ENGINE INDICATING

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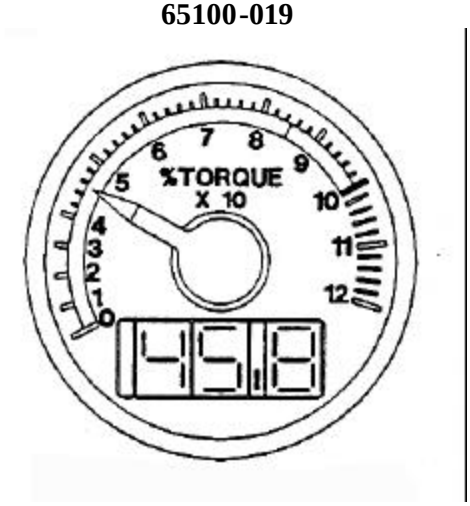
ENGINE INDICATING

77-1. TORQUE INSTRUMENT, PHYSICAL DESCRIPTION

This chapter describes the Diamond J, Inc. Model 65100-019 torque indicating instrument. The 65100-019 instrument digits are treated with blue filter material to give them a blue-white color.

65100-019



Green Arc 0% to 85%
Yellow Arc 85% to 100%
Red Radial 100%

Figure 77-1. Torque Digital Display

The 65100-019 is two-inches in diameter by 6-3/4 inches long and weighs less than 0.9 lbs. Case and bezel color is black per FED-STD-595, No. 37038. Lens coating is anti-reflective per MIL-C-675. The instrument has an analog and a digital display as shown in Figure 77-1 above. See Figure 77-2 for details of the rear connector and pin outs.

77-2. NORMAL OPERATION AND LIMITATION

The accuracy of the 65100-019 instrument is ±0.3%. The digital display resolution is ±0.1% and the analog display resolution is ±0.2% within the range of 40% and 120% torque. The digital display is an incandescent display that updates a minimum of twice per second. The internal backlight voltage controls the brightness of the digital display. The digits are full bright when the backlight voltage is between 0 VDC and approximately 0.7 VDC. This range is normally used for daylight operation. Above 0.7 VDC backlight voltage, the digits dim suddenly and their brightness follows the backlight voltage between 0.7 VDC and 5 VDC (maximum). This range is normally used for night operation.

77-3. EXCEEDANCE OPERATION AND LIMITATION

To warn the pilot of a potential over-torque condition, the digital display of a 65100-019 instrument flashes on and off once per second when the indicated torque goes above the red radial. The display will stop flashing when the indicated torque returns below the red radial, if an over-torque exceedance did not occur. If an exceedance does occur, the digital display will start flashing twice per second. The double flashing will stop one minute after the indicated torque returns below the red radial. This one minute delay is to insure that the pilot is made aware that an over-torque has occurred. Table 77-1 describes the torque limits for this instrument.

Double flashing (twice per second) resumes when the torque decreases below 5%.

77-4. DATA STORED IN NONVOLATILE MEMORY

The 65100-019 instrument records engine torque data into nonvolatile memory. The digital display plays back this data each time power is applied to the instrument. The following two paragraphs describe the torque information recorded for play back.

Table 77-1. TORQUE LIMITS

Instrument Part Number	Helicopter Manufacturer's Flight Manual	Helicopter Manufacturer's Maintenance Manual Over-torque Conditional Inspection		Engine Manufacturer's Maintenance Manual
65100-019	Greater than 100% for more than 5 seconds or greater than 110%	Greater than 110%	Greater than 120%	Greater than 106 psig (138.6%) for more than 10 seconds or greater than 109 psig (142.5%)

