



Application Note

Airframe Type: Bombardier Global Express

Procedure: Fan Trim Balance

Part Number: 11-200-0228
AppNote Number: A-BA-GXP-4040-FB

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Application Note

Application Note Number	A-BA-GXP-4040-FB
Version	0
Function	Fan Trim Balance
Airframe	Bombardier Global Express
Engine	RR BR710-A2-20
E-Setup Number	a-ba-gxp-4040-fb
ACES Systems Analyzer	Viper 4040
Firmware Version	2.04 or greater
Procedure	N/A

Introduction

This Application Note is number 1 of 1 Application Notes required to perform a fan trim balance on a Bombardier Global Express with Rolls-Royce BR710A2-20 engines. This Application Note describes the steps necessary for set up and operation of the Viper 4040 analyzer and associated equipment.

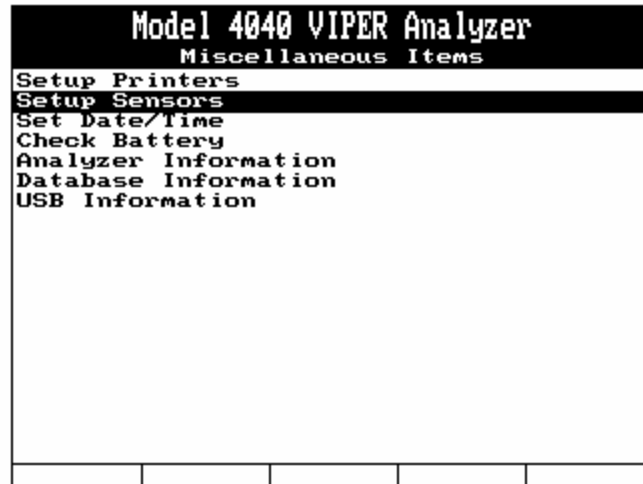
Required Equipment: The following equipment is required to accomplish a single engine fan trim balance.

Item	Quantity	Description	Part Number
1.	1EA	Analyzer, Viper 4040	10-100-4040
2.	1EA	Cable, Interface, Global Express to 4040	10-320-0320
3.	2EA	Cable, Generic Vibration, 50 Ft	10-320-0127
4.	2EA	Cable, Generic Tachometer, 50 Ft	10-320-0126

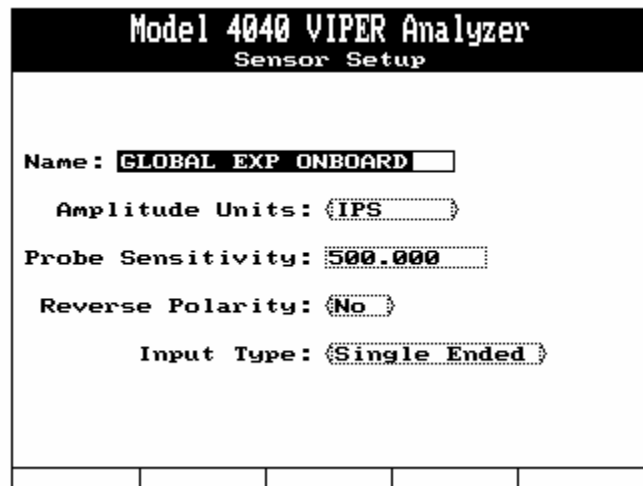
Optional Equipment: None.

A. Equipment Set Up

1. Connect the Global Express to 4040 Interface cable, item 2, to the front connector of the EVM (Engine Vibration Monitoring) unit in the lower equipment bay.
2. Connect the Generic 50 foot Vibration, item 3, and Generic 50 foot Tachometer cables, item 4, to the Global Express Interface Cable, item 2, and rout the cables to the location where the analyzer will be operated for the balance.

