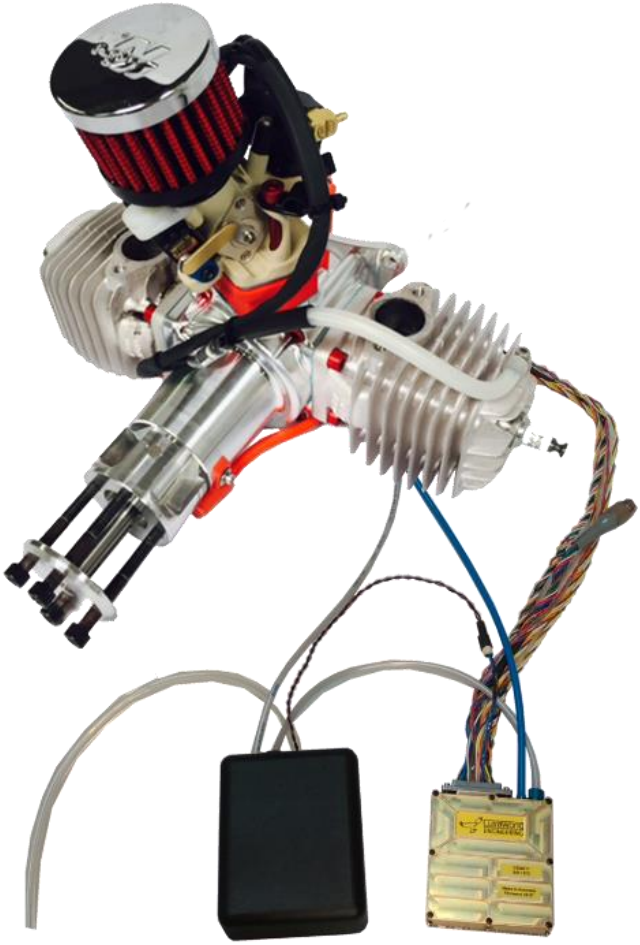
DA 35/70 EFI MIL SPEC

Electronic Fuel Injected Engines



OWNER'S MANUAL

Document Revision Table					
Rev.	Description of Change	Revised by	Revision Date	Approved By	Approved Date
B	Revision History Prior to "B" is undocumented. (Note: Previous Revisions were before ISO 9001 QMS.)	D.McClain	3/14/2017	T.West	3/28/2017
C	Updated Maintenance Schedule Table	D.McClain	11/1/2017	T.West	11/1/2017
D	Updated with Revision Table	A.Sanchez	12/15/2017	R.Denney	12/15/2017
E	Updated the Spark Plug Callout	D McClain	07/29/19	DRB	7/31/19

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1. General Safety:

Read and understand this owner's manual before operating your engine. You can help prevent accidents by being familiar with the controls and observing safe operating procedures.

Operators Responsibility:

1. The operator should know how to stop the engine quickly in case of emergency.
2. A safety zone around the propeller should be established in which no person or object is allowed to enter. Install a guard around the propeller when appropriate.

WARNING

1. Observe all safety precautions when working around the propeller.
2. Exhaust contains poisonous carbon monoxide, a colorless and odorless gas. Breathing carbon monoxide can cause loss of consciousness and may lead to death.
3. Never run your engine in an enclosed space. Always allow for appropriate ventilation.
4. Observe precaution around the muffler. The exhaust system gets hot enough to ignite some materials.
5. Keep flammable materials away from the engine.
6. Gasoline is extremely flammable and is explosive under certain conditions. Do not smoke or allow flames or sparks where the engine is operating.

2. Un-Packing Your Engine:

Caution:

Your Engine comes with the ECU attached via the wire harness and pressure port tubes. Handle the ECU with Care when removing the assembly from the box.

Package Contents:

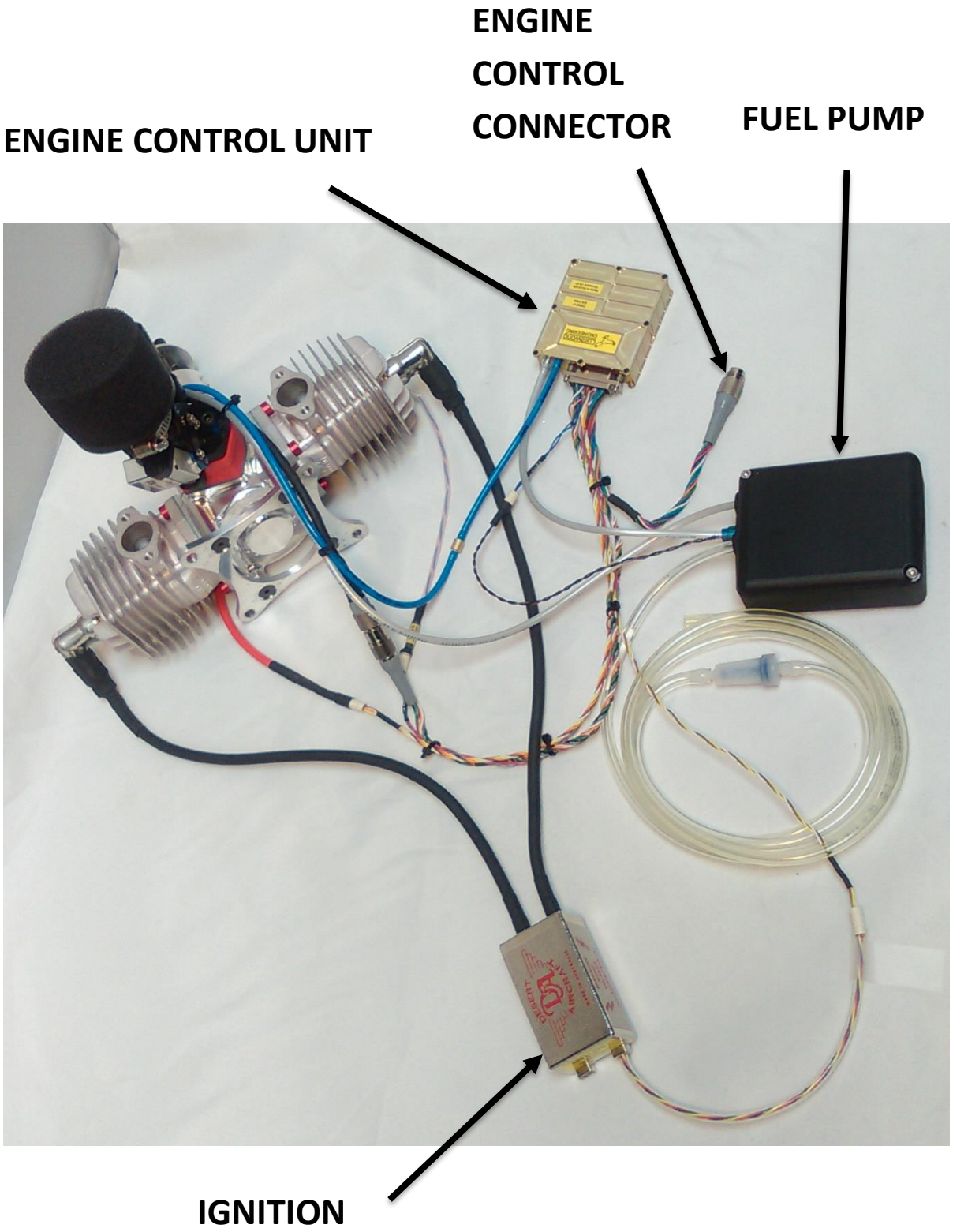
1. Engine with Intake Assembly
2. Engine Control Unit (ECU)
3. Main Wire Harness
4. Owner's Manual
5. Mufflers and Installation hardware
6. (Optional) Fuel Pump

ATTENTION

Observe Precautions for Handling

Electrostatic Sensitive Devices (ESD).