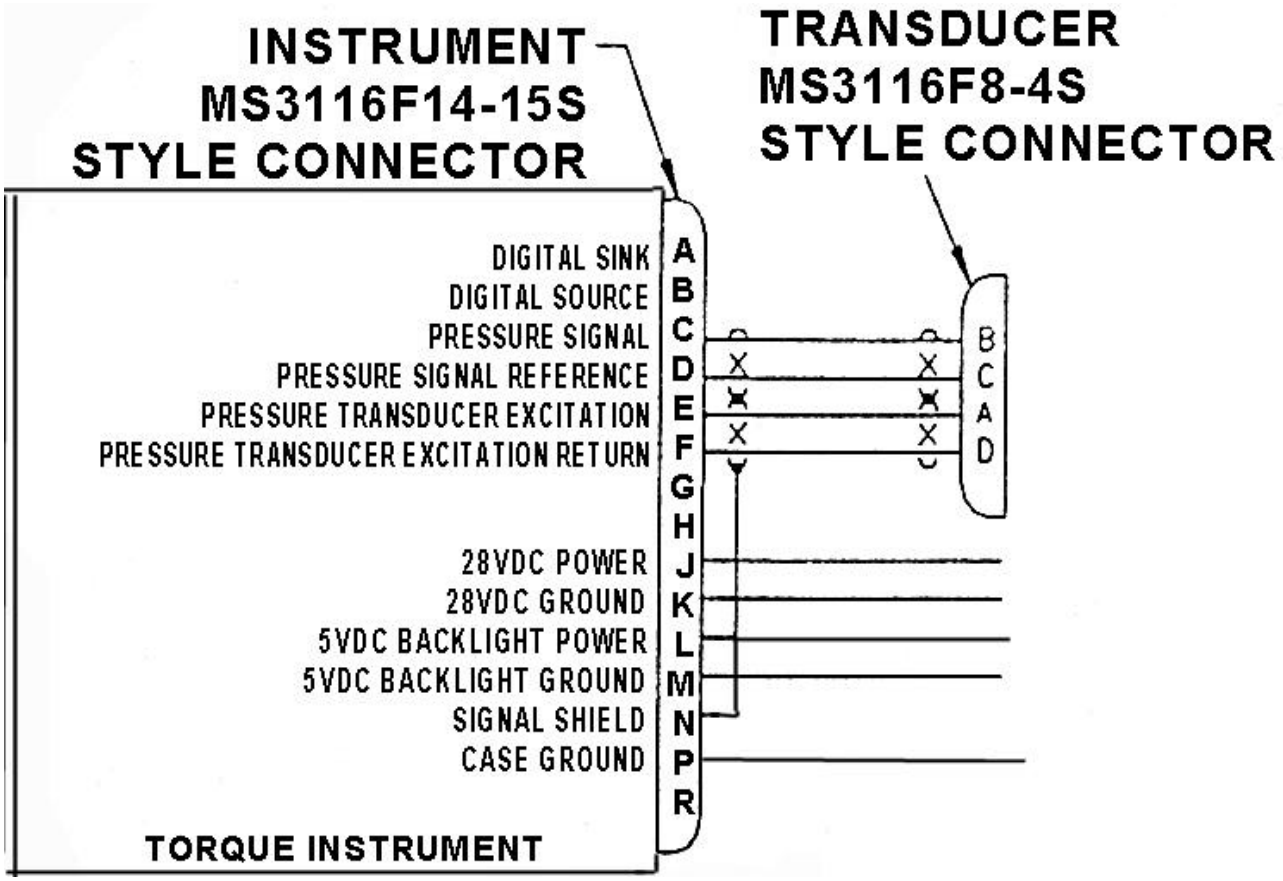


Figure 77-2. Torque Instrument Outline and Pin Out Drawing

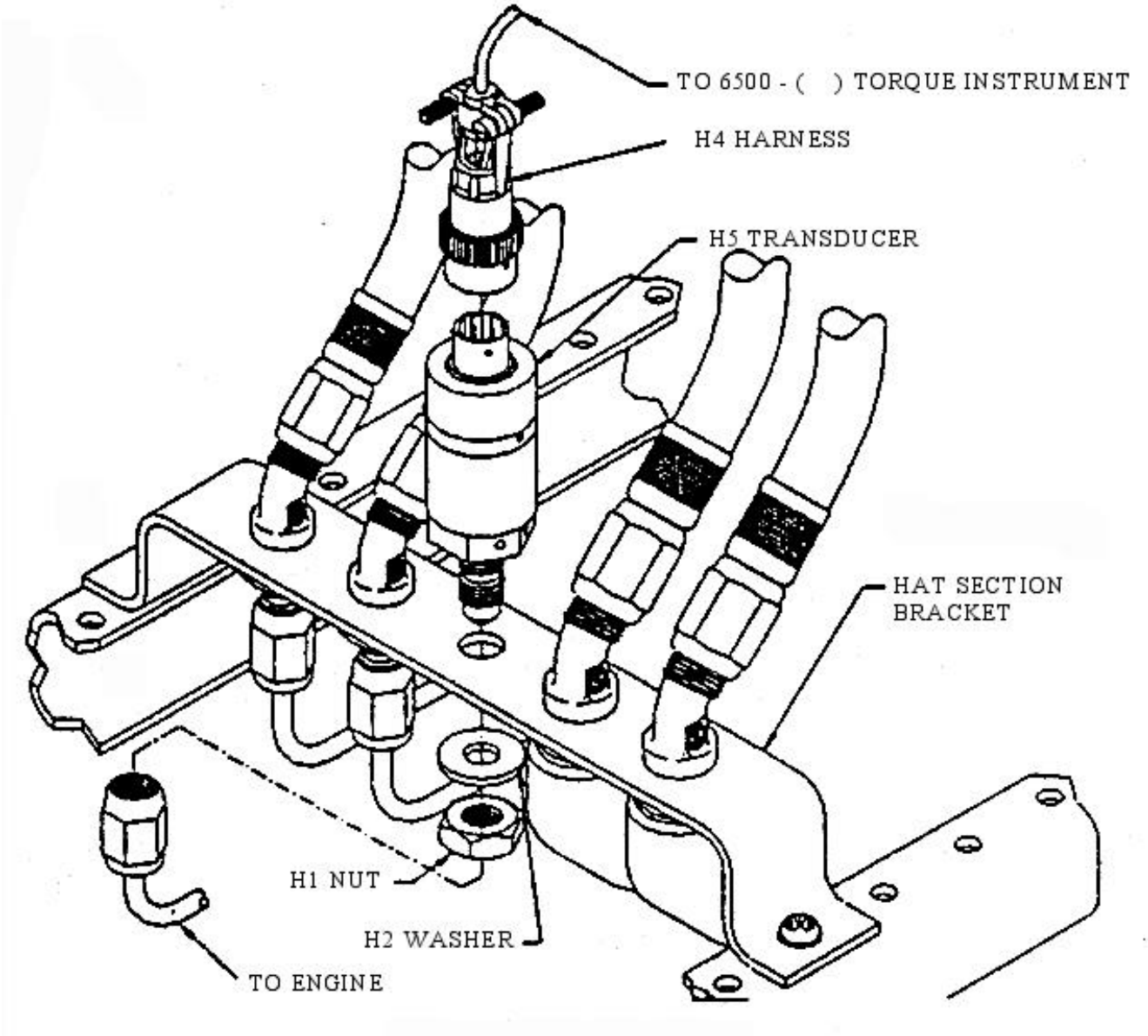


Figure 77-3. Torque Pressure Transducer

77-5. PEAK TORQUE EVENT

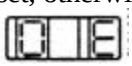
The peak torque (in % torque) and duration (in seconds) of the most severe torque event is recorded in memory. The 65100-019 instrument monitors torque and captures the peak torque during each event. If the new peak is greater than the old one, the new peak is recorded in memory over the current peak. The duration of this torque event is captured by a timer that is started when the indicated torque goes above the red radial and stopped when the indicated torque drops below the red radial. This transient torque event is also flagged as an exceedance if it is an over-torque event. Zero seconds is stored for the duration if the peak is less than the red radial. Table 77-1 describes the operation transient torque limits used to decide when the torque event is stored as an exceedance. This peak torque event remains in nonvolatile memory until a more severe torque event occurs or until a reset is performed. Paragraph 77-11, of this manual, provides further details on resetting the nonvolatile memory.

77-6. TORQUE EVENT COUNTERS

The 65100-019 instrument keeps track of the severity of each over-torque event by maintaining four counters in nonvolatile memory. Each counter is incremented depending on the severity of the over-torque event. The first counter is the Operation Exceedance Count (OEC) and is based on the torque limits set forth in the helicopter manufacturer's flight manual. The torque limits used to control the second and third torque event counters are based on the helicopter manufacturer's maintenance manual. These counters are called the Inspection Exceedance Count (IEC) and the Rebuild Exceedance Count (REC). The fourth exceedance counter is based on the engine manufacturer's maintenance manual. This counter is called the Engine Exceedance Count (EEC). The torque limits used for determining when to increment these counters are given in Table 77-1.