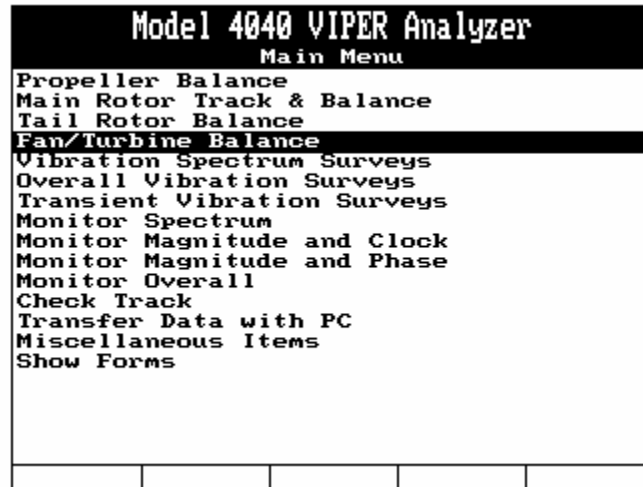


10. Complete the Sensor Setup screen, shown below, as follows:
 - 10.1. In the **Name:** field, enter “GLOBAL EXP ONBOARD”. This will indicate this sensor is installed permanently on the engine of the Global Express. Press the ↓ key to move to the next field.
 - 10.2. In the **Amplitude Units:** field, use the ⇒ key to select “IPS”. This is the engineering unit of output for the onboard sensor. It will be converted to mm/sec by the analyzer for balancing. Press the ↓ key to move to the next field.
 - 10.2. In the **Probe Sensitivity:** field, enter “500”. This indicates the output of the onboard sensor is 500 mV/IPS. Press the ↓ key to move to the next field.

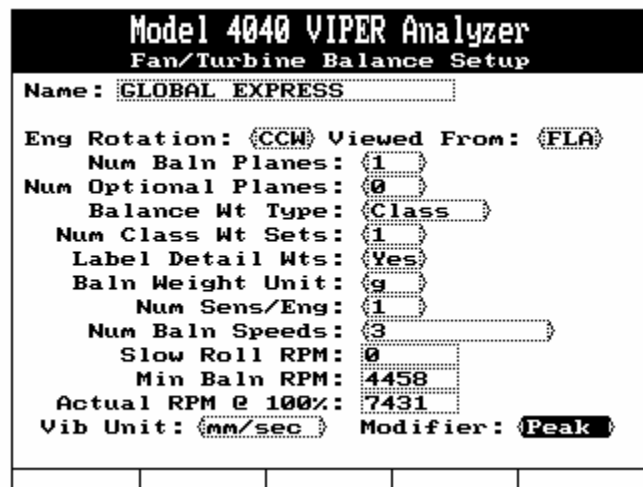


- 10.3. In the **Reverse Polarity:** field, use the ⇒ key, if necessary, to select “No” indicating the sensor polarity is not reversed. Press the ↓ key to move to the next field.
- 10.4. In the **Input Type:** field, use the ⇒ key, if necessary, to select “Single Ended” indicating the type input to the sensor.
- 10.5. When all fields are complete, press ENTER to accept and save. The screen will return to the “Manage Sensors” screen. From that screen, press [BACKUP] repeatedly until the Main Menu is again displayed.

11. From the Main Menu, select “Fan / Turbine Balance”



- 11.1 If there are other setups already in the analyzer, the Setup List banner screen will be displayed. From that screen, press the [F1] “New” key. If no setups are in the analyzer, the “Fan / Turbine Balance Setup” screen will be displayed. Complete the Balance Setup screen as follows:
- 11.1.1 Use the keypad to enter “GLOBAL EXPRESS” in the **Name:** field. Press the ↓ key to move to the next field.



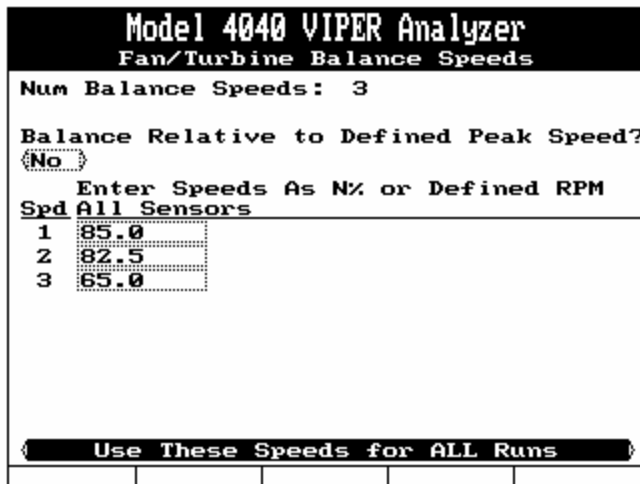
- 11.1.2 In the **Num Eng:** (number of engines) field, use the ⇒ key to select a number that indicates the number of engines that will be balanced using this setup. This is typically “1”. Press the ↓ key to move to the next field.
- 11.1.3 In the **Eng Rotation:** field, use the ⇒ key to select “CCW” indicating the fan rotates counter-clockwise as viewed from the front looking into the intake. Press the ↓ key to move to the next field.
- 11.1.4 In the **Num Balan Planes:** (number of balance planes) field, use the ⇒ key to select “1”. Press the ↓ key to move to the next field.