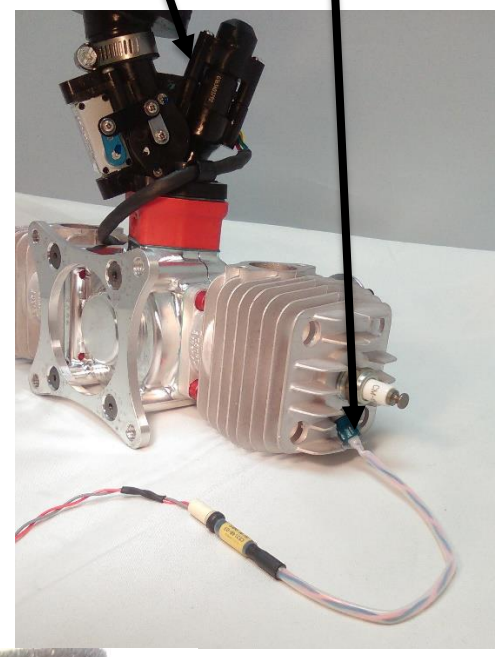
The ECU and Throttle servo on this engine contain sensitive electronic hardware. As a result this engine is packaged in electrostatic dissipative foam and contained in electrostatic dissipative bags. Any handling of these devices should be contained in an ESD safe area.

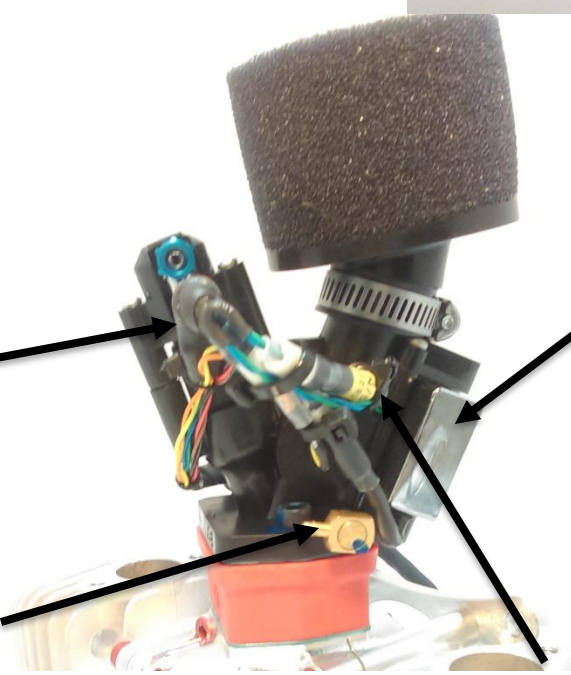


MAIN THROTTLE BODY CONNECTOR

CYLINDER HEAD TEMPERATURE SENSOR

THROTTLE BODY





FUEL INJECTOR

THROTTLE SERVO

MANIFOLD AIR PRESSURE LINE

MANIFOLD AIR TEMPERATURE SENSOR

3. Getting Started:

Engine Oil

This engine was calibrated using Red Line 2 Stroke Racing oil at a mix ratio of 40:1. This oil type and mix ratio should be maintained to ensure that the fuel injection system and engine operates as designed.

Oil Brand: **Red Line** Oil Type: **2 Stroke Racing Oil**	
Mix Ratio: 40:1 40 parts Gasoline to on part Oil.	

Fuel Recommendations

The engine was calibrated with 87 octane no-leaded gasoline. There is no need for premium grade gasoline due to the compression ratios of the engine.

- **High Altitude/High Temperature Operations**
  In some cases where Vapor lock is a risk, VP C-10 may be substituted.

Hardware Installation

1. Do not install the ECU to the engine or motor mount. The vibration will damage the hardware. Route the ECU to a location inside the aircraft and mount it where vibration is minimal. The ECU does not produce excessive heat and can be encapsulated in foam to isolate it from vibration if needed.

2. Although not required, the engine should be isolated from the aircraft using appropriately sized rubber isolators. Consult Desert Aircraft for your specific application if you would like mounting recommendations. Be sure to specify that you are installing a fuel injected engine.
3. Refer to the interface control document for the wire harness connection and power requirements.

FUEL SYSTEM WARNINGS:

Do not connect the fuel port to the Manifold Air Pressure tube.

Do not exceed 100 PSI (7 bar) of fuel pressure.

Do not connect or disconnect the tube from the ECU fuel pressure port without first consulting Desert Aircraft. Damage may occur to the ECU if mishandled.

Starting Your Engine for the First Time

1. Verify that the ECU is powered up (Red flashing light near the connector)
2. Verify that the throttle setting is at 30%. (1300 µs PWM)
3. There is no need to prime the fuel system. Fuel will be drawn from the fuel tank and sent to the injector upon power up.
4. Start Engine. Cranking speed needs to be in between 800 and 1200 rpm.
   Note: The engine may struggle to run for the first few minutes as it is purging all the air from the fuel system. This may not be evident until you go to wide open throttle.
5. Allow the engine to run for 5 minutes.
6. Progress slowly to wide open throttle.

7. Hold at wide open throttle for 15 seconds to verify that the air in the fuel system has been purged. The engine will hesitate and run rough if there is still air in the system.
8. Reduce the engine speed to idle.
9. Maintain at least 1 minute of idle time (after running at full speed) before turning the engine off to reduce thermal stresses on the hardware.

Stating again after first start.

1. If temperature is below 0 °C set throttle position to 40% or 1400 PWM. Engine should start within the first few seconds.
2. If temperature is above 0 °C set throttle position to 30% or 1300 PWM.

4. Maintenance:

Engine System Operational check

A proper running engine should maintain specific maximum speeds* under controlled conditions. This maximum speed can be used to qualify the engine for service along with the following parameters:

Engine Temperature:

Cylinder head Temperature should not exceed 160 °C as measured under the spark plug. The temperature reduces as you move down the cylinder to the base and crank case to about 80 °C when the engine is running at full speed. At the DA temperature sensor when running at full speed, the temperature should not exceed 180 °C during normal operation.

Fuel Pressure:

The Fuel pressure should be greater than 2 bar (29 PSI) and less than 4 bar (58 PSI). No adjustment to the Desert Aircraft fuel system is required.

Barometric Pressure:

Verify that the barometric pressure matches a calibrated weather station within ± 0.5 kPa.

Manifold Air Pressure:

When the engine is not running, the Manifold air pressure should match the barometric pressure within ± 0.5 kPa.

