

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	SERVICING AND CALIBRATION OF OPTICAL MONITORING DATALOGGERS
TYPE	STANDARD OPERATING PROCEDURE
NUMBER	4250
DATE	MARCH 1994

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the general procedures for servicing and calibrating dataloggers used with optical monitoring systems. Accurate and reliable operation of on-site dataloggers is critical to collection of high quality optical monitoring data. Regular servicing, performance testing, and calibration of dataloggers is performed to assure quality data capture and minimize data loss by:

- Performing functional checks and performance tests annually.
- Performing preventive maintenance servicing annually.
- Recalibrating the datalogger when performance tests indicate the unit is not operating within specifications.
- Documenting all servicing, repairs, and calibrations performed.

The following technical instructions (TIs) provide detailed information regarding specific datalogger servicing and calibration procedures:

- TI 4250-2000 *Servicing and Calibration of Campbell 21X Dataloggers*
- TI 4250-2010 *Servicing and Calibration of the Handar 540A/570A DCP*

Campbell 21X dataloggers are used as the primary datalogger for the IMPROVE nephelometer network, transmissometer calibration, and transmissometer field audits. Handar 540A/570A DCPs are used as the primary datalogger in the IMPROVE transmissometer network.

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Ensure that performance testing is conducted on all dataloggers annually.
- Ensure that fully serviced, calibrated, and field ready dataloggers are available as backups for units operating in the field.
- Ensure that all dataloggers that do not operate within factory specifications are returned to the manufacturer for factory servicing and recalibration.
- Ensure that all servicing and calibration is performed and documented according to procedures described in the datalogger-specific servicing and calibration TIs.

2.2 INSTRUMENT TECHNICIAN

The instrument technician shall:

- Perform all servicing and calibration of optical monitoring dataloggers.
- Coordinate with the manufacturer for return of dataloggers that fail to operate within factory specifications.
- Document and archive all datalogger servicing records.

2.3 DATA COORDINATOR

The data coordinator shall:

- Inform the instrument technician when a datalogger is removed from the field.
- Provide the instrument technician with a description of the field problems observed with the datalogger.

2.4 FIELD SPECIALIST

The field specialist shall provide the instrument technician with a description of problems observed during annual site visit testing.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following subsections provide summary lists of test equipment and materials required to service and calibrate optical monitoring dataloggers.

3.1 CAMPBELL 21X DATALOGGER

- Calibrated voltage source
- Campbell Scientific datalogger communications software (SMCOM)
- Campbell Scientific SC532 Peripheral Interface Module
- ARS Campbell 21X datalogger test program (21X_TEST.DLD)
- Digital voltmeter
- Waveform generator
- Frequency counter
- Campbell Scientific, Inc. *21X Micrologger Operator's Manual* and *21X Prompt Sheet*
- Reference thermometer (°C)
- Replacement components as required

- Battery pack
- Battery charger
- Desiccant packets
- Standard electronics laboratory small tools
- TI 4250-2000, *Servicing and Calibration of Campbell 21X Dataloggers*

3.2 HANDAR 540A/570A DCP

- Calibrated voltage source
- RF Wattmeter with 50 ohm RF load
- Digital voltmeter
- Reference AT/RH sensor
- Handar, Inc. *Operating and Service Manual for 540A Multiple Access Data Acquisition System, 560A Hydrologic Data Collection System, and 545A Programming Set*
- Handar, Inc. *570A Data Acquisition System Operating and Service Manual*
- Handar "TERM" program
- IBM PC-compatible computer
- Spare circuitboards as required
- 12 volt battery
- Desiccant packets
- Standard electronics laboratory small tools
- TI 4250-2010, *Servicing and Calibration of the Handar 540A/570A DCP*

4.0 METHODS

This section includes two (2) subsections:

- 4.1 Campbell 21X Datalogger Servicing Procedures
- 4.2 Handar 540A/570A DCP Servicing Procedures

4.1 CAMPBELL 21X DATALOGGER SERVICING PROCEDURES

Campbell 21X dataloggers are used as the primary datalogger for the IMPROVE nephelometer network, transmissometer calibration, and transmissometer field audits. Servicing procedures for the Campbell 21X datalogger are described in detail in TI 4250-2000, *Servicing and Calibration of Campbell 21X Dataloggers*. Servicing procedures include:

- Internal memory check
- Analog input check
- Analog output check
- Pulse counter check
- Panel temperature check
- Internal battery servicing
- Archiving Campbell 21X datalogger service records

4.2 HANDAR 540A/570A DCP SERVICING PROCEDURES

The Handar 540A/570A DCP is the primary datalogger in the IMPROVE transmissometer network. Servicing procedures for the Handar 540A/570A DCP are described in detail in TI 4250-2010, *Servicing and Calibration of the Handar 540A/570A DCP*. Servicing procedures include:

- Post-field inspection and performance checks
- Routine laboratory servicing
- DCP programming
- Pre-field performance testing
- Archiving Handar 540A/570A DCP service records

5.0 REFERENCES

Campbell Scientific, Inc., 1993, 21X Micrologger Operator's Manual. July.

Campbell Scientific, Inc., 1993, 21X Prompt Sheet.

Handar, Inc., 1982, Operating and Service Manual for 540A Multiple Access Data Acquisition System, 560A Hydrologic Data Collection System, and 545A Programming Set. June.

Handar, Inc., 1988, 570A Data Acquisition System Operating and Service Manual. March.

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1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes procedures for servicing and verifying calibration of Campbell 21X dataloggers. This TI, as referenced in Standard Operating Procedure (SOP) 4250, *Servicing and Calibration of Optical Monitoring Dataloggers*, specifically describes procedures for:

- Testing datalogger memory functions
- Checking the accuracy of all analog voltage input channels
- Checking the accuracy of the analog output ports
- Checking the accuracy of the pulse input port
- Checking the accuracy of the panel temperature measurement
- Checking the condition of the internal battery
- Replacing the internal battery
- Archiving datalogger servicing records

Campbell 21X dataloggers are primarily used by ARS as the:

- Primary datalogger at NGN-2 nephelometer monitoring sites (Refer to TI 4300-4006, *Nephelometer Data Collection via Campbell Scientific Data Storage Module (IMPROVE Protocol)*).
- Primary datalogger for transmissometer calibration (Refer to TI 4200-2100, *Calibration of Optec LPV-2 Transmissometers (IMPROVE Protocol)*).
- Primary datalogger for field audit of transmissometers (Refer to SOP 4710, *Transmissometer Field Audit Procedures*).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Verify that all Campbell 21X dataloggers are serviced at least annually.
- Verify that calibration checks are performed on all Campbell 21x dataloggers at least annually.
- Verify that all Campbell 21X dataloggers are operating within factory specifications prior to being shipped to the field.
- Verify that all Campbell 21X dataloggers that do not operate within factory specifications are returned to Campbell Scientific for factory servicing and recalibration.

- Ensure that all datalogger servicing is documented and archived in accordance with the procedures described in this TI.

2.2 INSTRUMENT TECHNICIAN

The instrument technician shall:

- Perform and document all calibration checks.
- Coordinate with Campbell Scientific for return and recalibration of Campbell 21X dataloggers that fail to operate within factory specifications.
- Prepare purchase orders for factory servicing and recalibration of Campbell 21X dataloggers.
- Replace the Campbell 21X internal battery as required.
- Archive all datalogger servicing records.

2.3 DATA COORDINATOR

The data coordinator shall:

- Inform the instrument technician when a 21X is being removed from the field.
- Provide the instrument technician with a description of the field problems observed with the 21X.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Specific instrumentation, tools, equipment, and materials required to service the Campbell 21X datalogger and to verify the datalogger calibration are:

- Calibrated voltage source - Datel Model DVC-350A or equivalent
- Campbell Scientific datalogger communications software (SMCOM)
- Campbell Scientific SC532 Peripheral Interface Module
- ARS Campbell 21X datalogger test program (21X_TEST.DLD)
- Digital voltmeter (4 1/2 digits)
- Waveform generator - Wavetek Model 185 or equivalent
- Frequency counter - Tenma Model 72-375 or equivalent
- Campbell Scientific, Inc. *21X Micrologger Operator's Manual* and *21X Prompt Sheet*
- Laboratory reference thermometer (°C)

- Replacement components as required
- Medium screwdrivers (flat-blade and Phillips-head)
- Battery charger
- Replacement sealed lead acid battery pack
- Two (2) dry half-unit DESI PAK desiccant packets

4.0 METHODS

Campbell 21X dataloggers should be serviced according to the following schedule:

- Prior to installation at a field monitoring site
- On an annual schedule (for units not used at field sites)
- Any time the operation or accuracy of the datalogger appears to be suspect

Calibration of the Campbell 21X datalogger is required any time calibration checks indicate that the datalogger is not operating within factory specifications.