- 11.1.5 In the **Num Optional Planes:** (number of optional balance planes), use the \Rightarrow key to select “0”. Press the \Downarrow key to move to the next field.
- 11.1.6 In the **Balance Wt Type:** field, use the \Rightarrow key to select “Class”. The class weights will be defined on another page. Press the \Downarrow key to move to the next field.
- 11.1.7 In the **Num Class Wt Sets:** (number of class weight sets), use the \Rightarrow key to select “1”. The BR710 has two one weight set that may be used to trim balance the engine. Press the \Downarrow key to move to the next field.

NOTE

You may choose to use the short, basic or extended weight sets according to your requirements. If using multiple weight sets, you should specify how many sets you will define here, ie: Num Class Wt Sets = 3 if using the short, basic and extended weight sets.

- 11.1.8 In the **Label Detail Wts:** field, use the \Rightarrow key to select “Yes”. This will allow you to inform the analyzer that holes used for spinner attachment bolts cannot be used to add weight. If the answer is yes in this field, the analyzer will optimize the balance solution on available holes only. Press the \Downarrow key to move to the next field.
 - 11.1.9 In the **Baln Weight Units:** field, use the \Rightarrow key to select “g” for grams. The class weights for the BR710 are measured in grams. Press the \Downarrow key to move to the next field.
 - 11.1.10 In the **Num Sens / Eng:** field, use the \Rightarrow key to select 1. Press the \Downarrow key to move to the next field.
 - 11.1.11 In the **Num Baln Speeds:** field, use the \Rightarrow key to select the total number of speeds (up to 9) you will use for this setup. Optionally, you may choose “Select in Job” which will allow you to specify the number of balance speeds with each new job rather than defaulting to a number you select here in the setup. Three speeds are recommended for balancing the BR710. Press the \Downarrow key to move to the next field.
 - 11.1.12 In the **Slow Roll RPM:** field, use the keypad to enter “0”. Slow roll is a compensating RPM for use in engine applications where proximity probes are used and does not apply to this engine. Press the \Downarrow key to move to the next field.
 - 11.1.13 In the **Min Baln RPM:** field, use the keypad to enter the minimum speed at which this engine can be balanced. This speed will normally be a speed in the flight range. Press the \Downarrow key to move to the next field.
 - 11.1.14 In the **Actual RPM @ 100%:** field, use the keypad to enter the speed of the fan at 100% rpm. For the BR710, this is 7431. Press the \Downarrow key to move to the next field.
 - 11.1.15 In the **Vib Unit:** field, use the \Rightarrow key to select “mm/sec”. The BR710 engine is balanced using velocity units of millimeters per second. Press the \Downarrow key to move to the next field.
 - 11.1.16 In the **Modifier:** field, use the \Rightarrow key to select “Peak”. When all fields are complete, press [ENTER] to accept and continue.
- 11.2 The Fan/Turbine Balance Speeds screen will be displayed. Select “No” to answer the question “Balance Relative to Defined Peak Speed?”. Use the analyzer keypad to enter the three balance speeds of 85%, 82.5% and 65% as shown below in the example. The line at the bottom of the screen should read “Use These Speeds for All Runs”. If it does not, press the \Downarrow key to move to the field, and then press the \Rightarrow key to select the option. Press [ENTER] to accept your entries and continue.



11.3 The Define Class Weights banner screen will be displayed where each of the class weights used for the BR710 fan trim balance will be added to the setup. Because the 4040 has a limited number of characters for the “Name” field of each individual weight, the conversion in table 1 below is used. Notice that the “ACES Designation” in the fourth column is a single letter. This allows the use of multiple weight combination and also allows for the removal of the W4 Spreader washer, designated by (-D) in the Name field of the analyzers weight definition screen. For example, the solution of “MH-D” indicates the use of 1 ACES Designation M weight (BRR40214 W3 – Trim Balance Plate), 1 ACES Designation H weight (AS44522-080, Cup Washer) and the removal (-D) of the ACES Designation D weight (AS12945, W4 – Spreader Washer). Table 2 shows all possible combinations of ACES Designated weights and their weight value which are entered in the analyzer setup.

