

Pilot Operating Manual



Smart EGT/CHT Scanner®
Exhaust Gas Temperature (EGT)
and
Cylinder Head Temperature (CHT)
Scanning Systems

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(POM Smart Scanner K)

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Supplemental Type Certificate

Number SA2586NM

This Certificate issued to J. P. INSTRUMENTS
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certifies that the change in the type design for the following product with the limitations and conditions therefor as specified hereon meets the airworthiness requirements of Part 3 of the Civil Aviation Regulations, including respective Amendments as specified in the attached Approved Model List.

Original Product Type Certificate Number: * *See attached FAA Approved J.P. Instruments
Make: * Master Eligibility List No. SA2586NM for list
Model: * of approved aircraft models and applicable TCDS

Description of Type Design Change:

Installation of J. P. Instruments temperature monitoring systems in accordance with FAA Approved J. P. Instruments Drawing List Report No. 100, Revision D, dated December 19, 1996, or later FAA approved revisions. FAA Approved Airplane/Rotorcraft Flight Manual Supplement No. 1 for EGT-701 temperature indicator, Revision A, dated December 13, 1996, or later FAA approved revisions.

Limitations and Conditions: The approval of the change in type design applies to the basic airplane of the specific models that are otherwise unmodified. This approval should not be extended to other specific airplanes of these models on which other previously approved modifications are incorporated, unless it is determined that the interrelationship between this installation and any previously approved configuration will not introduce any adverse effect upon the airworthiness of that airplane. If the holder agrees to permit another person to use this certificate to alter the product, the holder shall give the other person written evidence of that permission. (See continuation sheet)

This certificate and the supporting data which is the basis for approval shall remain in effect until surrendered, suspended, revoked or a termination date is otherwise established by the Administrator of the Federal Aviation Administration.

Date of application: December 31, 1984

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By direction of the Administrator



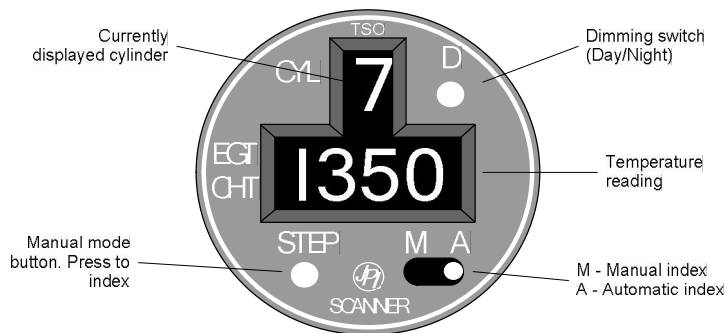
[Signature]
(Signature)
Manager, Propulsion Branch
Los Angeles Aircraft Certification Office

(Title)

Any alteration of this certificate is punishable by a fine of not exceeding \$1,000, or imprisonment not exceeding 3 years, or both.

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Operation Summary

After starting the engine all readings should reach 500°F in a few of seconds.

- M **MANUAL**, when the toggle switch is in the M position the Scanner® will display the current cylinder. To change the display press the STEP button and the display will index to the next measurement. Normal leaning is accomplished on the leanest cylinder in the Manual mode. The leanest cylinder can be found by peaking each cylinder and noting its fuel consumption. The cylinder with the largest fuel consumption at its peak is the leanest.
- A **AUTOMATIC**, this switch position will index through all the cylinders every four to five seconds in descending order. Pressing the step button, in the automatic mode, will index the unit to the next cylinder. Alarms are active only in the Automatic mode.
- D **DIMMING** has two levels: Day and Night. It is located in the upper right hand corner of the unit.
- c A small “c” displayed in the first digit c370 indicates the unit is scanning Cylinder Head Temperature
- . A decimal point in the second digit (I . 450) with the temperatures above 1000 F but less than 1900, indicates that this cylinder has reverse polarity wiring which must be corrected. A display of (I . 990) indicates that the temperature exceeds the normal range of 1999 F.
- V The voltage option will display voltage when the STEP button is held. Voltage readings are in tenths of a volt.

Section 1 - Introduction

You have just purchased the finest precision TSO'd temperature indicator available on the market. This instrument has met all the requirements of TSO-C43a, Aerospace Standard AS 8005 and RTCA Documentation DO-160A.

The Smart Scanner® continuously scans every probe three times a second—up to a maximum of 16 probes—in your system, converting the thermocouple's millivolt signal to a temperature on the display. The thermocouple's millivolt signal is amplified by precision instrument amplifiers which permit the use of fast, grounded type K probes.

