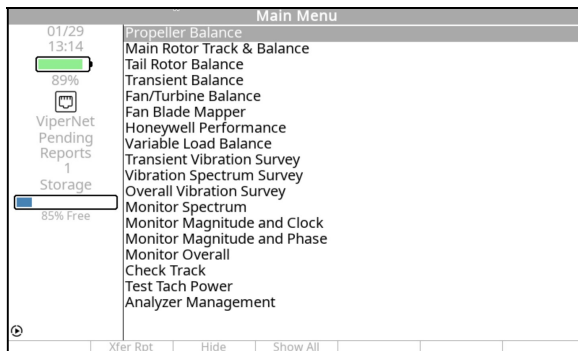


Chapter 4

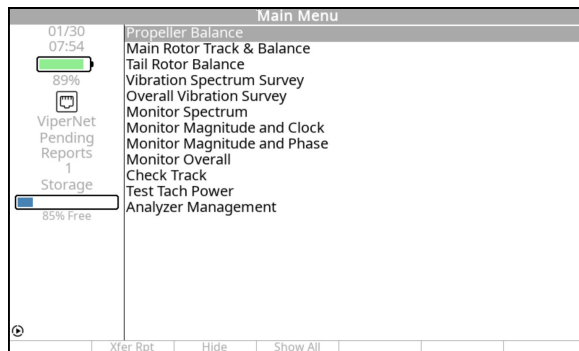
Propeller Balance

(Revision 2.2, Apr 2020)

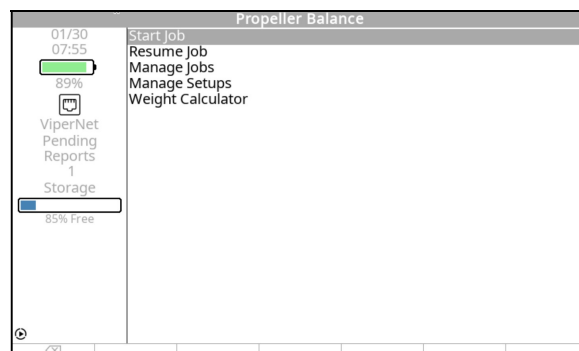
“Propeller Balance” is an analyzer function that is accessed from the analyzer’s Main Menu banner screen as shown in the illustration below. Selecting this function from the Main Menu brings up the “Propeller Balance” banner screen menu (also shown below). Each of the listings on this banner screen menu is an option within the function. Descriptions of each of these options follow, along with the information required to complete the menu screens within the options, and the steps necessary to perform the propeller balance function.



Viper II



Cobra II



Because most propeller balancing applications use common accessories, ACES Systems has assembled a propeller balancing kit, described below, which can be purchased with the Gen II Analyzers.

Propeller Balancing Kit

The propeller balancing kit contains all the necessary items to complete a single-engine, single-plane propeller balance. If your requirements are multiple-plane balance on a single-engine or multiple-engine balancing, additional equipment will be required. The items in the propeller balancing kit are described below.

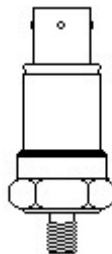
Manual, *ACES Systems Guide to Propeller Balancing*

The *ACES Systems Guide to Propeller Balancing* provides FAA-approved procedures and practices for completing a propeller balance job in lieu of airframe or propeller manufacturers' written instructions. The guide includes instructions on installing vibration sensors, photo tachometers, and reflective tape. Information on selecting the proper trim weights, attaching trial weights, attaching permanent weights, and other hints for simplifying the balance job are also included. The guide does not provide information on using the analyzer. Review this user's manual for detailed information on the analyzer's operation.

991D-1 Accelerometer

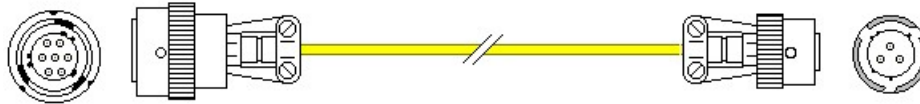
Although the Gen II analyzers will support a full range of vibration sensors, the 991D-1 accelerometer (see the illustration below) was selected as the standard for use with the propeller balance kit due to its rugged construction, accuracy, cost, and range of operation. A single sensor is supplied with the propeller balancing kit. Additional sensors may be purchased separately.

The output of the 991D-1 accelerometer is 20 mV per g. The 991D-1 is pre-programmed in the analyzer's sensor setup list. The operating temperature range is -50 to + 120 degrees C. The three-pin connector is a MIL-C -26482, and the mating connector is a Bendix PT06-8-3S. The mounting stud is 1/4 x 28. Although the sensor is rugged, it can be damaged when dropped on hard surfaces. Use care when installing the sensor, as you would with other electronic components.



991D-1 Sensor Cable

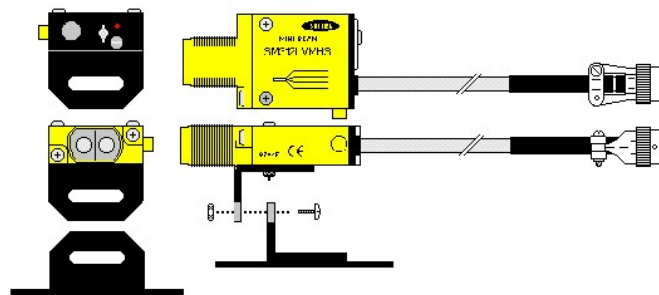
The 991D -1 sensor cable, shown below, is a 25-foot (50-foot optional) shielded and Teflon-coated four-conductor cable. The three-pin MS female connector on one end of the cable mates to the 991D -1 sensor. The six-pin MS male connector mates to one of the four (CHANNEL A, B, C, or D) vibration-input ports available on the analyzer. Contact ACES Systems for other sensor, cable, or adapter options.



Phototach

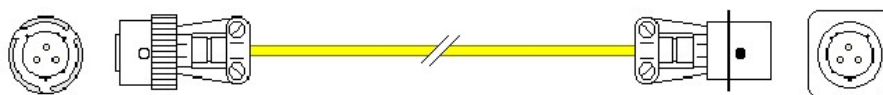
The Phototach is a short-range optical sensor used in acquiring speed and phase angle data. Its optimum range is 12 to 18 inches from the target (reflective tape, 3M 7610). It is supplied with a three-inch by three-inch base. An optional camera-type swivel mount is available from ACES Systems.

Hardware (screw, nut, and washers) for assembly of the supplied mount is contained in the tackle box which is also supplied with the propeller balance kit. The three-pin MS connector attaches directly to the Phototach cable. Other speed/phase sensors that can be used with the analyzer can be purchased separately. They include the ACES Systems' LASETACH®, Magnetic Interrupter, or specific-application speed interfaces. Call ACES Systems for further information.



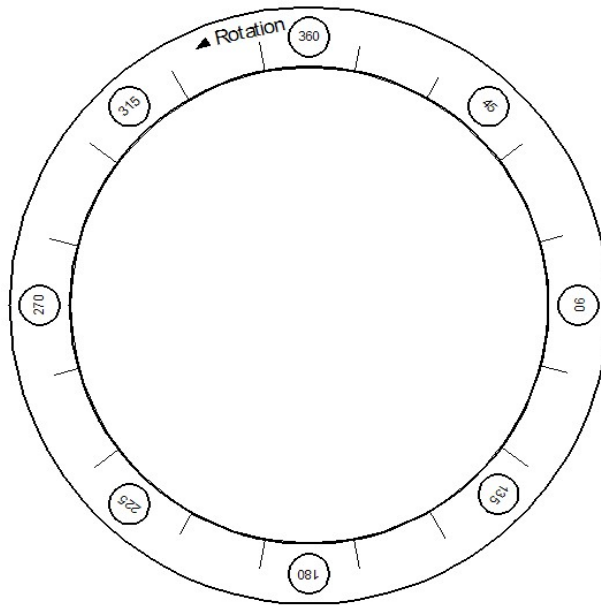
Tachometer Sensor Cable

The tachometer sensor cable connects the analyzer to a Phototach, an ACES Systems' LASETACH®, or an interface for optional speed sensors such as a magnetic pickup or pulse generator. The cable is a three-wire shielded cable, insulated in a bright yellow, petroleum-resistant jacket. Attached to one end of the cable is a female three-pin bulkhead-type socket connector. On the opposite end of the cable is a male three-pin, quarter-turn-locking MS connector. The connectors are constructed of aluminum alloy with olive drab chromate coating for corrosion resistance. The male end connects to the tach input of any ACES Systems' analyzer/balancer or to the female end of another cable of the same type. The opposite (female, bulkhead) end will accept another 10-320-0126 cable for extension or connect to an aircraft or sensor interface. There are 50-ft. and 25-ft. variants of this cable. The 25-ft. cable was built generally for propeller balancing applications, which normally require less distance to the sensors. LASETACHs® (Part Number: 10-100-1300) and Phototachs (Part Number: 10-100-1773) have a socket connector that connects directly to the bulkhead connector end of this cable.



Propeller Protractor

The propeller protractor is designed to measure angles in a typical propeller/spinner assembly. The propeller protractor pictured below is a complete circle. It is divided into five-degree increments. Every 15 degrees, the angle is identified by a tick mark. Every 45 degrees, the angle is printed in a circular identifier. Place the propeller protractor over the spinner with the proper direction of rotation side facing you as indicated by the text and an arrow. Since the analyzer can be configured to calculate solution angles relative to the vibration sensor or reflective tape, both methods are described in more detail below.



Using the Propeller Protractor

For correct use of the protractor when measuring relative to the vibration sensor, do the following:

WARNING

Always ensure mag switches are off prior to any movement of the propeller

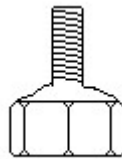
- Rotate the propeller until the reflective tape is directly in front of the Phototach.
- With the propeller in this position, place the protractor over the spinner with the Rotation indicator pointing in the direction of rotation (forward looking aft) and the 360-degree points aligned with the position of the vibration sensor.
- Read the numbers in the circles, and then interpolate values of the unmarked incremental lines to locate the desired angle.

For correct use of the protractor when measuring relative to the reflective tape:

- Place the protractor over the spinner with the Rotation indicator pointing in the direction of rotation (forward looking aft) and the 360-degree points aligned with the position of the reflective tape.
- Read the numbers in the circles, and then interpolate values of the unmarked incremental lines to locate the desired angle.

Case Bolt Adapter Set

An eight-piece case bolt adapter set with nut sizes 1/4 to 7/16 NF and NC threads is included in the propeller balancing kit. The stud portion uses 1/4 x 28 threads. To use the bolts/nuts during a typical propeller balance, select the adapter from the set to match the case bolts of a typical opposed engine. Attach the adapter nut end to the exposed case bolt threads then slide the right-angle mount over the stud end and secure with the supplied nut. Two sets of the adapters are required for dual-engine balancing.