Table 1, below should be copied and taped inside the analyzer lid for rapid identification of each class weight:

BR700 Trim Balance Weights	RR Part Number	Weight (grams)	ACES Designation
Cup washer	AS44522-020	2	A
Cup washer	AS44522-030	3	B
Cup washer	AS44522-040	4	C
W4 - Spreader washer	AS12945	4.5	D
W1 - Cup washer	AS44522-050	5	E
Cup washer	AS44522-060	6	F
Cup washer	AS44522-070	7	G
Cup washer	AS44522-080	8	H
Cup washer	AS44522-090	9	I
W2 - Cup washer	AS44522-100	10	J
Cup washer	AS44522-120	12	K
Cup washer	AS44522-140	14	L
W3 - Trim balance plate	BRR40214	15.5	M

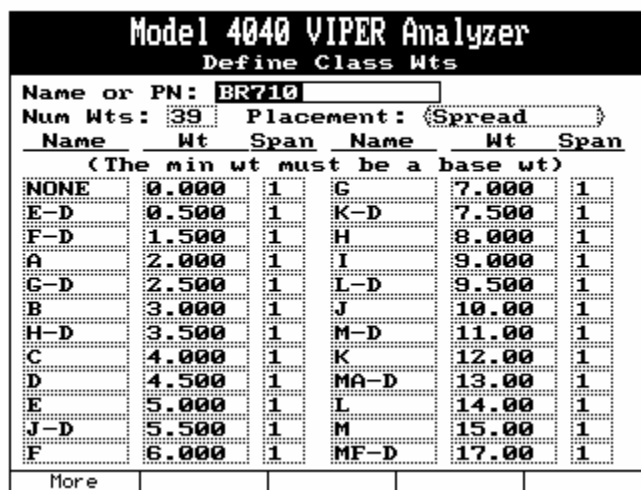
Table 1.

Possible Combinations	End Weight (grams)	Possible Combinations	End Weight (grams)
E-D	0.5	L	14
F-D	1.5	MC-D	15
A	2	M	15.5
G-D	2.5	MF-D	17
B	3	MA	17.5
H-D	3.5	MB	18.5
C	4	MH-D	19
D	4.5	MI-D	20
E	5	MF	21.5
J-D	5.5	MG	22.5
F	6	MK-D	23
G	7	MH	23.5
K-D	7.5	MI	24.5
H	8	ML-D	25
I	9	2M-D	26.5
L-D	9.5	MK	27.5
J	10	ML	29.5
M-D	11	2M	31
K	12	3M-D	42
MA-D	13		

Table 2.

11.4 Complete each field in the screen as follows:

11.2.1 In the **Name or PN:** field, use the keypad to enter “BR710”. This name is used in lieu of the multiple part numbers used for BR710 balance weights. Press the ↓ key to move to the next field.



Model 4040 VIPER Analyzer					
Define Class Wts					
Name or PN: BR710					
Num Wts: 39		Placement: Spread			
Name	Wt	Span	Name	Wt	Span
(The min wt must be a base wt)					
MA	17.50	1	ML	29.50	1
MB	18.50	1	2M	31.00	1
MH-D	19.00	1	3M-D	42.00	1
MI-D	20.00	1			
MF	21.50	1			
MG	22.50	1			
MK-D	23.00	1			
MH	23.50	1			
MI	24.50	1			
ML-D	25.00	1			
2M-D	26.50	1			
MK	27.50	1			
More					

- 11.7.1 In the **Num Wts:** field, use the keypad to enter a total number of weights in this class weight set 38, plus 1 for a total of 39. The first weight will be the NONE weight which means no weight to be added.
- 11.7.2 In the **Name, Wt,** and **Span** columns, enter the information as shown in the illustration above for the 39 class weights and weight combinations. The name will be the letter combinations of the various weights, the weight is measured in grams for each combination of class weights and the span is the number of holes each combination weight covers when installed. When all information is entered as shown for the first 24 weights, press [F1] “More” key to switch screen views for the remaining weights. Note that where letter and combinations of letters are followed by the “-D”, this indicates the removal of the “D” weight, which is the W-4 Spreader Washer, part number AS12945. When all weights have been entered on the second page, press [ENTER] to accept and continue.
- 11.8 The Balance Plane Information screen will be displayed. Complete the screen as follows:

Model 4040 VIPER Analyzer	
Balance Plane Information	
Plane:	1
Posn Type:	Hole
Num Holes:	16
Num Usable:	6
RivetWt:	0.000
Spacing:	Even
Hole Num Dir:	CW from FLA
MaxWt/Hole:	42.00
MaxWt/Plane:	252.0
Wt Set:	BR710
Trial Wt:	10.00
Angle of #1 Hole:	0

- 11.8.1 If the Plane ID: field does not read < 1 >, press the ⇨ key to select “1”. Press the ↓ key to move to the next field. In the Posn (Position) Type, use the ⇨ key to select “Hole”. Press the ↓ key to move to the next field.
- 11.8.2 In the Num Holes: field; use the analyzer keypad to enter “16”. Press the ↓ key to move to the next field.

- 11.8.3 In the Num Usable: field; use the analyzer keypad to enter “6”. Press the ↓ key to move to the next field.
- 11.8.4 Skip the RivetWt: field and leave the selection at 0.000 as rivets are not used to fasten the balance weights. Press the ↓ key to move to the next field.
- 11.8.5 In the Spacing: field, use the ⇒ key to select Even. Press the ↓ key to move to the next field. Press the ↓ key to move to the next field.
- 11.8.6 In the Hole Num Dir: field, use the ⇒ key to select CW (clockwise)
- 11.8.7 In the “from” field, use the ⇒ key to select FLA (forward looking aft). Press the ↓ key to move to the next field.
- 11.8.8 In the MaxWt/Hole: field, use the analyzer keypad to enter 42.0. Press the ↓ key to move to the next field.
- 11.8.8 In the MaxWt/Plane: field, use the analyzer keypad to enter 252. Press the ↓ key to move to the next field.
- 11.8.9 The Wt Set field will default to the BR710 set entered earlier. Press the ↓ key to move to the next field.
- 11.8.10 In the Trial Wt: field, use the analyzer keypad to enter 10.00. Press the ↓ key to move to the next field.
- 11.8.11 In the Angle of Hole #1 field, use the analyzer keypad to enter 0. Press [ENTER] to accept your entries and continue.
- 11.9 The Sensor Information screen will be displayed. Complete the screen as follows:
- 11.9.1 In the **Eng ID:** field; use the keypad to enter a single numeric character to identify this engine such 1 or 2. . Press the ↓ key to move to the next field.

Model 4040 VIPER Analyzer				
Sensor Information				
Eng ID:	1			
Tach Chan:	1	Tach Type:	Optical	
Tach Pos (FLA):	12			
Full Scale Vibration:	5.00			
Sensor Type	Ch	Desc	Pos	Targ
GLOBAL EXP ONBOARD	A	FAN	UNK	0.800

- 11.9.1 In the **Tach Chan:** field, use the use the ⇒ key to select the tach channel you wish to use. This must be the tach channel, 1, 2, 3, or 4, where you connect the tach input cable for this engine. Press the ↓ key to move to the next field.
- 11.9.2 In the **Tach Type:** field, use the ⇒ key to select the type of tachometer you are using. If using the EVM interface cable, a Lasetach or Phototach, select “Optical”. Press the ↓ key to move to the next field.
- 11.9.3 In the **Tach Pos (FLA):** (tachometer position as viewed from forward looking aft), use the ⇒ key to select a clock position where the tach probe is located on the engine. Press the ↓ key to move to the next field.