The operation of the Scanner® is simple. By spending time with this manual, you should gain a better appreciation of the complexities and critical nature of temperature patterns important to the operation of the aircraft engines. The discussions will be general. Specific temperatures must be determined by the airframe and engine manufacturers.

Section 2 - Understanding the display

The Scanner® System automatically displays TIT (turbine inlet temperature), EGT (exhaust gas temperature), OIL temperature, CHT (cylinder head temperature) and optionally OAT (outside air temperature) and Volts in sequence every 1 to 9 seconds (adjustable). When the TIT option is installed it will appear in place of an additional odd cylinder EGT. For example a 6 cylinder engine would display TIT in EGT scan position 7; OIL temperature in CHT scan position 7. The voltage option is displayed when the step switch is depressed.

The CYL digit is the cylinder number of the temperature currently displayed. In the EGT/CHT display a 4-digit value is an EGT and a 3-digit value with small leading c is a CHT.

Section 3 - Switch Mode Functions

Automatic or Manual operation is selected by the mode switch: M A. In the Automatic mode—A—the instrument will index through each measurement approximately every 4 seconds. In the Manual mode—M—the automatic indexing will stop.

In either mode, the STEP button may be used to manually index the cylinder selection.

Indexing counts down from the highest cylinder number to the lowest.

The dim switch—D—is a two state button. Each press alternates between bright and dim.

The field programmable switch is located in a hole on the bottom of the instrument case near the front bezel. Turn the Scanner® on and place a small slotted screwdriver into the hole and rotate it until it aligns with the switch slot. Clockwise rotation increases the number channels scanned up to 8. This can be verified by turning on the instrument and noting the initial cylinder number displayed.

The indexing rate in the Automatic mode can be adjusted. Place a small slotted screwdriver through hole below the CYL raised letters on the front panel. The control will vary the indexing rate from fast (1.5 sec) to slow (9 sec.) through $\frac{3}{4}$ of a turn, clockwise.

Section 4 - Alarms

An alarm indication for TIT or CHT is a flashing CYL digit for the cylinder that is out of range. In the automatic mode the scan sequence will stop on the out of range cylinder and flash the CYL digit. Tapping STEP will resume the scan. The instrument will continue to stop on the out of range cylinder until the temperature falls within the normal range.

The CHT alarm redline is factory set at 450°F and TIT option alarm redline alarm is set at 1650°F. This can be changed at the factory.

Section 5 - Scanner® Operation

Oil Temperature

Oil temperature option is a supplemental gauge to the factory installed oil temperature gauge. Because it is located in an alternate oil galley, the oil temperature displayed tends to be 5 degrees higher than the factory installed gauge. Oil temperature limits are in the aircraft manual and typically range from 225° to 245°F, depending on the engine.

Instruments with 1° resolution can be changed to 10° resolution by removing the internal jumper wire behind the front bezel.

OAT (Outside Air Temperature)

The Outside air temperature option is only available on instruments that have 1° resolution and is displayed on an additional EGT channel. When the OAT is below zero the display will show a vertical bar | rather than a minus sign.

CHT Gasket Probe

CHT gasket probes placed under the upper spark plug will read ~20° higher than a bayonet probe placed on that cylinder barrel. This probe is usually used in conjunction with the original CHT, giving a dual reading on that cylinder.

You may use a JPI adapter probe instead of a spark plug probe. The adapter probe will accommodate both the JPI and factory probe in the same location on the cylinder.

Calibration

The instrument is shipped calibrated to National Bureau of Standards for Chromel/Alumel thermocouples (Type K). The calibration should not change with time, but can be checked by placing a suspect probe in boiling water and verifying the temperature is close to 212°F, or by sending the instrument back to the factory. The Scanner® will read low (~100°F) if the probe or the thermocouple wire fails (opens). Probe lead length will not affect calibration.

Section 6 - Operating Instructions

Start Up

The Scanner® will be typically connected to the aircraft's avionics master switch through circuit breaker or fuse.

Before the engine is started the Scanner® should read within $\pm 10^\circ\text{F}$ of ambient air temperature on a cold engine. Once the engine is started the temperature in the EGT display should quickly stabilize at idle in the 500°F to 900°F range. All EGT probes should be reading at this time. CHT temperatures will take longer to stabilize. Important information is immediately conveyed to the Pilot. Abnormal indications at idle usually point out problems in the ignition system. A fouled plug can be found by placing the magneto switch on the rough magneto and monitoring the Scanner® in the automatic mode looking for a cold cylinder reading.