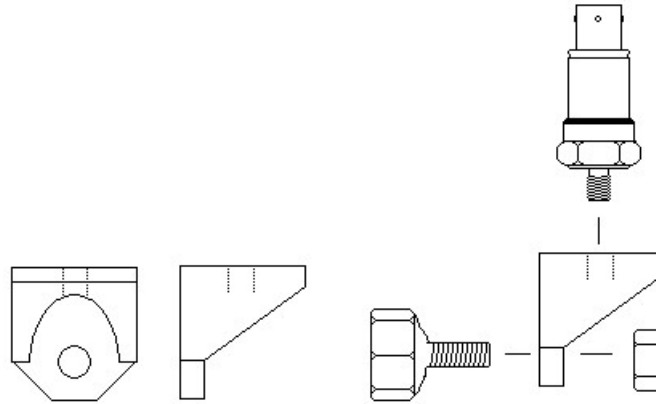


Tackle Box

A multi-compartment, high-impact plastic, tackle box is included with the propeller balancing kit. The box has ample storage space for vibration sensors, vibration sensor mounts, and the case bolt adapter set. It may also serve as storage for AN washers used as balance weights.

Right-Angle Sensor Mount

The right-angle sensor mount shown in the left portion of the illustration below is made of anodized aluminum and designed to be mounted directly on the engine case bolt or to the case bolt adapter, shown in the right portion of the illustration below. The mount has a 1/4 x 28-threaded hole for the vibration sensor and a 1/4-inch unthreaded hole for the case bolt adapter stud.



Gram Scale

An 800-gram capacity scale is included with the propeller balancing kit for weighing the washers or trim weights used in balancing. Read the operating instructions enclosed with the scale carefully prior to its use.

Reflective Tape

The reflective tape supplied with the propeller balancing kit is used as a tachometer trigger for the Phototach to generate a once-per-rev pulse used in speed readings and balancing calculations. The reflective tape (3M 7610) supplied with the propeller balancing kit was selected because of its excellent reflective quality and performance under varied operating conditions. Using a lower-quality tape will cause inaccurate tachometer readings or unreliable phase information. The tape is manufactured by the 3M Company and is the only tape we recommend for use with the system. Contact ACES Systems for replacement tape. (See Chapter 23, “Equipment and Accessory Setup and Troubleshooting” for additional information for high RPM.)

ACES Systems Balance Placard

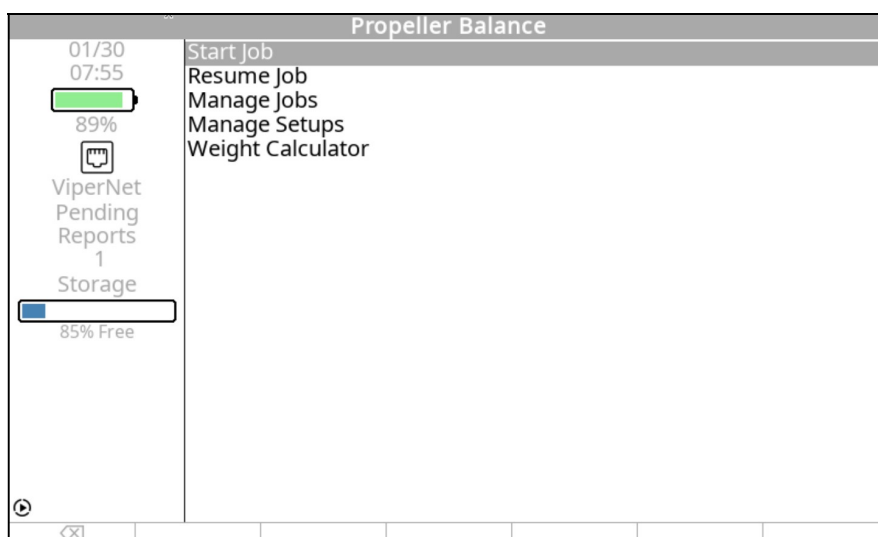
Placards similar to the one shown below are included in the propeller balancing kit. This, or a similar placard, should be attached to the spinner bulkhead upon completion of balancing to show that the propeller has been dynamically balanced and is indexed to the crankshaft of the engine.

NOTICE: This aircraft's power train rotating components compose an indexed assembly. The propeller was dynamically balanced using:

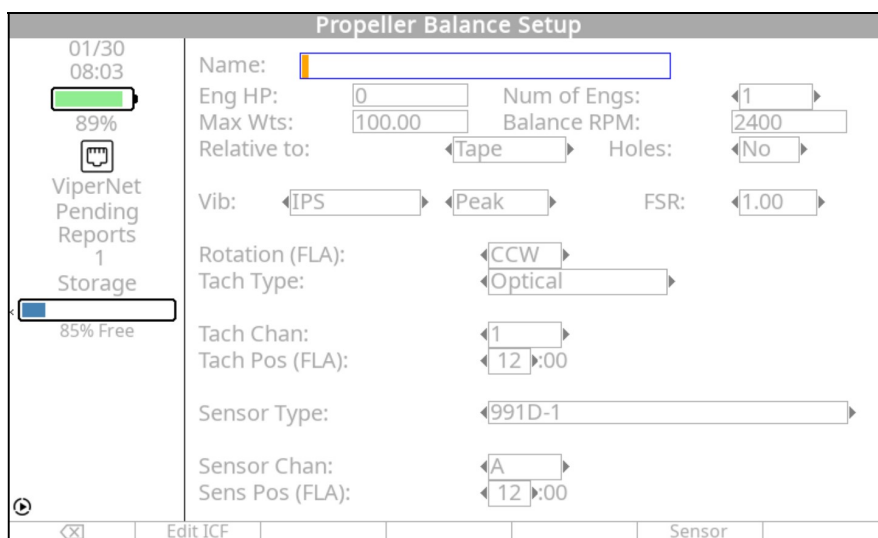


4.1 – Start Job

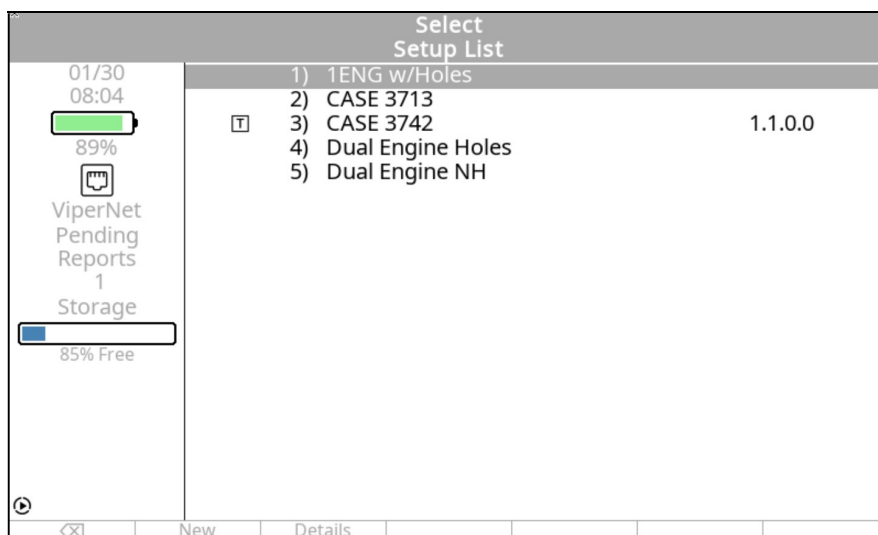
Selecting “Start Job” from the “Propeller Balance” banner screen allows you to begin a new propeller balance job. When you select this option, one of three screens will appear depending on whether you are: 1) Starting a new job with no setups previously defined in the analyzer’s memory; 2) starting a new job with previously-defined setups available in the analyzer’s memory; or 3) resuming an incomplete job being held in the analyzer’s memory.



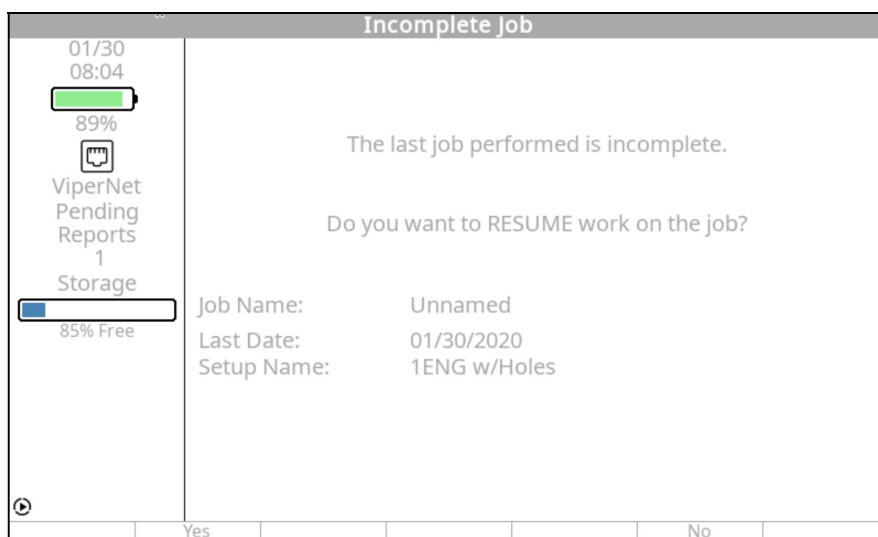
If you are starting a new job with no setups previously defined in the analyzer’s memory, the screen will automatically display the Prop Balance Setup banner screen shown below. See paragraph 4.1.1. for step-by-step instructions on completing the Prop Balance Setup.



If you are starting a new job with previously defined setups available in the analyzer's memory, the screen will automatically display the Select Setup List banner screen similar to the one shown below. The actual setup names will be those, which you have entered into your analyzer.



If you are resuming an incomplete job being held in the analyzer's memory, the opportunity to do so is presented immediately following the “Start Job” selection. The screen displays the message as shown below. If you press the [F1] “Yes” key, the analyzer will return you to the last logical in-progress step of the job. If you press the [F5] “No” key, the analyzer will proceed as described in the example above.



4.1.1. – Prop Balance Setup

The “Prop Balance Setup” banner screen allows you to define and store a propeller balance Setup. The “Prop Balance Setup” banner screen displays fill-in and selection type fields. The fill-in fields have squared off ends ([]). These fields are filled in using inputs from the analyzer keypad. The selection fields have pointed ends (< >). These fields have two or more preset values that are selected by using the [⇒] and [⇐] keys. Navigate between the fields on this screen using the [↓] and [↑] keys. (Refer to Chapter 3, “Using the Gen II Analyzer” if you are unfamiliar with using the keypad or inputting data.)

