

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Visit our website - *Click HERE*

HEWLETT PACKARD

Service Manual

C-Size VXIbus System

CENC-TAC8
Tachometer Module

VXI bus

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from date of shipment. Duration and conditions of warranty for this product may be superseded when the product is integrated into (becomes a part of) other HP products. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Hewlett-Packard (HP). Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with a product will execute its programming instructions when properly installed on that product. HP does not warrant that the operation of the product, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied products or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

The design and implementation of any circuit on this product is the sole responsibility of the Buyer. HP does not warrant the Buyer's circuitry or malfunctions of HP products that result from the Buyer's circuitry. In addition, HP does not warrant any damage that occurs as a result of the Buyer's circuit or any defects that result from Buyer-supplied products.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

NOTICE

The information contained in this document is subject to change without notice. HEWLETT-PACKARD (HP) MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HP shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance or use of this material. This document contains proprietary information which is protected by copyright. All rights are reserved. No part of this document may be photocopied, reproduced, or translated to another language without the prior written consent of Hewlett-Packard Company. HP assumes no responsibility for the use or reliability of its software on equipment that is not furnished by HP.

U.S. Government Restricted Rights

The Software and Documentation have been developed entirely at private expense. They are delivered and licensed as "commercial computer software" as defined in DFARS 252.227-7013 (Oct 1988), DFARS 252.211-7015 (May 1991) or DFARS 252.227-7014 (Jun 1995), as a "commercial item" as defined in FAR 2.101(a), or as "Restricted computer software" as defined in FAR 52.227-19 (Jun 1987) (or any equivalent agency regulation or contract clause), whichever is applicable. You have only those rights provided for such Software and Documentation by the applicable FAR or DFARS clause or the HP standard software agreement for the product involved.

Printing History

The Printing History shown below lists all Editions and Updates of this manual and the printing date(s). The first printing of the manual is Edition 1. The Edition number increments by 1 whenever the manual is revised. Updates, which are issued between Editions, contain replacement pages to correct the current Edition of the manual. Updates are numbered sequentially starting with Update 1. When a new Edition is created, it contains all the Update information for the previous Edition. Each new Edition or Update also includes a revised copy of this printing history page. Many product updates or revisions do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

CENC-TAC8 Service Manual Edition 1 ..... November 1993
CENC-TAC8 Service Manual Edition 2 ..... August 1996

Safety Symbols



Instruction manual symbol affixed to product. Indicates that the user must refer to the manual for specific WARNING or CAUTION information to avoid personal injury or damage to the product.



Frame or chassis ground terminal---typically connects to the equipment's metal frame.

WARNING Calls attention to a procedure, practice, or condition that could cause bodily injury or death.

CAUTION Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

Alternating current (AC).



Direct current (DC).



Indicates hazardous voltages.

WARNINGS

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), an uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.

For continued protection against fire, replace the line fuse(s) only with fuse(s) of the same voltage and current rating and type. DO NOT use repaired fuses or short-circuited fuse holders.

Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DO NOT service or adjust alone: Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT substitute parts or modify equipment: Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

Declaration of Conformity

according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name:	Hewlett-Packard Company Loveland Manufacturing Center
Manufacturer's Address:	815 14th Street S.W. Loveland, Colorado 80537 U.S.A

declares, that the product:

Product Name:	Tachometer Module
Model Number:	CENC-TAC8
Product Options:	All

conforms to the following Product Specifications:

Safety:	IEC 1010-1 (1990) Incl. Amend 1 (1992)/EN61010-1 (1993) CSA C22.2 #1010.1 (1992) UL 1244
EMC:	CISPR 11:1990/EN55011 (1991): Group 1, Class A IEC 801-2:1991/EN50082-1 (1992): 4kVCD, 8kVAD IEC 801-3:1984/EN50082-1 (1992): 3 V/m IEC 801-4:1988/EN50082-1 (1992): 1kV Power Line .5kV Signal Lines

Supplementary Information: The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC.

Tested in a typical configuration in an HP C-Size VXI mainframe.

December 9, 1993

Jim White, QA Manager

European contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department HQ-TRE, Herrenberger Straße 130, D-71034 Böblingen, Germany (FAX +49-7031-143143).

