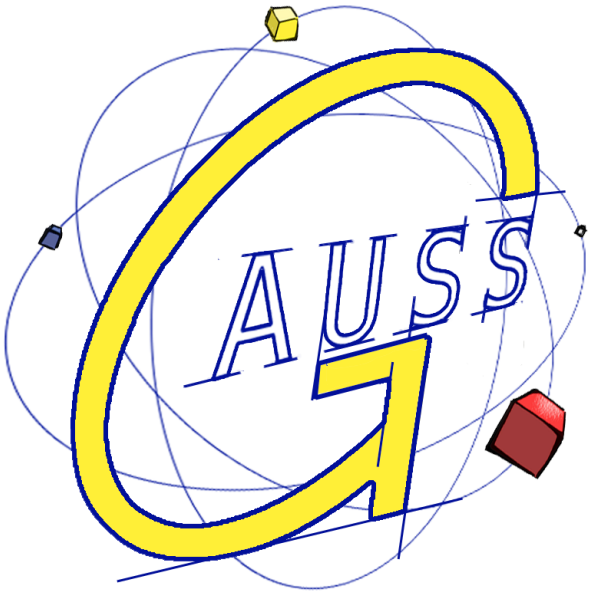
GAUSS Low Power UHF Radio

Datasheet

[LPUHF_201803]



Group of Astrodynamics for the Use of Space Systems

Table of contents

1. Introduction

GAUSS Low Power UHF Radio (*Figure 1*) is a low mass and high efficiency 2W radio designed for small satellites. The Low Power UHF Radio integrates both a low power UHF transceiver and a TNC, thus simplifying the satellite design while providing more than 50% efficiency with a 3.3V power supply.

Figure 1 GAUSS Low Power UHF Radio

The uplink and downlink are totally independent, meaning that they can be configured with different frequencies, modulations and protocols via software, changing dynamically also the output power. Two radios can be stacked on the same PC/104 board, allowing them to operate at redundancy mode (*Figure 3*).

It comes with an adapter board for testing (*see Figure 2*) and a computer software interface. It is fully compatible with the GAUSS Mini Ground Dongle. A special bundle includes both the Radio and the Mini Ground Dongle, for a quick system deployment.

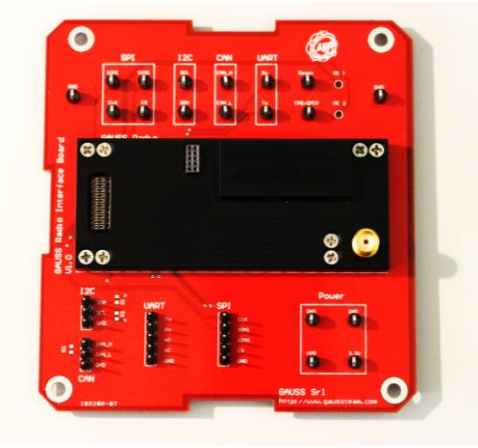


Figure 2 GAUSS Radio Adapter Board

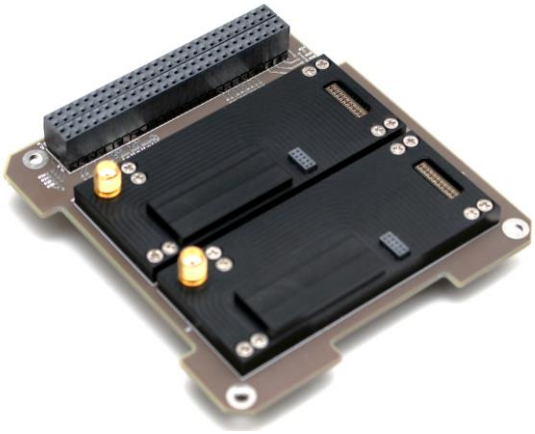


Figure 3 GAUSS Radio PC/104 Dual Radio

Features

Figure 4 GAUSS Low Power Radio UHF (SMA connector installed)

The primary features of the Low Power UHF Radio are:

- Up to 33dBm of output power dynamically configurable by software (and dependent on power amplifier supply voltage);
- 55% efficiency;
- Can be powered by a single 3.3V bus;
- UHF frequency band for TT&C;
- AX.25 protocol supported;
- FEC Viterbi k4 and Viterbi k7 & RS[1] supported;
- Integrated TNC, radio can be interfaced using KISS;
- Transparent mode supported (radio behaves like the analog fronted and the user implements its own protocols);
- Data-rate: 300bps to 100kbps;
- Sensitivity: -122dBm @1.2kbps, -119dBm @9.6kbps, -109dBm @50kbps;
- Configurable autonomous beacon;
- GPIOs available that can be commanded from ground;
- Configurable output power and frequencies in orbit;
- Firmware can be updated while in orbit;
- I2C[1], UART, SPI[1] and CAN Bus[1] interface support;

[1] Feature currently not supported; it will be available in future firmware upgrades or upon user request.