4.1.1.1. – Propeller Balance Setup Screen

To complete the “Prop Balance Setup” banner screen (as shown below), do the following:

- 4.1.1.1.1. In the “Name” field, enter a name for this setup using the keypad. (Refer to Chapter 3, “Using the Gen II Analyzer” if you are unfamiliar with using the keypad.)

The name you choose will aid you in differentiating this setup from other stored setups should you choose to review it at a later time. The name should be one of your choosing which will be easily recognized and associated with this setup such as “Cessna 150”, “King Air”, or “T-6 TEXAN II”.

- 4.1.1.1.2. Using the [↓] key, move down to the “Eng HP” field. Enter the rated horsepower of the engine using the keypad. The valid range of values for this field is 0 to 5000.
- 4.1.1.1.3. Using the [↓] key, move to the “Num of Engs” field. Use the [⇒] key to select the number of engines being balanced with this setup.

- 4.1.1.1.4. Using the [↓] key, move to the “Max Wts” field. Enter the maximum total trim balance weight (in grams) allowed for this installation. If the manufacturer does not specify a maximum weight, refer to the *ACES Systems Guide to Propeller Balancing*. The valid range of values for this field is 1 to 9999.
- 4.1.1.1.5. Move to the “Balance RPM” field using the [↓] key. Using the keypad, enter the actual propeller RPM at which you intend to balance. If no manufacturer recommendation is available, refer to the *ACES Systems Guide to Propeller Balancing* included with the Propeller Balance option. A low-cruise RPM is usually best. The valid range of values for this field is 50 to 10,000 for the Cobra II and 50 to 32767 for the Viper II.
- 4.1.1.1.6. Using the [↓] key, move to the “Relative to” field. Select “Tape” or “Sensor” using the [⇒] key. Decide if you wish to measure weight placement phase angles relative to the reflective tape or the vibration sensor as an index point. If using predetermined weight locations, described in paragraphs 4.1.1.1.77 and 4.1.1.4 below, select “Tape.”
- 4.1.1.1.7. Move to the “Holes:” field and select either “Yes” or “No” using the [⇒] key. Yes, indicates that the propeller assembly has predetermined locations, or holes where trim balance weights can be added. If you select “Yes,” a page for defining the angle of each hole will be provided. The “No” answer indicates that no predetermined locations are available and that you will be drilling holes for the permanent mounting of the final trim balance weights.
- 4.1.1.1.8. When “2” Engs are selected in step 4.1.1.1.3 AND “Yes” is selected in step 4.1.1.1.7, the “Engines Use Same Hole Layout:” field will appear. Use the [⇒] key to select “Yes” or “No”. Selecting “Yes” will indicate that both engines have the same predetermined locations, or holes with the same angles. See step 4.1.1.4 for detailed instructions on defining these settings.
- 4.1.1.1.9. Move to the “Vib:” field and use the [⇒] key to choose the vibration engineering units for this balance job. The choices are IPS (inches per second velocity), mm/sec (millimeters per second velocity), cm/sec (centimeters per second velocity), mils (1000ths of an inch displacement), microns (1000ths of a millimeter displacement), m/s/s (meters per second per second), and cm/s/s (centimeters per second per second). Unless otherwise directed by the propeller or aircraft manual, select IPS.
- 4.1.1.1.10. The field to the immediate right of the “Vib:” field is unmarked. It is also a selection field and contains the modifiers to be used with the units of vibration (Vib:). The selections are Peak (Peak may also be called single amplitude), Pk-Pk (Peak-to-Peak may also be called double amplitude), Avg. (Average), and RMS

(Root Mean Square). Typically, you will use Peak if using IPS in the “Vib:” field above.

- 4.1.1.1.11. Move to the “FSR” field and use the [⇒] key to select the Full-Scale Range for the vibration amplitude you reasonably expect to encounter on this job. For a propeller balance conducted using IPS, a normal selection would be 1. This value should be enough above the maximum allowable vibration for the engine so that any amplitude in excess of that limit can be readily seen.
- 4.1.1.1.12. Move to the “Rotation (FLA):” field for Eng 1 using the [↓] key. Using the [⇒] key, Select CW (Clockwise) or CCW (Counter-Clockwise) for the rotation of the propeller as viewed standing Forward of the propeller Looking Aft (FLA) toward the tail of the airplane
- 4.1.1.1.13. Move to the “Rotation (FLA):” field for Eng 2 using the [↓] key. Using the [⇒] key, Select CW (Clockwise) or CCW (Counter-Clockwise) for the rotation of the propeller as viewed standing Forward of the propeller Looking Aft (FLA) toward the tail of the airplane
- 4.1.1.1.14. Using the [↓] key, move to the “Tach Type” field. Using the [⇒] key, select the type of tachometer you are using.

Tach Type selections for this field include:

“Optical” - Includes the Phototach and LASETACH®. This selection will provide power to the Tach device.

“Mag P/U” - A magnetic pickup. This selection does not provide power to the Tach device.

- 4.1.1.1.15. Using the [↓] key, move to the “Tach Chan” field for Eng 1. Using the [⇒] key, select the appropriate value according to the analyzer’s tach input channel(s) you intend to use. The default is TACH 1.
- 4.1.1.1.16. Using the [↓] key, move to the “Tach Chan” field for Eng 2. Using the [⇒] key, select the appropriate value according to the analyzer’s tach input channel(s) you intend to use. The default is TACH 2.
- 4.1.1.1.17. Using the [↓] key, move to the “Tach Pos (FLA)” field for Eng 1. Using the [⇒] key, select the tach position. The tach position is determined by standing Forward of the propeller Looking Aft (FLA) toward the tail of the aircraft. From this viewpoint, determine the approximate clock position (1:00 to 12:00) of the tachometer pickup.

- 4.1.1.1.18. Using the [↓] key, move to the “Tach Pos (FLA)” field for Eng 2. Using the [⇒] key, select the tach position. The tach position is determined by standing Forward of the propeller Looking Aft (FLA) toward the tail of the aircraft. From this viewpoint, determine the approximate clock position (1:00 to 12:00) of the tachometer pickup.

CAUTION

Sensors connected to Channel A and Channel B (or Channel C and Channel D in the Viper II) must be of the same type. Using different sensors during the same job will cause erroneous readings and problems achieving good balance results.

- 4.1.1.1.19. Move down to the “Sens Type” field using the [↓] key. Select the sensor type from the available options using the [⇒] key. If your sensor type is not listed, see section Paragraph 4.1.1.3 of this manual entitled “Sensor Setup.”

NOTE

Sensor Channels C & D are only available on the Viper II

- 4.1.1.1.20. Move to the next field, “Sens Chan” for Eng 1 using the [↓] key. Select sensor channel “A, B, C, D, A&B or C&D” according to which of the analyzer’s input channels you intend to use. The default for single-sensor input is Channel A. Use the [⇒] key to make the selection. If you are conducting a two-sensor balance, choose A&B or C&D.
- 4.1.1.1.21. Move to the next field, “Sens Chan” for Eng 2 using the [↓] key. Select sensor channel “A, B, C, D, A&B or C&D” according to which of the analyzer’s input channels you intend to use. The default for single-sensor input is Channel B. Use the [⇒] key to make the selection. If you are conducting a two-sensor balance, choose A&B or C&D.
- 4.1.1.1.22. Using the [↓] key, move to the “Sens Pos (FLA)” field for Eng 1. Using the [⇒] key, select the vibration sensor position. The sensor position is determined by standing Forward of the propeller Looking Aft (FLA) toward the tail of the aircraft. From this viewpoint, determine the approximate clock position (1:00 to 12:00) of the vibration sensor.
- 4.1.1.1.23. Using the [↓] key, move to the “Sens Pos (FLA)” field for Eng 2. Using the [⇒] key, select the vibration sensor position. The sensor position is determined by standing Forward of the propeller Looking Aft (FLA) toward the tail of the aircraft. From this viewpoint, determine the approximate clock position (1:00 to 12:00) of the vibration sensor.

4.1.1.2. – Edit ICF

The “Edit ICF” (which corresponds to the [F1] key) selection appears at the bottom left of the “Prop Balance Setup” banner screen. Press the [F1] key if you wish to define the Influence Coefficients for this setup. The following “Edit ICF” banner screen is displayed. If you have selected a two (2) engine balance, the screen will contain individual ICF fields for each engine.

- 4.1.1.2.1. If you do not have ICF information for the balance setup, leave all fields set at “0” and press the [F0] “Back Up” key. This sets the ICF at the default for the known conditions. The ICF default value is added automatically when the Setup is created. The user may press this key at any time to reset the ICF to default. When satisfied with the displayed ICF, press [OK] to return to the “Prop Balance Setup” banner screen.
- 4.1.1.2.2. Making any changes on this screen will toggle the “Def by HP” menu item above the [F2] key. Pressing the [F2] key will display an additional screen giving you the option to press [F1] “Keep Last” to keep the last entered ICF or press [F5] “Def by HP” to return the ICF to its default value which is defined by the horsepower rating entered in paragraph 4.1.1.1.2 above.

- 4.1.1.2.3. A successful balance job (one that has updated the setup's ICF) will toggle the "Edit" menu item above the [F3] key. Pressing the [F3] key will display additional function key options giving you the option to press [F1] "Avg=Def" to set the averaged ICF to the default ICF, pressing [F2] "Def by HP" to return the ICF to its default value which is defined by the horsepower rating entered in paragraph 4.1.1.1.2 above. Pressing the [F3] "View Avg" key will return the screen to display the "Updated ICF".

4.1.1.3. – Sensor Setup

Pressing the [F5] “Sensor” key from the “Prop Balance Setup” banner screen displays the “Sensor Setup” banner screen shown below. The information on this screen should correspond to the sensor you selected for this setup in paragraph 4.1.1.1.199 above.

- 4.1.1.3.1. This is an information-only screen for use in verifying the parameters of the vibration sensor you have chosen. You may not edit or otherwise enter information on this screen. If this sensor does not possess the specifications you require for this setup, you may enter a new sensor in the “Sensor Setup” screen, or choose another sensor from the existing list. Press [F0] “Back Up” or [OK] to exit this screen and return to the “Prop Balance Setup” banner screen.

- 4.1.1.3.2. When all fields are completed to your satisfaction, press the [OK] key to accept the inputs and continue to the “Prop Hole Layout Setup”.