Tachometer Module Service Manual

Chapter 1. General Information
Introduction 1-1
Safety Considerations 1-1
Inspection and Shipping 1-1
Module Description 1-2
Recommended Test Equipment 1-2
WARNINGS and CAUTIONS 1-3

Chapter 2. Verification Tests
Introduction 2-1
Functional Verification 2-2
Self-Test Test Procedure 2-2
Sensitivity Test Procedure 2-2
Low-Pass Filter Test Procedure 2-5
Performance Verification 2-7
Performance Test Record 2-9

Chapter 3. Adjustments
Introduction 3-1
Tachometer Module Calibration 3-2

Chapter 4. Replaceable Parts
Introduction 4-1
Replaceable Parts Lists 4-1
Serial Numbers 4-1

Appendix. Accuracy Calculations

1
General Information

Introduction

This service manual contains information required to test, adjust, and calibrate the Tachometer Module. Refer to the Tachometer Module User's Manual for additional information.

Safety Considerations

This product is a Safety Class I instrument that is provided with a protective earth terminal when installed in the mainframe. The mainframe, Tachometer Module, and all related documentation should be reviewed for familiarization with safety markings and instructions before operation or service.

Refer to the WARNINGS page in this manual for a summary of safety information.

Inspection and Shipping

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, keep the container until the shipment contents have been checked and the instrument has been checked mechanically and electrically.

WARNING: To avoid possible hazardous electrical shock, do not perform electrical tests if there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

If the contents are not complete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance tests, notify your nearest Hewlett-Packard Sales and Support Office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as Hewlett-Packard, and keep the shipping materials for the carrier's inspection.

Module Description

The Tachometer Module is a C-size register-based VXIbus module that counts pulses from magnetic pickups and tachometer generators which are typically used to monitor rotor speeds on turbine and piston engines. It can correctly count both low and high pulse-encoded tachometer signals.

The Tachometer Module is capable of simultaneous measurement on all eight channels at a rate of up to 50 measurements per channel per second. The single active channel throughput is greater than 100 Hz. Output can be configured as frequency (Hertz), timer counts, or engineering units such as RPM, rad/sec, period, and fuel flow. Timer counts consist of event count and timebase count information. The event counter accumulates whole input signal periods during a given measurement while the timebase counter accumulates positive edge transitions of a precision 10-MHz clock for the duration of the measurement.

There are three measurement schemes available on a per-channel basis: user-specified constant measurement window, auto-ranged terminal event count, and user-specified terminal event count. These measurement schemes are further defined in Chapter 3 of the *CENC-TAC8 Tachometer Module User's Manual*, "Theory of Operation."

Recommended Test Equipment

The following table lists the test equipment recommended for testing and adjusting the Tachometer Module.

Instrument	Requirements	Recommended Model	Use
Frequency Counter	0.1 to 0.2 PPM accuracy	HP 5334B Universal Counter w/ Opt. 010	F, A
Function Generator	accuracy ±0.75 ppm @ 23 C	HP 3325B Function Generator w/Option 001	F, P
Mainframe	Compatible with Tachometer Module	HP 75000 Series C	F, P
Extender Board	C-size	HP E2441B	F, P, A

F = Functional Verification Tests
P = Performance Verification Tests
A = Adjustments

WARNING

TRAINED PERSONNEL ONLY. The information in this manual is for trained personnel who are familiar with electronic circuitry and are aware of the hazards involved. To avoid personal injury or damage to the instrument, do not perform procedures in this manual or do any servicing unless you are qualified to do so.

CHECK MAINFRAME POWER SETTINGS. Before applying power, verify that the mainframe setting matches the line voltage and the correct fuses are installed. An uninterruptible safety earth ground must be provided from the main power source to the mainframe input wiring terminals, power cord, or supplied power cord set.

GROUNDING REQUIREMENTS. Interruption of the protective (grounding) conductor (inside or outside the mainframe) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two-conductor outlet is not sufficient protection.)

COMMON GROUND. Verify that a common ground exists between the unit under test and the Tachometer Module (via the mainframe) prior to energizing either unit.

IMPAIRED PROTECTION. Whenever it is likely that instrument protection has been impaired, the mainframe must be made inoperative and be secured against any unintended operation.

USING AUTOTRANSFORMERS. If the mainframe is to be energized via an autotransformer (for voltage reduction), make sure the common terminal is connected to neutral (that is, the grounded side of the main's supply).

CAPACITOR VOLTAGES. Capacitors inside the mainframe may remain charged even when the mainframe has been disconnected from its source of supply.

USE PROPER FUSES. For continued protection against fire hazard, replace the line fuse(s) only with fuses of the same current rating and type (such as normal blow, time delay, etc.). Do not use repaired fuses or short-circuited fuse holders.

