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Hornet Sensor Hub Physical ICD

601-0045-000 Rev. C

The Hornet is a small form factor cost-effective sensor package with air data (barometric, dynamic), inertial (accelerometers, gyros), and magnetic sensors along with external analog inputs for outside air temperature, angle of attack, and sideslip. An internal expansion port also allows an optional GPS for even more flexibility.

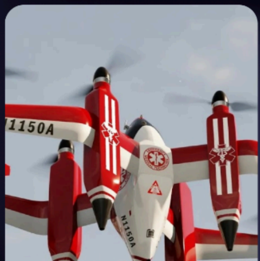


Table of Contents

Introduction

allocortech is pleased to present the Hornet ADAHRS, a cost-effective sensor package for small-aircraft and cost-sensitive applications. Sensor performance and minimum package size are the driving factors behind this design.

Scope of this Document

This document covers the electrical, sensor and mechanical specifications of the Hornet ADAHRS (part number 100-0045 and variants.)

Version History

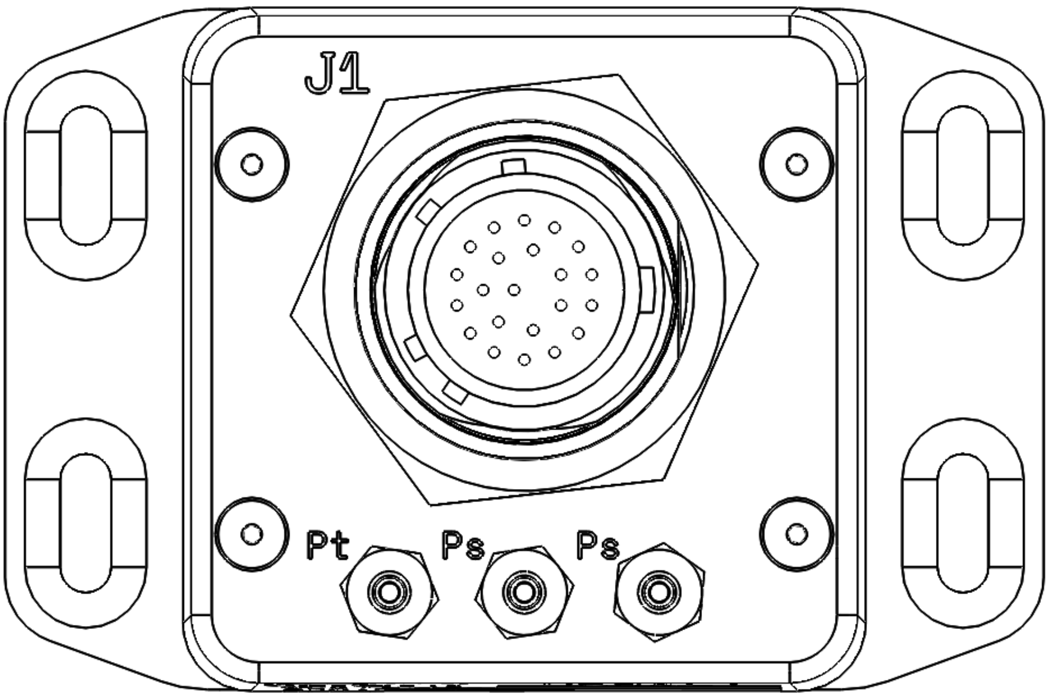
Revision	Changes
A	Initial Draft
B	Specifications updated to reflect actuals where applicable
C	Updated document template

List of Abbreviations

ADAHRS	Air Data Attitude and Heading Reference System
CAN	Controller area network
FM	Frequency Modulation
GND	(Power) Ground
MCU	Microcontroller Unit
OAT	Outside Air Temperature
PPS	Pulse per Second time synchronization
PWM	Pulse Width Modulation
UART	Universal asynchronous receiver-transmitter

Hornet ADAHRS Connections

The Hornet provides the following external connection points:

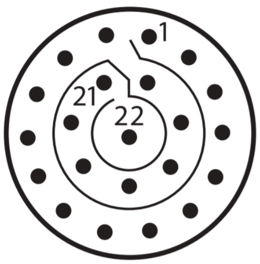


J1 - Primary Electrical Connector (see "Electrical Interface" section below)
Pt - Pitot (Total) Pressure Port
Impact pressure is the difference between the Pt port and the center Ps port.
Ps - Static (Absolute) Pressure Ports
It is expected that the static line from the air data boom is split outside of the Hornet into both ports.

Electrical Interface

Connector Pinouts

J1 - Main Connector



Face view of J1 receptacle D38999/24ZC35PN
22 qty size 22D male pins, 3A each

Mating connector is D38999/26ZC35SN

Pin	Description	Pin	Description
1	Vin	12	RS422 TX (+)
2	PPS (-)	13	RS422 RX (-)
3	Vsupply Alpha/Beta [1]	14	CHASSIS
4	CAN H	15	Vsupply Alpha/Beta [2]
5	CAN L	16	PPS (+)
6	OAT Drive (+)	17	GND (Vin)
7	OAT Measure (+)	18	GND (Vsupply Alpha/Beta [1])
8	OAT Measure (-)	19	GND (Vsupply Alpha/Beta [2])
9	OAT Drive (-)	20	RS422 TX (-)
10	Beta Signal	21	RS422 RX (+)
11	Alpha Signal	22	MCU Recovery

Power Input

The Hornet is powered primarily through J1, from +9 to +48 VDC. Nominal input voltage is +28 VDC.

The expected power consumption is approximately 1.6W. Expected current draw is listed for various input voltages:

Supply Voltage	Expected Current @ 1.6W
12	130 mA
28	60 mA

Chassis

The Chassis connection through J1 is the only defined method for establishing external Chassis reference. Though the enclosure may be grounded as part of physical installation, the electronics only receive Chassis reference potential through J1 as defined in the pinout table. The chassis is connected to ground inside the unit with a 2kV Y class capacitor and a 600V rated 1 MΩ drain resistor. Connection of the chassis pin to the J1 harness shield is recommended for EMI reduction reasons.

RS422

The Hornet has a full-duplex RS422 communication link that operates up to 1Mbps.

CAN

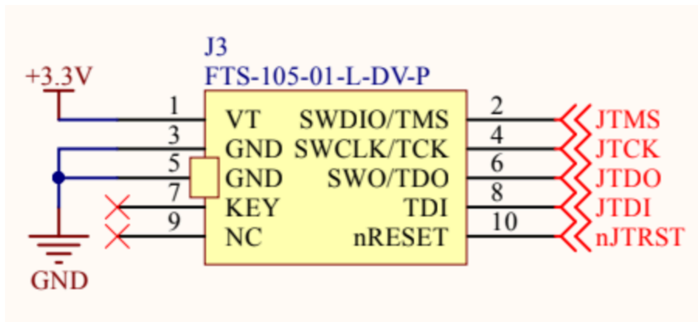
The Hornet has a CAN communication link that operates up to 1Mbps.

Pulse per Second

The Hornet has a PPS time coordination input/output signal. The direction of the PPS signal (input or output) is MCU controlled. The Hornet may accept an external PPS signal in, or if equipped with the optional GPS receiver, the Hornet may supply PPS to external users.