- FSK/MSK/GFSK/GMSK modulations;
- Speeds up to 250kbps (with 4GFSK)[1];
- Off the shelf industrial grade / automotive components;
- Operating temperature range -40°C to +85°C;
- Kits for PC/104 CubeSat form factor compatibility;
- Full Compatibility with GAUSS' USB Mini Ground Dongle;
- Radio Self protects itself when temperatures are beyond specification;
- SMA and MMCX connectors available.

Block Diagram

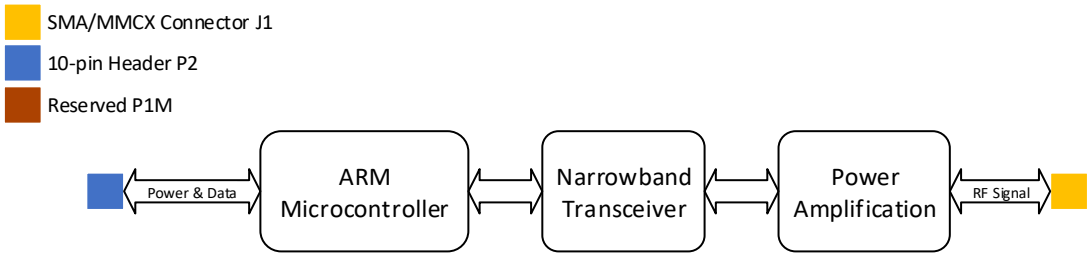


Figure 5 GAUSS Low Power UHF Radio General Overview

2. Pinouts

Figure 6 shows the location of each connector. Pinout information for these connectors can be found in Table 1.