Manifold Air Temperature:

This value should be approximately the same as the air temperature on the inside of the manifold ± 5 °C.

Maintenance Schedule:

Item	**Before each Flight**	**Every 50 Hours**	**Every 100 Hours**	**Every 300 Hours**
Engine Oil Pre-Mix	**X**			
Spark Plug Check/Adjust		**X**	**X**	
Spark Plug Replace			**X**	**X**
Air Filter Check/Clean		**X**		
Air Filter Replace				**X**
Fuel Filter		**X**		
HFE OEM Maintenance				**X**

Maximum engine RPM will vary with altitude and temperature. Engine power will decrease as the engine increases in altitude. RPM is also dependent on the type of propeller used and the specific installation. Consult Desert Aircraft with details about your specific installation to determine a maximum RPM curve. This curve can be used for your engine system operational check.

5. Absolute Ratings:

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input voltage *Note 2*	-26	+26	V
T_{stg}	Storage temperature range	-40	+85	°C
TPS PWM input, Digital 1, 2 and 3 inputs, Enable input (Pins 6, 25, 26, 7 and 3)				
V_{DIN}, V_{EIN}	Digital input voltage, Enable input voltage	-0.5	+7.0	V
Analog TPS input and Analog 3 (Pins 21 and 8)				
$V_{AIN\ 1}$	Analog input voltage	-0.3	+5.1	V
Analog 1 and UEGO (Pins 19 and 4)				
$V_{AIN\ 2}$	Analog input voltage	-0.5	+7.0	V
RS232 mode (Pin 17)				
$V_{MODE\ IN}$	RS232 mode input voltage	-1.5	+6.3	V
Drivers 1 to 8 (Pins 18, 31, 45, 46, 41, 43, 33, 35)				
V_{ESD}	ESD rating as per Mil-Std-883C, method 3015, using the human body model *Note 3*	5		kV
Pump+, Pump- outputs (Pins 47 and 48)				
V_{ESD}	ESD rating as per Mil-Std-883C, method 3015, using the human body model *Note 3*	4		kV
All other pins				
V_{ESD}	ESD rating as per Mil-Std-883C, method 3015, using the human body model *Note 3*	2		kV

6. Power Schematics:

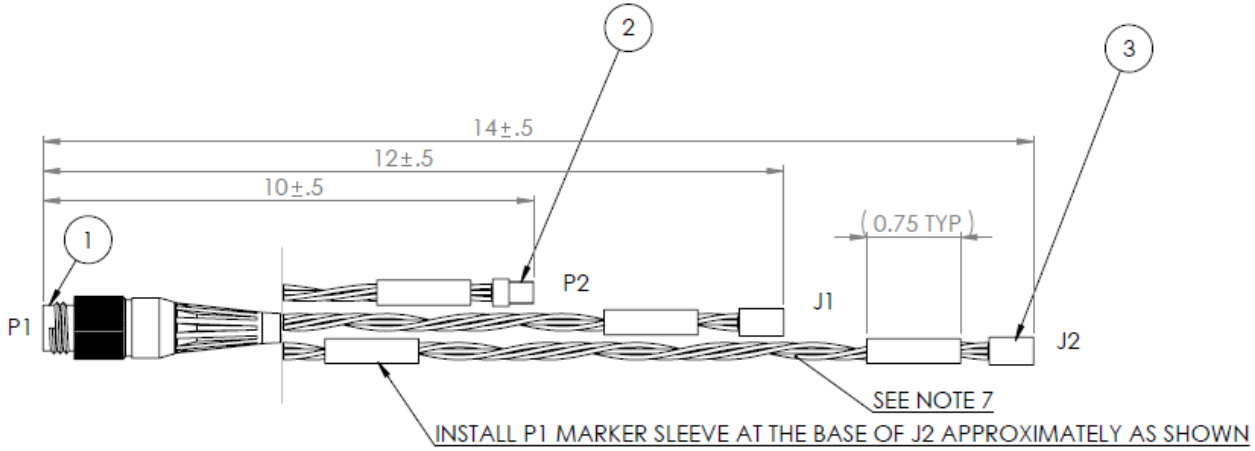
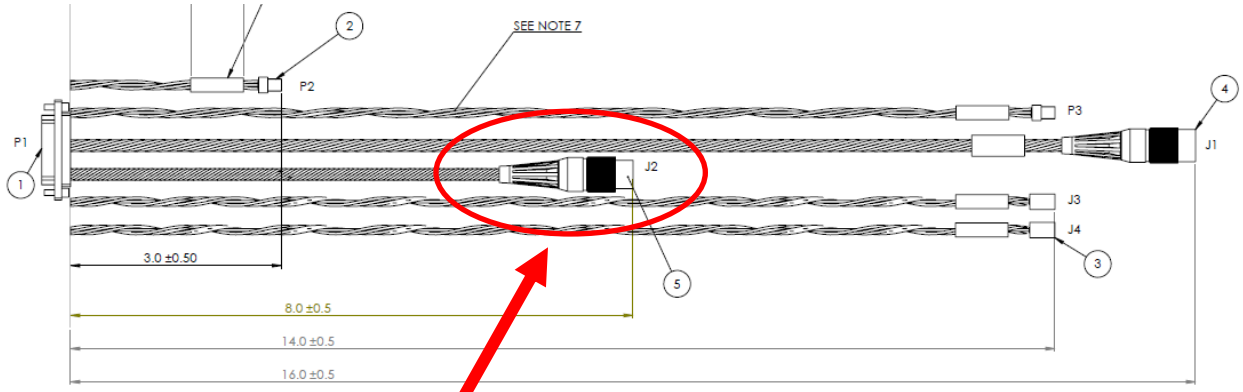


TABLE 2

FROM	TO	SIGNAL
P1-1	P2-3	SERVO +5V
P1-2	P2-1	GND
P1-3	P2-2	TPS PWM IN
P1-4	J1-1	INJ +
P1-5	J1-3	INJ -
P1-6	J2-1	GND
P1-7	J2-5	MAT
P1-8	NC	
P1-9	NC	
P1-10	NC	
P1-11	NC	
P1-12	NC	

The wiring held within the air cleaner assembly driving the throttle servo, fuel injector and manifold temperature readings.

FROM	TO	SIGNAL
P1-1	J2-7	RS232 TX
P1-2	J2-8	RS232 RX
P1-3	J2-9	ENABLE
P1-4	NC	UEGO
P1-5	J3-5	IGNITION
P1-6	J2-12	TPS PWM IN
P1-7	NC	DIGITAL 3
P1-8	NC	ANALOG 3
P1-9	NC	GND
P1-10	P3-2	CRANK
P1-11	NC	GND
P1-12	J1-3	TPS PWM OUT
P1-13	J2-6	CAN L
P1-14	J2-5	CAN H
P1-15	P3-1	GND
P1-16	J1-6	GND
P1-17	J2-11	RS232 MODE
P1-18	NC	DRIVER 1
P1-19	NC	ANALOG 1
P1-20	J1-4	INJECTOR PWR 1
P1-21	NC	ANALOG TPS IN
P1-22	NC	INJECTOR PWR 2
P1-23	J4-4	CHT
P1-24	J1-7	MAT
P1-25	NC	DIGITAL 1
P1-26	NC	DIGITAL 2
P1-27	NC	CAM
P1-28	NC	GND
P1-29	J4-1	GND
P1-30	J1-2	THROTTLE SERVO GND
P1-31	NC	DRIVER 2
P1-32	J3-1	IGNITION GND
P1-33	NC	DRIVER 7
P1-34	NC	INJECTOR 2
P1-35	NC	DRIVER 8
P1-36	J2-1	VIN
P1-37	J2-3	VIN
P1-38	J2-2	SUPPLY GND
P1-39	J2-4	SUPPLY GND
P1-40	J2-10	GND
P1-41	NC	DRIVER 5
P1-42	P3-3	CRANK +6V OUT
P1-43	NC	DRIVER 6
P1-44	P3-4	CAM
P1-45	NC	DRIVER 3
P1-46	NC	DRIVER 4
P1-47	P2-2	PUMP -
P1-48	P2-1	PUMP +
P1-49	J1-1	THROTTLE SERVO +6V
P1-50	J3-3	IGNITION POWER +6V
P1-51	J1-5	INJECTOR 1



Aircraft Omnetics 12 Socket #5

J2 pin	Description
1	V IN
2	SUPPLY GND
3	V IN
4	SUPPLY GND
5	CAN H
6	CAN L
7	RS232 TX
8	RS232 RX
9	ENABLE
10	GND
11	RS232 MODE
12	TPS PWM IN

P1- ECU Connection

J1- connects to the bottom rear of throttle body base plate.

J2- connects to aircraft avionics circled in RED. Programming harness also shares this connector for test running the engine without power from the aircraft.

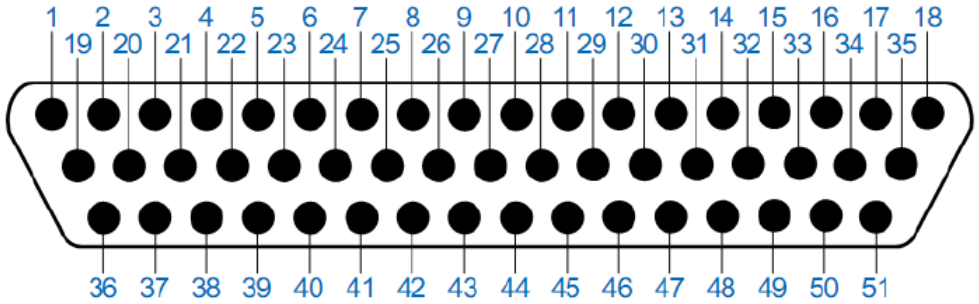
P2- provides Fuel Pump control

P3- Crank position

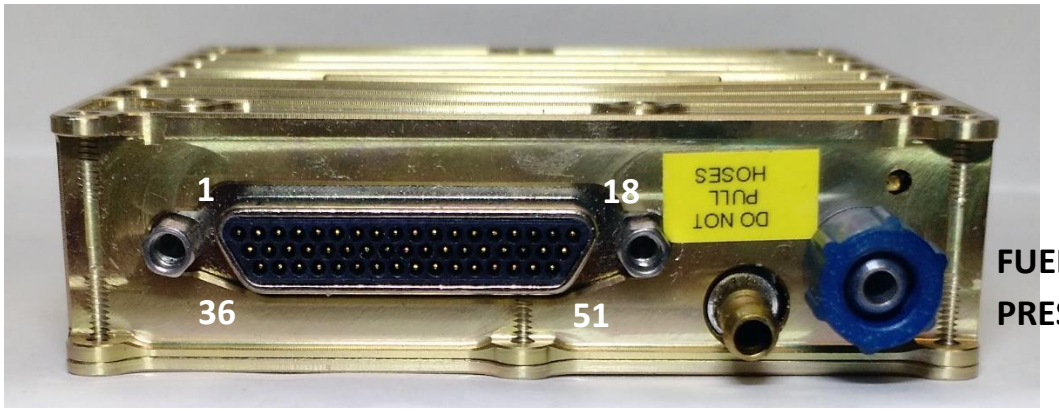
J3- Ignition power and trigger signal

J4- Cylinder Head Temperature

The figure below shows the pin output from the ECU on P1.



This side view of the ECU shows where P1 is connected along with manifold pressure and fuel pressure lines.



Pin	Name	Colour	Description
1	RS232 TX	Black	RS232 level transmit output from the ECU. Can be routed internally to either the main or auxiliary processor using the RS232 MODE pin – see description for pin 17.
2	RS232 RX	Brown	RS232 level receive input to the ECU. Can be routed internally to either the main or auxiliary processor using the RS232 MODE pin – see description for pin 17.
3	ENABLE	Red	5V logic-level digital input. Must be driven above +5V (5V-20V) for the ECU to operate normally. The driving circuit must be able to overcome the internal 10kΩ pull-down to ground.
4	UEGO	Orange	Universal Exhaust Gas Oxygen sensor. This is a high input-impedance analog input. The applied signal must be in the range 0 to 5V.
5	IGNITION	Yellow	Ignition output pulse for triggering a Capacitor Discharge Ignition (CDI) unit. Output is nominally 0 and +6V via a 33Ω series resistor.
6	TPS PWM IN	Green	Throttle position servo 5V logic-level input. A Pulse Width Modulated (PWM) signal at nominally 50Hz with ON time ranging from 1 to 2ms corresponding to the desired throttle setting is expected. This pin has an internal 3.3kΩ pull-up to +5V.
7	DIGITAL 3	Blue	Uncommitted 5V logic-level input. This pin has an internal 3.3kΩ pull-up to +5V. Maximum switching frequency should not exceed 1kHz. Connects to RB1 of auxiliary processor via inverting Schmitt trigger.
8	ANALOG 3	Purple	Uncommitted analog input, 0 to 5V. This pin has an internal 100kΩ pull-down resistor, and is low-pass filtered with a cut-off frequency of approximately 150Hz. Connects to RA2 of auxiliary processor.
9	GND	Gray	Ground
10	CRANK	White	Crank pulse input from Hall effect sensor. A 5V logic-level digital signal is expected. This pin has an internal 3.3kΩ pull-up resistor.
11	GND	Black	Ground
12	TPS PWM OUT	Brown	Throttle position servo output. This output consists of a Pulse Width Modulated (PWM) signal of nominally 50Hz with an ON time ranging from 1 to 2 ms depending on the current throttle setting. Output is nominally 0 and 6V via a 33Ω series resistor.
13	CAN L	Red	Controller Area Network transceiver, low side (terminated with 120Ω to CAN H)
14	CAN H	Orange	Controller Area Network transceiver, high side (terminated with 120Ω to CAN L)
15	GND	Yellow	Ground
16	GND	Green	Ground