CAUTION

MAXIMUM VOLTAGE. The maximum voltage which may be applied to any BNC connector is 250 volts peak with respect to chassis ground on the center conductor, and 42 V peak with respect to chasis ground on the outer shell. The maximum voltage between the inner and outer conductors is 200 V peak.

STATIC ELECTRICITY. Static electricity is a major cause of component failure. To prevent damage to the electrical components in the Tachometer Module, observe anti-static techniques whenever removing a Tachometer Module from a mainframe or whenever working on a Tachometer Module. Always tighten the module retaining screws securely.

2
Verification Tests

Introduction

The test procedures described in this chapter are used to verify that the Tachometer Module is fully functional and meets selected testable specifications (Performance Verification).

WARNING: Do not perform any of the following verification tests unless you are a qualified, trained technician and have read the WARNINGS and CAUTIONS included in this manual.

For valid tests, all test equipment and the Tachometer Module must have a one-hour warm-up. See the Recommended Test Equipment table in Chapter 1 of this manual.

For best accuracy, the ambient temperature of the test area should be between 18°C and 28°C and stable to within 1°C. You should perform the Performance Verification tests at least once a year. For heavy use or severe operating environments, perform the tests more often.

The verification tests assume the person performing the tests understands how to operate the mainframe, Tachometer Module, and specified test equipment. The test procedures do not specify equipment settings for test equipment, except in general terms. It is assumed a qualified, trained technician will select and connect the cables and adapters required for the tests.

The Performance Test Record table at the end of this chapter provides space to enter the results of each Performance Verification Test and allows you to compare the results with the upper and lower limits for the test. You may copy this form as desired.

Functional Verification

The functional verification tests for the Tachometer Module can be performed at any time to verify the module is functional and is communicating with the mainframe, external computer, and/or external terminal. The functional tests include the self-test, the sensitivity test and the low-pass filter test (optional).

If the Tachometer Module fails any of these tests, return it to Hewlett-Packard for repair or replacement.

Self-Test Test Procedure

The self-test verifies the measurement functions on channels 0 through 7.

1. Reset the Tachometer Module:

   ```
   *RST;*CLS
   ```

2. Execute the self test:

   ```
   *TST?
   ```

3. Read the result. A zero ("0") indicates that the test passed. A one ("1") in bit positions zero through seven indicates that the corresponding channel failed.

Sensitivity Test Procedure

This procedure verifies that the sensitivity thresholds are working and adjusted correctly.

1. Apply a 20-mV peak, 1000-Hz sine wave to channels zero through seven.

2. Reset the Tachometer Module:

   ```
   *RST; *CLS
   ```

3. Set up the Tachometer Module with a 0 V sensitivity and a 100-kHz low-pass filter:

   ```
   EVEN:LEV 0.0, (@100:107)
   INP:FILT:FREQ 100000, (@100:107)
   ```

4. Set up the Tachometer Module to make frequency measurements on channels zero through seven:

   ```
   FUNC FREQ, (@100:107)
   ```

5. Define CVT as the measurement destination:

   ```
   DATA:CVT:CHAN ON, (@100:107)
   ```

6. Specify a 0.2 second measurement aperture:

   ```
   FREQ:APER 0.2, (@100:107)
   ```

7. Configure the trigger subsystem and initiate measurement:

   ```
   TRIG:SOUR BUS
   INIT:CONT ON
   TRIG
   ```

8. Wait 20 seconds.

9. Read CVT data:

   ```
   DATA:CVT? (@100:107)
   ```

   Data should match input frequency. An inoperative channel returns 0.0 Hz.

10. Initialize the CVT:

    ```
    DATA:CVT:RES
    ```

11. Program the sensitivity to 328 mV peak-to-peak:

    ```
    EVEN:LEV 0.3281, (@100:107)
    ```

12. Increase the sine wave amplitude to 345 mV p-p.

13. Trigger the measurement; wait 20 seconds; and read the CVT data:

    ```
    TRIG
    (wait 20 seconds)
    DATA:CVT? (@100:107)
    ```

    All eight channels should match the input frequency.

14. Initialize the CVT:

    ```
    DATA:CVT:RES
    ```

15. Slowly decrease the sine wave amplitude; trigger the measurement; wait 20 seconds; read the CVT data; and initialize the CVT:

    ```
    TRIG
    (wait 20 seconds)
    DATA:CVT? (@100:107)
    DATA:CVT:RES
    ```

    This step should be repeated until all eight channels return 0.0 Hz. Measurement data should be 0.0 Hz before reaching 294 mV p-p.