4.1.1.4. – Prop Hole Layout Setup

If “Yes” was selected under the “Holes:” entry in paragraph 4.1.1.1.7 the “Prop Hole Layout Setup” banner screen is the next screen displayed. Note that if you have selected a two (2) engine setup, the Hole Layout for #1 engine will be displayed and completed first, then the action must be repeated for engine #2.

The screenshot shows the 'Engine Hole Layout: 1 of 2' screen. On the left, a sidebar displays system information: date/time (01/30 10:08), battery level (89%), ViperNet Pending Reports (1), and storage status (85% Free). The main area is divided into sections for configuration. The 'Name' field is pre-filled with 'Eng 1 Hole Layout'. Below it, 'Num of Holes' is set to 12, 'Space' is set to 'Even', 'Dir (FLA)' is set to 'CCW', 'Max Hole Wt' is set to 25, and 'Angle of #1 Hole' is set to 0.

- 4.1.1.4.1. The “Name” field is automatically filled in with “Eng 1(2) Hole Layout”. Complete the fields on the screen by doing the following:
- 4.1.1.4.2. Use the [↓] key to move to the “No. of Holes” field. Enter the number of holes that correspond to the total number of trim weight mounting locations. The valid range of values for this field is 1 to 36.
- 4.1.1.4.3. Move to the “Space” field using the [↓] key and then use the [⇒] key to select “Even” or “Uneven” from the available selections. Even indicates that all trim weight mounting locations are evenly spaced. The analyzer will automatically calculate the number of degrees between holes in this case. If you select “Uneven,” and then use the [↓] key to move away from the field, several fields (“Ang” and “No.”) appear at the bottom of the screen. You will complete these Angle and Number fields later in the process at paragraph 4.1.1.4.6.
- 4.1.1.4.4. Use the [↓] key to move to the next field, “Dir (FLA).” Complete this field by using the [⇒] key, select CW for clockwise or CCW for counter-clockwise to

indicate the direction of increasing hole numbers as viewed from forward looking aft.

- 4.1.1.4.5. Move to the “Max H. Wt” field using the [↓] key. Using the keypad, enter the maximum allowable weight (in grams) for any single hole. If you do not know this value, refer to the aircraft maintenance manual or the ACES Guide to Propeller Balancing. Use the [↓] key to move to the next field.
- 4.1.1.4.6. Complete the next fields differently depending on data you input in paragraph 4.1.1.4.3 above.

If you selected “Even” in paragraph 4.1.1.4.3 - The “Enter the Angle of No. 1 Hole” field is displayed. Use the keypad to enter the angle of hole number 1 as viewed from the front of the engine looking aft. To determine this angle, do the following:

- With mag switches OFF, rotate the propeller so the tachometer triggering device (magnetic interrupter, reflective tape, etc.) is at top dead center.
- With the propeller in this position, use the 12:00 position as the “0” or “360 degrees” (index point) and measure opposite the direction of rotation to the angle of hole number 1. For example, if the #1 hole is at the 3:00 position (simply as viewed on the face of a clock from in front of the engine, disregarding propeller direction of rotation) and the engine rotates counterclockwise, the angle would be 90 degrees. If the #1 hole is at the 3:00 position and the engine rotates clockwise it would be 270 degrees. **The measurement to hole # 1 must always be measured opposite the direction of rotation regardless of the hole numbering direction.**

Engine Hole Layout: 1 of 2

01/30
10:11
89%
ViperNet Pending Reports 1
Storage 85% Free

Name: Eng 1 Hole Layout

Num of Holes: 12 Space: Even

Dir (FLA): CW Max Hole Wt: 25

Angle of #1 Hole: 60

If you selected “Uneven” in paragraph 4.1.1.4.3 – Multiple angle/hole number fields are displayed. Each hole number (“No.”) is automatically populated and its corresponding angle must be defined individually. Using the keypad, complete each field by entering an angular (“Ang”) location as measured opposite the direction of propeller rotation. Use the [↓] and [↑] keys to move between these fields. To determine these values, do the following:

- With mag switches OFF, rotate the propeller so the tachometer triggering device (magnetic interrupter, reflective tape, etc.) is at top dead center.
- With the propeller in this position, use the 12:00 position as the “0” or “360 degrees” (index point) and measure opposite the direction of rotation to the angle of each hole number and record that angle adjacent to the hole number. (See the example “Prop Hole Layout Setup” screen shown at the beginning of the section.) For example, if the number 1 hole is near the 6:00 position, the angle may be measured as 174 degrees.
- On the screen, use the keypad to enter the angle of hole number 1 as “174” per the example. Then, using the [↓] key to move to the adjacent field (“No.”), input the number “1.”
- Next, measure to hole # 2. If hole #2 is measured as 156 degrees, enter that value and “2” in the adjacent field. Continue this process until all angles for all holes are defined. **The phase angle measurement must always be made with values INCREASING opposite the direction of rotation of the propeller regardless of the hole numbering direction.**

Engine Hole Layout: 1 of 2

01/30
10:22
89%
ViperNet
Pending Reports
1
Storage
85% Free

Name: Eng 1 Hole Layout

Num of Holes: 33 Space: Uneven

Dir (FLA): CCW Max Hole Wt: 25

Ang	Num	Ang	Num	Ang	Num	Ang	Num
174	1	92	10	348	19	252	28
156	2	84	11	340	20	228	29
148	3	66	12	332	21	220	30
140	4	54	13	324	22	212	31
132	5	36	14	306	23	204	32
124	6	28	15	294	24	186	33
116	7	12	16	276	25		
108	8	4	17	268	26		
100	9	356	18	260	27		

- 4.1.1.4.7. When all fields are complete, press [OK] to accept the settings and continue. If you have selected a two (2) engine balance, the Prop Hole Layout Setup screen will be displayed for engine #2. Repeat steps 4.1.1.4.1 through 4.1.1.4.6. Press

[OK] to accept the settings. The analyzer will return you to the “Propeller Balance Setups” menu.

4.1.2. – Job Identification

At this point in the “Propeller Balance” process, you should have completed the following steps: (1) selected “Propeller Balance” from the Main Menu; (2) selected “Start Job;” and (3) completed the “Prop Balance Setup” screen which included editing ICF and sensor setup, or you selected a setup from a list of predefined setups. Depending on whether or not you made use of predetermined hole locations, you may have also defined values for a number of trim weight mounting holes. If these steps have been completed, then the “Job Identification” banner screen will be displayed. Job information is optional but will appear on the job report if entered and will assist you in identifying this job when stored in memory. Complete the information fields using the keypad. Press [OK] to continue.

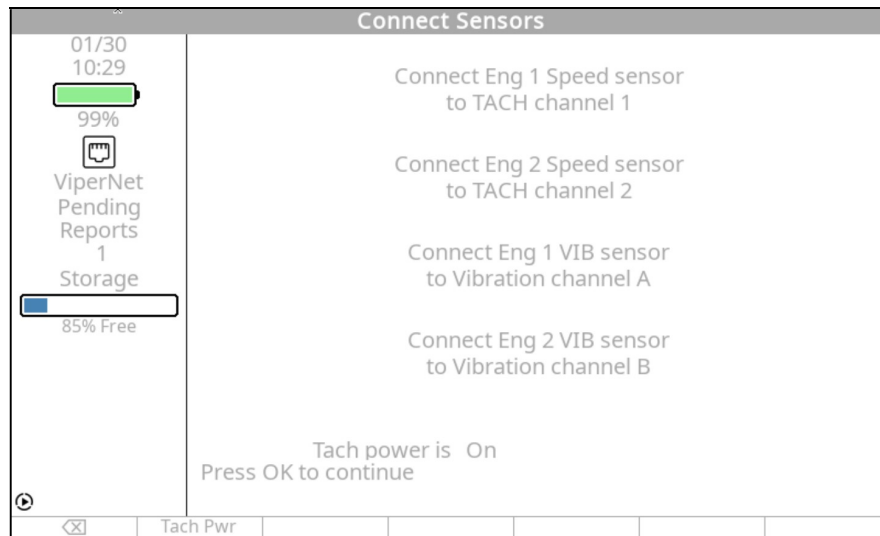
NOTE

If a name is not entered on the Job Identification screen, the job will be commonly labeled “Unnamed” in the resume and manage job lists. This will complicate finding a specific job, as multiple jobs are stored. We highly recommend you enter a name.

4.1.3. – Engine Selection / Engine Information

The “Engine Selection” banner screen is displayed. If you have selected a two (2) engine balance setup, the first screen above will be displayed. In that setup you may select to run either, or both the engines within the setup. Use the [=>] key to select the engine(s) to be balanced. After making your selection, press [OK]. The second screen above, the “Engine Information” screen will be displayed. Information on this screen is optional but will appear on the job report if entered. The function keys across the bottom of the screen will appear after an entry in a previous job has been made in the corresponding field. Pressing the function key below the name will take you to a listing of previous entries in that field. This list can be used as a shortcut when similar names need to be entered in subsequent jobs. Complete the information fields using the keypad. When finished, press [OK] to continue. If you have selected a two (2) engine setup, an identical screen will be displayed for engine #2. When finished, press [OK] to continue.

4.1.4. – Connect Sensors



The “Connect Sensors” banner screen will be displayed as shown above. Messages that appear on this screen prompt you to perform the physical installation and connection of the tach and vibration sensors to the input ports you specified in the setup.

4.1.4.1. – Phototach Setup (if required)

To install the Phototach, do the following:

- Install the Phototach at the position specified in the setup. The Phototach should be not less than 4 inches but no greater than 18 inches from the back surface of the target blade. Use speed tape or duct tape to secure the 3x3 base mount to the cowling surface. An angle of approximately 5 degrees from perpendicular to the target blade will produce the best results.
- Connect the tachometer cable to the Phototach connector. Route the cable away from hot areas and electrical equipment back to the cockpit and attach to the tach channel specified in the setup you are using. Secure the cable along its route with duct tape or tie wraps.
- Near the bottom of the analyzer screen, ensure that the message, “Tach Power is On” is displayed and that the block directly below this statement and corresponding to the [F1] key is labeled “Tach Pwr”. Tach Power is defaulted to ON to assist in proper alignment of the reflective tape. Pressing the [F1] key once will change the statement at the bottom of the screen to read “Tach Power is Off”. This will de-energize the tach until data acquisition is started. (This function is not required to power on the Phototach for balancing, just to enable in proper tape alignment)

WARNING

Ensure mag switches are off prior to any movement of the propeller.

- Rotate the propeller to visually align the Phototach with a point on the backside of the target blade where you intend to place the reflective tape. Clean this area thoroughly to ensure adhesion of the tape.
- Cut a strip of reflective tape (3M Tape, Model 7610 is recommended) approximately 1.5 to 2 inches long. With the tape backing still in place, hold the tape in position on the propeller blade and move the propeller blade back and forth in front of the Phototach beam.