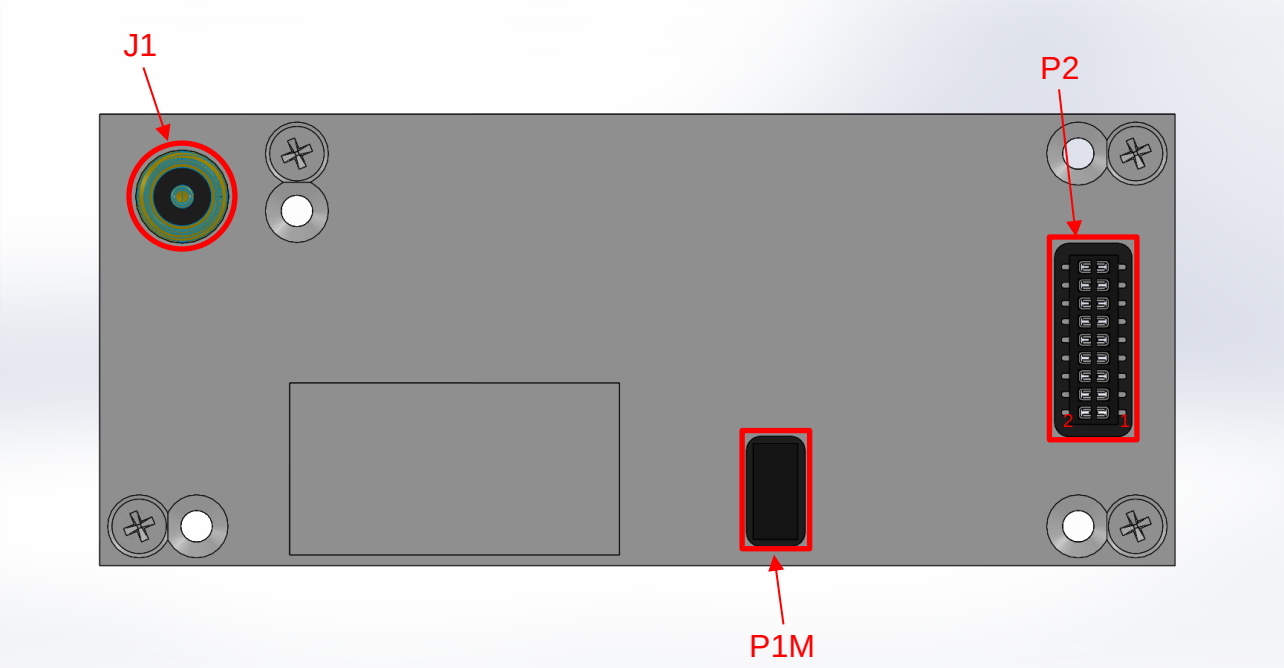


Figure 6 GAUSS Low power UHF Radio Available ports

Power to the Low Power UHF Radio can be supplied separately to the TNC/Transceiver and to the Power Amplifier, thus achieving maximum performance (see 4 General Recommended Operating Conditions for more information). However, if required, 3.3V can be provided for both power supplies, therefore, simplifying the power supply requirements.

The Low Power UHF Radio also provides the following communication interfaces: I2C[1], SPI[1], UART and CAN Bus[1] on P2 – see Table 1.

Connector P2 male header can be plugged either from the top or the bottom – see Figure 4, Figure 16, Figure 17 and Figure 18 for detailed information. The RF Connector J1 can be of type SMA or MMCX, according to Option Sheet.

Connector	Connector Type	Pin	Function
J1[2]	SMA Jack[3]/ MMCX Jack	-	RF Signal
P1M	5x2 Header	-	Reserved
P2	10x2 Header Model Harwin M503151042	1	Power Amp Power Supply V_{PA}
		2	Ground
		3	Power Amp Power Supply V_{PA}
		4	Ground
		5	Power Amp Power Supply V_{PA}
		6	Ground
		7	SPI SOMI
		8	SPI SIMO
		9	SPI SCLK
		10	SPI CS
		11	I^2C SDA
		12	UART Rx
		13	I^2C SCL
		14	UART Tx
		15	Reset
		16	CAN High
		17	Interrupt
		18	CAN Low
		19	Power Supply V_{DD}
		20	Ground

Table 1 GAUSS Low Power UHF Radio available ports pinout

[2] MMCX J1 Connector is available upon request (Option Sheet Document).
[3] Standard-polarity SMA Female Connector (jack): female body (outside threads) and female receptacle (sleeve).

3. Absolute Maximum Ratings

Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

T_A = 25°C, unless otherwise noted.

Parameter[4]	Min	Max	Unit
Power Supply V_{DD} (on P2 connector)	-0.3	+3.9	V
Power Amp Power Supply V_{PA} (on P2 connector)	-0.5	+6.0	V
Communication (except CAN Bus), Reset and Interrupt Pins Voltage Range (on P2 connector)	-0.3	+4	V
Communication (except CAN Bus), Reset and Interrupt Pins Maximum Current(on P2 connector)		64	mA
CAN Bus Voltage Range (on P2 connector) (CAN_H - CAN_L)	-7	+25	V
RF input level (on J1 connector)		+10	dBm
Storage temperature range	-40	+85	°C

Table 2 GAUSS Low Power UHF Radio Absolute Maximum Ratings

[4] Voltages refer to GND

4. General Recommended Operating Conditions

T_A = 25°C, unless otherwise noted.

Parameter[4]		Min	Typ	Max	Unit
Power Supply V_{DD} (on P2 connector)		+3.0	+3.3	+3.6	V
Power Amp Power Supply V_{PA} (on P2 connector)		+2.7	+3.5	+4.8	V
Input Reset and Interrupt Voltage	High-level	+0.65*V_{DD}	+3.3		V
	Low-level		0	+0.65*V_{DD}	
Input Reset and Interrupt Current	High-level (Sinking)			300	nA
	Low-level (Sourcing)			200	
Input Communication Signals Voltage (except CAN)	High-level	+0.65*V_{DD}	+3.3		V
	Low-level		0	+0.65*V_{DD}	
Output Communication Signals Voltage (except CAN)	High-level	+2.4	+3.3		V
	Low-level Output		0	+0.4	
Input Communication Signals Current (except CAN)	High-level (Sinking)			300	nA
	Low-level (Sourcing)			200	
Output Communication Signals Current (except CAN)	High-level (Sourcing)			2	mA
	Low-level (Sinking)			2	
UART Symbol Rate[5]		9.6	57.6	2000	kBd
CAN Bus Dominant Output Voltage	CAN High	2.45		V_{DD}	V
	CAN Low	0.5		1.25	
CAN Bus Recessive Output Voltage	CAN High		2.3		V
	CAN Low		2.3		
CAN Bus Differential Voltage (CAN High – CAN Low)	Input	-6		+6	V
	Output (Dominant)	+1.2	+2	+3	
	Output (Recessive)	-500	0	+12	mV
CAN Bus Input Current	High-level	-30			µA
	Low-level	-30			
CAN Bus Impedance[6]			120		Ω
Temperature range		-40		+85	°C