Pin	Name	Colour	Description
17	RS232 MODE	Blue	5V logic-level digital input. Pull to ground to internally route the RS232 TX and RS232 RX signals to the main processor. An internal 10kΩ pull-up to +5V defaults RS232 communications to the auxiliary processor.
18	DRIVER 1	Purple	Uncommitted high-side switched output. In concert with DRIVER 2, DRIVER 7 and DRIVER 8, this output may be configured to switch to either +6V or the unregulated input voltage. Controlled by RE0 of auxiliary processor.
19	ANALOG 1	Gray	Uncommitted analog input, 0 to 5V. This pin has an internal 100kΩ pull-down resistor, and is low-pass filtered with a cut-off frequency of approximately 150Hz. Connects to P0.2/ACH1 of main processor.
20	INJECTOR PWR 1	White	High-side injector driver output 1. Internally this pin is connected directly to the unregulated supply voltage (V_{IN}).
21	ANALOG TPS IN	Black	Analog throttle position signal input. An analog signal in the range 0 to 5V corresponding to the desired throttle setting is expected. This pin has an internal 100kΩ pull-down resistor.
22	INJECTOR PWR 2	Brown	High-side injector driver output 2. Internally this pin is connected directly to the unregulated supply voltage (V_{IN}).
23	CHT	Red	Cylinder Head Temperature input. Connect to the anode of a kty84/130 silicon temperature sensor (with its cathode grounded). The ECU will source current to the temperature sensor such that temperatures from -30 to +180° C can be measured.
24	MAT	Orange	Manifold Air Temperature input. Connect to the anode of a kty83 silicon temperature sensor (with its cathode grounded). The ECU will source an appropriate current to the temperature sensor.
25	DIGITAL 1	Yellow	Uncommitted 5V logic-level input. This pin has an internal 3.3kΩ pull-up to +5V. Maximum switching frequency should not exceed 1kHz. Connects to HSI.3/HSO.5 of main processor.
26	DIGITAL 2	Green	Uncommitted 5V logic-level input. This pin has an internal 3.3kΩ pull-up to +5V. Maximum switching frequency should not exceed 1kHz. Connects to HIS.2/HSO.4 of main processor.
27	CAM	Blue	Cam pulse input from Hall effect sensor. A 5V logic-level digital signal is expected. This pin has an internal 3.3kΩ pull-up resistor.
28	GND	Purple	Ground
29	GND	Gray	Ground
30	THROTTLE SERVO GND	White	This pin provides a dedicated ground connection for the +6V throttle servo power output (Pin 49). Internally this pin is connected directly to ground.

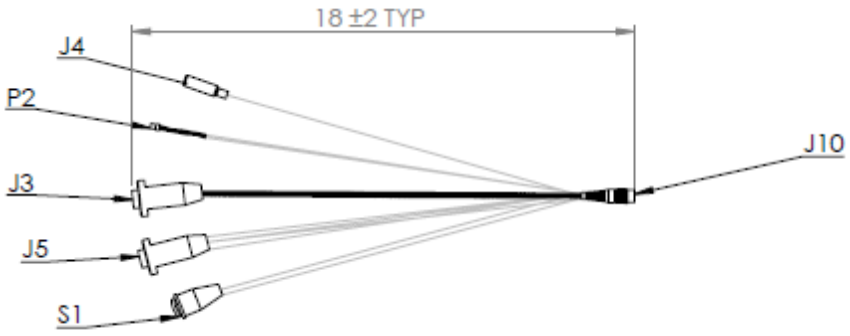
Pin	Name	Colour	Description
31	DRIVER 2	Black	Uncommitted high-side switched output. In concert with DRIVER 1, DRIVER 7 and DRIVER 8, this output may be configured to switch to either +6V or the unregulated input voltage. Controlled by RE1 of auxiliary processor.
32	IGNITION GND	Brown	This pin provides a dedicated ground connection for the +6V ignition power output (Pin 50). Internally this pin is connected directly to ground.
33	DRIVER 7	Red	Uncommitted high-side switched output. In concert with DRIVER 1, DRIVER 2 and DRIVER 8, this output may be configured to switch to either +6V or the unregulated input voltage. Controlled by RD5 of auxiliary processor.
34	INJECTOR 2	Orange	Low-side injector driver output. The peak-hold injector drivers are configurable to 4/1.6 or 2/0.8 Amps.
35	DRIVER 8	Yellow	Uncommitted high-side switched output. In concert with DRIVER 1, DRIVER 2 and DRIVER 7, this output may be configured to switch to either +6V or the unregulated input voltage. Controlled by RD6 of auxiliary processor.
36	VIN	Green	Positive terminal of the main power supply input. Both pins 36 and 37 must be connected.
37	VIN	Blue	Positive terminal of the main power supply input. Both pins 36 and 37 must be connected.
38	SUPPLY GND	Purple	Negative (ground) terminal of the main power supply input. Both pins 38 and 39 must be connected.
39	SUPPLY GND	Gray	Negative (ground) terminal of the main power supply input. Both pins 38 and 39 must be connected.
40	GND	White	Ground
41	DRIVER 5	Black	Uncommitted high-side switched output. In concert with DRIVER 3, DRIVER 4 and DRIVER 6, this output may be configured to switch to either +6V or the unregulated input voltage. Controlled by the main processor.
42	CRANK +6V OUT	Brown	+6V power supply output for a Crank Hall effect sensor. Maximum continuous load of 50mA.
43	DRIVER 6	Red	Uncommitted high-side switched output. In concert with DRIVER 3, DRIVER 4 and DRIVER 5, this output may be configured to switch to either +6V or the unregulated input voltage. Controlled by the main processor.
44	CAM +6V OUT	Orange	+6V power supply output for a Cam Hall effect sensor. Maximum continuous load of 50mA.
45	DRIVER 3	Yellow	Uncommitted high-side switched output. In concert with DRIVER 4, DRIVER 5 and DRIVER 6, this output may be configured to switch to either +6V or the unregulated input voltage. Controlled by the main processor.

Pin	Name	Colour	Description
46	DRIVER 4	Green	Uncommitted high-side switched output. In concert with DRIVER 3, DRIVER 5 and DRIVER 6, this output may be configured to switch to either +6V or the unregulated input voltage. Controlled by the main processor.
47	PUMP-	Blue	Complementary (with PUMP+) switched voltage output for the high-pressure pump. Switches between the unregulated input voltage (V_{IN}) and ground.
48	PUMP+	Purple	Complementary (with PUMP-) switched voltage output for the high-pressure pump. Switches between the unregulated input voltage (V_{IN}) and ground.
49	THROTTLE SERVO +6V	Gray	+6V power supply output for a throttle servo. Maximum of 1 Amp continuous, 2 Amps peak.
50	IGNITION PWR +6V	White	+6V power supply for a Capacitor Discharge Ignition (CDI) unit. Maximum of 1 Amp continuous, 2 Amps peak.
51	INJECTOR 1	Black	Low-side injector driver output. The peak-hold injector drivers are configurable to 4/1.6 or 2/0.8 Amps.

Connector pins descriptions

(OPTIONAL) Programming Harness

Programming Harness is included for initial set up and testing in or out of the aircraft. Providing 12 to 18 volts with 2.0A or greater capabilities to J4 will be enough to power the ECU. Sending a PWM signal (900 µs to 2100 µs) to P2 will determine commanded throttle position. J3 provides access to RS232 communication line to the ECU. J5 provides access to the CAN bus to the ECU.