This section includes seven (7) subsections:

- 4.1 Internal Memory Check
- 4.2 Analog Input Checks
- 4.3 Analog Output Checks
- 4.4 Pulse Counter Check
- 4.5 Panel Temperature Test
- 4.6 Internal Battery Servicing
- 4.7 Archiving Datalogger Service Records

Procedures for performing the internal memory check are documented on the Campbell 21X Datalogger Servicing Documentation Form (Figure 4-1) and are described in the following sections.

RECORD GENERAL INFORMATION	Record the datalogger serial number and the current date. The initials of the technician performing the inspection should also be recorded.
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4.1 INTERNAL MEMORY CHECK

The Campbell 21X datalogger will perform an internal memory check on power-up. This check indicates the status of each memory chip on the datalogger's CPU board. Procedures for performing the internal memory check are documented on the Campbell 21X Datalogger Servicing Documentation Form (Figure 4-1) and are as follows:

TURN DATALOGGER ON	Turn the datalogger ON . The datalogger display will read "HELLO."
---------------------------	---

**CAMPBELL 21X DATALOGGER
SERVICING DOCUMENTATION FORM**

Date: _____
Datalogger S/N: _____
Technician: _____

INTERNAL MEMORY CHECK

Memory Status = 11:111111? Yes No Status __:_____

ANALOG INPUT CHECK

Input Voltage (mV)	<u>Datalogger Readings (mV)</u>							
	<u>CH1</u>	<u>CH2</u>	<u>CH3</u>	<u>CH4</u>	<u>CH5</u>	<u>CH6</u>	<u>CH7</u>	<u>CH8</u>
0.000								
2.500								
5.000								

ANALOG OUTPUT CHECK

CAO PORT #	CORRECT OUTPUT (mV)	ACTUAL OUTPUT (mV)
#1	2500±1	
#2	5000±1	

PULSE COUNTER CHECK

Waveform Generator Frequency _____ Hz
Datalogger Counts _____

PANEL TEMPERATURE CHECK

Ambient Temperature - Lab Reference _____ °C
Datalogger Panel Temperature _____ °C

INTERNAL BATTERY SERVICING

Battery Voltage _____ Volts
Battery Installation Date _____
Battery Replaced Yes No
Desiccant Replaced Yes No Comment _____

Factory servicing or calibration required Yes No
Describe Servicing required _____

Figure 4-1. Campbell 21X Datalogger Servicing Documentation Form.

TURN DATALOGGER ON
(continued)

After a few seconds delay, the memory check results will be displayed. If all memory is installed and operating, the display will read "11:111111." The eight (8) characters in the display represent the eight (8) memory sockets numbered from left to right. A "1" indicates a good chip is in the corresponding socket. A "0" indicates the socket is empty or an error was detected in the chip. The five (5) left-most characters of the display represent the 8K ram chips. The three (3) right-most characters of the display are the 8K PROMs.

If the memory check results indicate that one or more memory chips are faulty, return the instrument to Campbell Scientific for repair.

4.2 ANALOG INPUT CHECKS

CONNECT VOLTAGE
CALIBRATOR

Connect the Datel voltage calibrator to the datalogger using the datalogger "analog inputs" test cable. This cable provides a connection from the voltage output of the calibrator to each of the eight (8) analog input channels of the datalogger.

DOWNLOAD TEST
PROGRAM

Download the datalogger test program (21X_TEST.DLD) to the datalogger to be tested using the Campbell Scientific datalogger communications software (SMCOM) and the Campbell Scientific SC532 Peripheral Interface Module.

RUN TEST PROGRAM

Press *0 on the datalogger to compile and run the test program.