- 11.9.4 In the **Full Scale Vibration:** field, use the \Rightarrow key to select the highest amplitude you reasonably expect to experience for this balance job. Amplitude of 5 mm/sec is sufficient for the BR710. Press the \Downarrow key to move to the next field.
- 11.9.5 In the **Sensor Type** column, use the \Rightarrow key to select a sensor from those sensors programmed into your analyzer. If using the engine installed sensor, select the GLOBAL EXPRESS Onboard sensor as programmed in paragraph 10 of this document. Press the \Downarrow key to move to the next field.
- 11.9.6 In the **Cha** field, use the \Rightarrow key to select the channel you will connect the incoming vibration signal to, A, B, C, or D. Press the \Downarrow key to move to the next field.
- 11.9.7 In the **Desc** field, use the keypad to enter an optional description of the channel identified sensor such as Fan, #1 or L. Press the \Downarrow key to move to the next field.
- 11.9.8 In the **Pos** (position) field, use the \Rightarrow key to select the approximate clock position of the vibration sensor on the engine as viewed from forward looking aft into the intake. If you are not sure of the position, select “UNK” for unknown. The analyzer will compensate for the unknown position and locate it automatically with one additional engine run. Press the \Downarrow key to move to the next field.
- 11.9.9 In the **Targ** (target amplitude) field, use the keypad to enter the amplitude you wish to achieve as a maximum acceptable using this setup. When all fields are complete, press [ENTER] to accept and continue.
- 11.10 The Define Fan / Turbine Balance ICFs banner screen will be displayed. In the **All Speeds Use the Same ICF:** field, use the \Rightarrow key to toggle the answer field to “No”. Press the \Downarrow key to move to the next field.

Model 4040 VIPER Analyzer			
Define Fan/Turbine Balance ICFs			
Plane ID: 1			
All Speeds Use the Same ICF:			No
Spd	Sensor	1	
	g/mm/se	Deg	
1	0.00	0	
2	0.00	0	
3	0.00	0	

- 11.10.1 In the **g/mm/se** column, use the keypad to enter the influence in grams per mm/sec if you know the influence for this engine. If you do not know the influence, leave it at zero. The analyzer will require one extra run to automatically calculate an influence for the engine and update these fields automatically. Press the \Downarrow key to move to the next field.
- 11.10.2 In the **Deg** field, use the keypad to enter the phase lag, if known. If you do not know the phase lag, leave this field at zero. The analyzer will calculate the phase lag automatically during the job. Repeat

steps 11.10.1 and 11.10.2 for each of the three speeds then Press [ENTER] to accept your settings and proceed.

- 11.11 After the setup is stored you may turn the analyzer off or proceed to the balance procedure. If you continue with the balance, the customer information screen below will be displayed. The information on this screen is optional and need not be filled in to continue with the job, however; this information will assist you in your record keeping efforts and greatly reduce the effort in recalling the job later from the analyzers memory or for the AvTrend database. Use the keypad to enter the Name, Aircraft Registration, and total aircraft time. If you have entered other names in the Name field previously, you may press the [F1] key and select from a list containing those stored names. When all fields are complete, press [ENTER] to accept and continue.

Model 4040 VIPER Analyzer				
Job Identification				
Name:	North Atlantic Oil			
A/C Registration:	[]			
A/C Total Time:	0.0			
Press ENTER to continue				
Names	[]	[]	[]	[]

- 11.11 The Engine Information screen will be displayed. Use the ⇐ key to select the engine Position: on the aircraft for the job you are about to begin. For the remainder of this screen, use the ↓ key to move from field to field and use the analyzer keypad to enter the optional information for the Engine serial number (S/N), Type, TSO, TSN and Cycles (Cyc). When all fields are completed as required, press [ENTER] to accept your entries and continue.

Model 4040 VIPER Analyzer				
Engine Information				
Position:	1			
Engine:	S/NRR1234			
Type:	[]			
TSO:	0			
TSN:	0			
Cyc:	0			
Serial Nos	[]	[]	[]	[]

- 11.12 The Label Detail Weight Holes screen will be displayed. Press the ↓ key to move from field to field. Mark positions 1, 5, 9 and 13 with an “X” by pressing the ⇌ key when the dark cursor is covering each of these numbers. This will exclude consideration of these holes for use in adding trim weights during the balance job. Press [ENTER] to accept the settings and continue.

Model 4040 VIPER Analyzer	
Label Detail Wt Holes	
Plane ID: 1	
X	15
2	16
3	
4	
X	
6	
7	
8	
X	
10	
11	
12	
X	
14	
Press → to Label as Detail Wt Hole	
Graph	

- 11.13 The Fan/Turb Balance Equipment Setup screen will be displayed with installation instructions as shown below. When the equipment is installed and your are ready to continue, press [ENTER].