Table 3 GAUSS Low Power UHF Radio Recommended Operating Conditions

[5] The typical symbol rate refers to the factory defult.
[6] As standard a single 120 Ω termination resistor is mounted, as seen on Figure 7 - see Option Sheet for other options.

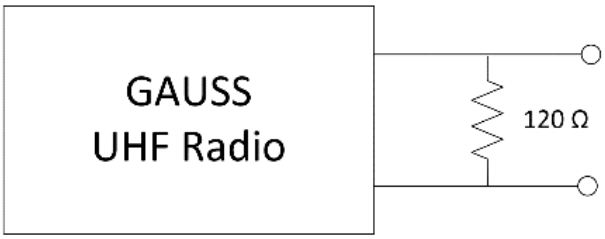


Figure 7 GAUSS Low power UHF Radio CAN Bus Termination

5. RF Characteristics

T_A = 25°C, unless otherwise noted.

Parameter			Min	Typ	Max	Unit
Frequency band		Reception F_{RX}	390		500	MHz
		Transmission F_{TX}[7]	415		450	
Frequency Resolution				15		Hz
Data rate			0.3		250[8]	kbps
Output Power[9]	$V_{PA} = 3.5\,V$, $F_{TX} = 425\,MHz$			33	33.3	dBm
Efficiency	$V_{PA} = 3.5\,V$, $F_{TX} = 425\,MHz$, $P_{OUT,MAX}$			50	55	%
Impedance					50	Ω
Saturation				+10		dBm
Sensitivity		0.3 kbps		-129		dBm
		1.2 kbps		-122		
		9.6 kbps		-119		
		50.0 kbps		-109		

Table 4 RF Characteristics

Conditions		Min	Typ	Max	Unit
300 bps	(adjacent channel) +6.25 kHz		65		dB
	(alternate channel) +12.5 kHz		66		
	±1 MHz		86		
	±2 MHz		90		
	±10 MHz		95		
1.2 kbps	(adjacent channel) +12.5 kHz		60		dB
	(alternate channel) ±25 kHz		61		
	±1 MHz		80		
	±2 MHz		85		
	±10 MHz		91		

Table 5 RF Characteristics - Blocking and Selectivity

[7] For other frequencies contact GAUSS Srl for more information.
[8] Not currently supported, it will be available in future firmware upgrades or upon user request. The current maximum data rate is 100 kbps.
[9] Output power is controlled both by V_{PA} and, dynamically, by a configuration parameter via software.