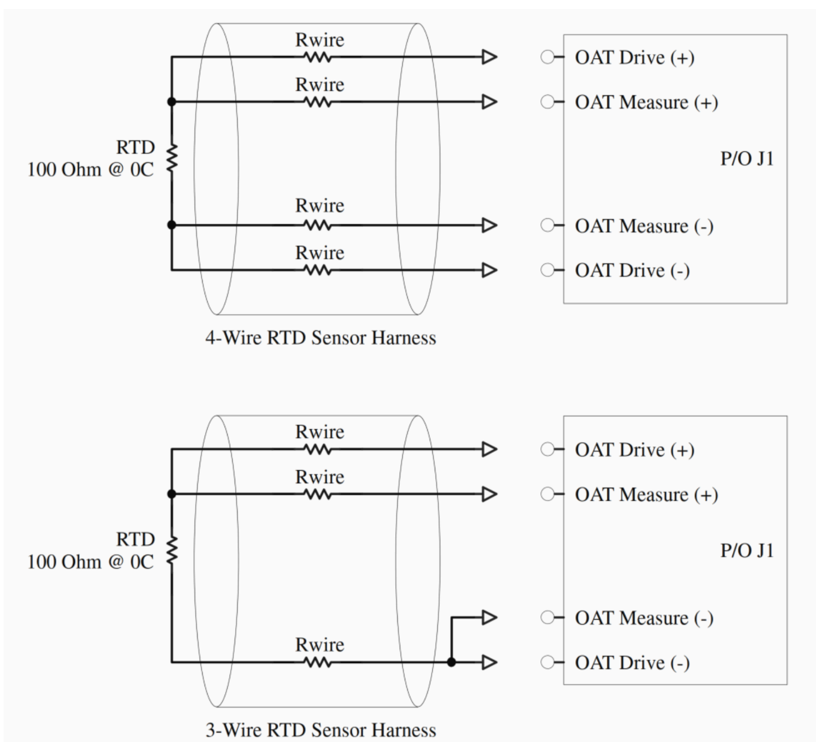
JTAG

The Hornet provides an industry-standard JTAG connection to the MCU, accessible by removing the bottom plate from the enclosure. The JTAG connector is located on the main circuit board.



Outside Air Temperature Sensor Input

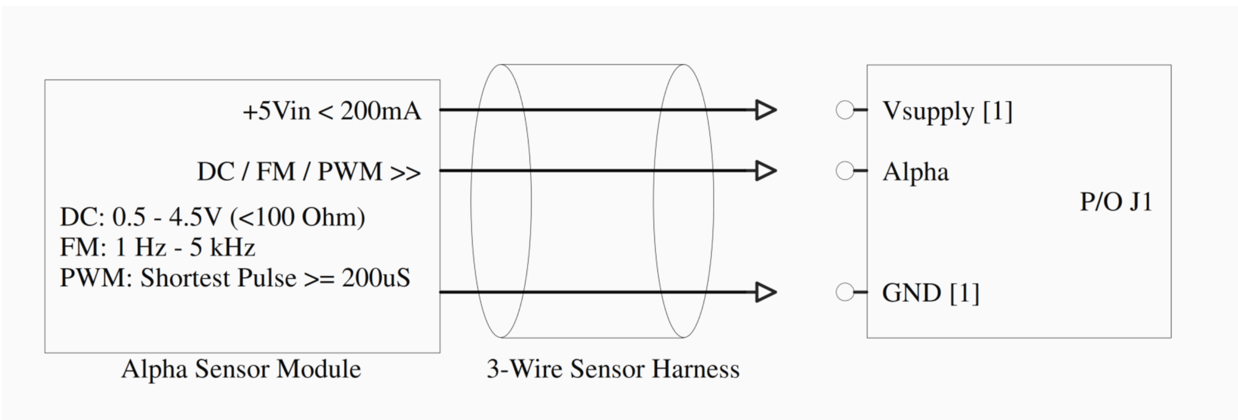
The Hornet provides for Outside Air Temperature (OAT) input. The sensor shall be a 100 ohm 3- or 4-wire RTD. 1mA of bias current is provided to excite the RTD sensor. When using a 3-wire sensor, “OAT Drive (-)” and “OAT Measure (-)” are to be connected together in the harness, directly at the connector that plugs into the Hornet. Wiring examples are shown in the figure below.