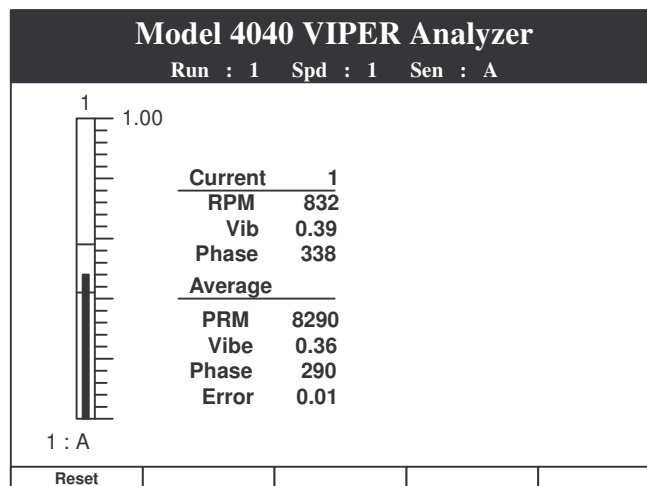
Model 4040 VIPER Analyzer	
Fan/Turb Balance Equipment Setup	
Install the speed sensor and connect to tach channel 1	
Install vibration sensor and connect to vib. channel A	
Tach power is Off	
Tach On	

- 11.14 The Start Aircraft banner screen will be displayed. The Run number is indicated at the top left of the screen followed by the information message “Remove all trim weights.” Insure all previously installed trim balance weights have been removed. Start the engine(s) and watch for the Current RPM indication on the analyzer screen. When an indication of RPM is noted, allow the engine to warm up to normal operating temperature then accelerate the engine until the Current RPM and the Desired PRM on screen match as closely as possible. The Difference indication will show how many RPM difference there is between the Current and the Desired RPM. When the speeds are matched, allow the engine to stabilize for a short time and make any minor adjustments necessary, and then press [ENTER] to continue.

Model 4040 VIPER Analyzer				
Start Aircraft				
Run 1				
Remove all trim weights.				
Start engine(s) per flight manual				
Current RPM: 400				
Desired RPM: 8500				
Difference : -8100				
When speed is stable at desired speed, press ENTER to continue.				

B. Data Acquisition

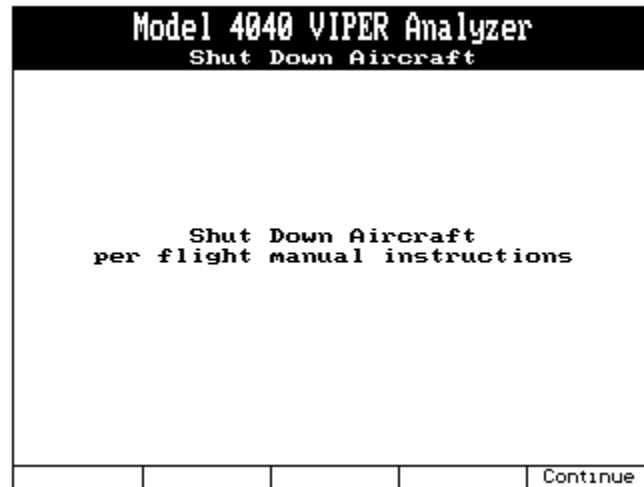
- 11.15 The Run 1, Spd 1, Sen 1 banner screen shown below will display the information for the first run. Indications of the Current and Average RPM, Vibration amplitude, and phase angle are displayed to the right of the converging scale. See the Viper 4040 User manual, chapter 20, Reading Spectrum and Scales for a detailed description of how to read the converging scale. After indications are stable, press [ENTER] to accept the collected data and continue. This screen will repeat for each of the speeds specified for balance. When all speeds are collected, the screen will automatically proceed to the shutdown message below in 11.17.



CAUTION: DO NOT LET THE ENGINE SPEED STABILIZE IN THE RANGE 66 TO 80 PERCENT N1 (FAN SPEED) (WHEN THE AIRCRAFT IS STABLE AND ENGINES IN FORWARD THRUST).

CAUTION: MAKE SURE ALL CHANGES IN ENGINE SPEED, BETWEEN 66 AND 80 PERCENT N1, ARE DONE IN 10 SECONDS OR LESS (WHEN THE AIRCRAFT IS STABLE AND ENGINES IN FORWARD THRUST ONLY)

- 11.16 The Shutdown Aircraft message will be displayed. Press the [F5] “Continue” key to acknowledge and proceed with a normal engine shutdown procedure.