NOTE

To ensure quality reflective action back to the Phototach, use 3M 7610 reflective tape. Use of other reflective tape or devices may result in poor signals back to the Phototach.

NOTE

If balancing large-diameter or high-speed propellers, refer to Chapter 23, Equipment and Accessory Setup and Troubleshooting for information on reflective tape width requirements for these applications.

- With an inspection mirror, watch the red LED gate indicator light on the aft end of the Phototach illuminate and extinguish as the tape crosses the beam. This indicates the position of the tape is correct.
- Remove the tape backing and attach the reflective tape to the propeller at that location. Be sure to smooth out any wrinkles or bubbles in the tape. Ensure the edges are smoothed and firmly attached. Recheck the previous step to ensure proper placement.
- Connect the vibration sensor cable to the sensor connector. Route the cable away from hot areas and electrical equipment back to the cockpit and attach to the sensor channel specified in the setup you are using. Secure the cable along its route with duct tape or tie wraps.

NOTE

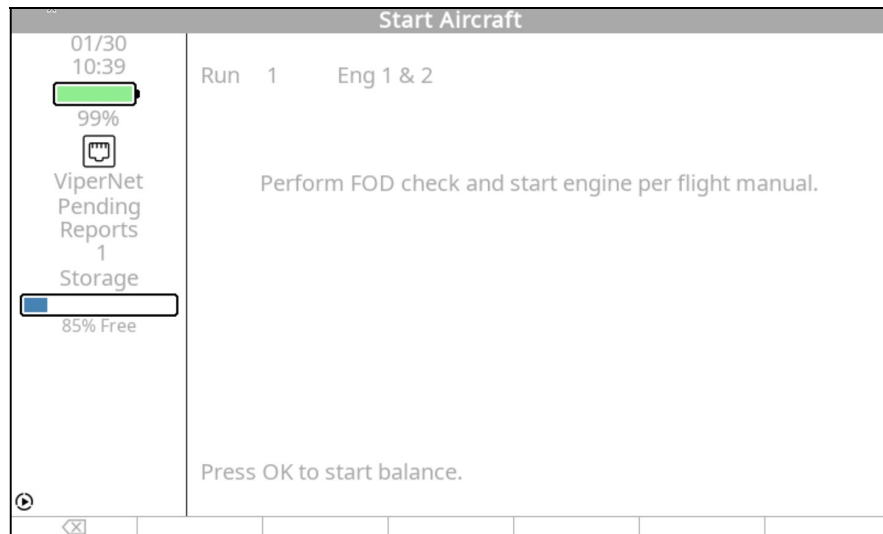
IF previously installed trim balance weights are left on prior to starting a dynamic balance, the total weight and location of each weight will need to be annotated in the analyzer, as shown in following steps, before a solution can be provided. Alternatively, all trim balance weights can be removed before proceeding beyond this point. Refer to the ACES Systems' Guide to Propeller Balancing (included with your propeller balancing kit) for a full list of FAA-approved inspection requirements.

- Repeat the installation process for the second engine if you have selected a two-engine balance.

4.1.5. – Start Aircraft

Prior to performing any dynamic balancing, it is advised to follow the instructions in the *ACES Systems' Guide to Propeller Balancing* included with your analyzer for inspections prior to balancing. The document is FAA approved and provides guidelines for the selection and installation of balance weights.

When you have completed the inspections, and physical equipment setup tasks, press [OK] on the analyzer to continue with the propeller balance job.



The analyzer will then display the “Start Aircraft” banner screen (shown above), with the statement to: “Perform a FOD check and start engine(s) per flight manual.” Start the engines and establish normal operating conditions. When normal operating conditions are established, press [OK] to continue.

4.1.6. – Acquiring Data

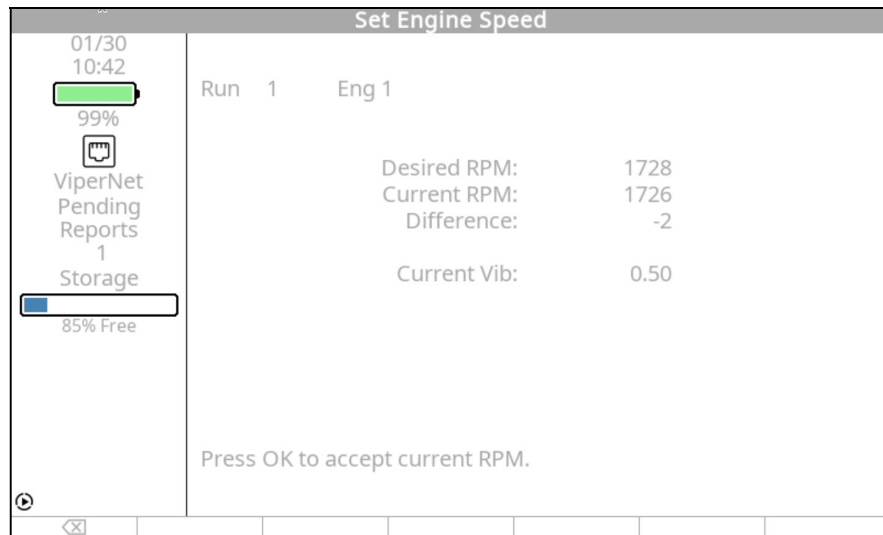
The “Set Engine Speed” banner screen is displayed. At the top left of the screen, the run number and engine number, if balancing two engines, is displayed. The center of the screen displays the following information;

- “Desired RPM:” - The balance speed entered in the setup being used. This is your target RPM for balancing.
- “Current RPM:” - Indicates the current propeller RPM. Attempt to match the Desired RPM with the Current RPM as closely as possible with throttle/prop lever adjustments.
- “Difference:” - The difference between the Desired and the Current RPM.

- “Current Vib:” – The current vibration reading. This value is for monitoring purposes only and is not being recorded.

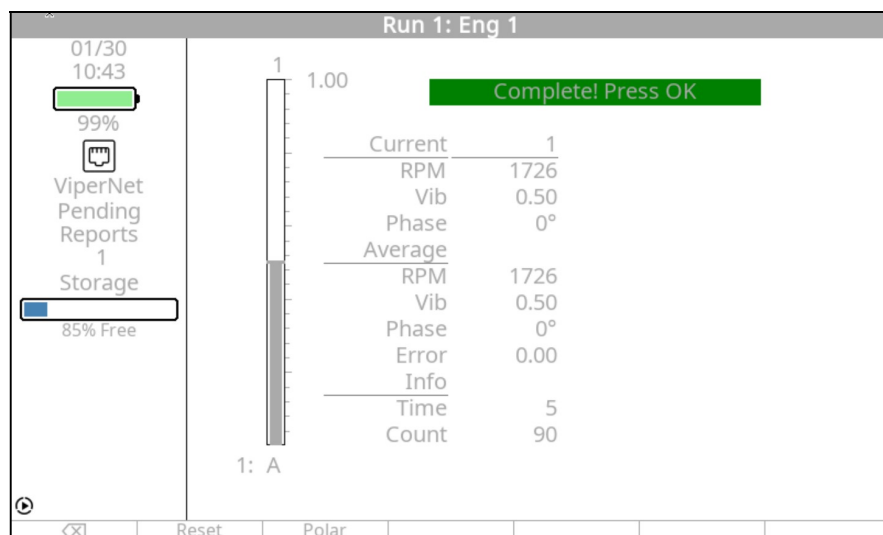
NOTE

The Difference between the Desired and Current RPM should not exceed the values outlined in Chapter 24, paragraph 24.2.5 “RPM Warnings”



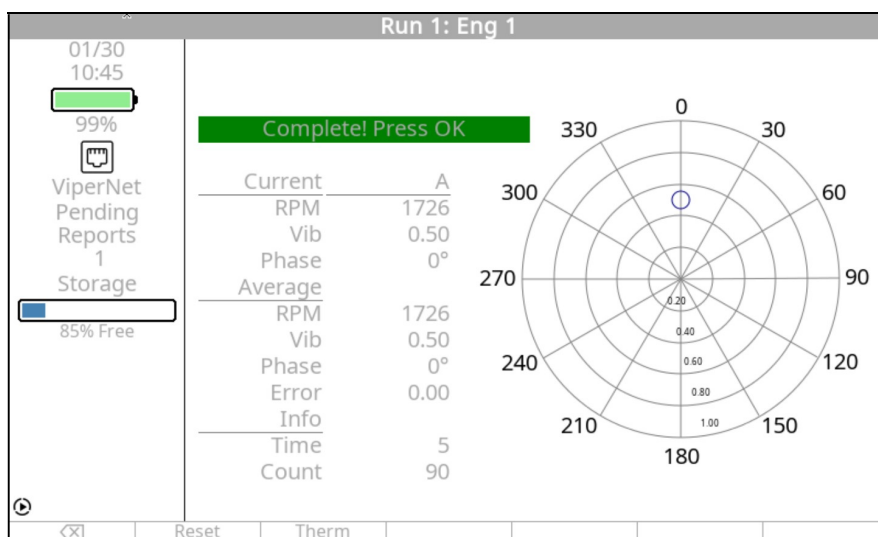
Once you have reached your target RPM, press [OK] to continue.

The screen changes to display the “Run: x” banner screen. (See the figure below.)