CONNECTOR	MARKING INFO
J10	66209-HFE0169-REV A SN:[XXXX]
S1	RS232-MODE
J3	RS232
P2	SERVO CONTROL
J5	CAN
J4	POWER 12-18V (1.5 A) CENTER POST +

7. Interface Control Documents:

RS232 Serial

Note: This section contains limited information about the communication spec. A full communication document can be provided upon request.

The Engine Control Unit (ECU) developed by Currawong Engineering provides two communication interfaces which provide telemetry data and control of various ECU functions. Serial (RS232) and CAN (Controller Area Network) interfaces are available for custom avionics software, with a comprehensive command set provided for each interface.

This document details communication specifications for interfacing with the auxiliary processor on the ECU. For communication with the auxiliary processor, the ECU must be placed in auxiliary mode. Refer to the ECU manual for further information.

Note that communication with the auxiliary processor follows the big-endian format. If information is spread over multiple bytes in a given packet, then the MSB (most significant byte) is sent first, followed by bytes of increasingly lower significance.

For example, the value 0xFE12BC would be sent as three separate bytes, in the following order:

Byte	Description	Value
0	Data_2	0xFE
1	Data_1	0x12
2	Data_0	0xBC

All packets transmitted over the serial interface (both input and output) follow a common format, as given in Table 2. Note that multi-byte values are always sent with the most significant byte first, in big-endian byte order. Where needed, bits are identified with the most significant (i.e. left most) bit as 0 and the least significant bit of a byte as 7.

Byte	Name	Description
0	SYNC_0	Synchronization character used to signal the receiving state machine that a packet *may* be forthcoming. Must be 0xA5.
1	SYNC_1	Second synchronization character used to signal the receiving state machine that a packet *may* be forthcoming. Must be 0x5A.
2	Serial_Number_1	Most and least significant byte of the serial number of the ECU board. Packets sent to an ECU must contain the correct serial number, or the broadcast address 0xFFFF.
3	Serial_Number_0	
4	Packet_Type	The packet type defines how to interpret the data contents of the packet. See Table 3 for a list of valid packet types.
5	Size	The number of data bytes in the packet.
6 → Size+5	Data	Data bytes
Size + 6	Checksum_0	Most and Least significant byte of the Fletcher's checksum. The checksum applies to bytes 0…Size+5. The ECU will not accept a packet without a valid checksum.
Size + 7	Checksum_1	

Each packet must begin with the two byte sequence "0xA5 0x5A". After these two synchronization bytes are transmitted, the serial number of the ECU is transmitted. The ECU will only accept packets addressed with the correct serial number.

The packet then contains a byte describing the type of data being transmitted, and the number of data bytes included.

After this metadata, the appropriate number of data bytes are included. The packet is terminated with a two byte checksum, calculated using Fletcher"s algorithm

This table shows the different packet types which can be specified in the Packet Type field (byte 4) in the serial packet structure. Each of these packet types are discussed further in this document.

ID	Name	Dir	Description
0x00	TELEMETRY	Out	ECU telemetry, transmitted at 6Hz
0x01	THROTTLE_CALIBRATION	Both	Throttle calibration data, sent to or requested from the ECU
0x02	THROTTLE	In	Throttle position command, send to ECU
0x03	THROTTLE_COMBINED	In	Throttle command plus servo pulse width sent to the ECU
0x04	RPM_LOOP_COMMAND	In	RPM command sent to the ECU for RPM governor operation
0x05	RPM_LOOP_CALIBRATION	Both	RPM governor control loop calibration parameters, either sent to or requested from the ECU
0x06	HARDWARE_CONFIG	Both	Hardware configuration data to be applied to or received from the ECU
0x07	TPS_DELAY	Both	TPS delay calibration, sent to or requested from the ECU
0x08	SN_REQUEST	In	Command the ECU to request serial number from Autronic Processor
0x09	PUMP_CONFIG	Both	Pump control configuration packet
0x0A	ERROR_MSG	Both	Error messages from Autronic processor
0x0B	SOFTWARE_VERSION	Both	ECU Software version information
0x0C	POWER_CYCLES	Both	Information on the number of ECU power cycles
0x0D	PUMP_2_CONFIG	Both	Second pump control configuration packet
0x0E	PUMP_DEBUG	Both	Pump control debug information
0x0F	TOTAL_ENGINE_TIME	Both	Engine running time information
0x14	SYS_MSG	In	Packet for sending byte commands to ECU

Fletcher's Checksum

Fletcher's checksum is a computationally cheap method of creating a bit pattern specific to the contents of a group of data. It is much more robust than the more common summation of all bytes checksum since it can detect byte re-ordering and the insertion or deletion of zero bytes. An algorithm in C is given below for computing the checksum on a sequence of 8 bit numbers.

```
#typedef UInt16 unsigned short
#typedef UInt8 unsigned char

UInt16 fletcher_encode( UInt8* buffer, int count )
{
      int i;
      UInt8 c0 = 0;
      UInt8 c1 = 0;
      UInt16 Checksum;

      // Calculate checksum intermediate bytes
      for ( i = 0; i < count; i++)
      {
            c0 = (UInt8)(c0 + *( buffer + i ));
            c1 = (UInt8)(c1 + c0);
      }// for all the bytes

      // Assemble the 16-bit checksum value
      Checksum = (UInt8)(c0 - c1);
      Checksum = Checksum << 8;           // MS byte
      Checksum |= (UInt8)(c1 - 2*c0);     // LS byte

      return Checksum;

}// fletcher_encode
```

The telemetry packet is sent at a rate of 6 Hz and contains all of the regularly reported information from the ECU.