16. Slowly increase the sine wave amplitude; trigger the measurement; wait 20 seconds; read the CVT data; and initialize the CVT:

    ```
    TRIG
    (wait 20 seconds)
    DATA:CVT? (@100:107)
    DATA:CVT:RES
    ```

    This step should be repeated until all eight channels match the input frequency. Measurement data should be 1000 Hz before reaching 345 mV p-p.

17. Program the sensitivity to 656 mV p-p:

    ```
    EVEN:LEV 0.656, (@100:107)
    ```

18. Increase the sine wave amplitude to 690 mV p-p.

19. Repeat steps 13 through 16 with the low measurement limit for step 15 at 640 mV p-p and the high measurement limit for step 16 at 690 mV p-p.

Low-Pass Filter Test This test verifies the operation of the programmable input filter on each channel.

1. Connect a function generator to all eight channels of the Tachometer Module. Configure the generator with a 1 V p-p sine wave with a 0 VDC offset at 850 Hz.

2. Reset the Tachometer Module and clear the status registers:

   ```
   *RST; *CLS
   ```

3. Configure the Tachometer Module on channels 0 through 7 with a sensitivity of 0.71:

   ```
   EVEN:LEV 0.71, (@100:107)
   ```

4. Configure the Tachometer Module on channels 0 through 7 with a 1-kHz low-pass filter:

   ```
   INP:FILT:FREQ 1000, (@100:107)
   ```

5. Set up the Tachometer Module to make the frequency measurements on channels 0 through 7:

   ```
   FUNC FREQ, (@100:107)
   ```

6. Define CVT as the measurement destination:

   ```
   DATA:CVT:CHAN ON, (@100:107)
   ```

7. Specify a 0.2-second measurement aperture:

   ```
   FREQ:APER 0.2, (@100:107)
   ```

8. Configure the trigger subsystem:

   ```
   TRIG:SOUR BUS
   INIT:CONT ON
   ```

9. Initiate measurement:

   ```
   TRIG
   ```

10. Wait 20 seconds; read the CVT data; and initialize the CVT:

    ```
    DATA:CVT? (@100:107)
    DATA:CVT:RES
    ```

11. Increase the input signal frequency in 10-Hz steps. Repeat steps 9 and 10 as many times as necessary, and note when each channel stops counting the input signal (returns a value of 0.0). This maximum frequency should be 900 to 1100 Hz.

12. Set input frequency to 1760, configure the Tachometer Module on channels 0 through 7 with a 2-kHz low-pass filter:

    ```
    INP:FILT:FREQ 2000, (@100:107)
    ```

13. Increase the input signal frequency in 20-Hz steps. Repeat steps 9 and 10 as many times as necessary, and note when each channel stops counting the input signal. This maximum frequency should be 1800 to 2200 Hz.

14. Set the input frequency to 8800 Hz, configure the Tachometer Module on channels 0 through 7 with a 10-kHz low-pass filter:

    ```
    INP:FILT:FREQ 10000, (@100:107)
    ```

15. Increase the input signal frequency in 100-Hz steps. Repeat steps 9 and 10 as many times as necessary, and note when each channel stops counting the input signal. This maximum frequency should be 9000 to 11000 Hz.

16. Set the input frequency to 88 kHz, configure the Tachometer Module on channels 0 through 7 with a 100-kHz low-pass filter:

    ```
    INP:FILT:FREQ 100000, (@100:107)
    ```

17. Increase the input signal frequency in 1-kHz steps. Repeat steps 9 and 10 as many times as necessary, and note when each channel stops counting the input signal (returns a value of 0.0). This maximum frequency should be 90 kHz to 110 kHz.

Performance Verification

Performance verification tests objectives are to instill a high degree of confidence that the CENC-TAC8 Tachometer Module is meeting selected specifications from those listed in Appendix B, "Tachometer Module Specifications," in the *CENC-TAC8 Tachometer Module User's Manual*. Performance verification tests can be used in applications such as incoming inspection and after repair.

NOTE: The Performance Verification tests assume that the test equipment is calibrated and is operating at peak performance. If this is not the case, problems can occur. For example, an uncalibrated source may cause what seems to be an inaccurate measurement. This condition must be considered when observed measurements do not agree with the performance test limits.

Test Procedure

This test checks frequency measurement accuracy on channels 0 through 7.

