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Oil Quantity Sensor for Aircraft Engines

PATENT PENDING

INSTALLATION and OPERATION MANUAL

Rev. - 2/27/2023

THANK YOU! . . . for purchasing our Oil Quantity Sensor from Aircraft Extras, Inc. Please review ALL instructions thoroughly before you install and program this product.

SUMMARY DESCRIPTION

This oil quantity sensor with its associated electronics package will give the pilot a real time oil quantity while in flight or on the ground. *This system is not meant to replace any other traditional methods of checking oil quantity.* It is a new device that the pilot of a small aircraft can use in flight that he or she never had before. It will also measure oil temperature if that option was selected at purchase. The electronics enclosure features two analog outputs, one for oil quantity and the other for oil temperature. It also features a four digital output alarms (open collector type) for sensor malfunction, oil level warning, oil level caution, and over oil temperature. You may program the alarm trigger values for those outputs and choose a scale for both analog outputs.

Presently, we have two types of oil sensors available, one for standard Lycoming engine oil pan fittings and the other for standard Continental engine oil pan fittings. The sensor will fit quite a number of engines, oil pans, oil sumps and oil containers. Presently, the length of sensors are custom built. The sensor's length must be determined by the customer at the time of purchase. Later, we plan to build them up ahead of time as we create a database of standard lengths ordered. A list of our available sensor fittings will be available in the purchase area on our Website. Sensors with other fitting types may already be in our design schedule.

INSTALLATION

INSTALLING the OIL QUANTITY SENSOR

The oil quantity sensor should be inserted into an existing threaded fitting in the bottom of your engine's oil pan. It can also be mounted in any other oil container, as long as the fitting threads are the same type. Refer to the list of fitting or thread types that are presently available. The sensor will not work if mounted horizontally. It can be oriented at a minimum angle from vertical. We suggest a maximum of 45° from vertical. The more vertical, the better the accuracy and repeatability. Always, use safety wire to lock the sensor fitting after torquing. The customer or installer will determine if the sensor will hit any obstruction within the oil pan.

INSTALLING the OIL QUANTITY SENSOR (from the TOP)

You may install the sensor from the top of your oil pan or oil container. Please be aware of two situations. First, the temperature sensor is mounted in the base of the sensor. This being the case, it will not give you an accurate oil temperature because it will not be immersed in the oil when less than full. Second, also be aware that when you calibrate the sensor by adding your quarts of oil, the sensor may not sense your lowest oil level. This is because your sensor tip may not extend to the bottom of your oil pan. For the sensor to be accurately calibrated, when you add your first quart of oil, the oil level must be between the sensor base and the sensor tip. If it is not, you might choose adding two quarts as your increment instead of a one quart increment. This may allow the oil level to be in between the sensor base and the sensor tip. It is up to the installer of customer to determine where your lowest oil level is for your installation.

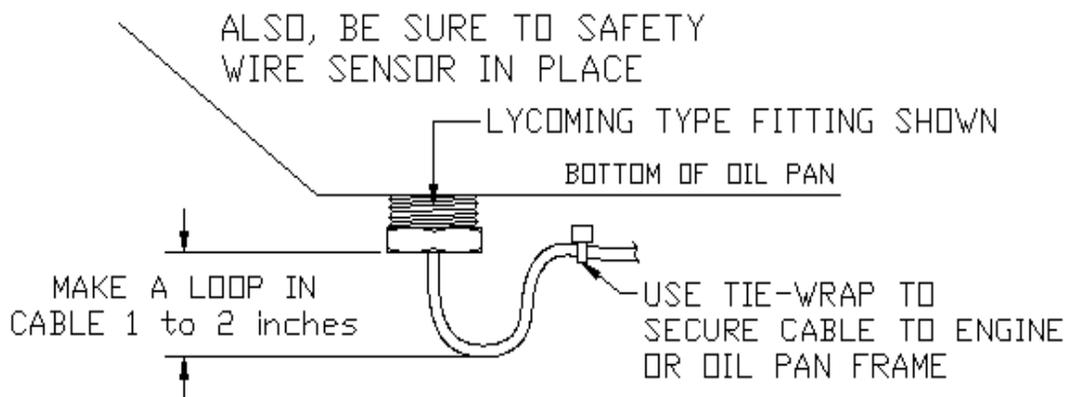
MOUNTING the ELECTRONICS ENCLOSURE

The associated electronics enclosure should be installed no further from the sensor than the length of the sensor cable will allow. We suggest that 4 ft. to be used as a maximum distance. The electronics enclosure is not hermetically sealed. The electronics will work best inside the cockpit rather than in the engine compartment. This is due to the more harsh environment of the engine compartment due to excessive vibration, and oil and gas contaminants. You "may" mount it in the engine compartment if, it can be mounted in an area that experiences a lower heat characteristic, minimum vibration, and as long as it is away from fuel and oil contamination.

SENSOR INTERCONNECTING CABLES

We provide one or two cables for each sensor. One is unmarked and is the oil quantity cable. The other cable, marked with a (RED BAND), is for the oil temperature if you selected that option at purchase. Make sure the cables are connected to the proper SMA connectors on the electronics. If they are connected backwards, it will not ruin anything. It just will not function properly.

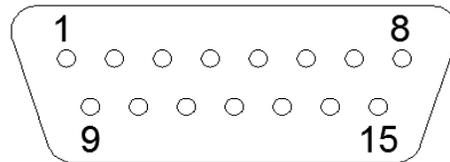
You should not alter the length of the cables. This will change the oil sensor's calibration and accuracy. The cables should only be shortened by making 3 inch diameter loops in the cables and tie-wrapping them to the aircraft chassis. Do not route the sensor cables near the exhaust pipes (allow 6" or more) or any other high temperature structures. If you have to route them in these areas, we suggest that they be protected by a heat shield. Details of this shielding is not covered in this manual.



ELECTRONICS WIRING

Review the wiring diagram included, along with the “Standard Aircraft Wiring Practices Guides”. Ref: FAA, AC 25-26. There are many others out there. All wires are low amperage wires and can be #20AWG to #24AWG. Fusing of the power in can be done with a 1/4 Amp fuse.

DSUB CONNECTOR REAR (SOLDER SIDE VIEW)



1 COMMON	9 OIL LEVEL ANALOG OUT
2 LED RED EXTERNAL	10 TEMP ANALOG OUT
3 LED GRN EXTERNAL	11 SENSOR MALFUNCTION ALARM
4 OIL LEVEL WARNING ALARM	12 DO NOT CONNECT !
5 OIL LEVEL CAUTION ALARM	13 OIL OVER TEMPERATURE ALARM
6 PB SWITCH EXTERNAL	14 DO NOT CONNECT !
7 DO NOT CONNECT !	15 DO NOT CONNECT !
8 (+9 to 30V) POWER IN	

(DO NOT CONNECT !) Damage to unit may occur!

CAUTION !!

To avoid electrical interference, avoid routing wiring for the oil quantity sensor electronics in the vicinity of your radio transmitter antenna cabling or the strobe light systems. This also includes devices such as the transponder, ADS-B or other types of RF transmitters, or devices that put transients on the +12V or 24V power bus.

DETAILED OVERVIEW

ALARMS

There are four digital alarm outputs. Each alarm output is in the form of an open collector transistor. These outputs can be connected to a number of different devices, or not used at all. You might want to rely on your EFIS or other systems to give you alerts for these alarms by using the analog outputs only. These outputs were mainly provided for installations without EFIS type of displays.

- Pin 5) Low Oil Level Caution Alarm (should be the higher oil level alarm)
- Pin 4) Low Oil Level Warning Alarm (should be the lowest oil level alarm)
- Pin 13) Over Oil Temperature Alarm
- Pin 11) Sensor Malfunction Alarm to indicate (a shorted sensor cable, out of programmed calibration range or sensor not connected)

OPEN COLLECTOR OUTPUTS

The alarm outputs are open collector type, which pull our electronics alarm pins down to common. If you are driving an LED, you will have to connect the LED anode to +V with a series resistor from the LED cathode. The other side of the resistor is wired to our alarm output pin.

If you are driving an EFIS display or similar, refer to your device's manual as how to handle an open collector output as an input to your device. In some cases, you may need to connect a pull up resistor from our alarm output pin to +V. If your device only accepts a voltage input, we suggest connecting a 5000 Ohm, 1/2W resistor from your +V bus voltage to one side of this resistor. Tie the other side of this resistor to our open collector alarm output and your device's voltage input.

LED INDICATOR

An LED is mounted on the electronics case, either on the top or on the side. It will be a RED/GREEN LED that will display a RED, GRN or YEL color. This LED will be used for programming and to let you know the electronics package is functioning normally by flashing GRN, approximately once every 4Sec.

LED BLINKING (in MODE 1)

NORMAL BLINKING - Blinks once GRN, then pauses for a longer time, then continuously repeats this. This is a normal operation indication meaning that the oil level sensor is working properly as programmed.

MALFUNCTION BLINKING - Alternately Blinking RED/GRN in equal time periods. This means that the the electronics package is sensing that the sensor is monitoring an oil level that is outside the normal programmed range. The sensor may be disconnected or wires shorted.

MALFUNCTION BLINKING - Blinking RED/GRN at intermittent or irregular time periods. This means that the the electronics package is sensing that the sensor has been disconnected or wires to it have been cut. It could be that the sensor is not properly connected to the electronics.

EXTERNAL (LED and PUSH BUTTON SWITCH)

If the electronics enclosure is mounted in an area not easily accessible in your aircraft, we have designed it so that you can connect an external LED and push button switch to program the unit. You will initially need to program the oil sensor quantity electronics package. Also, if you make a very different change in types of oils, you may want to reprogram the unit to achieve better accuracy for that oil type.

In the case where the electronics enclosure is mounted in a position where it is impracticable or hard to get to ,to perform these tasks, we have brought out 3 pins on the DSUB connector to aid in this situation. These pins are for the connection of a remote 2-color LED (RED, GRN) and push button switch. These pins parallel the LED and push button switch mounted on the electronics enclosure. Below is a diagram for wiring these remote devices.

MODES of OPERATION

There are several modes of operation. Modes 2 thru 5 are programming modes.

<u>Mode</u>	<u>Description</u>
1	Normal Operation - This is the mode at start-up. (if the push button is NOT pressed)
2	Programming of the oil levels for analog output linearization, (2 to 20 points) In this mode, you may also program the oil level alarms trigger values for the Caution and/or Warning oil levels.
3	Selects the alarm trigger value of the over temperature alarm (range 155°F to 295°F)
4	Selects the output scaling of the oil level (0 to 5V), (0.25V to 4.75V) or (0.5V to 4.5V)
5	Selects the output scaling of the oil temperature reading. (0 to 5V Out = -50 to 300°F), (0 to 5V Out = -33 to 300°F) or (0 to 5V Out = 0 to 300°F)

ENTERING A PROGRAMMING MODE

Make sure that the oil quantity sensor electronics package is off. While holding the programming button in, power up the unit. Release the button. You are now in the programming mode.

Notice the LED flashing YEL. By pressing the button, (with one short press at a time) you can now toggle thru the operating modes that you want to select. The operating mode you want to enter will be indicated by the yellow flashing LED. It will flash the number of times corresponding to the operating mode you want to enter next. This will keep repeating until you power down. When powered up again, the unit will enter the programming mode that you selected.

NOTE:

If you select Operating Mode 1, and you did not yet program the oil levels in using Operating Mode 2, the unit will not start up in the Normal Operating Mode 1. It will automatically start up in Operating Mode 2, to force you to program the oil levels.

PROGRAMMING an OIL LEVEL ALARM LEVEL (in Mode 2)

Again, programming the oil level alarm trigger values is optional as stated above. If you decide to program them, you **MUST** program these alarm values when you are in the process of adding your quarts of oil in Mode 2, (Step 10) in the procedure called "PROGRAMMING the OIL QUANTITY LINEARITY" below. You should do this as you are adding oil to linearize your oil level output.

There are two open collector transistor outputs provided for oil level alarms. They are pulled down to common when your oil level goes below your alarm trigger value. One output is for a Caution oil level. The other level is a Warning oil level. You do not have to program both of these alarm trigger values. You can only program one of them if you desire. You also have a choice of not programming or using these oil level alarms at all.

If you do program both oil level alarms, you should program the Warning oil level first being that it should be the lowest oil level. The Caution oil level should be programmed later, as it should be a higher oil level.

NOTE: When entering Mode 2 for programming the oil level points, all previously programmed alarms will be automatically erased.

NOTE: Before you program any of these alarm levels, you must make sure that that your engine manufacturer approves that your engine can operate safely in the air at those oil levels.

BUTTON PRESSES for PROGRAMMING the Oil Level Alarm Trigger Levels.

WARNING oil level alarm

■ 1 button press > 1.0Sec will store this oil level alarm trigger value. The LED will blink RED slower, (6 times in 2.4 Sec.) to acknowledge that you succeeded, then return to Mode 2 blinking.

CAUTION oil level alarm

■ ■ 2 consecutive button presses > 1.0Sec will store this oil level alarm trigger value. The LED will blink YEL slower, (6 times in 2.4 Sec.) to acknowledge that you succeeded, then return to Mode 2 blinking.

PROGRAMMING the OIL QUANTITY LINEARITY (in MODE 2)

The analog output for the oil quantity of this device is not always linear. This is the reason the electronics package is designed to be user programmable. The reason for this is, the oil pans or oil sumps are all different shapes and the oil sensor is not always linear. This being the case, the oil quantity sensor output will not be linear with each increment or oil quantity added to the oil pan. This being the case, the output will need to be linear if it is to be displayed on a linear gauge. The same goes for the signal sent into an EFIS system. The user will be able to linearize the output for each quantity (Example: Quarts) of oil added to an empty oil sump. This will be accomplished by emptying all of the oil out of the oil pan, then adding one quart of oil at a time while running this linearization programming routine as described below.

FIRST TIME SENSOR INSTALLATIONS

If you are installing the sensor for the first time, it has never had oil in it. The sensor is most sensitive at the lower oil levels than higher levels. Also, when you drain all of the oil out for an oil change, a bit of oil may remain in the very bottom of the sensor or even remain in the bottom of the oil pan. If this is the case, we want to call this level, a "zero oil level".

In order to obtain the best accuracy during oil level programming, you will need to simulate an oil change to get the sensor wet before you program it for the first time. We suggest installing the sensor, then plug up the oil pan. After that, add a quart or two of oil to the engine. Next, allow time to drain all of that oil out. Plug up the oil pan again, then proceed to program the oil levels as you add oil in Mode 2.

MODE 2 LED BLINKING

To program in Mode 2, you will need to understand the LED blinking. When entering Mode 2, the unit will blink twice and pause. This will repeat. The color of the light will indicate the stability of the oil level reading.

If the oil level is stable, it will blink twice GRN.

If the oil level is rising, it will blink twice RED.

If the oil level is falling, it will blink twice YEL.

This gives you an indication of the stability of your oil level when you are adding your quarts of oil for linearization. It takes time before the oil level is stable after adding a quart to your sump. When Programming in Mode 2, you **SHOULD NEVER** press the push button in Mode 2 unless the LED is flashing GRN twice. We even suggest a time period of 1 minute after the LED has returned to GRN. This indicates the best oil level stability. You do not want to press the program button if your quart is still slowly rising or falling in your oil sump. Please note, if you are programming in Mode 2 when it is cold, the oil level may take longer to settle.

STEPS to PROGRAM MODE 2

The user/installer can easily program this oil quantity linearization when changing engine oil. This only need to be accomplished once unless you change your oil type. You may accomplish this as follows:

- 1 Put your plane in either a "level flight attitude" or a normal attitude that the aircraft is in when you normally check oil. It is your choice. We recommend a "level flight attitude".
- 2 Empty all oil from the oil pan via the drain plug.
- 3 Close or plug all of the oil pan's drain holes.
- 4 Power up the electronics. Enter the linearization programming mode (Mode 2).
NOTE: All previous programming of the oil level points and all previously programmed "oil level alarms" will be automatically erased upon entering Mode 2.
- 5 Wait for the unit to stabilize. This will be indicated by the LED flashing twice, and turning GRN.
- 6 Press the programming button once to store the "NO OIL" or first point. The unit will respond by the LED flashing fast YEL, then returning to a double blink.
- 7 Add one quart of oil to the oil pan.
- 8 Wait for the oil to settle and the sensor output to be stable. We suggest waiting 1 minute after LED flashes GRN)
- 9 Press the programming button once (< 0.8Sec) to store the first oil level point.
The unit should respond by flashing YEL very fast.
- 10 **NOTE: *If you want to program an Oil Level "Caution" or "Warning" alarms, you will need to do it here, and/or before you program your last quart. Press the button (> 1.0Sec.) for the Warning Level or two consecutive presses (> 1.0 Sec.) for the Caution Level. The LED will respond by flashing (RED, Warning) or (YEL Caution). For details, see: PROGRAMMING an OIL LEVEL ALARM LEVEL***
- 11 Add another quart of oil to the oil pan.
- 12 Wait for the oil to settle and the sensor output to be stable. We suggest waiting 1 minute after LED flashes GRN)
- 13 Press the programming button once (< 0.8Sec) to store the next oil level point.
The unit should respond by flashing YEL very fast.
- 14 Repeat steps (10 thru 13) until you have done this for the last quart is added.
- 15 Make sure that you have pressed the button after the last quart was added, but only once!
- 16 Turn power off. When powered up again, the unit should be in Mode 1 and functioning normally with your programmed values.

CHECKING YOUR PROGRAMMING

The oil quantity output signal should be nearly linear now, depending upon the number of points that you programmed. The oil level alarms should trigger at the levels you programmed. To guarantee that you have done it correctly, drain the oil and add the quarts again to see if the output is linear, and if the alarms are triggered where you programmed them.

SENSOR or CONNECTION MALFUNCTION (in MODE 1)

After the successful programming in Mode 2, the electronics will now perform as follows in Mode 1. If the sensor is performing normally, the LED should slowly blink one time GRN, then pause, then continuously repeat.

If the electronics senses the sensor, or the connection to the sensor, has malfunctioned, two things will happen. The first thing that will happen, is that an open collector output (DSUB connector pin 11) will be pulled down to common. The second thing that will happen, is that the Oil Level Analog Output will go to zero, (DSUB connector pin 9). You may use this zero voltage reading as an alarm indication if you select an output scaling as (0.25V to 4.75V) or (0.5V to 4.5V). This output will also go to zero if you are using the (-50 to 300°F) scaling. You can use this for an alarm indication as well and program your EFIS or other device to recognize this as an alarm if you don't utilize our four digital output alarms.

ALSO, see LED BLINKING (in MODE 1) for further failure indications.

PROGRAMMING the Over Temperature Alarm Value (in MODE 3)

In order to program an alarm oil temperature value, please study the following table. You will be able to select a temperature value by interpreting the number of RED and GRN LED flashes while in Mode 3. This value is incremented in 5°F steps. If you just want to check what this value is, you may enter Mode 3 without pressing the programming button. After checking the LEDs, simply turn the unit off.

OIL OVER TEMPERATURE ALARM CHART (Programming in Mode 3)

		Numb of Blinks				Numb of Blinks	
ALARM	ALARM	LED	LED	ALARM	ALARM	LED	LED
TEMP °F	TEMP °C	RED	GRN	TEMP °F	TEMP °C	RED	GRN
155	68.3	0	1	230	110.0	3	1
160	71.1	0	2	235	112.8	3	2
165	73.9	0	3	240	115.6	3	3
170	76.7	0	4	245	118.3	3	4
175	79.4	1	0	250	121.1	4	0
180	82.2	1	1	255	123.9	4	1
185	85.0	1	2	260	126.7	4	2
190	87.8	1	3	265	129.4	4	3
195	90.6	1	4	270	132.2	4	4
200	93.3	2	0	275	135.0	5	0
205	96.1	2	1	280	137.8	5	1
210	98.9	2	2	285	140.6	5	2
215	101.7	2	3	290	143.3	5	3
220	104.4	2	4	295	146.1	5	4
225	107.2	3	0	NO ALARM		6	0

Programming Steps (in Mode 3)

- 1 Enter Mode 3 as described under "Entering Programming Mode".
- 2 Press the button < 0.8Sec once, to increment the Over Temperature value by 1.
or Press the button > 0.8Sec once, to increment the Over Temperature value by 50.
- 3 Note the number of RED/GREEN flashes and refer to the table. If you have not achieved your desired value, repeat step2.
- 3 After you obtain the correct number of RED/GREEN flashes, turn the unit off.
- 4 When powered on again, it will start up in Mode 1. It will remember your selected value.

PROGRAMMING the Oil Level Output Scaling (in Mode 4)

- A button press (< 0.8Sec) will toggle thru these settings

1 = (No oil to full oil as programmed) = (0 to 5V)	LED will blink GRN 4 times
2 = (No oil to full oil as programmed) = (0.25V to 4.75V)	LED will blink YEL 4 times
3 = (No oil to full oil as programmed) = (0.5V to 4.5V)	LED will blink RED 4 times

Programming Steps (in Mode 4)

- 1 Enter Mode 4 as described under "Entering Programming Mode".
- 2 Press the button (< 0.8Sec) once, to select your desired scaling.
Note the color of the LED flashes.
- 3 After you obtain the correct color of LED flashes, turn the unit off.
- 4 When powered on again, it will start up in Mode 1. It will remember your selected scaling.

PROGRAMMING the Oil Temperature Output Scaling (in Mode 5)

- A button press (< 0.8Sec) will toggle thru these settings

1 = (0 to 5V Out) = (-50 to 300°F)	LED will blink RED 5 times
2 = (0 to 5V Out) = (-33 to 300°F)	LED will blink YEL 5 times
3 = (0 to 5V Out) = (0 to 300°F)	LED will blink GRN 5 times

Programming Steps (in Mode 5)

- 1 Enter Mode 5 as described under "Entering Programming Mode".
- 2 Press the button (< 0.8Sec) once, to select your desired scaling.
Note the color of the LED flashes.
- 3 After you obtain the correct color of LED flashes, turn the unit off.
- 4 When powered on again, it will start up in Mode 1. It will remember your selected scaling.

SOFTWARE UP-DATES

The oil quantity sensor electronics package is micro-controller based. If there are any product software enhancement up-dates, we will post these notices on our Website for each product. Please check our Website for the latest up-dates for this product.

SPECIFICATIONS

Model: OSE-1 (Electronics package)

Power in:	+9Vdc to +30Vdc, (NEGATIVE ground system only)
Current Draw	Current draw, 80mA Typical, (200mA Max.)
Connector Types	D-Sub 15 pin, Connector Wiring, #20AWG aircraft wire suggested SMA male connector for sensor cables
Analog Outputs	Oil Quantity (scaling is selectable) (Empty to Full) = (0.0 to 5.0V) (Empty to Full) = (0.25V to 4.75V) (Empty to Full) = (0.5V to 4.5V) Oil Temperature (scaling is selectable) (0.0 to 5.0V) = (0 to 300°F) (0.0 to 5.0V) = (-33 to 300°F) (0.0 to 5.0V) = (-50 to 300°F)
Alarms Outputs:	Open Collector Output, (100mA, 30VDC Max.) for Low oil quantity Caution alarm Low oil quantity Warning alarm Over oil temperature alarm Oil sensor malfunction (or Out of Range) Alarm
Programmable Alarm Levels:	Oil quantity linearity increments (2 to 20 oil levels) Oil quantity Caution level Oil quantity Warning level High temperature Warning level
Weight	
Electronics Enclosure	3.4 oz. (97.0 grams)
Enclosure Material	ABS - Fire Retardant (not hermetically sealed)
Enclosure Dimensions	4.375" x 2.47" x 1.25" (111.12 x 62.72 x 31.8 mm)
Mounting Centers	2 Holes, 0.188" (4.775mm) Dia, Distance apart 3.875" (98.425mm)

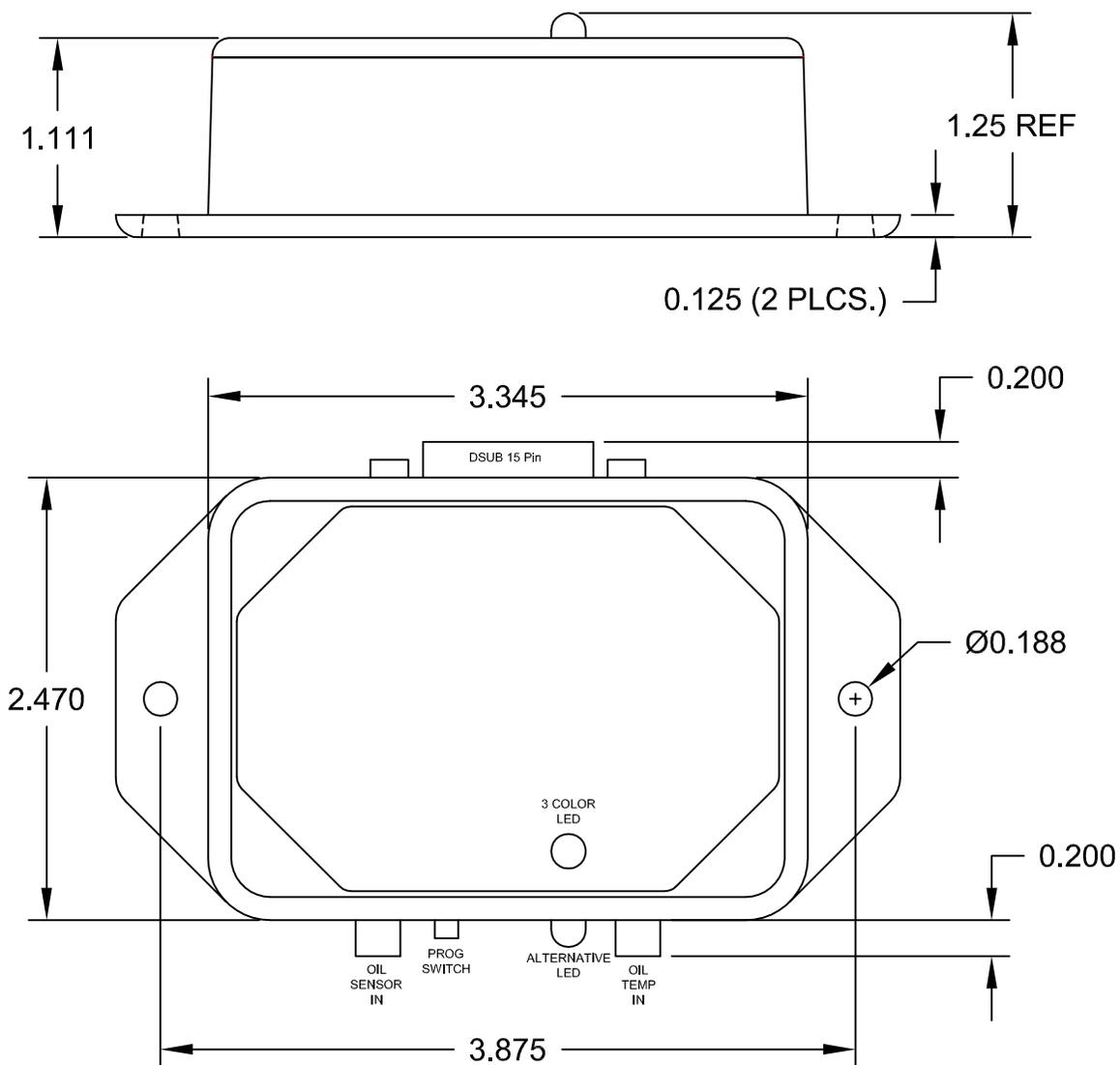
SPECIFICATIONS continued

Sensor Models: Sxx.x-5/8-18-xx.x and Sxx.x-1/2NPT-18.0

Sensor Thread Types	1/2NPT for typical Lycoming engines & others 5/8-18 for typical Continental engines & others (other fitting types will be added and available as needed)
Sensor length	Length will vary depending upon application (measured from the bottom of the fitting hole to the top of oil quantity sensor) See our Outline and Mounting drawings for each sensor type for specifics
Temperature Ratings:	
Sensor	-30 to 302°F, (-34 to 150°C)
Sensor Cables	-40 to 392°F, (-40 to 200°C)
Electronics	-30 to 160°F, (-34 to 71°C)
Weight	
Sensor	for Lycoming type, 1/2NPT, 5.5" long with 4ft. cables, 3.1oz. (88.0 grams) (actual weight depends upon sensor type and configuration)

GOOD LUCK, have FUN, and please FLY with SAFETY!

(On the web: www.aircraftextras.com, By e-mail: sales@aircraftextras.com)

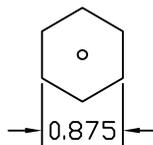
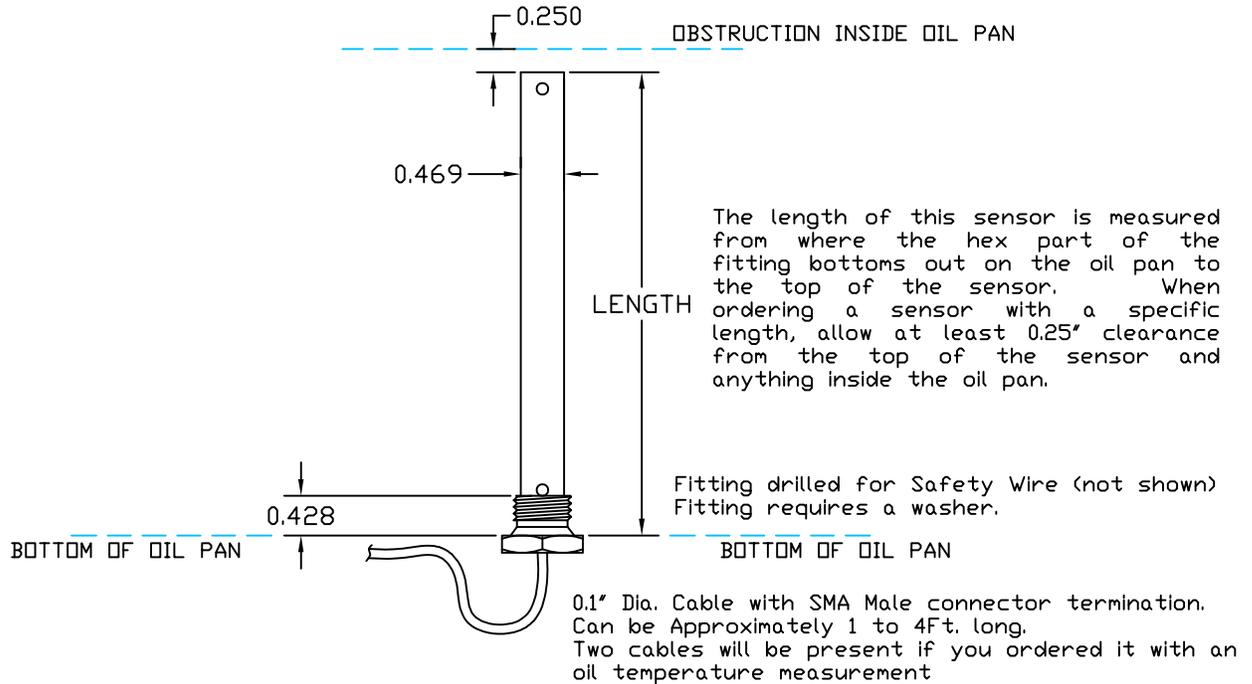


MATERIAL: BLACK Fire Retardant ABS
 POLYLAC® PA-765
 Acrylonitrile Butadiene Styrene
 CHI MEI CORPORATION

**Aircraft
 Extras** INC.

Oil Sensor Electronics Case OandM.dwg
 R.A.M. 12/6/2022

OIL QUANTITY SENSOR
for
CONTINENTAL ENGINES
1/6/2023



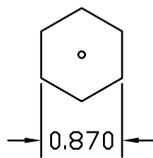
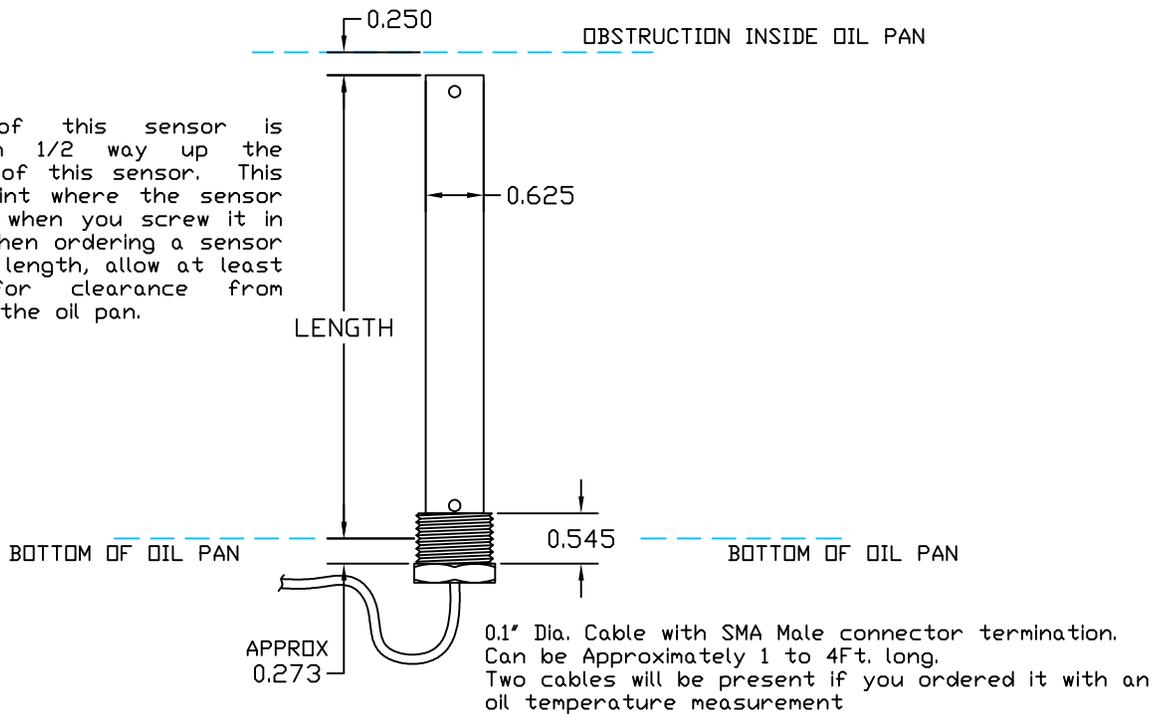
CONTINENTAL PLUG, THREAD TYPE, 5/8-18
for REF ONLY:
Continental A65, A75 & A80, Continental C125, C145 & □-300,
Continental C75 & C85, Continental C90 & □-200, Continental
E185 & E225, Continental GD-300, Continental □-470

**Aircraft
Extras_{INC.}**

Oil Quantity Sensor Continental 1-6-2023.dwg
ALL dimensions in inches.
R.A.M. 1/6/2023

OIL QUANTITY SENSOR for LYCOMING ENGINES 1/6/2023

The length of this sensor is measured from 1/2 way up the thread length of this sensor. This is also the point where the sensor normally stops when you screw it in the oil pan. When ordering a sensor with a specific length, allow at least 0.25" more for clearance from anything inside the oil pan.



LYCOMING PLUG, THREAD TYPE, 1/2NPT

**Aircraft
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Oil Quantity Sensor Continental 1-6-2023.dwg
ALL dimensions in inches.
R.A.M. 1/6/2023