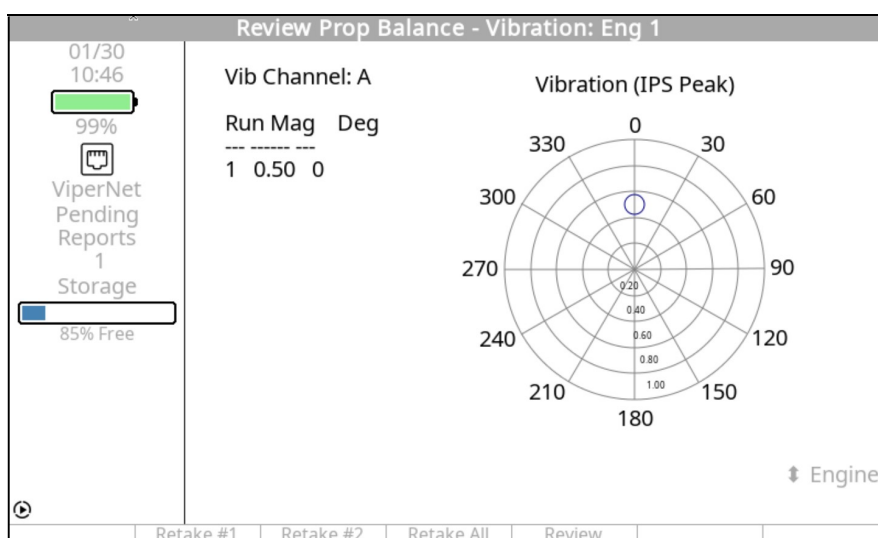
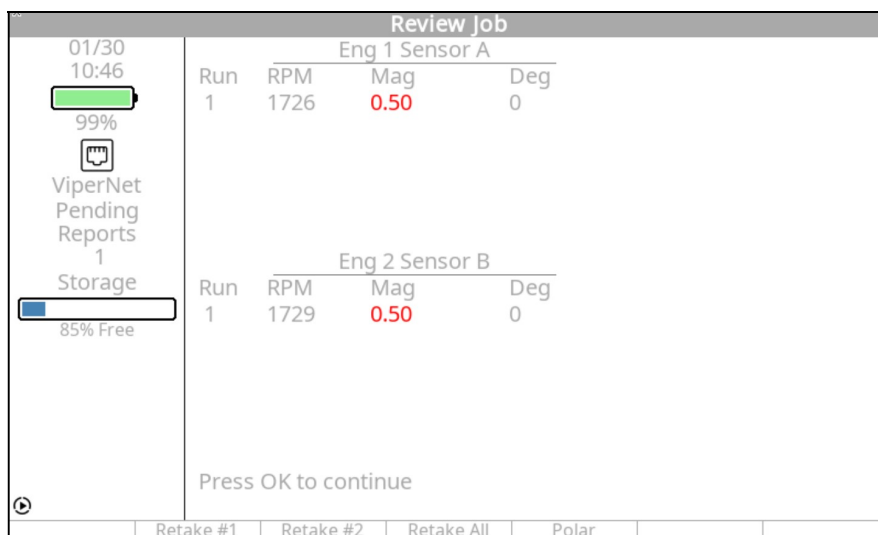
The converging vibration indicator shows the average amplitude. (See Chapter 24, Reading Spectrum and Scales, for information on how to read the data contained on this screen.). The current and average frequency, amplitude, and phase are also displayed along with the

percentage of error (Error) in the averaging. If you wish to reset the averaging and take new data, press the [F1] “Reset” key. The data can be viewed in a polar chart format by pressing the [F2] “Polar” key as shown in the example below. When the top line of this screen displays, “Complete! Press OK”, press the [OK] key to continue. This message will appear when a minimum number of consistent samples have been collected and it is ok to stop data acquisition. If you are conducting a two (2) engine balance, this process will be repeated for the second engine.



4.1.7. – Review Job

When you are finished acquiring data, the “Review Job” banner screen (shown below) is displayed next. The amplitude and phase (Mag/DEG.) are displayed for each engine and each sensor input channel. Data is displayed for only the input channels that were used for the job; others are left blank. Pressing the [F4] “Polar” key will produce the polar chart for the run as shown in the second screen example below.

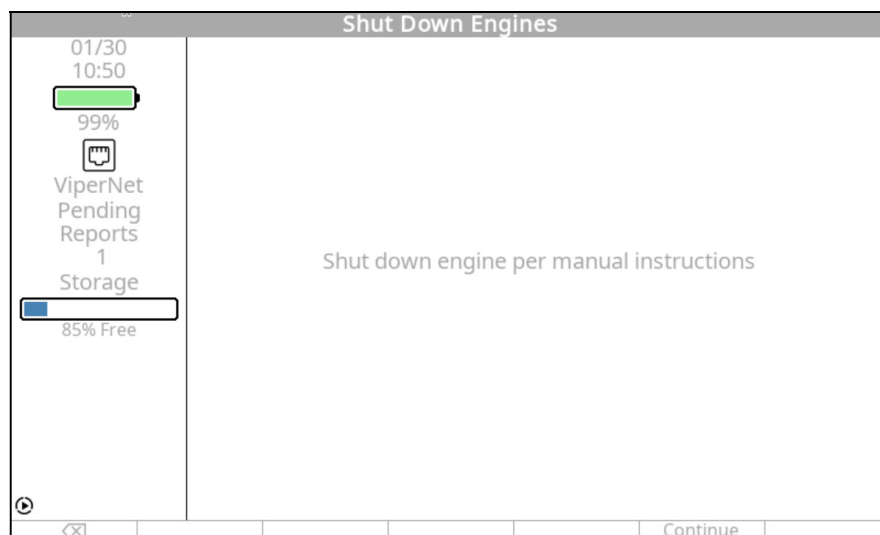


If you are satisfied with the results of the run and are ready for a solution, press [OK] to accept the data and continue.

If you want to retake data for this run, press the [F1] “Retake #1” key, [F2] “Retake #2”, or [F3] “Retake All” key (if balancing two engines). This option returns you to the “Set Engine Speed” banner screen (see paragraph 4.1.6 above).

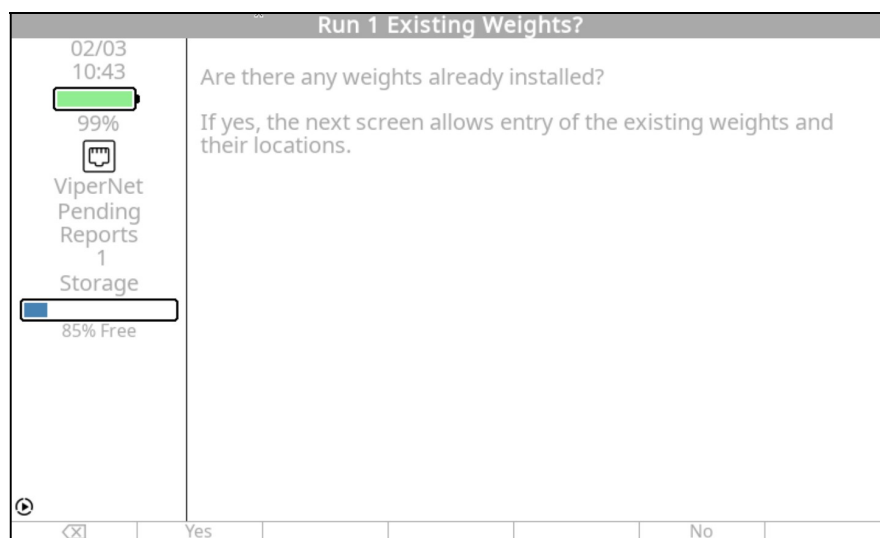
The data can be viewed in a polar chart format by pressing the [F4] “Polar” key. Pressing the [F4] “Review” key will return you to the “Review Job” screen.

An information screen will appear prompting you to “Shut down the engine(s) per manual instructions.” Press the [F5] “Continue” key to progress to the “Balance Solution” process as shown in paragraph 4.1.8 below.



4.1.8. – Balance Solution

The “Run 1 Existing Weights” screen will appear based on the selection made in step 4.1.1.1.7 above, ONLY after Run #1 and IF the “Holes:” field was set to “Yes”. This is a feature that will allow the existing trim balance weights to remain on for the data collection phase of the job on the **first run**. This option will only be available if “Holes:” field was selected to “Yes”.



If the previous trim balance weights were left on, press the [F1] “Yes” key. This will produce the “List Run 1 Existing Weights” screen as shown below. Enter the total amount of weight, in grams, that is installed at each hole location in the “Grams” column. Using the [↓] key, enter in the hole number as defined in step 4.1.1.4.6, in the “Hole” column. When all existing weights have been entered press the [OK] key.

Eng 1		Eng 2	
Grams	Hole	Grams	Hole
0.0	0	0.0	0
0.0	0	0.0	0
0.0	0	0.0	0
0.0	0	0.0	0
0.0	0	0.0	0
0.0	0	0.0	0
0.0	0	0.0	0

Press OK to continue

If you do NOT have existing trim balance weights installed press the [F5] “No” key to proceed to the next step.

The solution screen displayed will depend on the selection made in 4.1.1.1.7 above. If the “Holes:” field was set to “No,” the “Balance Solution” banner screen will be displayed as described in paragraph 4.1.8.1 below. If the “Holes:” field was set to “Yes,” the “Prop Suggested/Installed Weights” banner screen will be displayed as described in paragraph 4.1.8.3 below.

4.1.8.1. – “Prop Suggested/Installed Weights” banner screen

Run 1 Eng 1

RPM: 1728

Sens A 0.80 Vib @ 270 °

Solution: 32.4 g @ 270 °

Remove previous trim weights.

Enter actual installed weight: 0.0 g @ 0 °

Input installed weight and press OK to continue or press F1 to split weights.

Split Wt Quit Job

The screen is identified at the top left as being “Run: 1 Eng 1”. Vibration amplitude and phase angle are displayed for each channel being used (Channel A only in the example screen shown) and a solution for the first run.

In this example screen shown above, the “Solution” is “32.4g @ 270” which means to place 32.4 grams (g) of weight at 270 degrees from the index point. (see Chapter 2, Analyzer Description on how to use the Propeller Protractor to locate the phase angle.)

In the middle portion of the screen you see an information line stating “Remove previous trim weights.” Because all previously installed trim weights were removed prior to the start of the first run, this is only a reminder for Run 1. This same information line in following runs means to remove the trim weights installed on the previous run. In other words, the balance solution and resulting weight installed here after Run 1 may change in Run 2. The weights installed after Run 1 would be removed and new weights added at another location to refine the balance solution.

NOTE

In subsequent runs, all installed weights from each previous run must be removed. The “remove weight” message will be repeated for every run and solution. Each new solution dictates that the previously applied solution (installed weight) be totally replaced. In some cases, this may mean removing and reapplying weight at the same or near the same location. Failure to remove previously installed weight prior to applying the new solution weight will result in failure of the propeller balance function.

The next line of text states: “Enter Actual Weight Installed.” In the weight and angle fields directly below this line, enter the exact amount of weight and the angle, as near as possible, where it was installed. If you are unable to install the exact amount of weight in the recommended solution, install a weight as near the suggested solution weight as possible. The important point is whatever the actual amount of weight is, enter it here. If the solution exceeds the single location limits of the propeller or spinner assembly (refer to ACES Systems’ Guide to Propeller Balancing included with your analyzer), you may split the weight across two locations. If you do not wish to split the weights, press [OK] to continue and then move to the end of this section, to continue with the instructions at the “Start Aircraft” screen.

4.1.8.2. – Set Split Weights

To use the split weight option without predetermined holes, press the [F1] “Split Weight” key from the “Balance Solution” banner screen. The “Set Split Weights” banner screen below is displayed.

01/30 15:52
99%
ViperNet
Pending Reports 1
Storage 85% Free

Eng 1
Split: 32.4 g @ 270 °
Enter New Location:
Angle 1: 260
Angle 2: 280
Input desired angles and press OK.