77-7. DATA PLAYBACK

Each time the instrument is powered-up, the digital display automatically plays back the data stored in the nonvolatile memory (during this time the instrument pointer shows the current engine torque). Each torque parameter played back is preceded by a label identifying the data type. During play back each display frame is displayed for two seconds before stepping to the next frame, except when stated otherwise. The torque data is played back in the following order:

1. All segments are lit providing a  pattern to verify that all display elements are functioning.
2. The flight Operation label  is displayed if no exceedance has occurred since the last time the instrument was reset, otherwise the flight Operation Exceedance label  is displayed flashing on and off twice per second for ten seconds.
3. The peak torque in percent for the highest peak torque event since the last instrument reset is displayed followed by the number of seconds the torque was above the red radial during this event. If the torque was not over the red radial, a zero (for zero seconds) is displayed.
4. If the indicated torque is greater than 5%, the instrument will exit the playback mode and the digital display will start displaying the indicated torque. If the torque is below 5%, the indicator will continue to playback the following information.
5. The flight Operation Exceedance Count label  is displayed followed by the count.
6. The Inspection Exceedance Count label  is displayed followed by the count.
7. The Rebuild and overhaul Exceedance Count label  is displayed followed by the count.
8. The Engine Exceedance Count label  is displayed followed by the count. After the instrument has played back the recorded data, normal operation of the digits begins.