Byte	Name	Description
0	ThrottlePos	8-bit unsigned position of the throttle. The throttle position value ranges from 0 (throttle at min limit, i.e. closed) to 255 (throttle at max limit, i.e. wide open).
1	RPMCmd	8-bit unsigned RPM command in units of 50 RPM per bit (0 – 12750). This field has no meaning if bit 12 of ThrottlePulse is not set.
2	ThrottlePulse_1	16-bit field defined as: (where 0 is LSB and 15 is MSB)
3	ThrottlePulse_0	B0 – B11 – Throttle pulse width sent to the servo in units of micro-seconds B12-B15 – These 4 bytes represent the throttle pulse source 0x0 – Invalid Throttle Source 0x1 – RPM Governor 0x2 – Digital Throttle Input 0x4 – Serial Input 0x8 – CAN Input 0xF – Analog Throttle Input
4	RPM_1	16-bit unsigned RPM reading.
5	RPM_0	
6	CHT_A	8-bit unsigned cylinder head temperature for cylinder A from -10ºC (0x0) to 244ºC (0xFE). 0xFF is reserved to indicate no reading.
7	Status	8-bit field defined as: (where 0 is LSB and 7 is MSB) B0 – Enabled status of ECU. 1 = Enabled, 0 = Disabled B1 – Error status (Autronic processor). 1 = Autronic processor in error state. B2 – RS232 Mode. 0 = Auxiliary processor, 1 = Autronic processor B3 – Unused B4 – Status of Driver 1 Pin (1 = ON, 0 = OFF) B5 – Status of Driver 2 Pin (1 = ON, 0 = OFF) B6 – Status of Driver 7 Pin (1 = ON, 0 = OFF) B7 – Status of Driver 8 Pin (1 = ON, 0 = OFF)
8	Baro_1	16-bit unsigned barometric pressure reading in units of 2 Pascals (0 to 131070 Pa).
9	Baro_0	
10	MAP_Ratio	8-bit unsigned Ratio of manifold pressure to barometric pressure in units of 1/100th. I.e. 77 indicates a manifold pressure equal to 77% of the barometric pressure.
11	IAT	8-bit signed inlet air temperature in degrees Celsius (-128 to 127).
12	FuelPress_1	16-bit unsigned fuel rail pressure in units of 20 Pascals/bit (0 to 1,310,700 Pa) [0 to 190 psi]
13	FuelPress_0	
14	FuelUsed_3	32-bit unsigned fuel used value. This number is dimensionless and should be used to calibrate fuel consumption in units of choice (grams, milliliters etc). Data is persistent even when ECU is reset (with capacitor backup).
15	FuelUsed_2	
16	FuelUsed_1	
17	FuelUsed_0	
18	EngineTime_2	24-bit engine time counter in units of seconds. This counter value only accumulates when the RPM reading is non-zero. Data is persistent even when ECU is reset.
19	EngineTime_1	
20	EngineTime_0	
21	InputVoltage	8-bit unsigned input voltage to the ECU in units of 0.1 Volts per bit.
22	CustomerID_1	16-bit unsigned customer ID. This ID number can be set with the HARDWARE_CONFIG packet.
23	CustomerID_0	

Serial Throttle Commands

The throttle command packet simply sets the throttle command. The ECU will generate the pulse width and TPS signal needed to respond to this command. The pulse width is determined from a simple linear calibration giving the minimum and maximum pulse width of the throttle servo.

Byte	Name	Description
0	ThrottleCmd	8-bit unsigned commanded position of the throttle. The throttle position value ranges from 0 (throttle at min limit, i.e. closed) to 255 (throttle at max limit, i.e. wide open).
1	Reserved	Reserved, set this value to zero

CAN BUS

CAN is a multi-drop 2-wire differential serial bus, typically used for automotive applications. The CAN protocol provides a well-defined datalink layer that includes frame identification and validation. A CAN frame can have from 0 to 8 bytes of data. The CAN interface used in the ECU is based upon CAN 2.0b, i.e. CAN frames have a 29-bit identifier associated with them.

Interpretation of the CAN ID

Each CAN message is preceded by the 29-bit CAN ID, which specifies the direction (to or from a particular ECU), the message type, and the serial number of the ECU associated with the message.

The 29-bit CAN ID is interpreted as follows:

Bit	Group	Description
28	5-bit group ID from 0 to 31	The group ID identifies the category of device that this CAN frame came from or goes to. The group ID for frames coming from the ECU is 8. For frames going to the ECU it is 9.
27		
26		
25		
24		
23	8-bit frame type from 0 to 255	The frame type identifies the contents of the CAN frame, similar to the packet type used in the serial interface. See Table 23 for a list of frame types.
22		
21		
20		
19		
18		
17		
16		
15	16-bit serial number from 0 to 65534	The serial number of the ECU. For Group ID = 8 this identifies the specific ECU that generated this CAN frame. For Group ID = 9 this identifies the ECU that should process this message. Note that 0xFFFF (65535) can be used for the serial number to indicate a broadcast frame that all ECUs on the bus should process.
14		
13		
12		
11		
10		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		

CAN Frame Types

The available packet types are shown below in Table 23. These values are used in bits 5-12 of the CAN ID to indicate the type of message being transmitted.

ID (Hex)	Name	Dir	Description
0x00	CAN_TELEMETRY_FAST	Out	High priority telemetry data from the ECU for user consumption.
0x01	CAN_TELEMETRY_SLOW_0	Out	Basic telemetry from the ECU for user consumption.
0x02	CAN_TELEMETRY_SLOW_1	Out	Basic telemetry from the ECU for user consumption.
0x05	CAN_THROTTLE_CALIBRATION	Both	Throttle calibration sent to the ECU, or requested from the ECU.
0x06	CAN_THROTTLE	In	Throttle command sent to the ECU.
0x07	CAN_THROTTLE_COMBINED	In	Throttle command plus servo pulse width sent to the ECU.
0x08	CAN_RPM_LOOP_COMMAND	In	RPM command sent to the ECU for RPM governor operation.
0x09	CAN_RPM_LOOP_CALIBRATION	Both	RPM governor PID gains and operating limits, either sent to or requested from the ECU.
0x0A	CAN_HARDWARE_CONFIG	Both	Hardware configuration data to be applied to or received from the ECU.
0x0B	SOFTWARE_VERSION	Both	ECU Software version information
0x0C	CAN_TPS_DELAY	Both	Configuration of TPS delay. Either sent to or request of the ECU
0x0D	CAN_SN_REQUEST	In	Command the ECU to request serial number from Autronic
0x0E	CAN_PUMP_CONFIG	Both	Pump control configuration packet
0x0F	CAN_ERROR_MSG	Both	Error messages from Autronic processor
0x10	CAN_POWER_CYCLES	Both	Information on number of ECU power cycles
0x11	CAN_PUMP_2_CONFIG	Both	Second pump control configuration packet
0x12	CAN_PUMP_DEBUG	Both	Pump control debug information
0x13	CAN_TOTAL_ENGINE_TIME	Both	Engine running time information
0x14	CAN_SYS_CMD	In	Packet for sending byte commands to ECU

CAN Frames

While serial (RS232) transmission of messages to and from the ECU required extra synchronization, checksum and metadata relating to the number of data bytes, all this is automatically handled by the CAN protocol. A CAN frame is constructed simply from the CAN ID (29 bits) and then between 0 and 8 data bytes. Transmission control and determination of the number of data bytes is handled by CAN hardware.

Also, unlike the serial packet structure as discussed earlier in this document, each CAN frame is limited to 8 bytes of data. Therefore some of the packets have a different structure when transmitted over CAN

CAN_TELEMETRY_FAST

Since 8 bytes is not enough data to fit all of the telemetry into the data are split across multiple frames. The first frame (CAN_TELEMETRY_FAST) contains higher priority telemetry data and is sent upon reception of every packet from the ECU (about 20 Hz).

The other two frames contain the remaining data contained by the serial telemetry packet.