The single location solution (in this case 32.4 g @ 270 degrees) is displayed at the top of the screen. The next line states: “Enter New Location.” Use the keypad to complete the next two fields, “Angle 1” and “Angle 2.” Locate the two available weight installation locations (one on each side of the 270-degree location) and enter them in the two fields. Use the [↓] key to move between the fields. Press [OK] to continue.

The screen displays the “Record Split Weights” banner screen like the one shown below.

01/30 15:54
99%
ViperNet
Pending Reports 1
Storage 85% Free

Eng 1 New Solution:
Angle 1: 16.5 g @ 260 °
Angle 2: 16.5 g @ 280 °
Actual Installed Weight:
Angle 1: 16.5 g @ 260 °
Angle 2: 16.5 g @ 280 °
Input installed weight and press OK to continue, F1 or <X> to resplit weights.

<X> Re-split

The “New Solution” is given for the two new angles you specified as available for weight application. Match the new weight solution as near as possible to the recommended solution and install it at the new angles. Weigh the test weights carefully and enter the exact amount of weight in the “Actual Installed Weight” fields.

If you discover a problem with the split weight locations you specified, press the [F1] “Re-split” or [F0] “Back Up” key and enter the two new angles. When the “Actual Installed Weight” fields are completed, press [OK] to continue.

The screen will return to the “Balance Solution” banner screen with the combined split-weight solution being displayed for the user. Press [OK] to continue.

4.1.8.3. – “Prop Suggested/Installed Weights”

If the “Holes:” field in paragraph 4.1.1.1.7 above was set to “Yes,” the “Prop Suggested/Installed Weights” banner screen shown below will be displayed.

Prop Suggested/Installed Weights			
Run 1		Eng 1	
Suggested		Installed	
20.4	@ 180 °	20.4	@ 180 °
Grams	Hole	Grams	Hole
6.0	6	6.0	6
10.0	7	10.0	7
6.0	8	6.0	8
0.0	0	0.0	0
0.0	0	0.0	0
0.0	0	0.0	0

Remove old weights; install and enter new weights.

Press OK to continue

Inst=Sugg Inst=None Quit job

The screen is identified at the top left as being “Run: 1 Eng 1”. The center of the screen is divided into two columns, “Suggested” and “Installed”.

In the example screen shown above, the “Suggested” solution is “20.4 @ 180°” which means the analyzer suggests 20.4 grams (g) of weight at 180 degrees from the index point. (see Page 4-4 on how to use the Propeller Protractor to locate the phase angle). Below this solution are the calculated weight placements for each identified hole location. These fields cannot be edited.

The “Installed” solution indicates the calculated solution based on the weights and hole locations shown in this column. These fields can be edited and allows the user to enter the exact amount of weight and the hole location where it was installed. If you are unable to install the exact amount of weight in the recommended solution, install a weight as near the suggested solution weight as possible. **It is important to note that you must enter the actual amount of weight installed and its location.** If these values are not accurate, subsequent solutions will not be accurate.

In the lower portion of the screen you see an information line stating: “Remove old weights; install and enter new weights.” If the previous dynamic balance trim weights were left installed, as explained in step 4.1.8 above, at this point the existing weights will be removed and replaced with the new solution. If the previous dynamic balance weights were already removed for Run 1, this is just a reminder text. This same information line in following runs means to remove the trim weights installed on the previous run. In other words, the balance solution and resulting weight installed here after Run 1 may change in Run 2. The weights installed after Run 1 would be removed and new weights added at another location to refine the balance solution.

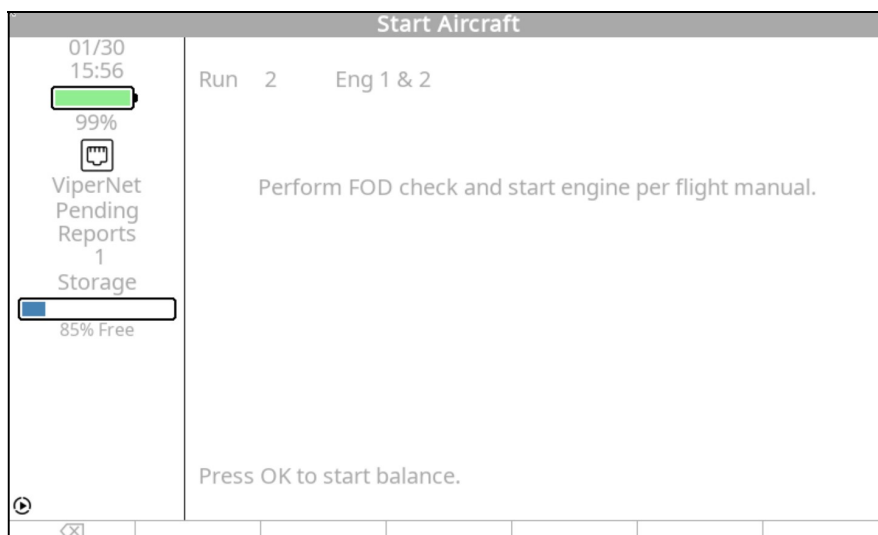
NOTE

In subsequent runs, all installed weights from each previous run must be removed. The “remove weight” message will be repeated for every run and solution. Each new solution dictates that the previously applied solution (installed weight) be totally replaced. In some cases, this may mean removing and reapplying weight at the same or near the same location. Failure to remove previously installed weight prior to applying the new solution weight will result in failure of the propeller balance function.

The menus above the function keys are as follows;

- [F0] “Backup” – Returns the user to the previous screen
- [F1] “Inst=Sugg’ – Returns all “Installed” values to the values listed under the center “Suggest” column.
- [F2] “Inst=None” – Returns all “Installed” values to the null or “0” weight.
- [F5] “Quit Job” – Terminates the job without the option to resume it later.
- Press [OK] to continue with the Prop Suggested /Installed solution for engine #2 (if conducting a two (2) engine job). If conducting a single engine job, move to the end of this section, to continue with the instructions at the “Start Aircraft” screen.

The screen will display the “Start Aircraft” banner screen shown below.



The “Start Aircraft” banner screen indicates the upcoming run number and directs you to “Perform FOD check and start engine(s) per flight manual”. Press [OK] to start prop balance.” Then repeat the procedures described above starting with paragraph 4.1.5 until the level of vibration is at or better than an acceptable level. See the *ACES Systems Guide to Propeller Balancing* for details of vibration levels and weight installation procedures.

NOTE



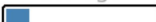



If the engine/propeller assembly is mechanically sound, a normal balance job should take no more than three runs to complete. The analyzer will only allow you to complete 6 runs in attempts to balance. If the balance job is not completed by the sixth run you should suspect possible problems with your technique or mechanical faults with the engine and/or propeller assembly. Mechanical faults may also be indicated by drastic changes in suggested weight or angle from one solution to the next.

4.1.9. – Vibration Summary

The “Vibration Summary” screen will appear when the vibration measured during any run is lower than:

Cobra II	Viper II	Units	English	Metric
■	■	Velocity	0.07 IPS peak	1.78 mm/sec peak 0.178 cm/sec peak
N/A	■	Displacement	0.35 mils peak	8.0 microns peak
■	■	Acceleration	0.04 g’s peak	0.35 m/s/s peak 35.0 cm/s/s peak

These levels are approximately equivalent to 0.07 IPS at propeller balance speeds in the 2000-2400 RPM range. It is recommended that you quit balancing when the vibration drops below these levels.

Vibration Summary			
01/30 15:58	Run 2	Eng 1	Eng 2
 99%	Eng Vib:	Good	Good
 ViperNet Pending Reports 1	Starting Vibration:		
Storage  85% Free	S1:	0.80 @ 270 °	0.50 @ 0 °
	Current Vibration:		
	S1:	0.03 @ 270 °	0.02 @ 0 °
			
	<input type="text" value="CURSOR HERE AFTER SELECTION"/>		
	Install permanent weights for Eng 1 & 2		
	Quit Job	Wt Calc	Continue

The “Vibration Summary” banner screen will display run number at which the current vibration level was recorded. It will give a brief description of the current engine vibration level. The screen will show the starting vibration magnitude and phase angle on any channels defined in the setup. In the case above, measurements were recorded on channel A only. The screen will also display the current vibration magnitude and phase on any channel defined in the setup. Values displayed in **RED** are above the targeted max vibration amplitudes while values displayed in **GREEN** are below the targeted max vibration and acceptable for discontinuing the balance job.

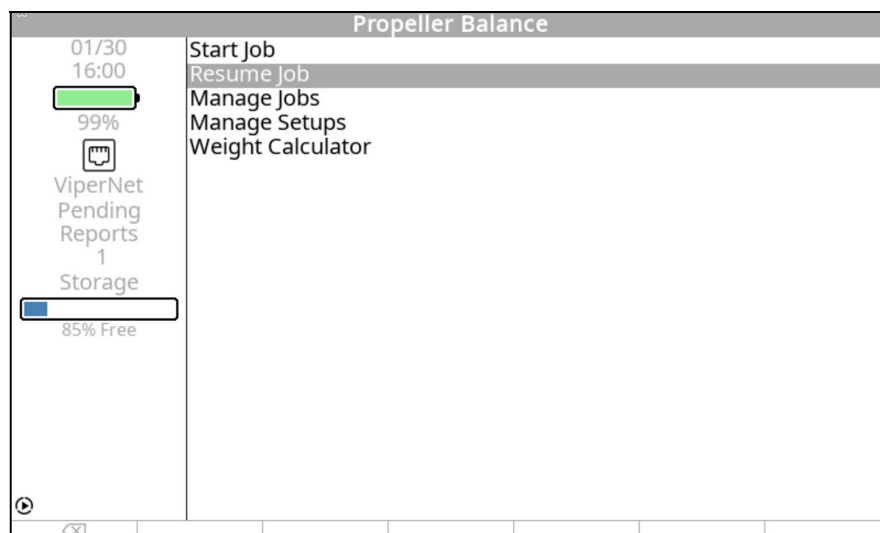
The bottom of the screen prompts you to install the permanent weights on the engine(s) that meet or exceed the maximum vibration levels. Use the [F3] “Wt Calc” button to automatically access the “Weight Calculator” when balancing without predetermined hole locations as explained in Paragraph 4.5 below. The selection field below the “Current Vibration” line allows you to use the [⇒] or [⇐] keys to select a next action for each engine individually. The possible selections are “Do Verify Run” which will validate the final added solution, “Cont. Balance which allows you to attempt to improve the Current Vibration level, even if it is already below the maximum acceptable, and “Completed” to indicate you are accepting the current vibration level and terminating the balance process on the indicated engine column. When this field selection reads per your desired next action, use the [↓] key to move the cursor to “CURSOR HERE AFTER SELECTION” then press [F5] “Continue” to execute the selected action.