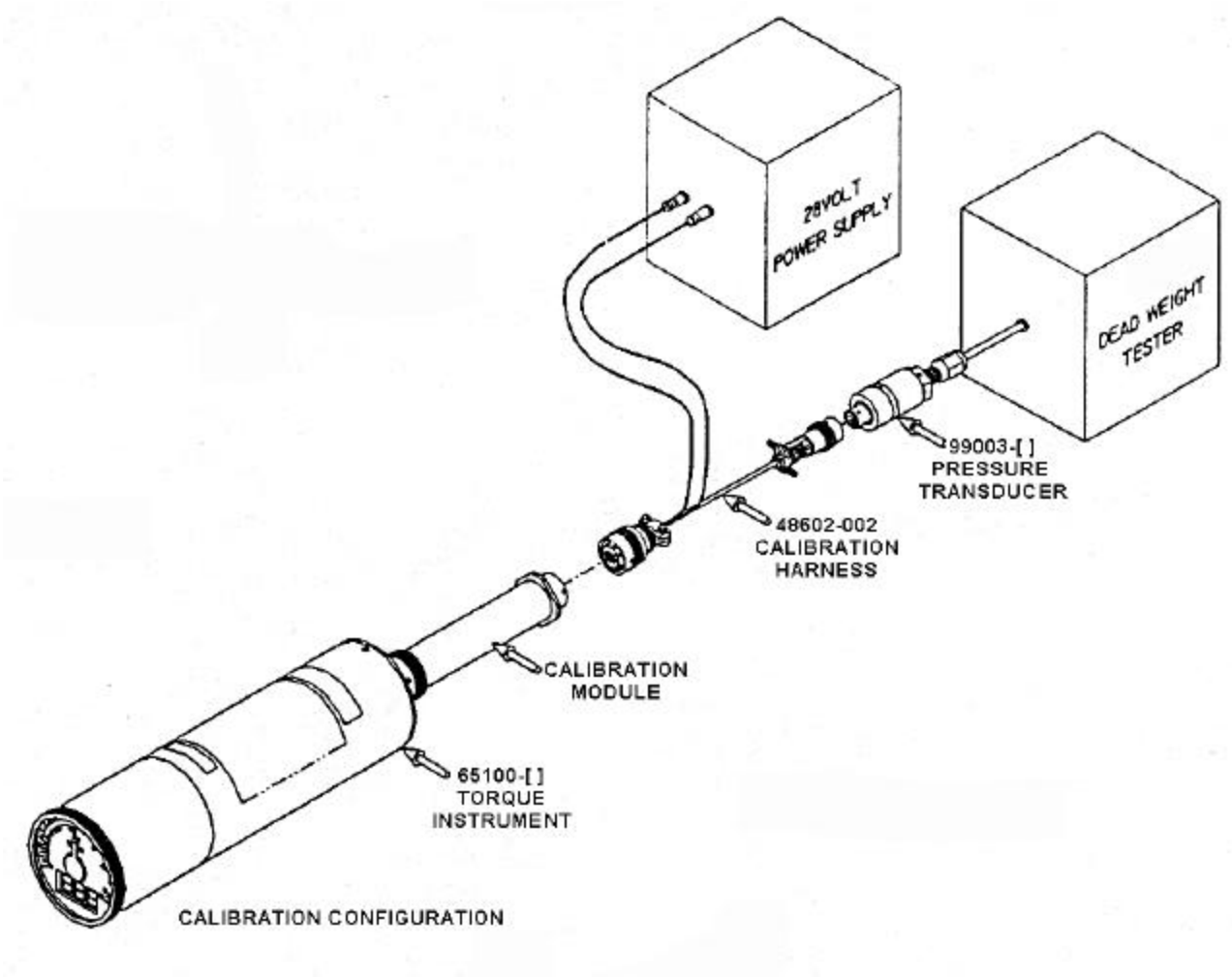


Figure 77-4. Torque Calibration Test Setup

77-8. INSTRUMENT INSTALLATION

1. Ensure that power is removed from the aircraft connector.
2. Check that the connector is through the proper instrument hole on the instrument panel.
3. Reconnect the Torque instrument to the connector.
4. Slide the Torque instrument in the hole and align the instrument so that the digital display is horizontal.
5. Tighten the instrument clamp screw (panhead screw) adjacent to the Torque instrument on the instrument panel. If there is more than one panhead screw adjacent to the instrument, tighten the larger panhead screw.

77-9. TRANSDUCER INSTALLATION

1. Ensure that power is removed from the instrument.
2. Insert the pressure fitting end of the transducer downward into the hat section bracket. Install the washer and mounting nut and tighten the nut. (Figure 77-3).
3. Connect the torque pressure tubing and tighten securely.
4. Reconnect transducer to the instrument connector.

77-10. RESETTING THE NONVOLATILE MEMORY

The following temperature parameters can be cleared from nonvolatile memory via a memory reset module (reset stick):

1. the highest peak torque
2. the time over red radial
3. the exceedance bit
4. the operational exceedance count (OEC)
5. the inspection exceedance count (IEC)
6. the rebuild and overhaul exceedance count
7. the engine exceedance count (EEC)

77-11. TORQUE SYSTEM CALIBRATION

The following equipment is needed to calibrate the 65100-019 torque instrument and the 99003-002 torque pressure transducer:

QTY	REQUIRED EQUIPMENT
1	Calibration module (DIAMOND J part number 10012-015 or equivalent).
1	Calibration test harness (DIAMOND J part number 48602-002) or equivalent. See Figure 5 Test Harness Wiring Diagram.
1	Dead weight pressure tester (Hydra-lite HLG636 or equivalent) accuracy of 0.1% of reading traceable to NIST.
1	28Vdc power supply capable of providing 0.5 Adc.

77-12. CALIBRATION PROCEDURE

NOTE

If a mistake is made, the procedure can be repeated as often as necessary, in any order. The two calibration points are stored independently; while both are needed for a correct calibration, either one can be repeated without repeating the other.