Outside Air Temperature Connection Diagram

Angle-of-Attack / Sideslip Sensor Vane Input

The Hornet provides for Angle-of-Attack (AoA, or Alpha) and Sideslip (Beta) vane inputs. The Alpha/Beta inputs may be Analog voltages, FM or PWM signals. When using analog voltage inputs, the driving impedance should be less than 100 ohms for accuracy, and the voltage may range from 0.5V to 4.5V. The analog signal measurement has a high-frequency rolloff of approximately 2 Hz. When using FM inputs, the maximum frequency should not exceed 5kHz. For PWM inputs, minimum pulse width should not fall below < 200us. For both FM and PWM signals, 5 Vpp square wave is expected. (These input specifications may be customized by signal conditioning component value changes on the main circuit board). A wiring example is shown in the figure below.



Alpha/Beta Connection Diagram (Alpha shown)

Environmental Sensing

Magnetic Heading

The Hornet has built-in magnetic heading sensors with an accuracy of 1 degree magnetic heading.

Static Pressure

The Hornet provides an external barb to route air tubing for detection of static pressure. Measurement range is 0 to 103.4 kPa (15 PSI) absolute pressure over 24bits. Accuracy over full scale range is 0.25% or 250Pa (0.0375 PSI.) Maximum working overpressure is 30 PSI without damage, and burst pressure is 60 PSI. The outermost Ps port is used to make this measurement.

Differential Pressure

The Hornet provides external barbs to route air tubing to two pitots for measurement of differential pressure. Measurement range is +/- 6 kPa over 24bits. Accuracy over full scale range is 0.25% or 15 Pa. Maximum working overpressure is 85 kPa without damage, burst pressure is 100 kPa, and maximum common-mode pressure is 1,000 kPa. The Pt and central Ps port are used to measure the differential pressure. Impact pressure is defined as Pt - Ps(central).

IMU

The hornet has built-in 6-axis IMU capability.

Outside Air Temperature Sensor

See “Output Air Temperature Sensor Input” under Electrical Interfaces.