Inefficiencies in the fuel distribution system generally cause a greater spread in EGT readings at idle and run-up. However, the pilot should note the

characteristic temperature spread at all power settings at a time when the engine is in good repair. Any large deviation from normal characteristic may indicate a problem.

Run Up

Unlike conventional EGT gauges, the Scanner® conveys important information to the pilot from the moment the engine is started. The normal engine characteristics

- the hottest cylinder
- EGT span (highest to lowest)
- CHT distribution pattern

are important indicators of the engine condition when they deviate from normal values. A monthly EGT log should be kept to compare normal values and should become part of the engine run-up procedure.

Prepare the following run-up chart by running your engine to a given RPM (close to the magneto test RPM) and recording the EGT readings for each cylinder. Wait for the readings to stabilize. This should take no more than 30 seconds.

EGT Log

Test RPM	
----------	--

Date	EGT 1	EGT 2	EGT 3	EGT 4	EGT 5	EGT 6

How to use this log

Once the EGT stabilizes, monitor cylinder #1 and make small adjustments in RPM to establish an EGT reading the same as that on the chart. Note the RPM and compare it to that on the chart. Allow for some differences due to outside air temperature, altitude and humidity. Any large differences may be due to system problems such as intake manifold leaks, timing or magneto problems,

contaminated or improper fuel, carburetor problem, fouled plug and many others.

Operation on one magneto should cause a 50° to 100°F increase in EGT during magneto checks. During extended ground hold, CHTs should remain below 425°F. Corrective action should be taken if this temperature is exceeded.

Take-off

Before application of take-off power, the oil and CHTs should have approached normal values: above 100°F for OIL and above 150°F for CHT. Note: check your airframe and engine manufacturer's recommendations.

DO NOT lean the engine during take-off. Excess fuel in the rich mixture is needed to cool the engine and prevent detonation. Check engine manufacturer's recommendations for high altitude take-off.

During Take-off, with the mixture at full rich, the EGTs should range between 1100° and 1250°F at full throttle. The normal take-off EGT span should be less than 200°F. Normal temperatures should be placed on the EGT Log for future reference.

During hot weather operation it is recommended that the hottest CHT be monitored for take-off and climb out by placing the Scanner® in the manual mode and stepping to the hottest CHT cylinder.