If the instrument finds either input not within a few percent of the expected value, the calibration will be aborted with "CA-" showing on the display. If during calibration the instrument displays "CA-", verify that the deadweight tester is set to the proper calibration point. If the torque system will not calibrate return the torque instrument and the pressure transducer to a DIAMOND J INC authorized repair facility for repair.

This calibration procedure adjusts the sensitivity of the 65100-019 instrument to compensate for minor errors built into the pressure transducer and must be done on a test bench and NOT on the aircraft. It is accomplished as follows:

1. Remove 65100-019 instrument and 99003-002 pressure transducer per the removal section of this manual.
2. Write the part number and serial number of the instrument and transducer on the torque calibration report form.
3. Plumb the pressure transducer to the deadweight tester.

4. Connect the instrument, the calibration module, the test harness, and the pressure transducer per Figure 77-5.

5. Set the pressure on the dead weight tester per Table 77-2 for calibration point CA1.

6. Apply power to the instrument. The instrument will display 'CA' for five seconds to indicate calibrate mode. Next the digital display will start indicating the current torque for 30 seconds to insure that the instrument and pressure signal are stable. At the end of the 30 seconds the instrument will display 'CA ' to indicate that it has read the torque signal used to calibrate the instrument. The instrument waits five more seconds then displays 'CA1' indicating that calibration point one has been stored. The instrument will continue to display 'CAV' until power is removed.

7. Remove power from the instrument.

8. Apply a pressure equivalent to Calibration point CA2 per Table 77-2.

9. Apply power to the instrument. The instrument will display 'CA ' for five seconds to indicate calibrate mode. Next the digital display will start indicating the current torque for 30 seconds to insure that the instrument and pressure signal are stable. At the end of 30 seconds the instrument will display 'CA' to indicate that it has read the torque signal used to calibrate the instrument. The instrument waits five more seconds then displays 'CA2' indicating that calibration point two has been stored. The instrument will continue to display 'CA2' until power is removed.

10. Calibration is complete, remove power from the instrument.

77-13. VERIFY CALIBRATION

Once the instrument and the pressure transducer are calibrated, remove the calibration module and connect the instrument directly to the test harness. Apply power to the instrument and verify calibration per the following table. Fill in the torque system calibration report.

Table 77-2. CALIBRATION TABLE

TORQUE INSTRUMENT	CALIBRATION POINT CA1 (20% Torque)	CALIBRATION POINT CA2 (95% Torque)
	INPUT PSIG	INPUT PSIG
65100-019	16.7	74.1

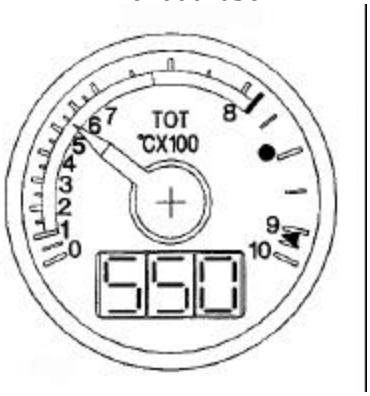
Table 77-3. VERIFY CALIBRATION TABLE

INSTRUMENT	INSTRUMENT READING in % TORQUE					
	20.0+/-0.5	40.0 +/-0.5	70.0 +/-0.5	80.0 +/-0.5	90.0 +/-0.5	99.0 +/-0.5
	TRANSDUCER INPUT in PSIG					
65100-019	16.7	32.0	55.0	62.6	70.3	77.1

77-14. THERMOCOUPLE TEMPERATURE INSTRUMENT - PHYSICAL DESCRIPTION

The 61000-036 is two-inches in diameter by 6-3/4 inches long and weighs less than 0.9 lbs. Case and bezel color is black per FED-STD-595, No. 37038. Lens coating is anti-reflective per MIL-C-675. The instrument has a range of 0 to 1000°C and has both analog and digital read-outs as shown in Figure 77-5. See Figure 77-7 for details of the rear connector and pin outs.

61000-036



Green Arc 100°C to 738°C
Yellow Arc 738°C to 810°C
Red Radial 810°C
Red Dot 843°C
Red Triangle 927°C

Figure 77-5. Thermocouple Temperature Display

77-15. NORMAL OPERATION AND LIMITATION

The accuracy of the 61000-036 series instruments is ±5°C with digital resolution of ±1 °C. The analog scale is expanded over a portion of the range to provide better readability. The three incandescent digits provide one-degree resolution throughout the total range of the instrument. The digital display updates a minimum of twice per second. The internal backlight voltage controls the brightness of the digital display. The digits are full bright when the backlight voltage is between 0 VDC and approximately 0.7 VDC. This range is normally used for daylight operation. Above 0.7 VDC backlight voltage, the digits dim suddenly and their brightness follows the backlight voltage between 0.7 VDC and 5 VDC (maximum). This range is normally used for night operation.

The 61000-036 instrument receives its temperature information from a Chromel/Alumel thermocouple to measure temperatures up to 1000°C in a jet engine.