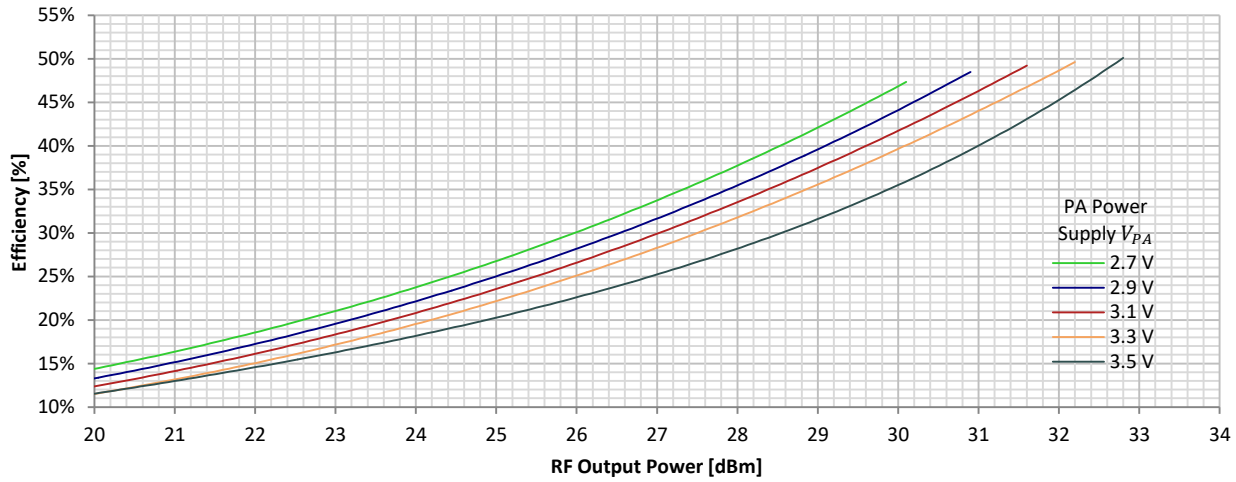


Figure 8 RF Efficiency versus RF Output Power @ 415 MHz

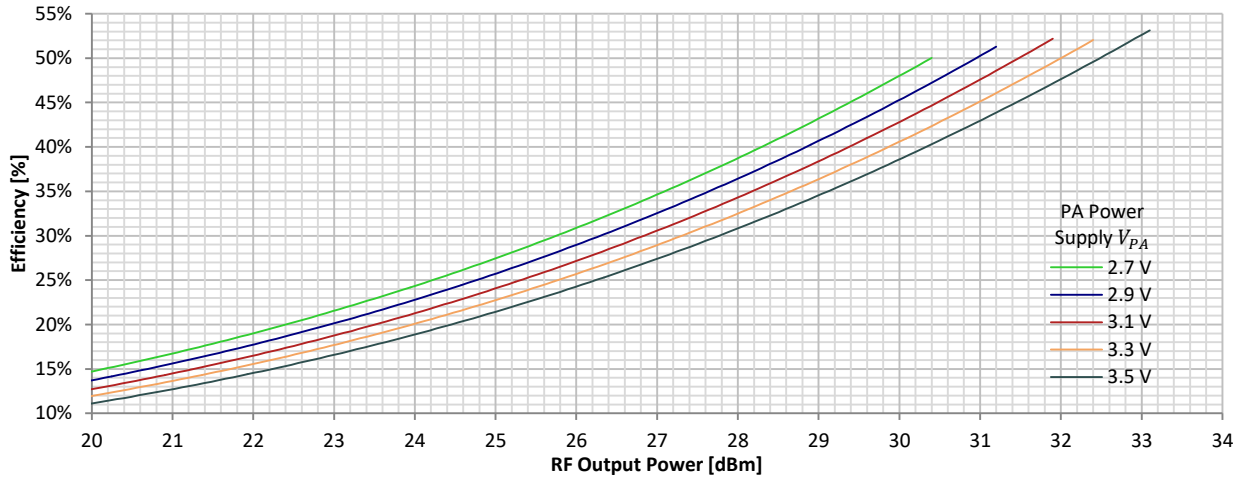


Figure 9 RF Efficiency versus RF Output Power @ 430 MHz

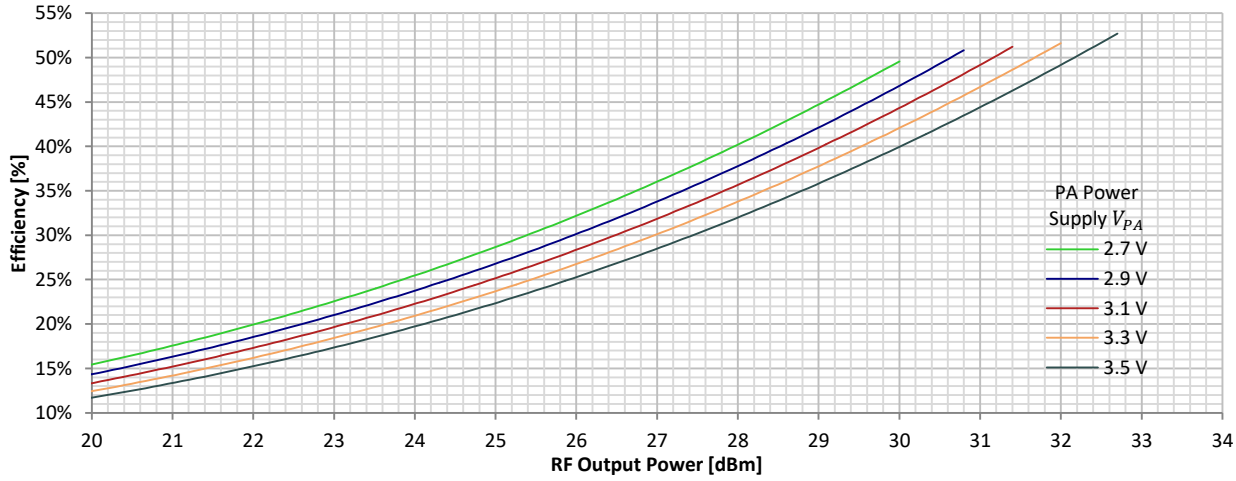


Figure 10 RF Efficiency versus RF Output Power @ 445 MHz

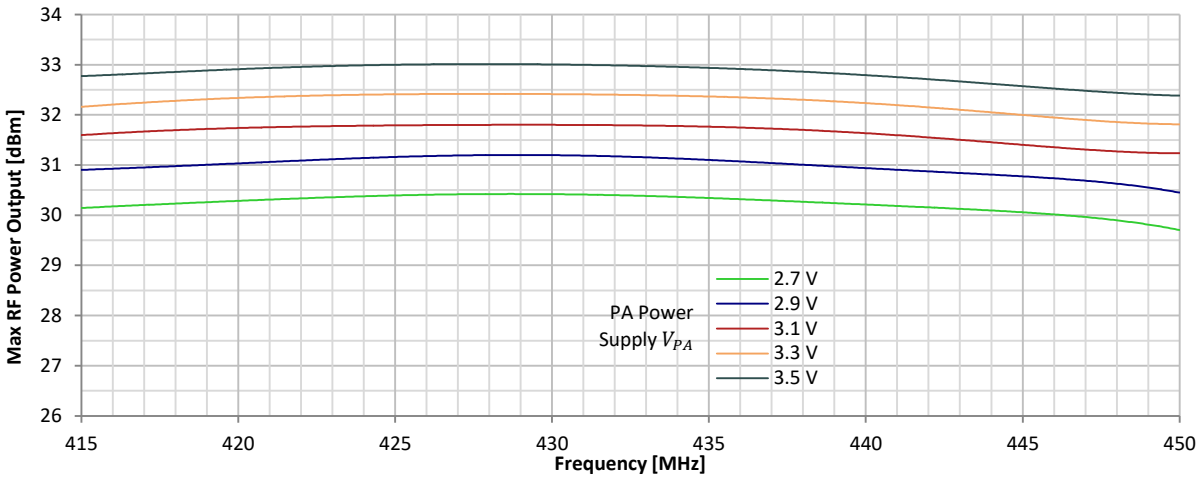


Figure 11 Maximum RF Power Output versus Frequency

6. Electrical Characteristics

Considering $V_{DD} = 3.3\ V$, $V_{PA} = 3.5\ V$ and T_A = 25°C, unless otherwise noted.

Parameter	Condition		Peak	Unit
Power Supply Current I_{DD}	Stand-by/Reception		67	mA
	Transmission		69	
Power Amplifier Current I_{PA}	Transmission	$P_{OUT,MAX}, F_{TX} = 415\ MHz$	1090	mA
		$P_{OUT,MAX}, F_{TX} = 425\ MHz$	1100	
		$P_{OUT,MAX}, F_{TX} = 450\ MHz$	970	

Table 6 GAUSS Low Power UHF Radio Electrical Characteristics

7. Physical Characteristics and Drawings

Table 7 presents the physical characteristics, whereas Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17 and Figure 18 present the detailed dimensions, of the Low Power UHF Radio with the SMA connector.

Measure	Value
Mass including all connectors	37 g
External size including all connectors (SMA)	75 x 31.5 x 12.50 mm

Table 7 GAUSS Low Power UHF Radio Physical Characteristics

All dimensions are in mm.