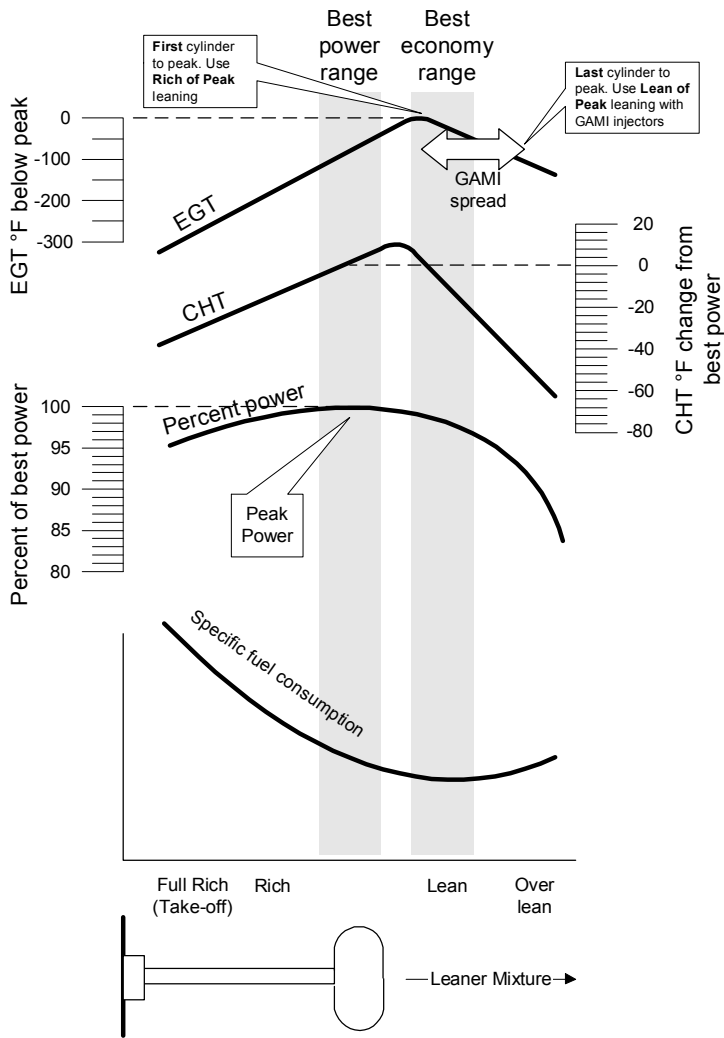
Leaning the Mixture in Cruise

The goal of leaning the mixture in cruise is to select the optimum mixture setting for the engine at the current density altitude and power setting. "Best Power" and "Best Economy" are terms that describe cruise mixture settings. The best power setting derives maximum power from the engine while consuming 20 to 30 percent more fuel than best economy. The best economy setting delivers the highest range (miles per gallon) from the aircraft with a slight penalty in airspeed—about 1 percent. The best power setting is typically specified as 100 degrees rich of peak and the best economy setting is peak EGT.

Leaning Procedure

1. Establish the desired cruise altitude and power setting 65 to 75 percent.
2. Place the Scanner® into the manual mode and index to the cylinder that leans first (see finding leanest cylinder). In some cases it may not be the hottest cylinder.

- Peak EGT should be around 1300° to 1500°F. The vernier mixture control should be turned counter clockwise stopping every 1/4 turn for a second letting temperatures stabilize.



As you lean mixture control from a full rich position, you will immediately see the EGT start to rise in 10° increments.

Example: typical Scanner® temperatures as the vernier mixture control is turned counterclockwise (lean)

Cyl. #1 of a Mooney M20E with an IO-360 at 65 percent power

- 1360 F – Mixture control pre-leaned to close to peak
- 1380 F – ¼ turn of the mixture control gives a 20°F rise
- 1410 F – ¼ turn (temperature should stabilize in 3 sec)
- 1430 F – ¼ turn and you are at peak lean (but you don't know it yet)
- 1430 F – ¼ turn (in the flat region of peak, little or no change).
- 1420 F – ¼ turn and the EGT drops 10°F indicating 1430°F was the peak.

Once the peak EGT has been found the mixture may be enriched according to the airframe and engine manufacturer's approved methods.

Finding the First Cylinder to Peak

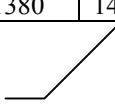
Without a fuel flow gauge find the leanest cylinder at the two or three altitudes and power settings you normally fly. This cylinder—once determined—will usually always be the first cylinder to peak in the 60 to 70 percent power range. The following is one method of determining the first cylinder to peak, using 65 percent power.

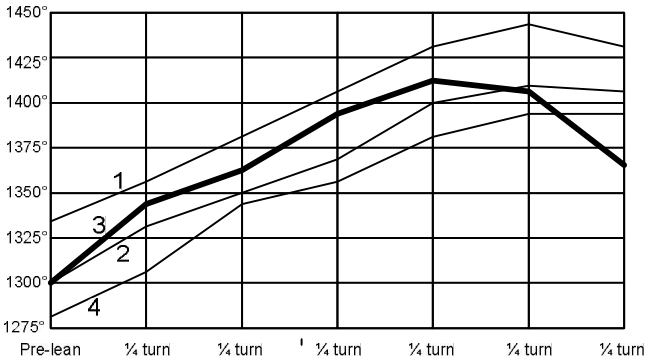
1. Lean on the cylinder that is connected to the factory EGT gauge.
2. Enrich the mixture to ~100° rich of peak.
3. Begin leaning the mixture again using ¼ turn increments on the mixture vernier control.
4. Record all EGTs at each ¼ turn.
5. When a peak is reached on any cylinder, stop
6. The first cylinder to peak is the leanest and should be used in the future.

Example test data to determine first cylinder to lean.

Cylinder	100° rich of peak	¼ turn	¼ turn	¼ turn	¼ turn	¼ turn	¼ turn
4	1280	1310	1340	1360	1380	1390	1390
3	1300	1340	1370	1380	1420	1410	1370
2	1300	1330	1350	1370	1400	1410	1410
1	1330	1360	1380	1410	1430	1440	1440

First cylinder to peak





Alternate Method of Finding the Cylinder that Peaks First

Fuel flow gauge equipped aircraft can find the leanest cylinder by placing the Scanner® in the manual mode, leaning Each cylinder to peak EGT and recording the total fuel flow at each cylinder peak. The cylinder having the highest total fuel flow is the leanest or first to peak.

An alternative method is to peak each cylinder individually and record the total engine fuel flow at each peak EGT. The cylinder with the highest fuel flow at peak EGT is the leanest cylinder. Lean on that cylinder.