The 61000-036 series instruments are designed for 28 VDC input, but will operate, continuously, reliably, and accurately with input power between 10 VDC and 40 VDC.

The 61000-036 instrument requires 160 mA at 28 VDC. The 160 mA is the worst case with all three of seven-segment digital lights and backlighting at full bright. Make sure that the electrical bus powering the instrument is maintained within the electrical load limits of the bus.

77-16. EXCEEDANCE OPERATION AND LIMITATION

The 61000-036 instrument has two operation modes: engine start mode and flight operation mode. The instrument operates in engine start mode when 28 VDC is applied to the start signal input (pin A of the instrument connector). The instrument operates in flight operation mode when the start signal is open or grounded to aircraft ground.

To warn the pilot of a potential over-temperature condition, the digital display will

Table 77-4 TRANSIENT TEMPERATURE LIMITS

Instrument Part Number	Engine Start Mode Transient Limits (SEC)	Flight Operational Mode Transient Limits (OEC)	Threshold Temperature
61000-036	Greater than 810°C for more than 10 seconds or greater than 927°C	Greater than 810°C for more than 6 seconds or greater than 843°C	360°C

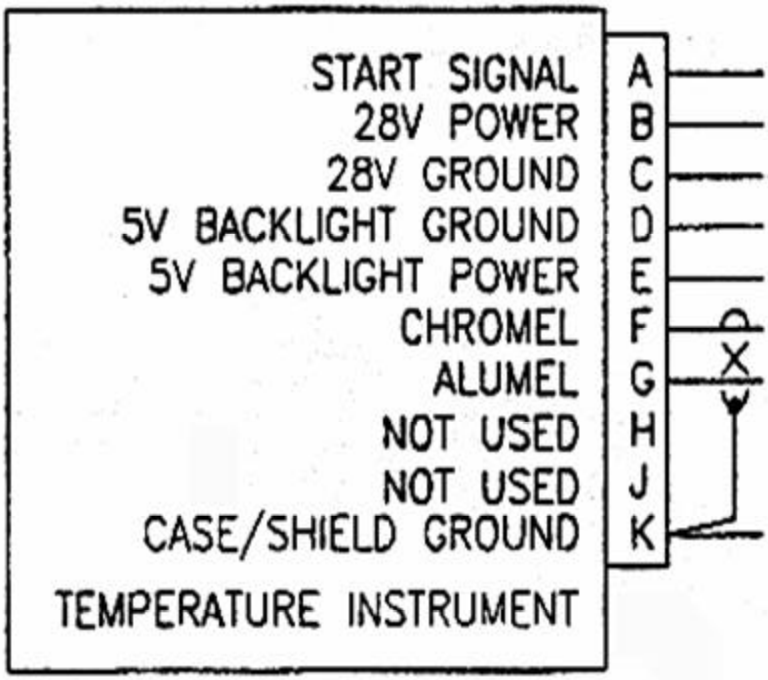


Figure 77-6. Thermocouple Temperature Outline and Pin Out Drawing

flash on and off twice per second when the indicated temperature goes above the lower transient limits specified in Table 77-4. The display will stop flashing when the indicated temperature returns below the transient limits if an over-temperature exceedance did not occur. If an exceedance does occur, the digital display will flash on and off twice per second when the indicated temperature exceeds the transient limits described in Table 77-4. The flashing will stop one minute after the indicated temperature returns below the transient limits in Table 77-4. This one minute delay is to insure that the pilot is made aware that an over-temperature exceedance has occurred. Table 77-4 describes the temperature limits programmed into the instrument for engine start mode and flight operation mode.

Double flashing (twice per second) resumes when the temperature decreases below the threshold temperature specified in Table 77-4.

77-17. DATA STORED IN NONVOLATILE MEMORY

The 61000-036 instrument records engine temperature data into nonvolatile memory. The digital display plays back this data each time power is applied to the instrument. The following two paragraphs describe the information recorded for play back.

77-18. PEAK TEMPERATURE EVENT

The peak temperature and duration (in seconds) of the most severe transient temperature event is recorded in memory during start mode and flight operation mode. The 61000-036 instrument monitors and captures the peak temperature during each event. If the new peak is greater than the old one, the new peak is recorded in memory over the current peak. The duration of this transient temperature event is captured by a timer that is started when the temperature enters the transient temperature limit given in Table 77-4 and stopped when the temperature drops below these limits. This transient event is also flagged as an exceedance if it exceeds the limits described in Table 77-4. Zero seconds is stored for the duration if the peak is below the temperature limits given in Table 77-4 for either mode.

77-19. TEMPERATURE EVENT COUNTERS

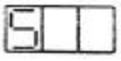
The 61000-036 instrument keeps track of each temperature exceedance event by maintaining counters in its nonvolatile memory. The Operation Exceedance Count (OEC) keeps track of the number of temperature exceedances that occur during flight operation mode. The Start Exceedance Count (SEC) keeps track of the number of temperature exceedances that occur during engine start mode. The limits used for determining when to increment these counters are given in Table 77-4.

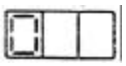
77-20. START CYCLE COUNTER

The 61000-036 instrument keeps track of each engine start cycle event by maintaining a counter in its nonvolatile memory. This Start Cycle count (SC) keeps track of the number of engine starts by incrementing this counter each time 28VDC is applied to the start signal and the indicated temperature is above the threshold temperature specified in Table 77-4.

77-21. DATA PLAYBACK

On power-up, the digital display plays back the data stored in the nonvolatile memory (during this time the instrument pointer shows the current engine temperature). Each parameter played back is preceded by a label identifying the data type. During play back each display frame is displayed for two seconds before stepping to the next frame, except when stated otherwise. The data is played back in the following order:

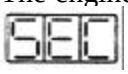
1. All segments are lit providing a  pattern to verify that all display elements are functioning.
2. The engine Start label  is displayed if no start mode exceedance has occurred since the last time the instrument was reset, otherwise the engine Start Exceedance label  is displayed flashing on and off twice per second for ten seconds.
3. The maximum temperature of the engine start temperature event since the last instrument reset is displayed followed by the time in seconds the temperature was above the lower transient temperature limit specified in Table 77-4. If the temperature was not over the lower transient temperature limit, a zero (for zero seconds) is displayed.

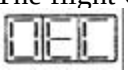
4. The flight Operation label  is displayed if no exceedance has occurred since the last time the instrument was reset, otherwise the flight Operation Exceedance label  is displayed flashing on and off twice per second for ten seconds.

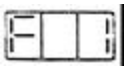
5. The peak temperature for the highest flight operation temperature event since the last instrument reset is displayed followed by the time in seconds the temperature was above the lower transient temperature limit specified in Table 77-4. If the temperature was not over the lower transient temperature limit a zero (for zero seconds) is displayed.

6. If the indicated temperature is greater than the threshold temperature specified in Table 77-4, the instrument will exit the playback mode and the digital display will start displaying the indicated temperature. If the temperature is below this threshold the indicator will play back the following information.

7. The Start Cycle count label  is displayed followed by the count. If the number of start cycles is greater than 999 the start cycle count label will be shown with the first digit of the number of start cycles. For example, 1956 start cycles is indicated by  followed by  .

8. The engine Start Exceedance Count label  is displayed followed by the count.

9. The flight Operation Exceedance Count label  is displayed followed by the count.

10. The most recent flight label  is displayed followed by the average temperature and duration of this flight (where the temperature was greater than the bottom of the green arc and the time is in minutes rounded down to full 10-minute intervals).

11. Repeat step 10 for previous flights "F2" through "F4".

After the instrument has played back the recorded data, normal operation of the digits begins.

77-22. MAINTENANCE

DIAMOND J exceedance monitoring instruments do not have adjustments or field serviceable components. For service the instruments must be returned to a factory authorized repair facility. The 61000-036 is calibrated for the life of the instrument by the design and the use of high quality and highly accurate electronic components. The DIAMOND J 61000-036 temperature instrument is designed to be used with a chromel/alumel thermocouple to measure temperatures up to 1000°C in a jet engine. Overall accuracy is ±5°C over the range of 0 to 1000°C.

In order to prevent the TOT from recording a false exceedance during aircraft maintenance DIAMOND J recommends the following precautionary steps:

1. **Record the TOT play back data before starting the maintenance procedure.**

2. **Pull the TOT circuit breaker before disconnecting the thermocouple.**

77-23. REMOVAL

The instructions provided in this manual supplement the helicopter manufacturer's maintenance manual. They only supersede the helicopter manufacturer's maintenance manual in the areas indicated. All other helicopter manufacturer's maintenance manual procedures should be strictly adhered to.

77-24. INSTRUMENT REMOVAL

1. Ensure that power is removed from the instrument.

2. Loosen the instrument clamp screw (panhead screw) adjacent to the temperature instrument on the instrument panel. If there is more than one panhead screw adjacent to the instrument, loosen the larger panhead screw.

3. Slide the instrument out the front (pilot's side) of the instrument panel.

77-25. INSTALLATION

The instructions provided in this manual supplement the helicopter manufacturer's maintenance manual. They only supersede the helicopter manufacturer's maintenance manual in the areas indicated.

All other helicopter manufacturer's maintenance manual procedures should be strictly adhered to.

77-26. INSTRUMENT INSTALLATION

1. Ensure that power is removed from the aircraft connector.
2. Check that the connector is through the proper instrument hole on the instrument panel.
3. Reconnect the temperature instrument to the connector.
4. Slide the temperature instrument in the hole and align the instrument so that the digital display is horizontal.
5. Tighten the instrument clamp screw (panhead screw) adjacent to the temperature instrument on the instrument panel. If there is more than one panhead screw adjacent to the instrument, tighten the larger panhead screw.

77-27. RESETTING THE NONVOLATILE MEMORY

The following temperature parameters can be cleared from nonvolatile memory via a memory reset module (reset stick):

1. the highest peak temperature during engine start mode
2. the time of the recorded start transient event
3. the highest peak temperature during flight operation mode
4. the time of the recorded flight transient event exceedance bit -which controls digital display flashing flight averaging data
5. the start cycle count
6. the start exceedance count (SEC)

Use the black banded 10012-016 reset stick to clear the following parameters:

1. Remove power from the temperature indicator. Remove the temperature indicator from the instrument panel. Disconnect the electrical connector from the back.
2. Connect the reset stick in-line between the indicator and the electrical connector.
3. Re-apply power to the temperature indicator. The digital display of the indicator will show " EC" for five seconds then change to "-EC", indicating the memory is cleared.
4. Remove power, remove the reset stick and re-install the indicator.

77-28. OPERATIONAL CHECK - ENGINE SYSTEM

The following is an inexpensive and reliable method for verifying the calibration of the 61000-036 instrument. This method electrically simulates a thermocouple signal that is fed simultaneously to the instrument and an Omega HH21 (or equivalent) thermocouple meter. The instrument is compared to the HH21 thermocouple meter.

NOTE

The verification method presented here is not meant to imply that this is the only or necessarily the best method. It is important to be aware that the 61000-036 is a very accurate and stable instrument and the equipment used to verify the instrument must be more accurate than the instrument. Because of this accuracy, DIAMOND J recommends that the test equipment used to check the 61000-036 have an accuracy of ±2°C or better over the range being verified.

WARNING

When performing the operational check, do not apply a temperature in excess of the transient temperature limits shown in Table 77-4. Temperatures in excess of these limits will cause the instrument to record the operational check as an exceedance and increment the operation exceedance count (OEC).

The circuit shown in Figure 77-8 simulates a thermocouple input. The source of the voltage can be a DIAMOND J model 10013 or a similar source.

77-29. INSPECTION REQUIREMENTS

The indicator does not require periodic calibration or maintenance. It is recommended that the instrument be checked by the "Operational Check" when required by the Aircraft Manufacturer's Maintenance Manual.

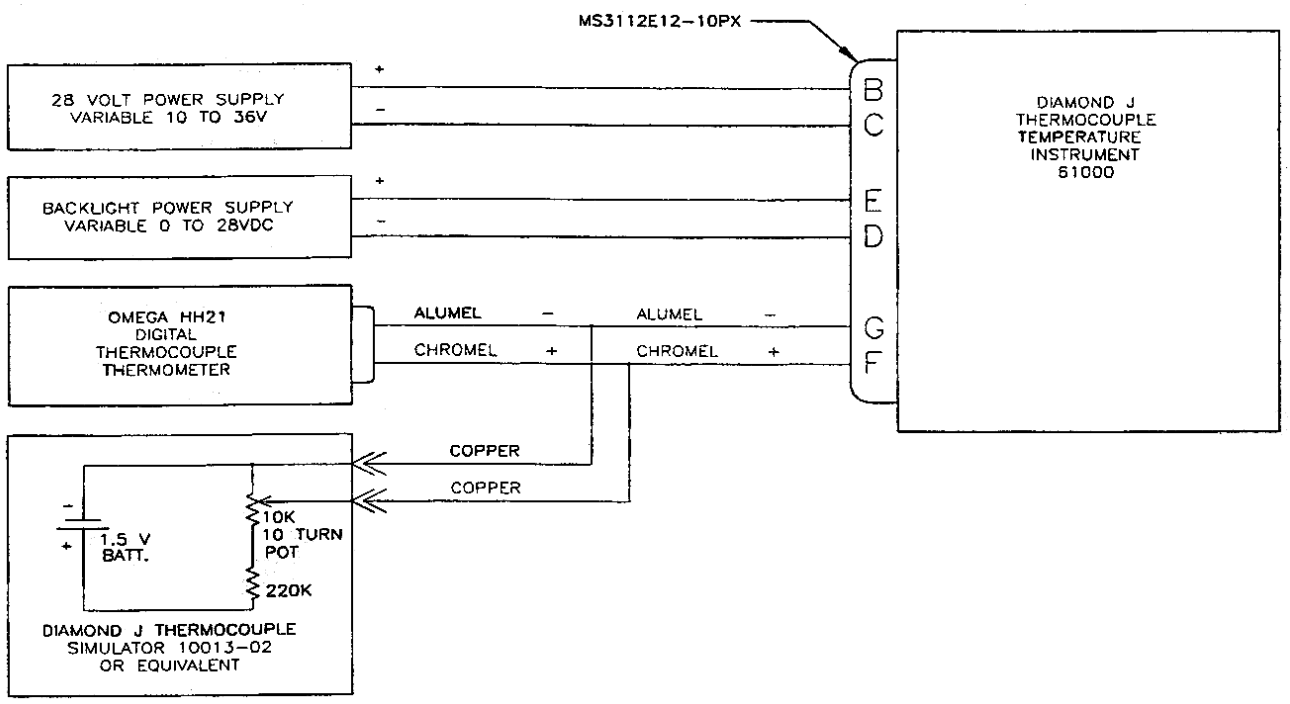


Figure 77-7. Calibration Setup For Diamond J Model 61000