- 11.17 The Review Prior Run(s) Data will be displayed for your review of the data collected up to this point. You may view data from all runs by scrolling through the available run data using the ⇐ and ⇒ keys. Optionally you may use the [F1] and [F2] keys to Retake one or all data as required. When you are satisfied with the review, press [ENTER] to continue.

Model 4040 VIPER Analyzer
Review Prior Run(s) Data

Run 1

Spd	Sensor 1		
	Rpm	Vib	Deg
1	6316	1.20	22
2	6093	1.10	35
3	5945	1.30	27

<> Run

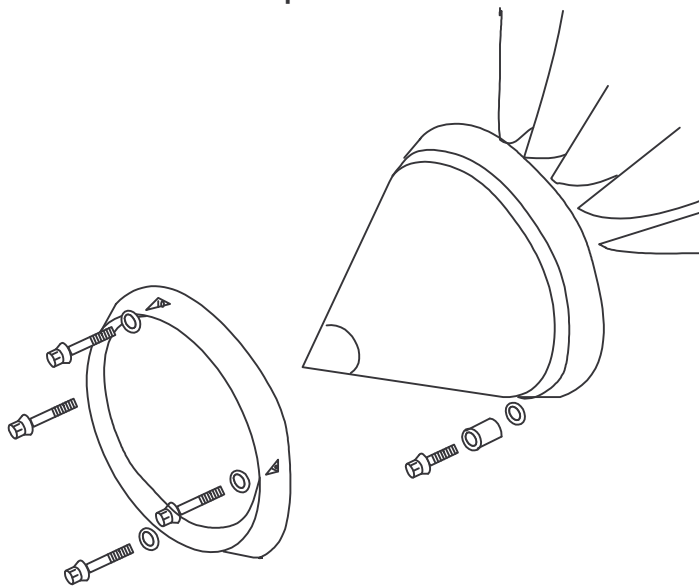
RetakeOne RetakeAll

- 11.19 The Fan / Turb Suggested / Installed Wts screen will be displayed. Notice the first line of text in the screen shows the Run number and the message “Remove Old Wts, Inst. New Wts.” Remove all previously installed trim weights for the previous run and install the weights in the “Suggested” column in the hole numbers indicated to their immediate left. The right side of the screen reflects what you actually installed. Be sure the information in

the Hole/Bld and Installed column are correct before exiting this screen. If you install the exact suggested weight, you need only press the [ENTER] key to exit this screen with that information. If you installed different weights or installed weights in different holes than those suggested, use the arrow key to navigate the matrix and indicate your exact installation. This is very important in that the analyzer will use this information to calculate an influence for all subsequent runs. Notice the the function keys at the bottom of the screen are labeled for the options of “Inst=Sugg” (install the suggested weights in the suggested holes), “Inst=None” (Install None or no weights), “Sel Pla/W” (select a different Plane or weight set), and “Quit Job” When all fields are complete, press [ENTER] to accept and continue.

Model 4040 VIPER Analyzer			
Fan/Turb Suggested/Installed Wts			
Run 1 Remove Old Wts, Inst. New Wts			
Name: Plane 1, BR710			
Hole	Suggested	Hole	Installed
2	B	2	B
3	A	3	A
4	H-D	4	H-D
14	C-D	14	C-D
15	E	15	E
1	NONE	1	NONE
1	NONE	1	NONE
1	NONE	1	NONE
1	NONE	1	NONE
1	NONE	1	NONE
1	NONE	1	NONE
Total: Soln = 10.000 @ 0		Total: Inst = 9.999 @ 360	
Inst=Sugg	Inst=None	Graph	Quit Job

NOTE: Before removing the nose cone to add trim weights, make a temporary mark on the nose cone and the nose cone fairing with an OMat Temporary marker felt/fibre tip to identify the angular position of the nose cone fairing and the nose cone. This is so that the fairing and cone can be installed back in to its initial position.



11.18 The Start Aircraft banner screen will be displayed for the next sequential run as indicated in the upper left portion of the screen. From this point, the sequence of events from paragraph

11.15 through 11.18 repeat until the fan vibration is reduced to an acceptable level. Normally this goal will be attained in one to three runs.

Model 4040 VIPER Analyzer				
Start Aircraft				
Run 2				
Start engine(s) per flight manual				
Current RPM: NO TACH				
Desired RPM: 13746				
Difference :				
When speed is stable at desired speed, press ENTER to continue.				