Byte	Name	Description
0	Throttle_Position	8-bit unsigned position of the throttle. The throttle position value ranges from 0 (throttle at min limit, i.e. closed) to 255 (throttle at max limit, i.e. wide open).
1	RPM_Hi	16-bit unsigned RPM reading.
2	RPM_Lo	
3	FuelUsed_3	32-bit unsigned fuel used since last reset in units of grams. If more than 4,294,967,295 units of fuel are used this number will roll over.
4	FuelUsed_2	
5	FuelUsed_1	
6	FuelUsed_0	
7	Status	8-bit field defined as: (where 0 is LSB and 7 is MSB) B0 – Enabled status of ECU. 1 = Enabled, 0 = Disabled B1 – Error status (Autronic processor). 1 = Autronic processor in error state. B2 – RS232 Mode. 0 = Auxiliary processor, 1 = Autronic processor B3 – Unused B4 – Status of Driver 1 Pin (1 = ON, 0 = OFF) B5 – Status of Driver 2 Pin (1 = ON, 0 = OFF) B6 – Status of Driver 7 Pin (1 = ON, 0 = OFF) B7 – Status of Driver 8 Pin (1 = ON, 0 = OFF)

Telemetry Fast Frame: Type 0x00

CAN_TELEMETRY_SLOW_0

This is the first of two slower telemetry frames which are transmitted by the ECU at a rate of 1Hz. These two frames contain data that is not likely to change as quickly as the data transmitted at a faster rate in the fast telemetry frame.

Byte	Name	Description
0	RPMCmd	8-bit unsigned RPM command in units of 50 of RPM per bit (0 – 12750). This field has no meaning if bit 12 of ThrottlePulse is not set.
1	ThrottlePulse_1	16-bit field defined as: (where 0 is LSB and 15 is MSB) B0 – B11 – Throttle pulse width sent to the servo in units of micro-seconds B12-B15 – These 4 bytes represent the throttle pulse source 0x0 – Invalid Throttle Source 0x1 – RPM Governor 0x2 – Digital Throttle Input 0x4 – Serial Input 0x8 – CAN Input 0xF – Analog Throttle Input
2	ThrottlePulse_0	
3	CHT	8-bit cylinder head temperature, range is from -10 (0) to 245 (255) degrees celcius.
4	Reserved	
5	Baro_1	16-bit unsigned barometric pressure reading in units of 2 Pascals (0 to 131070 Pa).
6	Baro_0	
7	MAP_Ratio	8-bit unsigned Ratio of manifold pressure to barometric pressure in units of 1/100th. I.e. 77 indicates a manifold pressure equal to 77% of the barometric pressure.

Telemetry Slow0 Frame: Type 0x01

CAN_TELEMETRY_SLOW_1

This is the second of the two slower telemetry frames, and contains the remainder of engine performance information.

Byte	Name	Description
0	IAT	8-bit signed inlet air temperature in degrees Celsius (-128 to 127).
1	FuelPress_1	16-bit unsigned fuel rail pressure in units of 20 Pascals/bit (0 to 1,310,700 Pa) [0 to 190 psi]
2	FuelPress_0	
3	EngineTime_2	24-bit engine time counter in units of seconds. This counter value only accumulates when the RPM reading is non-zero.
4	EngineTime_1	
5	EngineTime_0	
6	InputVoltage	8-bit unsigned input voltage to the ECU in units of 0.1 Volts per bit.
7	Status	8-bit field defined as: (where 0 is LSB and 7 is MSB) B0 – Enabled status of ECU. 1 = Enabled, 0 = Disabled B1 – Error status (Autronic processor). 1 = Autronic processor in error state. B2 – RS232 Mode. 0 = Auxiliary processor, 1 = Autronic processor B3 – Unused B4 – Status of Driver 1 Pin (1 = ON, 0 = OFF) B5 – Status of Driver 2 Pin (1 = ON, 0 = OFF) B6 – Status of Driver 7 Pin (1 = ON, 0 = OFF) B7 – Status of Driver 8 Pin (1 = ON, 0 = OFF)

Telemetry Slow1 Frame: Type 0x02

CAN_THROTTLE

The throttle command frame simply sets the throttle command. The ECU will generate the pulse width and TPS signal needed to respond to this command. The pulse width is determined from a simple linear calibration giving the minimum and maximum pulse width of the throttle servo.

Byte	Name	Description
0	ThrottleCmd	8-bit unsigned commanded position of the throttle. The throttle position value ranges from 0 (throttle at min limit, i.e. closed) to 255 (throttle at max limit, i.e. wide open).
1	Reserved	Reserved, set this value to zero

8. Technical Specifications

Throttle Body torque

25 in-lbs

Only use NGK CM-6 spark plugs.

Plug gap is .018" to .020" (.38 to .50 mm)

	Size	Torque
Spark plug:	CM-6, 10mm	90 in. lbs.
Steel prop bolts:	M5x 50mm	90 in. lbs. /carbon props.
Aluminum crankcase bolts:	M5x16mm	70 in. lbs.
Aluminum cylinder base bolts:	M5x16mm	60 in. lbs.
Steel cylinder base bolts:	M5x16mm	95 in. lbs.
Steel motor mount bolts:	M6x16mm	120 in. lbs.

*Caution: Care must be taken to not over tighten the carb mounting bolts. Over tightening can distort and damage the injected molded reed valve parts and rubber gaskets.

9. Warranty

Thank you for choosing a Desert Aircraft Product.

Your Total satisfaction is our #1 priority.

If you have any questions on the installation and operation of this engine, please contact us directly. Please have your engine serial number on hand when calling for service.

Desert Aircraft Fuel Injected Engine Customer Service:

Phone: 520.722.0607
Email: UAV@Desertaircraft.com

1815 South Research Loop
Tucson, Arizona 85710
U.S.A

Engine Core Warranty

Your DA35/70 motor and ignition system are covered with a 3 year warranty by Desert Aircraft, starting from the date of purchase.

- This warranty covers defects in workmanship and materials only.
- Do not disassemble the motor or ignition system. Disassembly of the motor or ignition system can void the warranty on that item.
- Any modifications to the motor, or the ignition system, other than those authorized by Desert Aircraft, will void this warranty.

This warranty does not cover the following:

- Shipping expenses to and from Desert Aircraft for warranty service.
- Damage caused by improper handling, operation, or maintenance.
- Damage caused by a crash.
- Damage caused by using improper fuel or additives.
- Damage incurred during transit to Desert Aircraft. **WRAP AND PACK ENGINE CAREFULLY!!**

NOTE: *DESERT AIRCRAFT WILL NOT SHIP ANY WARRANTY REPLACEMENT ITEMS UNTIL POSSIBLY DEFECTIVE ITEMS IN QUESTION ARE RECEIVED BY DESERT AIRCRAFT.*

EFI System Warranty

Your Desert Aircraft EFI system is covered with a 30 day warranty by Desert Aircraft starting from the date of shipment from Desert Aircraft.

This warranty covers defects in workmanship and materials only to include Fuel Pump, wiring, ECU and throttle body.

Do not disassemble the ECU or Throttle Body assembly. Disassembly of the ECU or Throttle Body assembly will void the warranty on that item.

Any modifications to the ECU, or Throttle Body assembly, other than those authorized by Desert Aircraft, will void this warranty.

This warranty does not cover the following:

- Shipping expenses to and from Desert Aircraft for warranty service.
- Damage caused by improper handling, operation, or maintenance.
- Damage caused by a crash.
- Damage caused by using improper fuel or additives.
- Damage incurred during transit to Desert Aircraft.

NOTE: *DESERT AIRCRAFT WILL NOT SHIP ANY WARRANTY REPLACEMENT ITEMS UNTIL POSSIBLY DEFECTIVE ITEMS IN QUESTION ARE RECEIVED BY HFE INTERNATIONAL.*