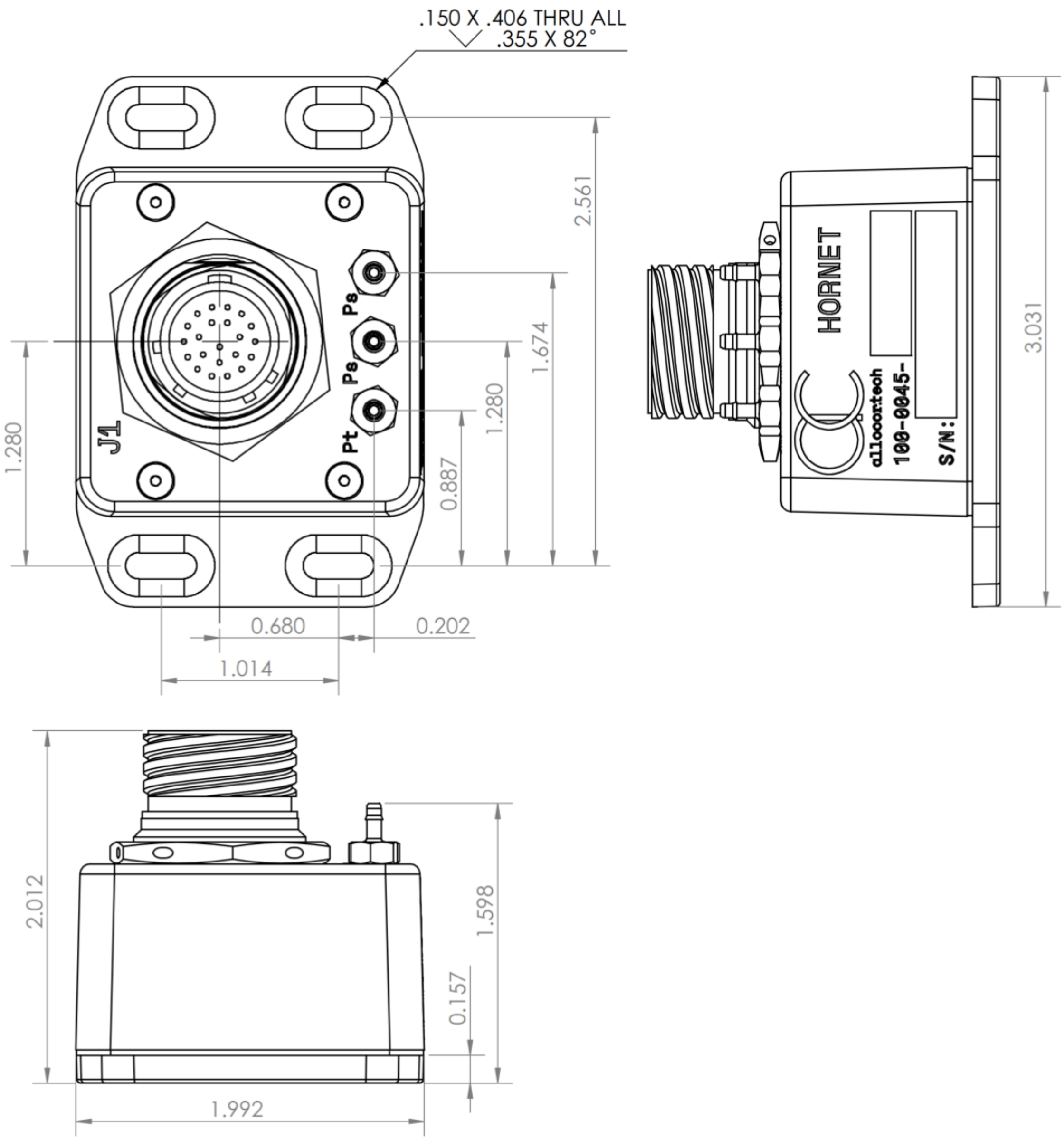
Angle-of-Attack / Sideslip Sensor

See “Angle-of-Attack / Sideslip Sensor Input” under Electrical Interfaces.

Mechanical Interface

Dimensions

Measurements given in inches.



Weight

The Hornet weighs 112g.

Environmental

Grounding and Bonding

The Hornet nominally withstands up to 600V potential between power ground and chassis. See note on Chassis input under “Electrical Interface.”

Temperature

The Hornet is nominally rated from -40°C to +70°C operation.

Vibration and Shock

Shock & Vibration ratings are TBD.

Pressure

The Hornet provides a sealed enclosure and is nominally rated to operate up to TBD ft altitude.

Solid and Liquid Ingress

The Hornet is fully gasketed and nominally rated for IP64.

Software Interface

The Hornet has a RS422 serial interface that can be set to either Yap protocol to communicate with the Hornet GUI application or it can be a command shell interface. The choice of which is active is configurable using the DroneCan interface for editing configuration parameters. The Hornet also supports both Yap and DroneCan protocols on its CAN interface. The Yap protocol is used to drive the Hornet GUI on an external Linux PC. DroneCan is used to broadcast various messages containing data the Hornet is collecting. The choice of which protocol is active is configurable by the Hornet GUI application when running on its serial interface.

DroneCAN Messages

When configured in DroneCAN mode, the following messages emit from the CAN interface. The basic messaging concepts can be found within the DroneCan github repository (https://dronecan.github.io/Specification/2._Basic_concepts/).

NOTE: Message definitions are listed in Section 7 of the DroneCan specification. Additional vendor specific information (where applicable) is provided in the sub-sections below.