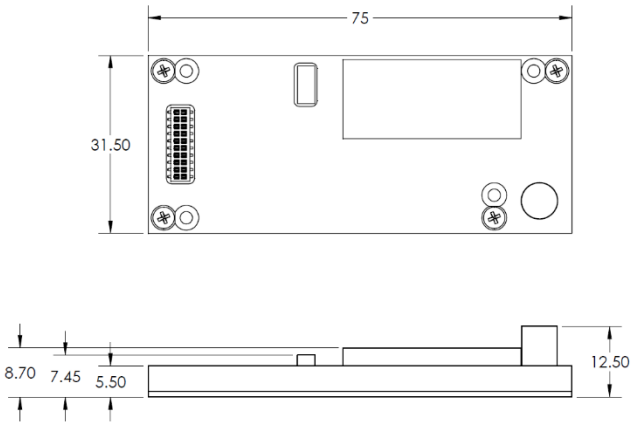


Figure 12 Low Power UHF Radio Outer Dimensions

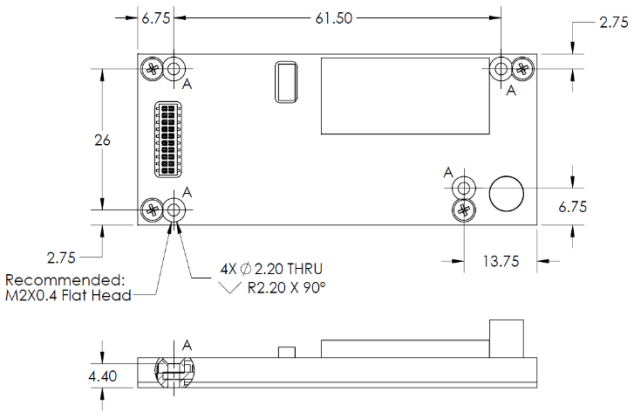


Figure 14 Low Power UHF Radio Mounting Details

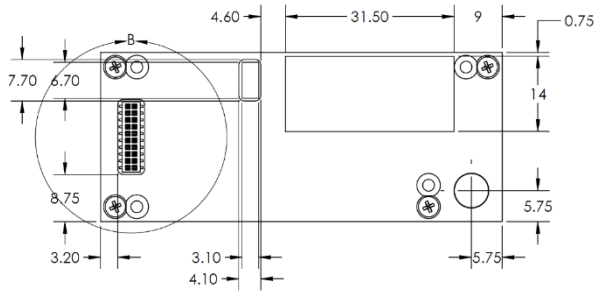


Figure 13 Low Power UHF Radio Connectors and Features Top View

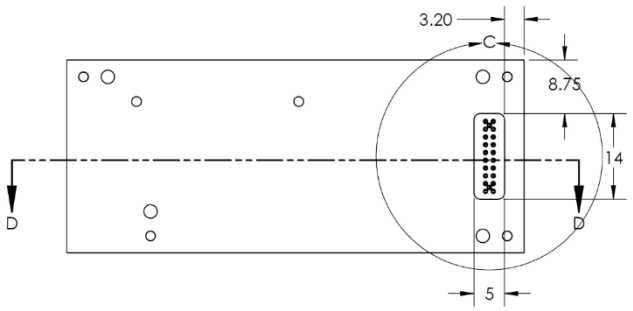