SET VOLTAGES

Set the calibrator to the input voltages specified on the Campbell 21X Datalogger Servicing Documentation Form (Figure 4-1). All input voltages are specified in millivolts. All datalogger readings should be recorded as millivolts.

RECORD DISPLAY
READINGS

Enter *6 on the datalogger and record the datalogger display reading (storage locations 01 - 08) for each of the eight analog channels at each of the three input voltages specified on the Campbell 21X Datalogger Servicing Documentation Form.

If the datalogger readings for any of the analog channels differ from the specified values by more than ± 5.0 millivolts, return the datalogger to Campbell Scientific for recalibration.

4.3 ANALOG OUTPUT CHECKS

The test program sets up a continuous DC voltage output on both analog output ports (CAO 1 and CAO 2).

MEASURE OUTPUT
VOLTAGE

Measure the output voltage at CAO ports 1 and 2 with a calibrated and certified 4½ digit voltmeter. Record these

MEASURE OUTPUT
VOLTAGE (continued)

measurements (in millivolts) on the Campbell 21X Datalogger Servicing Documentation Form. The correct reading for each port is shown, along with the manufacturers' specified accuracy, on the Campbell 21X Datalogger Servicing Documentation Form.

If the datalogger readings for either CAO port differ from the specified values by more than ± 5.0 millivolts, return the datalogger to Campbell Scientific for recalibration.

4.4 PULSE COUNTER CHECK

CONNECT GENERATOR
TO FREQUENCY
COUNTER

Connect the waveform generator to pulse input channel #1.

SETUP WAVEFORM
GENERATOR

Setup the waveform generator for a square wave output with a frequency of 1000 Hz and an amplitude of 1 volt (rms).

RECORD COUNTS

The test program will count pulses from the waveform generator for a period of 10 seconds. Record the number of counts in the pulse counter channel at storage location 09 (press *6 9 on the datalogger). Based on an input frequency of 1000 Hz, a datalogger count of 10,000 should be displayed.

If the datalogger reading for the pulse counter channel differs from the specified value by more than ± 5 counts, return the datalogger to Campbell Scientific for recalibration.

4.5 PANEL TEMPERATURE CHECK

RECORD AMBIENT
TEMPERATURE

Read the ambient temperature in the laboratory with the laboratory reference thermometer. Record this temperature ($^{\circ}\text{C}$) on the Campbell 21X Datalogger Servicing Documentation Form (Figure 4-1).

RECORD PANEL
TEMPERATURE

Read the datalogger panel temperature at storage location 10 (press *6 10 on the datalogger) and record the reading on the Campbell 21X Datalogger Servicing Documentation Form.

If the datalogger panel temperature measurement differs from the laboratory reference thermometer reading by more than ± 1.7 $^{\circ}\text{C}$, return the datalogger to Campbell Scientific for recalibration.

4.6 INTERNAL BATTERY SERVICING

RECORD BATTERY
VOLTAGE

Read the internal battery voltage at storage location 11 (press *6 11 on the datalogger). Record this reading on the Campbell 21X Datalogger Servicing Documentation Form.

RECHARGE BATTERY If the battery voltage is less than 11.76 volts, connect the datalogger to the battery charger. Recharge the battery for eight (8) hours.

REPLACE BATTERY Disconnect the datalogger from the battery charger and recheck the battery voltage (press *6 11 on the datalogger). If the battery voltage is still less than 11.76 volts, replace the battery as described below:

- Turn the power switch **OFF**.
- Remove the two front panel screws and carefully raise the front panel away from the datalogger case.
- Disconnect the used battery from the charging circuit and remove from the datalogger case.
- Install a fresh battery. Mark the installation date on the battery.
- Remove the datalogger desiccant packets and replace with two (2) dry half unit DESI PAK desiccant packets.
- Replace the front panel.
- Turn the power switch **ON** and recheck the battery voltage.

4.7 ARCHIVING DATALOGGER SERVICE RECORDS

All service records for Campbell 21X dataloggers are maintained by the instrument technician. The records are archived by datalogger serial number in three-ring notebooks located in the ARS instrumentation laboratory.

5.0 REFERENCES

Campbell Scientific, Inc., 1993, 21X Micrologger Operator's Manual. July.

Campbell Scientific, Inc., 1993, 21X Prompt Sheet.