1. Connect a function generator to all eight channels of the Tachometer Module. Configure the generator with a 1-Hz, 1 Vp-p, square wave with a 0 VDC offset.

2. Reset the Tachometer Module and clear the status registers:

   ```
   *RST; *CLS
   ```

3. Configure the Tachometer Module on channels 0 through 7 with a sensitivity of 0.1 V:

   ```
   EVEN:LEV 0.5, (@100:107)
   ```

4. Configure the Tachometer Module on channels 0 through 7 with a 100-kHz low-pass filter:

   ```
   INP:FILT:FREQ 100000, (@100:107)
   ```

5. Set up the Tachometer Module to make frequency measurements on channels 0 through 7:

   ```
   FUNC FREQ, (@100:107)
   ```

6. Define CVT as the measurement destination:

   ```
   DATA:CVT:CHAN ON, (@100:107)
   ```

7. Specify a 0.2-second measurement aperture:

   ```
   FREQ:APER 0.2, (@100:107)
   ```

8. Configure the trigger subsystem:

   ```
   TRIG:SOUR BUS
   INIT:CONT ON
   ```

9. Initiate the measurement:

   ```
   TRIG
   ```

10. Read CVT data and initialize the CVT:

    ```
    DATA:CVT? (@100:107)
    DATA:CVT:RES
    ```

    Compare the CVT results against the limits provided in the tables following this test (page 2-12).

11. Configure the function generator with a 1-kHz, 1 Vp-p, square wave with a 0 VDC offset.

12. Specify a 1.0-second measurement aperture:

    ```
    FREQ:APER 1.0, (@100:107)
    ```

13. Repeat steps 9 and 10.

14. Configure the function generator with a 100-kHz, 1 Vp-p, square wave with a 0 VDC offset.

15. Specify a 0.006-second measurement aperture:

    ```
    FREQ:APER 0.006, (@100:107)
    ```

16. Repeat steps 9 and 10.

17. Specify a 1.0-second measurement aperture:

    ```
    FREQ:APER 1.0, (@100:107)
    ```

18. Repeat steps 9 and 10.

The value in the Measurement Uncertainty column in the table on page 2-12 is derived from the specifications for the source used for the test, and represents the expected accuracy for the source.

The value in the Test Accuracy Ratio column is the ratio of the Tachometer Module accuracy to the measurement uncertainty, rounded to the nearest integer for TARs < 10:1. For example, if Tachometer Module accuracy = $\pm 6.0 \times 10^{-6}$ Hz and measurement uncertainty = $\pm 3.0 \times 10^{-7}$ Hz, TAR = $\pm(6.0 \times 10^{-6}/3.0 \times 10^{-7}) = \pm 20{:}1$. Since this is > 10:1, the entry in the table is "> 10:1".

As required, see the mainframe user's manual for information on address selection and cabling guidelines. See the *CENC-TAC8 Tachometer Module User's Manual* for information on C-SCPI.

Performance Test Record

The performance test record on page 2-10 is a form you may copy and use to record performance verification test results for the Tachometer Module. This table shows accuracy, measurement uncertainty, and test accuracy ratio (TAR) values.

Test limits are defined using the 1-year specifications in Appendix B of the *CENC-TAC8 Tachometer Module User's Manual*. For the performance verification tests in this manual, the measurement uncertainties are based on the 90-day accuracy specifications for the source (HP 3325B with Option 001).

The Test Accuracy Ratio (TAR) for the Tachometer Module is defined as follows.

$$\text{TAR} = \frac{\text{Maximum Value - Expected Reading}}{\text{Measurement Uncertainty}}$$

For TARs that exceed 10:1, the entry is ">10:1".

The values for Tachometer Module accuracy, measurement uncertainty, and TAR in the Performance Test Record assume the following conditions. If your test conditions differ from these conditions, you will need to compute the appropriate values.