Figure 15 Low Power UHF Radio Connector and Features Bottom View

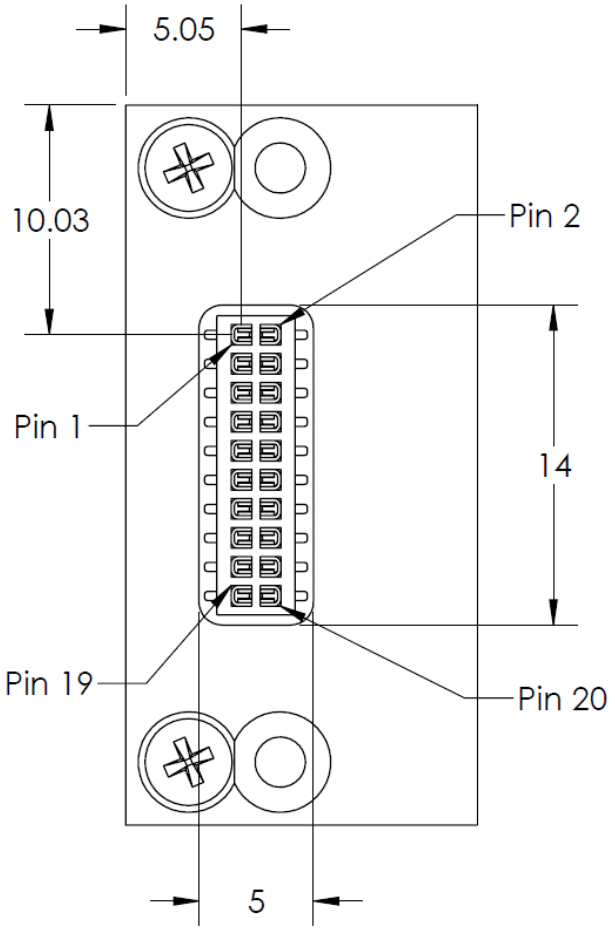


Figure 16 Low Power UHF Radio Top Detail B (P2 Connector)

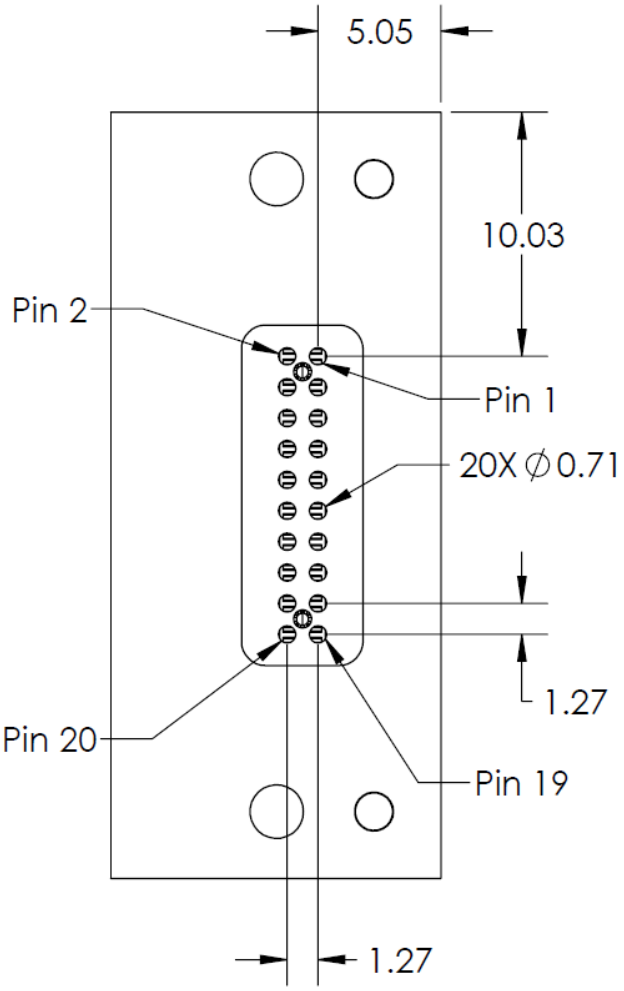


Figure 17 Low Power UHF Radio Bottom Detail C (P2 Connector)

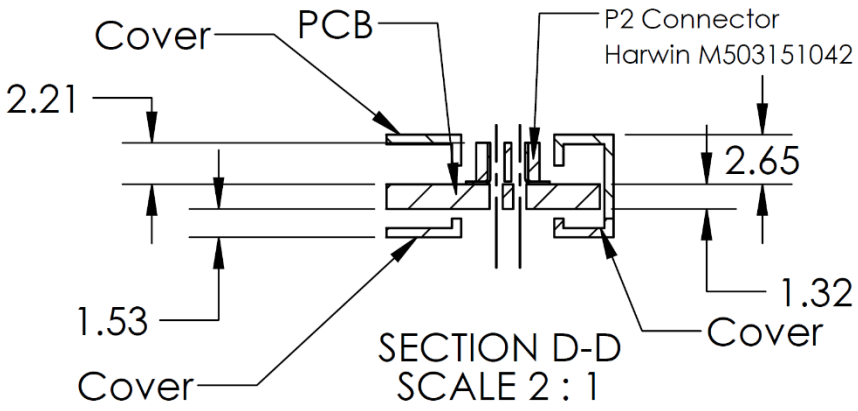


Figure 18 Low Power UHF Radio Connectors and Features Section D-D