You may also terminate the job at the current vibration reading and weight installation by pressing the [F1] “Quit Job” key. This will mark the job as complete. The warning screen, which is shown below, asks you to confirm that you want to Quit the Job in progress. Press [F1] “Yes” if you are sure you want to complete this job. Press [F3] “No” to return to the “Vibration Summary” screen.



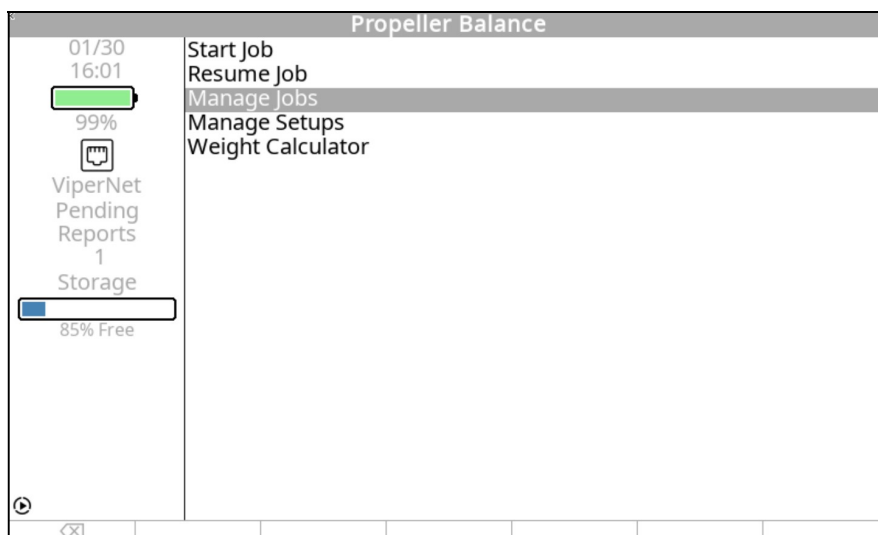
4.2. – Resume Job

The features in this section are common among all jobs. Because of this, they are contained in “Chapter 3, Using the Gen II Analyzer”.



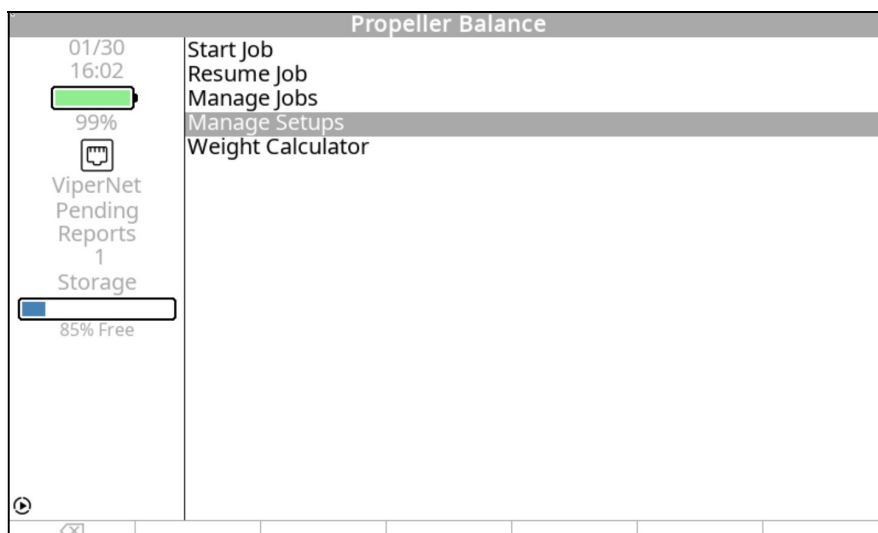
4.3. – Manage Jobs

The features in this section are common among all jobs. Because of this, they are contained in “Chapter 3, Using the Gen II Analyzer”.



4.4. – Manage Setups

The features in this section are common among all jobs. Because of this, they are contained in “Chapter 3, Using the Gen II Analyzer”.



4.5. – Weight Calculator

CAUTION

If test weights were used on the spinner, they must be removed before installing any permanent weights. The test weights will be replaced by the weight suggested in the analyzer to compensate for the change in arm of the permanent installation location.

The weight calculator, as shown below, can be used for placement of the final balance weights. This function can be accessed by using the [F3] “WtCalc” function key from the “Balance Summary” screen shown in paragraph 4.1.9 above .

For your convenience, this function can also be accessed at any time from the “Propeller Balance Jobs” menu shown in paragraph 4.1 above.

Permanent Weight Calculator

01/30
16:03
99%
ViperNet
Pending Reports
1
Storage
85% Free

Solution Weight: 40
Solution Angle: 189
* Spinner Diameter: 20
* Offset: 5
Split Angle: Yes

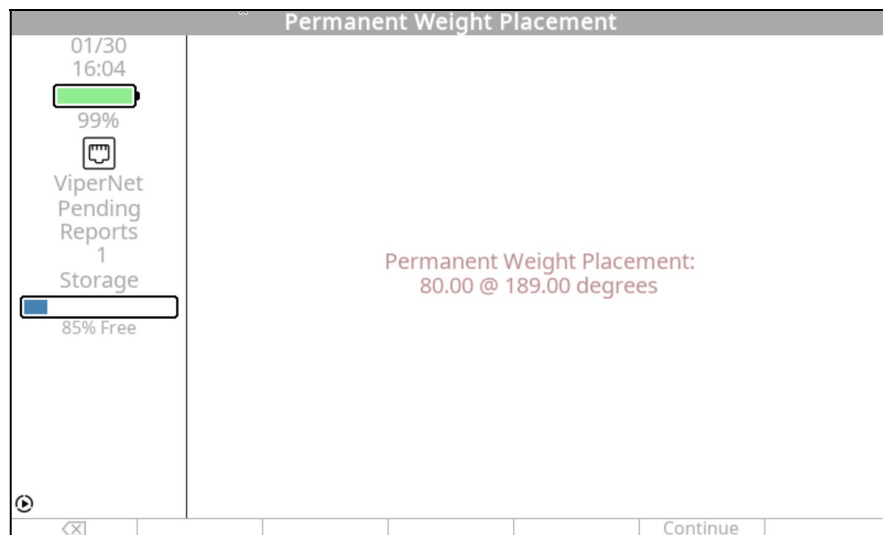
* Offset is the distance from the test weight to the permanent weight. Diameter and offset must be entered in the same measurement units.

Press OK to continue

Use the following description of each line to enter data in the weight calculator. Use the [↓] or [↑] key to move between fields.

- In the “Solution Weight” line enter the amount of test weight in grams installed at the test location. This field will be automatically filled in if the weight calculator was activated as a result of pressing the “Wt Calc” key on the “Vibration Summary” screen.
- In the “Solution Angle” line enter the angle of the installed test weight. Use the same method that you used for placing the test weight. This field will be automatically filled in if the weight calculator was activated as a result of pressing the “Wt Calc” key on the “Vibration Summary” screen. This value will take into account the effective angle of any weight splits.
- The “Spinner Diameter” value will be determined by measuring the outside diameter of the spinner. If the test weights were installed on a location other than the outer circumference of the spinner, use the measurement from the location where the test weights were installed. This value will typically be in inches.
- The “Offset” is the distance the radius will change between the test weight location and the final weight location. This value must be entered in the same measurement units as used to enter the Spinner Diameter.

- The “Split Angle” toggle field allows you to split the weight across two locations. Selecting “No”, the final weight solution will be installed at a single weight location as shown below.

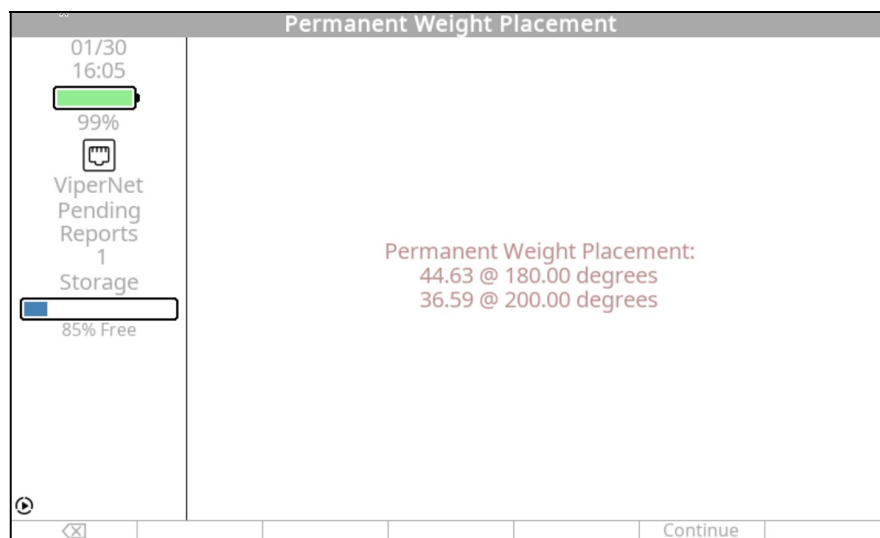


- By selecting “Yes” in the “Split Angle” field, the “Set Split Weight” screen is displayed as shown below.



The single location solution (in this case 80 Grams @ 189 degrees) is displayed at the top of the screen. The next line states “Enter New Location.” Use the keypad to complete the next two fields, “Angle 1” and “Angle 2.” Locate the two available weight installation locations (one on each side of the 189-degree location) and enter them in the two fields. Use the [↓] key to move between the fields. Press [OK] to continue.

The “Permanent Weight Placement” screen seen below will show the suggested weight to place at each location to compensate for the reduced radius from the previously installed test weights.



Revision History

3/12/2015	1.01: Corrected reference for use of Propeller Protractor from Chapter 2 to Page 4-4 in sections 4.1.8.1 and 4.1.8.2.	Berlin
11/9/2015	1.02: Added text about the Polar Chart view. Main Polar view explanation in Chapter 24.	Lucas
2/17/2016	2.00: Major rewrite generalizing the manual to cover both the Viper II and Cobra II. This chapter was updated with screenshots and corrections to minor typographical errors.	East
10/24/18	2.1: Major Rewrite for the addition of Dual Prop Balancing in SP5.	Justice
4/1/2020	2.2: Rewrite for UI changes for SP7. Added Screen Shots and Verbiage reflecting SP7 UI changes. Added verbiage about existing weights feature.	Shively