- source noise ≤ 1 mV rms
- slew rate > 2 kV/s
- timebase error = 1 ppm

Performance Test Record for the Tachometer Module

Test Facility:	
Name:	**Report No.:**
Address:	**Date:**
City/State:	**Customer:**
Phone:	**Tested by:**
Model:	**Ambient temperature:**
Serial No.	**Relative humidity:**
Options:	**Line Frequency:**
Firmware Rev.:	

Notes:

Model:_____ Report No.:_____ Date:_____

Test Equipment Used	Model No.	Trace No.	Cal Due Date
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			

Frequency Measurements

Source Freq	Aper Time (sec)	Low Limit (Hz)	Measured Frequency (Hz)	High Limit (Hz)	Measurement Uncertainty (Hz)	Test Accuracy Ratio
Channel 0						
1 Hz	0.20	0.999		1.001	7.5E-7	>10:1
1 kHz	1.0	999.996		1000.004	7.5E-4	5:1
100 kHz	0.006	99998.0		100002.0	0.075	>10:1
100 kHz	1.0	99999.6		100000.4	0.075	5:1
Channel 1						
1 Hz	0.20	0.999		1.001	7.5E-7	>10:1
1 kHz	1.0	999.996		1000.004	7.5E-4	5:1
100 kHz	0.006	99998.0		100002.0	0.075	>10:1
100 kHz	1.0	99999.6		100000.4	0.075	5:1
Channel 2						
1 Hz	0.20	0.999		1.001	7.5E-7	>10:1
1 kHz	1.0	999.996		1000.004	7.5E-4	5:1
100 kHz	0.006	99998.0		100002.0	0.075	>10:1
100 kHz	1.0	99999.6		100000.4	0.075	5:1
Channel 3						
1 Hz	0.20	0.999		1.001	7.5E-7	>10:1
1 kHz	1.0	999.996		1000.004	7.5E-4	5:1
100 kHz	0.006	99998.0		100002.0	0.075	>10:1
100 kHz	1.0	99999.6		100000.4	0.075	5:1

Source Freq	Aper Time (sec)	Low Limit (Hz)	Measured Frequency (Hz)	High Limit (Hz)	Measurement Uncertainty (Hz)	Test Accuracy Ratio
Channel 4						
1 Hz	0.20	0.999		1.001	7.5E-7	>10:1
1 kHz	1.0	999.996		1000.004	7.5E-4	5:1
100 kHz	0.006	99998.0		100002.0	0.075	>10:1
100 kHz	1.0	99999.6		100000.4	0.075	5:1
Channel 5						
1 Hz	0.20	0.999		1.001	7.5E-7	>10:1
1 kHz	1.0	999.996		1000.004	7.5E-4	5:1
100 kHz	0.006	99998.0		100002.0	0.075	>10:1
100 kHz	1.0	99999.6		100000.4	0.075	5:1
Channel 6						
1 Hz	0.20	0.999		1.001	7.5E-7	>10:1
1 kHz	1.0	999.996		1000.004	7.5E-4	5:1
100 kHz	0.006	99998.0		100002.0	0.075	>10:1
100 kHz	1.0	99999.6		100000.4	0.075	5:1
Channel 7						
1 Hz	0.20	0.999		1.001	7.5E-7	>10:1
1 kHz	1.0	999.996		1000.004	7.5E-4	5:1
100 kHz	0.006	99998.0		100002.0	0.075	>10:1
100 kHz	1.0	99999.6		100000.4	0.075	5:1

3
Adjustments

Introduction

This chapter contains procedures to adjust the Tachometer Module for peak performance. Included are procedures to adjust the temperature compensated crystal oscillator (TCXO).