Message Type	Rate	Method
uavcan.protocol.NodeStatus	4 Hz	Broadcast
uavcan.equipment.ahrs.MagneticFieldStrength2	25 Hz	Broadcast
uavcan.equipment.ahrs.RawIMU	100 Hz	Broadcast
uavcan.equipment.air_data.RawAirData	10 Hz	Broadcast
uavcan.equipment.power.CircuitStatus	0 Hz	Broadcast
uavcan.equipment.device.Temperature	0.5 Hz	Broadcast

uavcan.protocol.NodeStatus

```
uint2 health                          // Always HEALTH_OK
uint3 mode                            // Always MODE_OPERATIONAL
uint3 sub_mode                        // Unused
uint16 vendor_specific_status_code    // Unused
```

uavcan.equipment.ahrs.MagneticFieldStrength2

```
uint8 sensor_id                            // Always 0
float16[3] magnetic_field_ga               // x, y, z gauss
float16[<=9] magnetic_field_covariance     // Unused
```

uavcan.equipment.ahrs.RawIMU

```
uavcan.Timestamp timestamp              // MicroSeconds
float32 integration_interval            // Unused
float16[3] rate_gyro_latest             // x, y, z radian/sec
float32[3] rate_gyro_integral           // Unused
float16[3] accelerometer_latest         // x, y, z meter/(sec^2)
float32[3] accelerometer_integral       // Unused
float16[<=36] covariance                // Unused
```

uavcan.equipment.air_data.RawAirData

```
float16 static_air_temperature    // Unused
float16 pitot_temperature         // Unused
float16[<=16] covariance          // Unused
```

uavcan.equipment.power.CircuitStatus

See `dronecan_circuit_stat_hz` Configuration Parameter to update default output frequency.

```
uint16 circuit_id          // see definition below, 0 to disable all messages
float16 voltage
float16 current
uint8 error_flags          // unused

// Circuit ID assignments: These can be added together to send multiple in
the same period

enum class CircuitId : uint16_t {
  kSendVin    = 1,
  kSend3_3v   = 2,
  kSend5v     = 4,
  kSendLoad0v = 8,         // (Wasp only)
  kSendLoad1v = 16,        // (Wasp only)
  kSendLoad2v = 32,        // (Wasp only)
  kSendLoad3v = 64,        // (Wasp only)
};
```

uavcan.equipment.device.Temperature

```
uint16 device_id          // see definition below, 0 to disable all messages
float16 temperature       // in kelvin
uint8 error_flags         // unused

// Device ID assignments: These can be added together to send multiple in
the same period

enum class DeviceId : uint16_t {
  kSendPcbTemp     = 1,
  kSendStaticTemp  = 2,
  kSendDynamicTemp = 4,
  kSendOAT         = 8,      // not implemented, future use
  kSendPcbTemp2    = 16, // (Wasp only)
};
```

Configuration Parameters

Parameter Name	Default Value	Units	Description
baro_offset	0.0	Pa	Caution: Calibrated barometer offset
pitot_offset	0.0	Pa	Caution: Calibrated pitot offset
dronecan_node_status_hz	4.0	Hz	Frequency of node status message output
dronecan_raw_air_data_hz	10.0	Hz	Frequency of air data message output
dronecan_temperatures_hz	0.5	Hz	Frequency of temperature message output
dronecan_raw_imu_hz	100.0	Hz	Frequency of IMU message output
dronecan_mag_hz	25.0	Hz	Frequency of magnetometer message output
dronecan_node_id	100	N/A	DroneCan node id of this device
rs422_mode	0	N/A	0 = yap for GUI, 1 = command shell
rs422_bitrate	500000	bps	Serial baud rate
dronecan_circuit_stat_hz	0.0	Hz	Frequency of circuit message output
circuit_report	127	N/A	Bit field (add values to combine) 1 = Vin 2 = 3.3v 4 = 5v
circuit_base_id	0	N/A	Base circuit id number within msg
temperature_report	1	N/A	Bit field (add values to combine) 1 = PCB temperature 2 = Static temperature 4 = Dynamic temperature
temperature_base_id	0	N/A	Base temp device id number within msg