Note: Engine manufacturers differ in their approval of operation at peak EGT. Lycoming recommends operation at peak EGT for power settings of 75 percent and less while Continental recommends operation at peak EGT for power settings of 65 percent and less. No matter which power setting you use, JPI recommends that peak EGT at 65 percent power be used as the never-to-exceed EGT. Other restrictions may apply geared to turbo-charged engines the pilots should consult the aircraft flight manual for details

Do not lean to peak EGT at power settings greater than 75 percent power

Descent—Shock Cooling

When descending, many pilots will push the mixture to full rich, slightly reduce power and start moderate descent at a higher cruise airspeed. This is great for making up time, but will be hard on your engine. This descent mode

can cause lead fouling, cracked cylinder heads, broken rings and warped exhaust valves. Avoid cooling your engine too quickly.

Monitor the Cooling Rate

Place the Scanner® in the manual mode and index the instrument to display CHT of the front-most cylinder. On Lycoming engines it will be cylinder number 1 or 2. On Continental engines it will be cylinder 3 or 4 for four cylinder engines and cylinder number 5 or 6 for six cylinder engines.

Monitor the front-most cylinders for shock cooling. This can be accomplished by monitoring the rate of cooling. Stay below 40°F per minute or 10°F per 15 seconds. Consult the engine manufacturer for their recommended rate. Cooling rate can be reduced by closing the cowl flaps, adjusting the aircraft descent rate, airspeed and engine power.

During prolonged descent, maintain sufficient power to keep EGTs 100 to 200°F below peak for cruise (rich). This will assist in keeping engine temperatures above minimums and prevent over-cooling.

Section 7 - Limitations

1. Never lean the mixture to peak EGT above normal 75 percent cruise power settings.
2. Never exceed TIT or CHT limitations—they take precedence over EGT.

Section 8 - General Diagnostic Indicators

POSSIBLE PROBLEM	SYMPTOM
1- Burnt or warped exhaust valve. 2- Broken ring 3- Defective spark plug wire 4- Fouled Spark plug	The EGT will read higher than normal and the CHT will read lower than normal for the defective cylinder.
1- Leaking intake manifold gasket 2- Plugged injector 3- Broken or leaking primer tube	The EGT and CHT will read higher than normal for the defective cylinder. This cylinder will peak sooner than the others. If another cylinder leaned. The defective cylinder will over lean and read low EGT and CHT do to over cooling.
1- Retarded timing.	The EGT will read higher than normal and the CHT will read lower than normal on all cylinders.
1- Faulty magneto	Sudden rise in EGT on all cylinders.
1- Sticking exhaust valve	Intermittent rise 100 F in EGT
1- Pre ignition 2- Advanced spark timing	Sudden high rise in EGT and CHT on the defective cylinder.
1- Detonation 2- Low octane fuel	EGT will read lower than normal and the CHT will read higher than normal.
1- Unstable temperature readings on all cylinders in level flight	Poor engine ground strap. Ground the instrument at the engine block and NOT at the instrument panel.

Section 9 - Technical Support

JPI offers both e-mail and telephone technical support. Have your model and serial number ready when you call. Call **JPI** for a return authorization number before returning any equipment.

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Section 10 - Limited Warranty

J.P. Instruments Inc. (JPI) warrants all parts in your new Smart Scanner® to be free from defects in material and workmanship under normal use. Our obligation under this warranty is limited to repair or exchange of any defective part of this unit if the part is returned, shipping prepaid, within two years for electronics and one year for probes from the date of original purchase.

Installation labor is the responsibility of the aircraft owner. Homebuilt aircraft warranty starts when the aircraft is certified for flight. Replacement parts carry a warranty for the balance of the warranty period.

Under this warranty, JPI is not responsible for any service charges, including removal, installation, nor any other consequential damages. JPI incurs no obligation under this warranty unless a Warranty Registration Certificate describing the warranted product has been completed and mailed to JPI with all information requested.

This warranty is void on any product which has been subject to misuse, accident, damage caused by negligence, damage in transit, handling or modification which, in the opinion of JPI, has altered or repaired the product in any way that effects the reliability or detracts from the performance of the product, or any product whereon the serial number has been altered, defaced, effaced or destroyed.

This warranty is in lieu of all other warranties expressed or implied and other obligations of liability on JPI's part, and it neither assumes nor authorizes any other person to assume for JPI any other liability in connection with the sale of JPI products.

To initiate this warranty, the aircraft owner must submit a completed Data Logging Worksheet to JPI. Upon receiving a completed worksheet, JPI will initiate the warranty from the date of original purchase. Any replacement parts carry a warranty that extends for the balance of the period of the original warranty. For homebuilt aircraft the warranty starts when the aircraft is certificated for flight and noted on the warranty card.