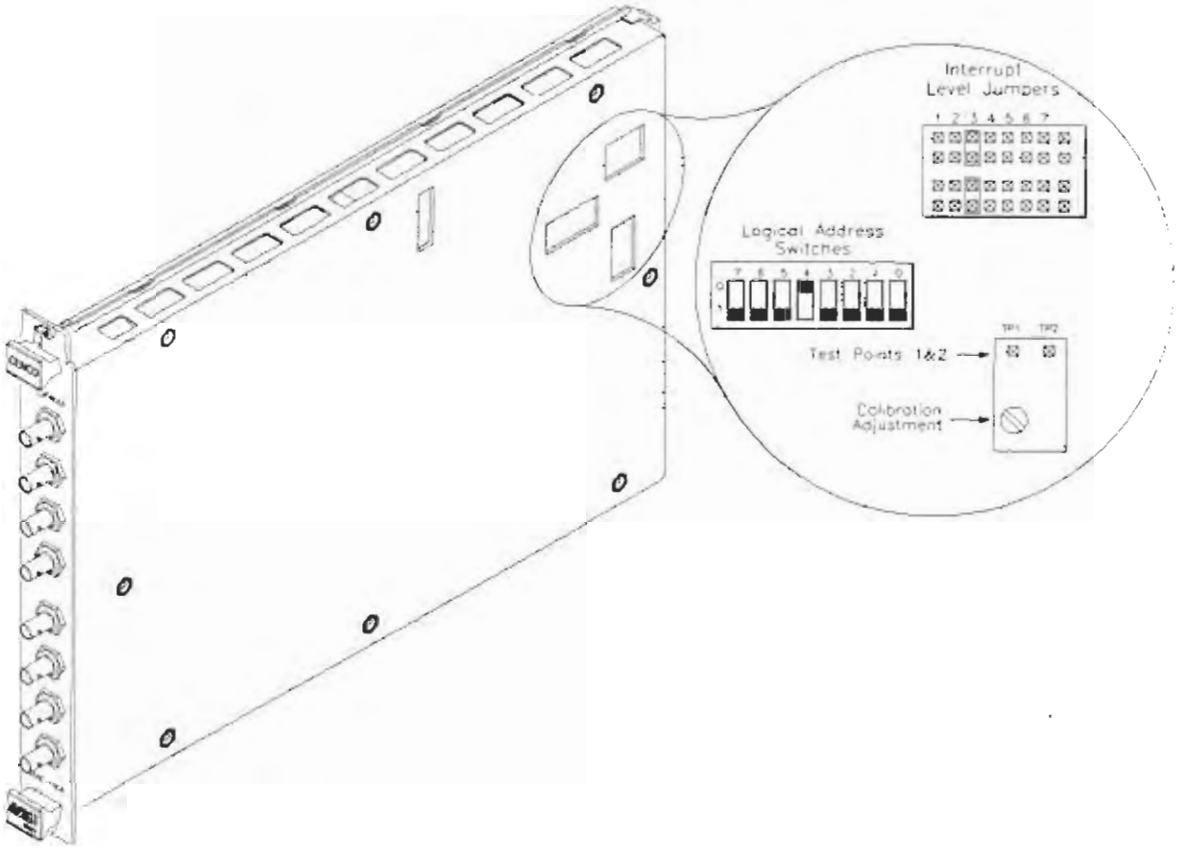
WARNING: Do not perform any of the following adjustments unless you are a qualified, trained technician, and have read the WARNINGS and CAUTIONS in Chapter 1.

For best accuracy, the temperature of the area where adjustments are made should be between 18 and 28 °C and stable to within ±1°C. Allow at least one hour for the Tachometer Module to warm up. Refer to the table of Recommended Test Equipment in Chapter 1 of this manual.

The adjustment procedures assume that the person performing the adjustments understands how to operate the mainframe, Tachometer Module, and specified test equipment. The adjustment procedures do not specify test equipment settings, except in general terms. It is assumed that a qualified, trained technician will select and connect the cables and jumpers required for the adjustments.

Tachometer Module Calibration

The Tachometer Module Calibration procedure entails adjusting the temperature compensated crystal oscillator (TCXO) output to 20 MHz.



Required Equipment

HP 5334B Universal Counter or equivalent (accuracy of 0.1 PPM)
HP E2441B Extender Board

Procedure

1. Mount the Tachometer Module on an extender card.
2. Mount the Tachometer Module in a VXI chassis and apply power for at least one hour.
3. Connect the Universal Counter to TP1 (labeled CLK20 on the side panel, temperature compensated crystal oscillator output), and to TP2 (ground).
4. Allow two minutes to warm up.
5. Adjust the potentiometer until the Universal Counter reads 20 MHz $\pm$10 Hz.

4
Replaceable Parts

Introduction

This chapter contains information on replacing parts of the Tachometer Module. The only replaceable parts in the Tachometer Module are two fuses.

Replaceable Parts List

1. fuse, 4 amp, 125 volt, 5 mm x 20 mm, fast acting
2. fuse, 2 amp, 250 volt, 5 mm x 20 mm, fast acting
3. Tachometer Module (new) HP part # E1401-66301
4. Tachometer Module (exchange) HP part # E1401-69301

Note: If the FAILED LED never illuminates (the red LED on the front panel), check the 5-V fuse on the circuit board. If the fuse is OK and the self-test LED still never illuminates, return the module to Hewlett-Packard for repair.

If the FAILED LED never extinguishes, check the 12-V fuse on the circuit board. If the fuse is OK and the LED still never goes out, return the module to Hewlett-Packard for repair.

The FAILED LED illuminates during a self-test. A self-test occurs at power-on, immediately after a reset, or when it's commanded to do so (e.g. *TST? common command or SELFTEST low-level command).

Serial Numbers

Hewlett-Packard serial numbers for the Tachometer Module are used to track warranty status and for internal use. The serial number has a prefix of US0000 and a suffix of a sequential four-digit number.

Appendix. Accuracy Calculations

This appendix shows how accuracy is defined and calculated for the Tachometer Module. Accuracy is defined as the expected accuracy of the measurement due only to the Tachometer Module.

For the Tachometer Module, accuracy is defined for frequency measurements by the following equation.

accuracy = ±[resolution + timebase error + trigger noise error]

Resolution is defined as the smallest change in the measurement that can be detected. For frequency measurements,

resolution

$$= (\text{input events})\,(\text{timebase})\left(\frac{1}{\text{TB counts}} - \frac{1}{\text{TB count} + 1}\right)$$

where:

input events = # of rising edges of input signal counted
timebase = 10 MHz
TB counts = # of rising edges of timebase counted

Note: the Tachometer Module always counts a whole number of events. The measurement window closes on the rising edge of the input signal.

Timebase error is defined as the maximum fractional change in the 10-MHz reference timebase frequency due to all error sources, which we will call the timebase (initial accuracy, aging and temperature drift) multiplied by the measurement result. That is:

timebase error = ±[initial accuracy + aging rate + temperature drift] x measurement result

For the Tachometer Module, the worst-case timebase values are:

initial accuracy = 1 PPM
aging rate = 1 PPM
temperature drift = 1 PPM

Calibration is usually performed yearly. Thus, a typical timebase error is equal to a factor (3E-6) times the measurement result.

Trigger Noise Error

Trigger Noise Error is defined as the additional error caused by input noise (typically less than 1 mV for the Tachometer Module) and by noise on the input signal. The input slew rate at trigger point is the rate at which the input voltage is changing when the input is triggered.

$$\text{slew rate} = \frac{\Delta V}{\Delta t}$$

Typically, however, the slew rate is not a constant, but varies linearly with the input frequency. For a sine wave, slew rate is defined as:

$$s = A2\pi f \cos 2\pi ft$$

where: s = slew rate
f = frequency
A = peak amplitude, $A/\sqrt{2}$ = RMS amplitude

At the 25% and 75% of peak-to-peak amplitude levels, the slew rate for a 50-mV RMS sine wave at 10 kHz is 2.2×10^3 v/sec.

Trigger Noise Error (RMS) = T, where:

$$T = \frac{\sqrt{(1\text{mV})^2 + (e_n)^2}}{\text{input slew rate at trigger point}}$$

e_n = rms noise in mV on the input signal for a 100-kHz bandwidth.

However, T is not the trigger noise error term for frequency measurements accuracy, but is only part of the equation.

trigger noise error (Hz)

=[(1.4 x T)/aper time] x frequency

$$= 1.4 \times \frac{\sqrt{(1\text{mV})^2 + (e_n)^2}}{\text{input slew rate at trigger point}} \times \text{frequency}$$

Example: Calculating Frequency Accuracy

For this example, assume the following values/conditions.

- input frequency: 10 kHz sinewave
- input amplitude: 50 mV rms
- aper time: 100 msec
- timebase: 3E-6
- source noise (e_n): 1 mV rms
- slew rate: 2.2 kV/sec

Note: The source noise of 1 mV rms is a typical value. Measure your source noise for more accurate calculations.

Frequency Measurement Accuracy Equation

For frequency measurements:
accuracy (Hz)
= ±(resolution + timebase error + trigger noise error)

Calculate Resolution

$$(1000)\,(10 \times 10^6)\left(\frac{1}{1 \times 10^6} - \frac{1}{1 \times 10^6 + 1}\right) = 0.01 \text{ Hz}$$

Calculate Timebase Error

For frequency measurements:
timebase error
= timebase x frequency
= ±(initial accuracy + aging rate + temp drift) x frequency =
(1ppm + 1ppm + 1ppm) 10 kHz = 0.03 Hz

Calculate Trigger Noise Error (Hz)

$$1.4\left(\frac{\sqrt{(1\text{mV})^2 + (1\text{mV})^2}}{2.2 \text{ kV/sec}}\right) 10 \text{ kHz} = 0.009 \text{ Hz}$$

Calculate Frequency Measurement Accuracy

accuracy (frequency measurements)
= ±(resolution +timebase error + trigger noise error)
= ±(0.01 Hz + 0.03 Hz + 0.009 Hz)
= ±0.049 Hz



Copyright © 1996
Hewlett-Packard Company
Printed in U.S.A.
E0896



Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP