# Vector™ Series


## Models H410 & H410D

## Laser Power and Energy Meters

# Operating Manual

Thank you for choosing a Scientech Vector™ calorimeter detector. Scientech's employees are pleased to provide you with a product designed for years of reliable and accurate service. Please read this operating manual before using your detector and power meter. This reference information will allow you to fully understand the capabilities of the product. The detector is intended to be used only in the manner outlined in this manual. Operation not within specifications for the product may cause product damage.

# Table of Contents

## DETECTOR OPERATING PARAMETERS

All detectors are calibrated at a specific wavelength and the detector's operating parameters are derived for that wavelength. This information is recorded below and on the detector's serial tag. When a detector is used at a wavelength other than the calibration wavelength some of the operating parameters may need to be adjusted. For specific instructions please refer to the Operating Procedures section for the type of detector you are using.

Power Meter Serial Number_____

| **Calorimeter 1:** | | **Calorimeter 2:** | |
|---|---|---|---|
| Model No: | _____ | Model No: | _____ |
| Serial No: | _____ | Serial No: | _____ |
| Group No: | _____ | Group No: | _____ |
| Calibration Wavelength or µm | _____nm or µm | Calibration Wavelength: | _____nm |
| Output Sensitivity (S): | _____V/W | Output Sensitivity (S): | _____V/W |
| Time Constant (1/e): | _____sec. | Time Constant (1/e): | _____sec. |
| Calibration Temp: | _____°C | Calibration Temp: | _____°C |
| Calibration Humidity: | _____%R.H. | Calibration Humidity: | _____% R.H. |
| Sub. Heater Resistance ($R_c$): | _____ohms | Sub. Heater Resistance ($R_c$): | _____ohms |
| Sub. Heater Voltage ($V_h$): | _____volts | Sub. Heater Voltage ($V_h$): | _____volts |
| Sub. Heater Wattage ($W_h$) | _____watts | Sub. Heater Wattage ($W_h$): | _____watts |

**Pyroelectric Detector 1:**

Model No: _____
Serial No: _____
Group No: _____
Calibration Wavelength: _____nm or µm
Output Sensitivity:[1] _____V/J or _____V/mJ S_____ I_____ L_____
Output Sensitivity:[1] _____V/J (Scope)
Calibration Temp: _____°C Calibration Humidity: _____%R.H.

**Pyroelectric Detector 2:**

Model No: _____
Serial No: _____
Group No: _____
Calibration Wavelength: _____nm or µm
Output Sensitivity:[1] _____V/J or _____V/mJ S_____ I_____ L_____
Output Sensitivity: V/J (Scope)
Calibration Temp: _____°C Calibration Humidity: _____%R.H.

The V/J is used to calibrate the power meter to a known NIST traceable standard. This is the value the meter must use.
The V/J (Scope) is the "true" Volts per Joule as seen at an oscilloscope.

## ENVIRONMENTAL REQUIREMENTS

This product is intended for indoor use at altitudes up to 2000 meters, Pollution Degree 2 in accordance with IEC 664 and transient overvoltages according to Installation Categories (Overvoltage Categories) II. Note that each of the above detectors will not pass the IEC 801 Publication, Part 3, Radiated Electromagnetic Field Requirements. The system, meter and detector, is designed to measure radiation within the test's radiation band. The detectors were held outside the radiated electromagnetic field during this test. It is up to the user to be aware of RF fields present during measurements and their effects if any on those measurements.

### CE Mark Certification

All of the power meters listed in this manual have been certified for the European CE mark.

## VECTOR™ H410 POWER METER SPECIFICATIONS

The Models H410 and H410D are identical to each other in every respect except the analog meter. The H410 has both an analog and digital display. The H410D has only a digital readout. All references to the H410 are intended to include the H410D except where noted. Also, the words "indicator" and "meter" are synonymous. Specifications are summarized in Table 1.

## UNPACKING

The meter, detectors, and accessories are shipped in custom packing materials. All packing materials should be saved for future damage free shipments.

If using the AC battery charger, verify that the electrical outlet is compatible with the charger. When using a charger, the H410 will operate with or without batteries installed. However, if batteries are installed, they must have a minimum charge of approximately 1 hour before the H410 will turn on, even if the AC battery charger is used.

The H410 also runs off of four AA rechargeable batteries, which provide approximately 6 hours of usage before requiring recharge. To recharge the batteries, connect the charger to the power meter and the appropriate electrical outlet. Allow 16 to 20 hours for a full charge.

## Table 1. H410 Specifications

| **Model** | **Handheld: H410** | **H410D** |
|---|---|---|
| Display | 4 Digit LCD with analog indicator | 4 Digit backlight, LCD |
| Modes, Power or Energy | Pyroelectric: energy, average energy, power, statistics<br>Calorimeter: energy, power, calibration | Pyroelectric: energy, average energy, power, statistics<br>Calorimeter: energy, power, calibration |
| Pyroelectric Statistics Mode | Pulses collected, average energy, min energy, max energy, standard deviation, coefficient of variation | Pulses collected, average energy, min energy, max energy, standard deviation, coefficient of variation |
| For 25mm Calorimeters:<br>Power Full Scale Ranges<br>Energy Full Scale Ranges | <br>10mW, 100mW, 1W, 10W, Auto<br>10mJ, 100mJ, 1J, 10J | <br>10mW, 100mW, 1W, 10W, Auto<br>10mJ, 100mJ, 1J, 10J |
| For 50mm Calorimeters:<br>Power Full Scale Ranges<br>Energy Full Scale Ranges | <br>300mW, 3W, 30W, Auto<br>300mJ, 3J, 30J | <br>300mW, 3W, 30W, Auto<br>300mJ, 3J, 30J |
| For Pyroelectric Detectors:<br>Power Full Scale Ranges<br>Energy Full Scale Ranges | <br>3mW, 30mW, 300mW, 3W, Auto<br>3mJ, 30mJ, 300mJ, 3J | <br>3mW, 30mW, 300mW, 3W, Auto<br>3mJ, 30mJ, 300mJ, 3J |
| For HR Pyroelectric Detectors | Not supported | Not supported |
| For 100mm Calorimeter:<br>Use Interface Module, PN 10735<br><br>Use Interface Module, PN 10748 | <br>300mW, 3W, 30W, Auto or 300mJ, 3J, 30J<br>500mW, 5W, 50W, Auto or 1.5mJ, 15J, 150J | <br>300mW, 3W, 30W, Auto or 300mJ, 3J, 30J<br>500mW, 5W, 50W, Auto or 1.5mJ, 15J, 150J |
| For 200mm Calorimeter:<br>Use Interface Module, PN 10747<br><br>Use Interface Module, PN 10769 | <br>300mW, 3W, 30W, Auto or 300mJ, 3J, 30J<br>1W, 1W, 100 W, Auto or 3J, 30J, 300J | <br>300mW, 3W, 30W, Auto or 300mJ, 3J, 30J<br>1W, 1W, 100 W, Auto or 3J, 30J, 300J |
| Calorimeter max repetition rate, power mode | Unlimited | Unlimited |
| Calorimeter max repetition rate, energy mode | 1 pulse every 60 to 90 sec, calorimeter dependent | 1 pulse every 60 to 90 sec, calorimeter dependent |
| Pyroelectric, max repetition rate collecting data in statistics mode | 300 pps | 300 pps |
| Response time for calorimeter, power mode | 3-10 seconds depending on calorimeter | 3-10 seconds depending on calorimeter |
| Response time for calorimeter, energy mode | 1-3 seconds depending on calorimeter | 1-3 seconds depending on calorimeter |
| Operating temperature | 5 to 40 ºC | 5 to 40 ºC |
| Power Requirements | 120 Volts, 60 Hz ± 10 % or<br>220 Volts, 50 Hz ± 10 % | 120 Volts, 60 Hz ± 10 % or<br>220 Volts, 50 Hz ± 10 % |
| Rechargeable Batteries | 4 Ni-MH or NI-Cad, included | 4 Ni-MH or NI-Cad, included |
| Dimensions D x L, inches<br>cm | 8.25 x 4.0 x 1.5<br>20.96 x 10.16 x 3.81 | 8.25 x 4.0 x 1.5<br>20.96 x 10.16 x 3.81 |
| Weight, lbs<br>kg | 1.23<br>0.56 | 1.23<br>0.56 |
| Other Specs: | Stand option: VHSTAND | Stand option: VHSTAND |

## CHANGING OR INSTALLING BATTERIES

**Warning**: Use only Ni-MH or NI-Cad rechargeable batteries. If non-rechargeable batteries are used with the battery charger the batteries may burst and cause damage to you or the power meter.

**Note**: Dispose of used batteries according to local regulations.

To install batteries refer to Figure 2 and proceed as follows:

1. Loosen the screw holding the battery compartment cover.
2. Remove the old batteries if necessary.
3. Observing the polarity, install the new batteries.
4. Replace the cover and charge the batteries for 16 to 20 hours.

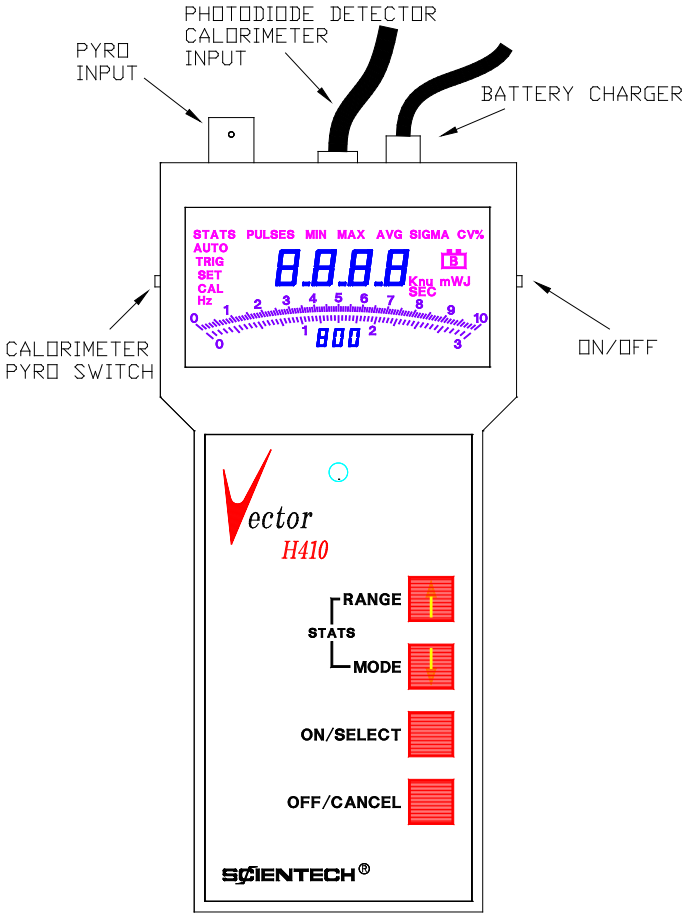



**Figure 1. H410 Meter Front**

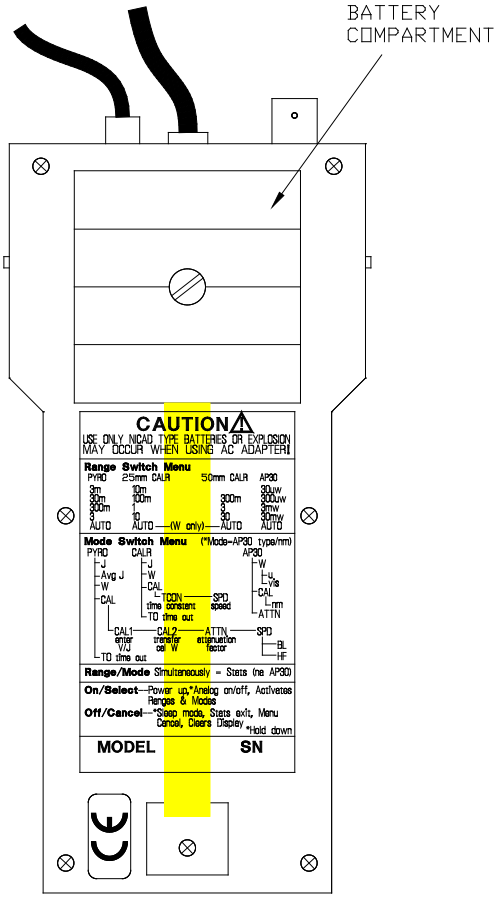



**Figure 2. H410 Meter Back**

## QUICK SETUP

**Note**: For detailed instructions for each type of detector, refer to the Operating Procedures section.

### 1. Turn On the Meter:

**Note**: For the most accurate measurements possible, the H410 should be turned on and warmed up for 30 minutes.

Slide the ON/OFF switch, located on the upper right side of the H410, to the ON position. The power meter will immediately turn on in the operational state last used. If you purchased the H410 with one detector, this detector's operating parameters will be in the power meter's memory and you are ready to take measurements.

If you purchased more than one detector with the H410, you must make sure the operating parameters for the detector you plan to use are in the power meter's memory. For detailed instructions please refer to the Operating Procedure section for that type of detector.

### 2. Turn the Analog Needle On or Off (does not apply to the H410D)

To turn the analog meter on or off, press and keep holding down the ON/SELECT button. Then release the button after the meter appears or disappears.

### 3. Zero the Analog Needle (does not apply to the H410D)

Refer to Figure 1. The black slotted button located just below the display allows screwdriver adjustment to set the analog needle to zero. This adjustment should be made before connecting the detector.

### 4. Connect a Detector

**Note**: Only one detector should be plugged in at any time.

Refer to Figure 1. Slide the CAL/PYRO switch, located on the upper left side of the H410, into the CAL (up) position for use with Vector calorimeters and photodiode detectors or into the PYRO (down) position for use with Vector pyroelectric detectors.

A 3 meter mini-DIN type cable with "D" shaped connectors comes with Vector and Large Aperture calorimeters and Scientech photodiode detectors. A 3 meter BNC type cable comes with Vector pyroelectric detectors. Plug in the detector's cable into the appropriate connector on the H410. Detectors have a 1/2" diameter mounting post hole for installing a detector post. Mounting bases and posts are available at Scientech to attach the detector to a working surface.

### 5. Select a Range

Press the RANGE button, the analog scale (if active) will disappear, then the H410 will begin cycling through the ranges available for the detector you have connected. Press the ON/SELECT button when the range you desire appears in the display.

### 6. Select a Mode

The MODE button allows selection of the type of measurement to be made (watts, joules, etc). The different modes available are:

When configured for a pyroelectric detector: **Energy (J), Avg. Energy (J AVG), Power (W)**, Configuration (CAL) and Time Out (tO).

When configured for a calorimeter: **Energy (J), Power (W)**, Configuration (CAL), Time Out (tO) and Calorimeter Delay (cd).

When configured for a photodiode detector: **Power (W)**, Configuration (CAL) and Attenuation (ATTN).

The preceding list of modes in bold type represents the measurement modes of the H410. These modes are discussed in this Quick Setup section. The modes in normal type allow you to customize the H410's set up for different detectors and are discussed in detail in the Operating Procedure section for each detector.

Press the MODE button to start the menu cycle. Press the ON/SELECT button when the measurement mode you desire appears in the display.

### 7. Zero the display

If you have chosen the calorimeter Power (W) mode or are using a photodiode detector you must zero the display by pressing the CANCEL button before any measurements are taken. It is not necessary to zero the display in any other mode of operation, but if you choose to do so no errors will be introduced.

### 8. Take your measurement

Direct the laser beam onto the absorbing surface of the detector.

# OPERATING PROCEDURES

## Using the H410 with Vector™ Pyroelectric Detectors

Pyroelectric detector models P25, P50, SP25 and SP50 are coated with a special black absorbing material which provides a very flat spectral response over a broad wavelength band. Pyroelectric detector models PHD25, PHDX25, PHDX25UV, PHD50, PHDX50, PHDX50UV, SPHD25, and SPHD50 are coated with a special high damage absorbing material which provides absorption over a broad wavelength band. Models PHF25, PHF50, SPHF25 and SPHF50 have a partially absorbing, partially reflecting chromium coating. The relative spectral responses of these detectors are shown in the following graph. Please be aware of the absorption differences between the detector's calibration wavelength and your operational wavelength. Detailed absorption information is contained in the charts at the end of this manual.

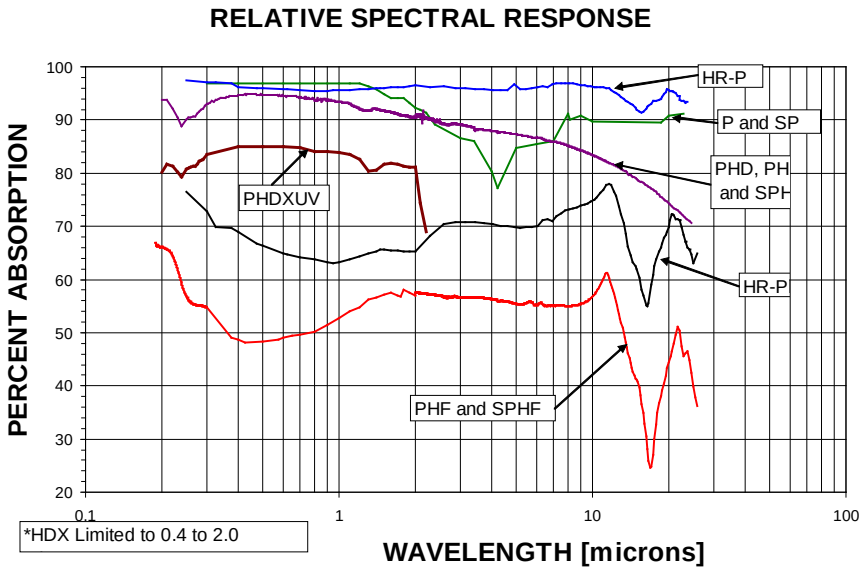



**Figure 3. Pyroelectric Detector Spectral Response**

Before using your Vector power meter, please review the energy density formulas given in the chart at the front of this manual. Familiarize yourself with all of the specifications of the detector models which you are using. A damage test slide is provided with each P and PHF type detectors, ***but not with PHD type detectors***. Fire the beam at the test slide before using the detector to be sure you are operating under safe conditions.

**Note**: The trigger threshold of the H410 is 7 % of full scale.

### 1. To Turn On the Meter

**Note**: For the most accurate measurements possible, the H410 should be turned on and warmed up for 30 minutes.

Slide the ON/OFF switch, located on the upper right side of the H410, to the ON position. The power meter will immediately turn on in the operational state last used. If you purchased the H410 with one detector, this detector's operating parameters will be in the power meter's memory and you are ready to take measurements.

If you purchased more than one detector with the H410, you must make sure the operating parameters for the detector you plan to use are in the power meter's memory. For detailed instructions please refer to the operating parameters listed on page 2 and the following procedure.

### 2. Turn the Analog Needle On or Off (does not apply to the H410D)

To turn the analog meter on or off, press and keep holding down the ON/SELECT button. Then release the button after the meter appears or disappears.

### 3. Zero the Analog Needle (does not apply to the H410D)

Refer to Figure 1. The black slotted button located just below the display allows screwdriver adjustment to set the analog needle to zero. This adjustment should be made before connecting the detector.

### 4. To Connect a Pyroelectric Detector

Only one detector should be plugged in at any time.

Refer to Figure 1. Slide the CAL/PYRO switch, located on the upper left side of the H410, to the PYRO (down) position. A 3 meter BNC type cable comes with Vector pyroelectric detectors. Connect the cable to the power meter's BNC connector.

### 5. To Configure the H410 for a Pyroelectric Detector

**Note**: Some of the menu selections are skipped in this section. They are discussed in detail in later sections.

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved they will be lost.

The operating parameters for the pyroelectric detector you are going to use must be entered into the H410's memory. First the output sensitivity of the detector's crystal is entered, then the speed, based of the detector's type of absorbing surface is entered.

To enter into the configuration mode:

A. Press the MODE button. A menu cycle of J, AVG J, W, CAL and tO will begin.

B. Press the ON/SELECT button when “CAL” appears. A menu cycle of CAL 1, CAL 2, Attn and SPd will begin.

C. Press the ON/SELECT button when “CAL 1” appears. The current V/J output sensitivity will be displayed and the “SET CAL” annunciator will flash.

D. Use the RANGE (count up) button to increase the value or the MODE (count down) to decrease the value to enter the V/J value listed on the pyroelectric detector’s serial tag.

E. Press the ON/SELECT button to exit this menu. The power meter will return to the last operational state.

F. Press the MODE button to return to the menu in step A.

G. Press the ON/SELECT button when “CAL” appears. A menu cycle of CAL 1, CAL 2, Attn and SPd will begin.

H. Press the ON/SELECT button when “SPd” appears. Choose between “hF” for high frequency absorbers and “bL” for black coated absorbers according to the Table 2 chart.

**Table 2. Mode Selection Criteria**

| Type of Absorber | Pyroelectric Detector Model Type | Speed Selection |
|---|---|---|
| Black Coated | P, SP, PHD and SPHD | bL |
| High Frequency | PHF and SPHF | hF |

I. Press the ON/SELECT button to select the appropriate “SPd” setting. The power meter will return to the last operational state.

J. Press and hold the OFF/CANCEL button until the display blanks to save the settings.

K. Press the ON/SELECT button to turn the H410 back on.

### 6. To Select a Range

**Note**: AUTO range may be selected if the energy levels of repetitive pulses are to be measured. However, *do not* select AUTO range if you want to measure single pulse energy or pulses running at repetition rates lower than 10 Hz.

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

A. Press the RANGE button. The analog scale (if active) will disappear and AUTO, 3m, 30m, 300m and 3 will cycle through the display.

B. To select a range, press the ON/SELECT button when the range you desire appears in the display. The H410 will return to the last operational state.

C. Press and hold the OFF/CANCEL button until the display blanks to save the setting.

C. Press the ON/SELECT button to turn the H410 back on.

### 7. To Select a Measurement Mode

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

Available measurement modes are:

Energy (J), Avg

Energy (J AVG), and

Power (W)

### 8. To Measure Energy (J)

**Note**: The update rate of the display is 20Hz.

The energy mode displays the energy of each pulse of a repetitively pulsed laser or a single pulse.

i. Press the MODE button to start the menu cycle of J, AVG J, W, CAL and tO.

ii. Press the ON/SELECT button when the J annunciator appears on the display.

iii. The energy level of each laser pulse will be displayed on the LCD.

iv. Press and hold the OFF/CANCEL button until the display blanks to save the setting.

v. Press the ON/SELECT button to turn the H410 back on.

### 9. To Measure Average Energy (J AVG)

**Note**: The maximum repetition rate for average energy is 300Hz.

The average energy mode displays an average of a selectable number of pulses from 2 to 9999.

i. Press the MODE button to start the menu cycle of J, AVG J, W, CAL and tO.

ii. Press the ON/SELECT button when the AVG J annunciators appear on the display. The number of pulses to be averaged will now appear in the display.

iii. To change the number of pulses to be averaged, press the RANGE (count up) and/or MODE (count down) buttons until the desired number of pulses to be averaged appears in the display.

iv. Press the ON/SELECT button to select the pulse population. The average energy of the number of pulses you selected will be displayed after the number of pulses entered in step iii is received by the pyroelectric detector. This is not a running average, but is the average for the pulse population selected in step iii. Nothing is displayed until the full pulse population is delivered. This average is displayed until another full population of pulses is delivered at which time the display is updated with the average for that population of pulses.

v. Press and hold the OFF/CANCEL until the display blanks to save the setting.

vi. Press the ON/SELECT button to turn the H410 back on.

### 10. To Measure Average Power (W)

**Note**: The maximum repetition rate for average power is 300Hz. The minimum repetition rate for average power is 10Hz.

**Note**: The average power mode displays the average power (watts) of repetitively pulsed lasers. Pyroelectric detectors will not work with continuous wave lasers.

The average power mode displays the average power of repetitively pulsed lasers.

i. Press the MODE button to start the menu cycle of J, AVG J, W, CAL and tO.

ii. Press the ON/SELECT button when the W annunciator appears on the display.

iii. The average power will be displayed.

iv. Press and hold the OFF/CANCEL until the display blanks to save the setting.

v. Press the ON/SELECT button to turn the H410 back on.

### 11. To Measure a Statistical Run of Energy Pulses

**Note**: Do not use AUTO range when making a statistical run.

**Note**: Do not go from the Average Power Mode to Stats since the range will be too high. Select the range manually.

**Note**: Each time a new stats run begins, data from the previous run is lost.

**Note**: To exit the statistical mode at any time, press the OFF/CANCEL button.

**Note**: Statistics mode can collect data at repetition rates of up to 300 Hz depending on the detector model.

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved they will be lost.

The statistics mode will collect data on a pulse population of up to 1000 pulses. At your prompting, the power meter will display the number of pulses delivered, average energy, minimum energy, maximum energy, standard deviation, and coefficient of variation. When the statistics mode is selected, the energy mode is automatically activated regardless of the mode previously selected. Select the appropriate range for the pulse energy level to be measured. It is very important to select the most appropriate range. If you have selected a manual range and the laser pulse(s) has overflowed the maximum energy of the range, OF will be displayed when the data is recalled. You should then select a higher range.

To enter into the statistics mode:

A. Press the RANGE and MODE buttons simultaneously. The number of pulses in the last statistics run and a flashing SET annunciator will appear in the display.

B. Use the RANGE (count up) and MODE (count down) buttons to change the display to the desired number of pulses to include in the statistics run (up to 1000).

C. Press the SELECT button to enter the pulse population to memory. The display will blank and a flashing STATS annunciator will appear.

D. Press the MODE button to begin the run. The STATS annunciator will stop flashing. The power meter will automatically stop once the data has been collected.

D. Press the ON/SELECT button to recall the data to the display one item at a time. Each time the ON/SELECT button is pressed the following statistical calculations will be sequentially displayed:

Number of pulses collected

Average energy (AVG)

Minimum energy (MIN)

Maximum energy (MAX)

Standard deviation (SIGMA)

Coefficient of variation (CV%)

F. Press the ON/SELECT button one more time to return to step D for a new stats run. The flashing STATS annunciator indicates that the H410 is ready for a new run. Each time a new run begins the data from the previous run is lost.

G. Press the OFF/CANCEL button to return the power meter to the mode of operation in effect prior to statistics mode.

H. Press and hold the OFF/CANCEL until the display blanks to save the setting.

I. Press the ON/SELECT button to turn the H410 back on.

**12. To Perform a Transfer Calibration**

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved they will be lost.

You can transfer a calibration from a calorimeter to a Vector pyroelectric detector using the Transfer Calibration function of the H410. This function allows adjustment of the output sensitivity of your Vector pyroelectric detector in combination with your H410 meter in order to match the average power reading from the H410 to that of a NIST certified system. Typically, a 50/50 beam splitter is used with the Vector pyroelectric detector to be calibrated in one beam path and the NIST certified calorimeter in the other beam path.

To enter into the transfer calibration mode:

A. Press the MODE button to start a menu cycle of J, AVG J, W, CAL and tO.

B. Press the ON/SELECT button when the CAL annunciator appears. A second menu cycle of CAL 1, CAL 2, Attn and SPd will start.

C. Press the ON/SELECT button when the CAL 2 annunciator appears. The average power (W) mode will automatically be selected and SET CAL will flash.

D. Direct the laser beam through the calibrated beam splitter onto both the pyroelectric detector and the calorimeter transfer standard.

E. Adjust the power reading of the H410 by using the RANGE (count up) and MODE (count down) buttons to agree with the transfer standard.

F. Press the ON/SELECT button. The power meter is now calibrated and will return to the last operational state.

G. Press and hold the OFF/CANCEL until the display blanks to save the setting.

H. Press the ON/SELECT button to turn the H410 back on.

## 13. Attenuation Factors

**Note**: You must enter an attenuation factor of 1.0 when not using an attenuator.

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

The attenuation factors of optics can be entered into the H410 so the displayed value will automatically compensate for the amount of attenuation. For example, assume a beam splitter is being used that transmits 75% and reflects 25% of the beam. If the H410 is set up to measure the reflected beam the attenuation could be set up as follows:

- An attenuation factor of 1 would display the value of the reflected beam.
- An attenuation factor of 3 would display the value of the transmitted beam.
- An attenuation factor of 4 would display the value of the source.

To enter into the attenuation factor mode:

A. Press the MODE button to start a menu cycle of J, AVG J, W, CAL and tO.

B. Press the ON/SELECT button when the CAL annunciator appears. A second menu cycle of CAL 1, CAL 2, Attn and SPd will start.

C. Press the ON/SELECT button when the Attn annunciator appears. The current attenuation factor will be displayed and SET will flash.

D. Press the RANGE (count up) and MODE (count down) buttons to change the attenuation factor to the desired value. Values of 0.01 to 99.99 may be selected.

E. Press the ON/SELECT button. The attenuation factor is now active and the power meter will return to the last operational state.

F. Press and hold the OFF/CANCEL until the display blanks to save the setting.

G. Press the ON/SELECT button to turn the H410 back on.

**14. Time Out**

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved they will be lost.

**Note**: The time out default setting is 10 minutes.

The time out feature conserves battery power by putting the H410 to sleep if there is no input from a detector after a selected period of time. To awaken the H410 once it is in the sleep mode press the ON/SELECT button.

To enter into the time out mode:

A. Press the MODE button to start a menu cycle of J, AVG J, W, CAL and tO.

B. Press the ON/SELECT button when the tO annunciator appears. The current time out setting will be displayed and SET will flash.

E. Press the RANGE (count up) and MODE (count down) buttons to change the desired number of minutes, from 1 to 9999.

D. Press the ON/SELECT button. The time out setting is now active and the power meter will return to the last operational state.

E. Press and hold the OFF/CANCEL until the display blanks to save the setting.

E. Press the ON/SELECT button to turn the H410 back on.

## Correcting Pyroelectric Detector Operating Parameters for Use at Different Wavelengths

**Note**: Due to variability in the manufacturing process the absorption characteristics of the HD and P model detectors can vary in the UV region (190 to 400nm). Scientech recommends optical calibration at 266nm if the detector is to be used in the UV region instead of relying on an absorption rate in the chart at the end of this manual.

All pyroelectric detectors are calibrated at a specific wavelength and the detector's output sensitivity is derived for that wavelength. The output sensitivity and calibration wavelength is recorded in the

Operating Parameters section at the front of the manual and on the detector's serial tag. When a pyroelectric detector is used at a wavelength other than the calibration wavelength, its output sensitivity can be adjusted to compensate for the absorption rate at the new wavelength. The new output sensitivity is calculated as follows:

1. Find the absorption rate from the chart at the end of this manual for the calibration wavelength of your pyroelectric detector.
2. Find the absorption rate for the wavelength where you will be working.
3. Determine the new output sensitivity using the following formula:

$$\left[\frac{\text{absorption rate of new wavelength}}{\text{absorption rate of calibration wavelength}}\right] \times \text{output sensitivity (V/J)} = \left[\begin{array}{l}\text{output sensitivity for new}\\ \text{wavelength from serial tag}\end{array}\right]$$

This new output sensitivity can be entered into the H410 as described in Group Settings or when using the pyroelectric detector without a H410 power meter as discussed later in this manual.

## Using the H410 with Vector™ Series Calorimeter

The calorimeter selected needs to be the appropriate model for the planned laser measurements. Please familiarize yourself with the operating specifications which are provided in the Vector™ Calorimeter Operating Manual.

**Note**: Vector™ calorimeters are sensitive to all types of thermal input. Due to the handling of the calorimeter during setup and possible environmental temperature differences, thermal gradients may exist in the calorimeter. Allow the calorimeter to sit undisturbed for several minutes to, reach thermal equilibrium, before using.

**Note**: When using a 25mm Vector™ calorimeter for measuring average power levels below 30mW and single pulse energy levels below 30mJ, a Scientech Model 360203A, Isoperibol Enclosure, is highly recommended. The isoperibol enclosure should not be used at average power levels above 30mW, and single pulse energy levels above 100mJ because heat build-up will occur.

**Note**: Large Aperture calorimeters and the Interface Modules that they are calibrated with are matched sets and must be used together.

### 1. To Turn On the Meter

**Note**: For the most accurate measurements possible, the H410 should be turned on and warmed up for 30 minutes.

Slide the ON/OFF switch, located on the upper right side of the H410, to the ON position. The power meter will immediately turn on in the operational state last used. If you purchased the H410 with one detector, this detector's operating parameters will be in the power meter's memory and you are ready to take measurements.

If you purchased more than one detector with the H410, you must make sure the operating parameters for the detector you plan to use are in the power meter's memory. For detailed instructions please refer to the operating parameters listed on page 2 and the following procedure.

### 2. Turn the Analog Needle On or Off (does not apply to the H410D)

To turn the analog meter on or off, press and keep holding down the ON/SELECT button. Then release the button after the meter appears or disappears.

### 3. Zero the Analog Needle (does not apply to the H410D)

Refer to Figure 1. The black slotted button located just below the display allows screwdriver adjustment to set the analog needle to zero. This adjustment should be made before connecting the detector.

### 4. To Connect a Calorimeter

Only one detector should be plugged in at any time. Refer to Figure 1. Slide the CAL/PYRO switch, located on the upper left side of the H410, to the CAL (up) position. A 3 meter mini DIN type cable comes with Vector calorimeters. For large aperture calorimeters the interconnect cables for both the calorimeter and the power meter are hard wired to the interface module. Connect the cable(s) to the detector and the power meter's mini DIN connector.

### 5. To Configure the H410 for a Calorimeter

**Note**: Some of the menu selections are skipped in this section. They are discussed in detail in later sections.

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

The operating parameters for the calorimeter you are going to use must be entered into the H410's memory.

To enter into the configuration mode:

A. Press the MODE button. A menu cycle of J, W, CAL, tO and cd will begin.

B. Press the ON/SELECT button when “CAL” appears. A menu cycle of tCon, SPd and Attn will begin.

C. Press the ON/SELECT button when “tCon” appears. The current time constant value will be displayed and the “SET CAL” annunciator will flash. The time constant is a measure of the length of time the calorimeter takes to respond to a laser beam.

   Use the RANGE (count up) button to increase the value or the MODE (count down) to decrease the value. Enter the time constant value listed on the serial tag of your calorimeter or interface module for large aperture calorimeters.

D. Press the ON/SELECT button. The time constant is now active and the power meter will return to the last operational state.

E. Press the MODE button to return to the menu in step A.

F. Press the ON/SELECT button when “CAL” appears. A menu cycle of tCon, SPd and Attn will begin.

G. Press the ON/SELECT button when “SPd” appears. The current speed up value will be displayed and the “SET CAL” annunciator will flash. The speed up setting allows you to control the power meter’s display rate. The best value will cause a slight overshoot then a quick settling on the final value. Too high of a setting will cause the display to overshoot then slowly drift back down to the final value. A slow setting will cause the display to slowly count up to the final value.

   Use the RANGE (count up) button to increase the value or the MODE (count down) to decrease the value. Enter the appropriate speed value from the following table.

| | |
|---|---|
| AC2500 | 103.0 |
| AC2501, AC25HD, ACX2501, AC25UV, AC2504, AC25FX, ACX25HD, ACX25FX | 136.0 |
| AC5000 | 100.0 |
| AC5001, AC50HD, ACX5001, AC50UV, AC5004, AC50FX, ACX50HD, ACX50FX | 120.0 |

| | |
|---|---|
| 360401 with interface module | 150.0 |
| 380401, 380402, 384UV5 with interface module | 245.0 |
| 360801 with interface module | 170.0 |
| 380801, 380802, 388UV5 with interface module | 280.0 |

H Press the ON/SELECT button. The speed setting is now active and the power meter will return to the operational state last used.

I. Press the MODE button. A menu cycle of J, W, CAL, tO and cd will begin.

J. Press the ON/SELECT button when the cd annunciator is displayed. The current calorimeter delay setting is displayed and the SET annunciator flashes. The calorimeter delay feature prohibits the display of energy if a pulse is fired before the entered time (1 to 255 seconds) elapses. The calorimeter must reach environmental thermal equilibrium before a subsequent pulse is fired or low energy measurements will occur.

To set the time delay between pulses use the count up (RANGE) and count down buttons (MODE) buttons to enter the time in seconds. Press the SELECT button after the time has been entered to save the setting. The following time delays are recommended:

| | |
|---|---|
| AC2500, AC25FX, ACX25FX, ACX25HD | 60 seconds |
| AC2501, AC25HD, AC25UV, AC2504 | 60 seconds |
| AC5000, AC50FX, ACX50FX, ACX50HD | 90 seconds |
| AC5001, AC50HD, AC50UV, AC5004 | 90 seconds |
| 360401 with interface module | 105 seconds |
| 380401, 380402, 384UV5 with interface module | 180 seconds |
| 360801 with interface module | 125 seconds |
| 380801, 380802, 388UV5 with interface module | 200 seconds |

**Note**: Make sure the calorimeter delay is less than the time out setting you will make in section 10.

K. Press and hold the OFF/CANCEL button until the display blanks to save the settings.

L. Press the ON/SELECT button to turn the H410 back on.

### 6. To Select a Range

**Note**: AUTO range is not available in the energy mode for calorimeters.

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

A. Press the RANGE button. The analog scale (if active) will disappear and the available ranges will cycle through the display. The ranges available for calorimeters are in Table 3.

**Table 3. H410 Ranges for Calorimeters**

| Model | Vector 25mm | | Vector 50mm | | Vector Large Aperture 100mm with PN10735 Interface Module* | | Vector Large Aperture 200mm with PN10747 Interface Module** | |
|---|---|---|---|---|---|---|---|---|
| Mode | Power | Energy | Power | Energy | Power | Energy | Power | Energy |
| Range | 10mW<br>100mW<br>1W<br>10W<br>AUTO | 10mJ<br>100mJ<br>1J<br>10J | 300mW<br>3W<br>30W<br>AUTO | 300mJ<br>3J<br>30J | 300mW<br>3W<br>30W<br>AUTO | 300mJ<br>3J<br>30J | 300mW<br>3W<br>30W<br>AUTO | 300mJ<br>3J<br>30J |

* With a PN10748 – 10X attenuator, the actual power or energy is 10 times the displayed value up to 50 W or 150J.

** With a PN10769 – 10X attenuator, the actual power or energy is 10 times the displayed value up to 100 W or 300 J.

B. To select a range, press the ON/SELECT button when the range you desire appears in the display. The selected range will be activated and the H410 will return to the last operational state.

C. Press and hold the OFF/CANCEL button until the display blanks to save the settings.

D. Press the ON/SELECT button to turn the H410 back on.

**Note**: When using PN10748 or PN10769, 10X attenuators, you may want to use an attenuation factor of 10 so the displayed reading on the H410 is correct. However, the range designation may be incorrect if

the power or energy reading exceeds the upper limit of the range. See the Group Settings section for details.

### 7. To Select a Measurement Mode

The modes available for the calorimeters are: Energy (J) and Power (W).

### 8. To Measure Energy (J)

**Note**: Calorimeters can only measure single shot energy pulses with the time between pulses dependent on the calorimeter delay setting from section 5J. With the calorimeter delay entered, the H410 will display the "trig" annunciator and the single pulse energy after the first pulse is delivered. The "trig" annunciator will then disappear after the calorimeter delay time has elapsed prompting you to fire another pulse. Do not fire another pulse until the “trig” annunciator disappears. If you do, the H410 resets the time delay and ignores the sequential pulse altogether.

**Note**: Make sure the calorimeter delay, set in section 5J, is shorter that the time out set in section 10. If not the H410 will go into sleep mode before the pulse energy is displayed.

i. Press the MODE button. A menu cycle of J, W, CAL, tO and cd will begin.
ii. Press the ON/SELECT button when the J annunciator appears and the joules mode will be activated.
iii. The energy level of each laser pulse will be displayed.

### 9. To Measure Power (W)

**Note**: The speed-up circuit is not active in AUTO range.

The average power mode displays the average power (watts) of repetitively pulsed lasers or continuous wave lasers.

i. Press the MODE button. A menu cycle of J, W, CAL, tO and cd will begin.
ii. Press the ON/SELECT button when the W annunciator appears and the watts mode will be activated.
iii. Press the CANCEL button to zero the display.
iv. The power will be displayed.

### 10. To Measure a Statistical Run of Single Shot Energy Pulses

**Note**: Calorimeters can only measure single shot energy pulses (time between pulses is dependent on the calorimeter delay from section 5J). With the calorimeter delay entered, the H410 will display the "trig" annunciator and the single pulse energy after the first pulse is delivered. The "trig" annunciator will then disappear after the calorimeter delay time has elapsed prompting you to fire another pulse. Do not fire another pulse until the “trig” annunciator disappears. If you do, the H410 resets the time delay and ignores the sequential pulse altogether.

**Note**: Make sure the calorimeter delay, set in section 5J, is shorter that the time out set in section 10. If not the H410 will go into sleep mode before the pulse energy is displayed.

**Note**: Do not use AUTO range when making a statistical run.

**Note**: Do not go from the Average Power Mode to Stats since the range will be too high. Select the range manually.

**Note**: Each time a new stats run begins, data from the previous run is lost.

**Note**: To exit the statistical mode at any time, press the OFF/CANCEL button.

The statistics mode will collect data on a pulse population of up to 1000 pulses. At your prompting, the power meter will display the number of pulses delivered, average energy, minimum energy, maximum energy, standard deviation, and coefficient of variation. When the statistics mode is selected, the energy mode is automatically activated regardless of the mode previously selected. Select the appropriate range for the pulse energy level to be measured. It is very important to select the most appropriate range. If you have selected a manual range and the laser pulse(s) has overflowed the maximum energy of the range, OF will be displayed when the data is recalled. You should then select a higher range.

To enter into the statistics mode:

A. Press the RANGE and MODE buttons simultaneously. The number of pulses in the last statistics run will appear in the display and the SET annunciator will flash.

B. Use the RANGE (count up) and MODE (count down) buttons to change the display to the desired number of pulses to include in the statistics run (up to 1000).

C. Press the ON/SELECT button to enter the pulse population to memory. The display will blank and the STATS annunciator will flash.

D. Press the MODE button to begin the run. The STATS annunciator will stop flashing and the power meter will automatically stop once the data has been collected.

E. Press the ON/SELECT button to recall the data to the display one item at a time. Each time the ON/SELECT button is pressed the following statistical calculations will be sequentially displayed:

Number of pulses collected

Average energy (AVG)

Minimum energy (MIN)

Maximum energy (MAX)

Standard deviation (SIGMA)

Coefficient of variation (CV%)

F. Press the ON/SELECT button one more time to return to step D to begin a new stats run. The flashing STATS annunciator indicates that the H410 is ready for a new run. Each time a new run begins the data from the previous run is lost.

G. Press the OFF/CANCEL button to return the power meter to the mode of operation in effect prior to statistics mode.

H. Press and hold the OFF/CANCEL button until the display blanks to save the settings.

H. Press the ON/SELECT button to turn the H410 back on.

### 11. Attenuation Factors

**Note**: You must enter an attenuation factor of 1.0 when not using an attenuator.

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

The attenuation factors of optics can be entered into the H410 so the displayed value will automatically compensate for the amount of attenuation. For example, assume a beam splitter is being used that transmits 75% and reflects 25% of the beam. If the H410 is set up to measure the reflected beam the attenuation could be set up as follows:

- An attenuation factor of 1 would display the value of the reflected beam.
- An attenuation factor of 3 would display the value of the transmitted beam.

- An attenuation factor of 4 would display the value of the source.

To enter into the attenuation factor mode:

A. Press the MODE button to start a menu cycle of J, W, CAL and tO and cd.

B. Press the ON/SELECT button when the CAL annunciator appears. A second menu cycle of tCon, SPd and Attn will start.

C. Press the ON/SELECT button when the Attn annunciator appears. The current attenuation factor will be displayed and SET will flash.

D. Press the RANGE (count up) and MODE (count down) buttons to change the attenuation factor to the desired value. Values of 0.01 to 99.99 may be selected.

E. Press the ON/SELECT button. The attenuation factor is now active and the power meter will return to the last operational state.

F. Press and hold the OFF/CANCEL until the display blanks to save the setting.

G. Press the ON/SELECT button to turn the H410 back on.

Attenuation factors can also be used to enable the H410 to display the correct reading when HD and HDX calorimeters are used with wavelengths other than their calibration wavelength. See the discussion at the beginning of this section for details.

**12. Time Out**

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

**Note**: The time out default is 10 minutes.

The time out feature conserves battery power by putting the H410 to sleep if there is no input from a detector after a selected period of time. To awaken the H410 once it is in the sleep mode press the ON/SELECT button.

To enter into the time out mode:

A. Press the MODE button to start a menu cycle of J, W, CAL, tO and cd.
B. Press the ON/SELECT button when the tO annunciator appears. The current time out setting will be displayed and SET will flash.
C. Press the RANGE (count up) and MODE (count down) buttons to change the desired number of minutes, from 1 to 9999.
D. Press the ON/SELECT button. The time out setting is now active and the power meter will return to the last operational state.
E. Press and hold the OFF/CANCEL until the display blanks to save the setting.
F. Press the ON/SELECT button to turn the H410 back on.

## Correcting FX Calorimeters Operating Parameters for Use at Different Wavelengths

**Note**: Due to variability in the manufacturing process the absorption characteristics of the HD and P model detectors can vary in the UV region (190 to 400nm). Scientech recommends optical calibration at 266nm if the detector is to be used in the UV region instead of relying on an absorption rate in the chart at the end of this manual.

Scientech calorimeters in general have a flat response to all wavelengths within their specified spectral response. FX and FXX calorimeters are an exception to that rule and are calibrated at a specific wavelength by adjusting the calorimeter's gain circuitry for that wavelength. The calibration wavelength is recorded in the Operating Parameters section at the front of the manual and on the detector's serial tag. When a FX or FXX calorimeter is used at a wavelength other than the calibration wavelength, the power meter's displayed value can be adjusted to compensate for the absorption rate at the new wavelength by using an attenuation factor. The attenuation factor is calculated as follows:

1. Find the absorption rate from the chart at the end of this manual for the calibration wavelength of your calorimeter.

2. Find the absorption rate for the wavelength where you will be working.

3. Determine the attenuation factor using the following formula:

$$\frac{\text{absorption rate of calibration wavelength}}{\text{absorption rate of the new wavelength}} = \text{attenuation factor}$$

The attenuation factor can be entered into the H410 as described in step 9.

## Using the H410 with Scientech Photodiode Detectors

Be sure the photodiode detector is appropriate for the laser measurements you plan to make. Please familiarize yourself with the detector's operation specifications before you use it.

**Note**: Photodiode detectors can only be used to measure continuous wave lasers.

### 1. To Turn On the Meter

**Note**: For the most accurate measurements possible, the H410 should be turned on and warmed up for 30 minutes.

Slide the ON/OFF switch, located on the upper right side of the H410, to the ON position. The power meter will immediately turn on in the operational state last used. If you purchased the H410 with one detector, this detector's operating parameters will be in the power meter's memory and you are ready to take measurements.

If you purchased more than one detector with the H410, you must make sure the operating parameters for the detector you plan to use are in the power meter's memory. For detailed instructions please refer to the operating parameters listed on page 2 and the following procedure.

### 2. Turn the Analog Needle On or Off (does not apply to the H410D)

To turn the analog meter on or off, press and keep holding down the ON/SELECT button. Then release the button after the meter appears or disappears.

### 3. Zero the Analog Needle (does not apply to the H410D):

Refer to Figure 1. The black slotted button located just below the display allows screwdriver adjustment to set the analog needle to zero. This adjustment should be made before connecting the detector.

### 4. To Connect a Photodiode Detector

Only one detector should be plugged in at any time.

Refer to Figure 1. Slide the CAL/PYRO switch, located on the upper left side of the H410, to the CAL (up) position. A 3 meter mini DIN type cable comes with Scientech photodiode detectors. Connect the cable to the power meter's mini DIN connector.

### 5. To Configure the H410 for a Photodiode Detector

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

To enter into the configuration mode:

A. Press the MODE button. A menu cycle of W, CAL and Attn will begin.

B. Press the ON/SELECT button when W appears. A menu cycle of U and UIS will begin. Choose U (ultraviolet) for the model AP30UV or UIS (visible) for the model AP30.

C. Press the ON/SELECT button when the appropriate option is in the display. The H410 is now configured for the chosen photodiode detector and will return to the last operational state.

D. Press and hold the OFF/CANCEL until the display blanks to save the setting.

A. Press the ON/SELECT button to turn the H410 back on.

### 6. To Select a Wavelength

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

To enter into the wavelength selection mode:

A. Press the MODE button. A menu cycle of W, CAL and Attn will begin.

B. Press the ON/SELECT button when CAL appears. The current wavelength is displayed and the SET annunciator is flashing.

D. Use the RANGE (count up) and MODE (count down) buttons to change the display (in 1 nm increments) to the desired wavelength. The available wavelengths are as follows:

200 nm to 1100 nm for Model AP30UV

400 nm to 1100 nm for Model AP30

D. Press the ON/SELECT button. The new wavelength setting is now active and the H410 will return to the last operational state.

E. Press and hold the OFF/CANCEL until the display blanks to save the setting.

B. Press the ON/SELECT button to turn the H410 back on.

**7. To Select a Range**

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

A. Press the RANGE button. The analog scale (if active) will disappear and AUTO, 30μW, 300 μW, 3mW and 30mW will cycle through the display.

B. Press the ON/SELECT button when the range you desire appears in the display. The selected range is activated and the H410 will return to the last operational state.

C. Press and hold the OFF/CANCEL button until the display blanks to save the setting.

D. Press the ON/SELECT button to turn the H410 back on.

**8. To Zero the Display**

A. Press the CANCEL button before the photodiode is lased.

## 9. Attenuation Factors

**Note**: You must enter an attenuation factor of 1.0 when not using an attenuator.

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

The attenuation factors of optics can be entered into the H410 so the displayed value will automatically compensate for the amount of attenuation. For example, assume a beam splitter is being used that transmits 75% and reflects 25% of the beam. If the H410 is set up to measure the reflected beam the attenuation could be set up as follows:

- An attenuation factor of 1 would display the value of the reflected beam.
- An attenuation factor of 3 would display the value of the transmitted beam.
- An attenuation factor of 4 would display the value of the source.

To enter into the attenuation factor mode:

A. Press the MODE button to start a menu cycle of W, CAL and Attn.

B. Press the ON/SELECT button when the Attn annunciator appears. The current attenuation factor will be displayed and SET will flash.

C. Press the RANGE (count up) and MODE (count down) buttons to change the attenuation factor to the desired value. Values of 0.01 to 99.99 may be selected.

D. Press the ON/SELECT button. The attenuation factor is now active and the power meter will return to the last operational state.

E. Press and hold the OFF/CANCEL until the display blanks to save the setting.

C. Press the ON/SELECT button to turn the H410 back on.

### 10. Time Out

**Note**: You must save all settings by pressing and holding the OFF/CANCEL button until the display blanks. If the H410 is turned off, by using the ON/OFF slide switch, before settings are saved, they will be lost.

**Note**: The time out default is 10 minutes.

The time out feature conserves battery power by putting the H410 to sleep if there is no input from a detector after a selected period of time. To awaken the H410 once it is in the sleep mode press the ON/SELECT button.

To enter into the time out mode:

A. Press the MODE button to start a menu cycle of J, AVG J, W, CAL and tO.

B. Press the ON/SELECT button when the tO annunciator appears. The current time out setting will be displayed and SET will flash.

C. Press the RANGE (count up) and MODE (count down) buttons to change the desired number of minutes, from 1 to 9999.

D. Press the ON/SELECT button. The time out setting is now active and the power meter will return to the last operational state.

E. Press and hold the OFF/CANCEL until the display blanks to save the setting.

F. Press the ON/SELECT button to turn the H410 back on.

# CALIBRATION OF VECTOR™ CALORIMETERS

## Calibration of 25mm & 50mm Vector™ Calorimeters Using Electric Substitution Heating

For Vector calorimeters the electric substitution heating option must be ordered and installed at the factory when the calorimeter is purchased. It can not be retrofitted to a calorimeter at a later time. To calibrate using electric substitution heating proceed as follows.

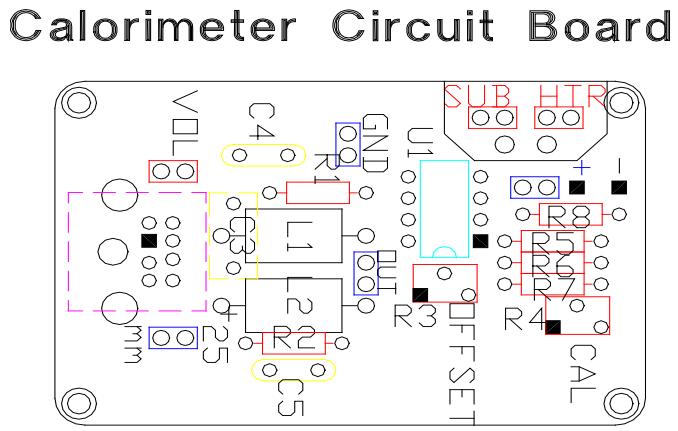



**Figure 4. Vector Calorimeter Circuit Board**

A. Remove the screws holding the calorimeter's ID tag and remove the plate to expose the circuit board as shown in Figure 4.

B. Connect the calorimeter to the power meter, turn on the power and let the system equilibrate.

C. Connect a DVM to the test points labeled SUB and HTR on the calorimeter circuit board.

D. Measure the resistance of the substitution heater making sure to subtract the resistance of the patch cables from the total resistance measurement. Compare this resistance to $R_C$ in the calibration data in the front of the manual. The two should agree within 2%. If not contact Scientech.

E. Remove the DVM. Connect a power supply to the SUB and HTR test points and connect the DVM to monitor the power supply.

F. Set up the power meter in the Watts Mode and the 10W range for 25 mm calorimeters or the 3W range for 50 mm calorimeters.

G. Apply $V_h$ volts, stated in the calibration data you received with the calorimeter, to the substitution heater.

H. If needed, adjust the calibration trim pot, R4 on the calorimeter circuit board, until $W_h$ Watts, from the calibration data, is displayed by the power meter.

## Calibration of Large Aperture Calorimeters Using Electric Substitution Heating

Electrical substitution heating is a standard feature of large aperture calorimeters.

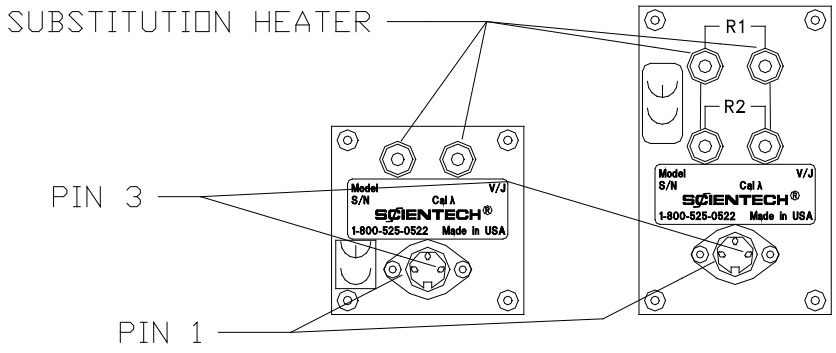



**Figure 5. 100 & 200 mm Calorimeter Connector Panel**

## Calibration with an Interface Module and H410 Power Meter

A. Connect a DVM to the white jacks of the calorimeter. Refer to Figure 5.

B. Measure the resistance of the substitution heater making sure to subtract the resistance of the patch cables from the total resistance measurement.

**Note**: When measuring the substitution heater resistance of a 200 mm calorimeter, R1 and R2 must be connected together in series.

Compare this resistance to $R_c$ in the calibration data in the front of the manual. The two should agree within 2%. If not, contact Scientech.

C. Remove the DVM. Connect a power supply to the white jacks and connect the DVM to monitor the power supply.

D. Set up the power meter in the Watts Mode and the 30W range.

E. Remove the screws holding the interface module's ID tag and remove the plate to expose the circuit board. Refer to Figure 4.

F. Apply $V_h$ volts, stated in the calibration data you received with the calorimeter, to the substitution heater.

G. If needed, adjust the calibration trim pot, R4 on the calorimeter circuit board, until $W_h$ Watts, from the calibration data, is displayed by the power meter.

## Calibration without an Interface Module and H410 Power Meter

**Note**: Whenever a large aperture calorimeter is used without an power meter the interface module is not used.

For this procedure you will need to make an adapter cable to go from the calorimeter's DIN connector to the DVM. The voltage output is on pin 1 of the DIN connector and should be connected to the positive side of the DVM. Ground is on pin 3 and should be connected to the negative side. Pin 2 is not used. Refer to Figure 5.

A. Connect a DVM to the white jacks of the calorimeter. Refer to Figure 5.

B. Measure the resistance of the substitution heater making sure to subtract the resistance of the patch cables from the total resistance measurement.

**Note**: When measuring the substitution heater resistance of a 200 mm calorimeter, R1 and R2 must be connected together in series.

Compare this resistance to $R_C$ in the calibration data in the front of the manual. The two should agree within 2%. If not, contact Scientech.

C. Calculate the voltage equivalent to laser power using the following formula:

$$\mathbf{V = (R_c \times C \times W)^{1/2}}$$

where:

V = voltage applied to the heater coil

$R_c$ = substitution heater resistance from step B

C = Cal coefficient

| | |
|---|---|
| 360401 = 1.018 | 360801 = 1.000 |
| 380401 = 0.974 | 380801 = 1.008 |
| 380402 = 1.024 | 380802 = 1.008 |
| 384UV5 = 1.021 | 388UV5 = 1.002 |

W = desired laser power in watts

D. Connect the DVM to the calorimeter's DIN connector.

E. Apply the calculated voltage (V) to the electrical substitution heater.

F. Record the voltage reading of the DVM ($V_c$).

G. Calculate the calorimeter's output sensitivity (S) as follows:

$$\mathbf{S = V_c/W}$$

where:

S = calorimeter's output sensitivity

$V_c$ = voltage output from the calorimeter in mV

W = desired laser power output.

The measured sensitivity should be ± 3 % of the calorimeter's original sensitivity value.

# DETECTOR OPERATION WITHOUT A POWER METER

## Pyroelectric Detectors

### Standard and SP Models:

Pyroelectric detectors can be operated with a 1MΩ input oscilloscope. The peak voltage shown on the oscilloscope can be divided by the V/J output sensitivity of the detector to calculate energy.

## Vector™ Calorimeters

### Cable Requirements

Vector calorimeters are powered up by the power meter. To use a Vector calorimeter without a Scientech power meter, but with a volt meter or chart recorder, you must apply +/-8VDC to the mini DIN connector as shown in Figure 6. The voltage output of the calorimeter, from pin 8, should be connected to the positive side of the DVM or chart recorder. All 3 of the grounds should be tied together at the negative side. Pins 2 and 3 are not used.

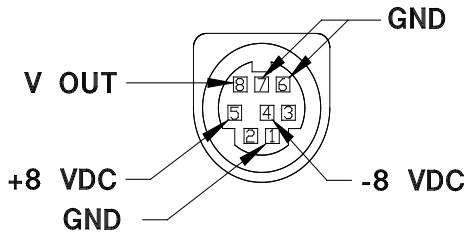



**Figure 6. Calorimeter Output Pin Configuration**

When large aperture calorimeters are used without an power meter their interface module is not used. The output of the calorimeter is connected directly to the DVM or chart recorder. Large aperture calorimeters do not require any power. The voltage output is on pin 1 of the DIN connector and should be connected to the positive side of the DVM or chart recorder. Ground is on pin 3 and should be connected to the negative side. Pin 2 is not used. Refer to Figure 5.

## OPERATION OF VECTOR™ AND LARGE APERTURE CALORIMETERS WITH A DIGITAL VOLT METER

**Note**: Whenever a large aperture calorimeter is used without a power meter the interface module is not used.

The calorimeters may be used with any digital volt meter (DVM) capable of reading 5 volts full scale.

A. Connect the output of the calorimeter to the DVM.

B. Select the DC volts mode.

C. Direct the laser beam on to the absorbing surface of the calorimeter.

D. When the display of the DVM has stabilized (about 2 minutes), calculate the laser power using the formula:

**W = V/S**

where:

W = Laser power in watts

V = Voltage reading of the DVM in volts

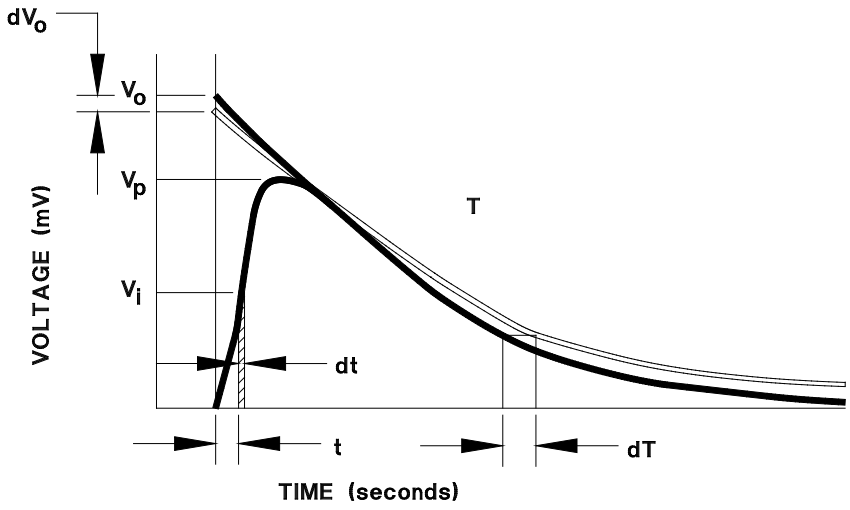
S = Sensitivity of the calorimeter

## OPERATION OF VECTOR™ AND LARGE APERTURE CALORIMETERS WITH AN ANALOG RECORDER

**Note:** Whenever a large aperture calorimeter is used without an indicator the interface module is not used.

**Calorimeter Response:**

The response of a calorimeter to a single pulse input as displayed by a chart recorder appears below.




The output voltage from a chart recorder can be converted to wattage at any time by:

$W = V/S$, $W_i = V_i/S$

V = Chart recorder voltage level in mV

S = Calorimeter sensitivity in mV/W

The total energy (E) in the pulse can be found by integrating the instantaneous wattage over time:

$$E = \int_0^\infty W(t)\, dt$$

The following methods may be used to compute the total integrated energy:

**Numerical Integration:**

Finding the area under the curve in figure 7 is the equivalent procedure for determining pulse energy. Choose an appropriate time interval, dt, and perform the summation:

$$E = \sum_{I=1}^{N} W_i x dt = (dt/S) \sum_{i=1}^{N} V_i$$

The error caused by this procedure is:

$$dE = (dt/S) \Sigma\, dV_i$$

i=1

The error, in theory, is only dependent upon the value of $\sum dV_i$, that is the cumulative random error of $V_i$. This number should approach zero if data is carefully taken. The accuracy is also increased if the time interval, dt, is minimized. Numerical integration can yield accurate results, but is a tedious task.

**Initial Voltage Interpolation:**

A method used to eliminate the tedious numerical integration task is to project the thermal decay envelope on to the voltage axis, determine the 1/e decay time constant T, and estimate the total energy value (E):

$$E = (V_o/S) \times T$$

The change from thermal absorption to thermal transport phenomena near the peak causes difficulty in accurately projecting the envelope on to the voltage axis introducing an error, $dV_o$. Further, the determination of the time constant T, introduces another error, dT. The total error is the sum of the two errors.

$$dE = (V_o/S)dT + (T/S)dV_o$$

The difficulty in eliminating the potential error makes this method typically less accurate than numerical integration, but much faster in application.

**Peak Voltage Estimate:**

The peak voltage method requires using an independent determination of total energy and referencing it back to the peak voltage value, $V_p$.

For a given pulse, use the numerical integration method to obtain E. Note the peak voltage, $V_p$. Compute the value, F

$$F = E/V_p$$

For the next pulse compute the total energy: $E = F \times V_p$

The error in using this method yields: $dE = FdV_p + V_pdF$

The accuracy of this measurement depends upon the error in the original calibration, dF, and the error in the peak voltage $dV_p$. A careful numerical integration yields a value for dF near zero. The value of $dV_p$ can be minimized by maintaining the geometry of the system (i.e. beam intensity, beam profile, wavelength and environment) during operation to be the same as during calibration. Under controlled

circumstances, the peak method accuracy usually falls between the numerical integration and initial voltage interpolation methods.

## SCIENTECH PHOTODIODE DETECTORS

Scientech does not recommend that Scientech photodiode detectors be used without a H410 power meter. The crystals used in the detectors are wavelength dependent and the absorption characteristics vary from batch to batch as they are manufactured. The H410 power meter's software contains the correction factors necessary to get accurate readings.

### Cable Requirements

Photodiode detectors are powered up by the power meter. To use a photodiode detector without a Scientech power meter you must construct a cable as described on page 30 and shown in Figure 6.

## Operation of Scientech Photodiode Detectors with a Digital Volt Meter

The detectors may be used with any digital volt meter (DVM) capable of reading 5 volts full scale only at the 632 nm wavelength. For use at any wavelength other than 632 nm you must contact Scientech to determine the correct sensitivity for that wavelength.

A. Connect the output of the detector to the DVM.
B. Select the DC volts mode.
C. Direct the laser beam on to the absorbing surface of the detector.
D. When the display of the DVM has stabilized calculate the laser power using the formula:

**W = V/S**

where:

W = Laser power in watts

V = Voltage reading of the DVM in volts

S = Sensitivity of the calorimeter from page 2.

## SCIENTECH CALIBRATION SERVICE

Scientech recommends that a complete calibration be performed annually to verify system accuracy. Please visit Scientech's website at **www.scientechinc.com** to obtain an RMA (returned material authorization) number and complete the form noting that you are requesting calibration of your detector.

You may also contact our Product Service Department at (800)525-0522 or (303)444-1361 or Fax (303)444-9229 or email inst@scientechinc.com. Be prepared to provide model number, serial number along with contact information. to arrange for a NIST traceable, factory calibration. Scientech calibrates the detector with its power meter for the same price.

## LIMITED WARRANTY

Scientech warrants and represents that the laser power measurement product will be free from defects in design, materials and workmanship and conform with applicable Scientech product specifications for a period of three (3) years. The product warranty period begins on the date of shipment from Scientech. Scientech warrants that its products shall conform to applicable Scientech specifications and drawings and will meet all the functional and performance requirements when properly installed, operated, and maintained in accordance with Scientech's operating manual. Warranty does not extend to any Scientech products that have been subjected to misuse, abuse, or accidents, or improper installation, maintenance or applications, repaired by unauthorized personnel, or Products in which the tamper proof sticker has been removed or broken.

During the warranty period, Scientech will repair, or at its option replace at no charge, components that prove to be defective. The product must be returned, shipping prepaid, to Scientech's authorized repair facility. Products repaired by Scientech's authorized repair personnel/facilities will be warranted against defects in the repaired component and workmanship for a period of 365 days from the date of shipment of the repaired Product.

## RETURN MATERIAL PROCEDURE

Should it become necessary to return any product to Scientech for any reason including calibration, please visit Scientech's website at **www.scientechinc.com** to obtain an RMA (returned material authorization) number and complete the form. You may also contact our Product Service Department at (800)525-0522 or (303)444-1361 or Fax (303)444-9229 or email inst@scientechinc.com. Be prepared to provide model number, serial number, and a description of the problem along with contact information. Frequently we can provide self-help information which will eliminate the need for returning the product.

If product return is required, please pack the items in the original box and packing material. As an alternate, place the equipment in a snug-fitting box, and then pack that box in a larger box with at least four inches of packing material. Scientech does not assume responsibility for products damaged during shipping and shipping damage will not be treated as a warranty repair. Please include a point of contact, email address, and phone number of the person we should contact regarding repair questions.

Normally, products are repaired and shipped within five (5) business days following receipt of the product at the authorized service facility. The repair turn-around time could vary depending on the workload.

Shipping Address: Scientech, Inc.

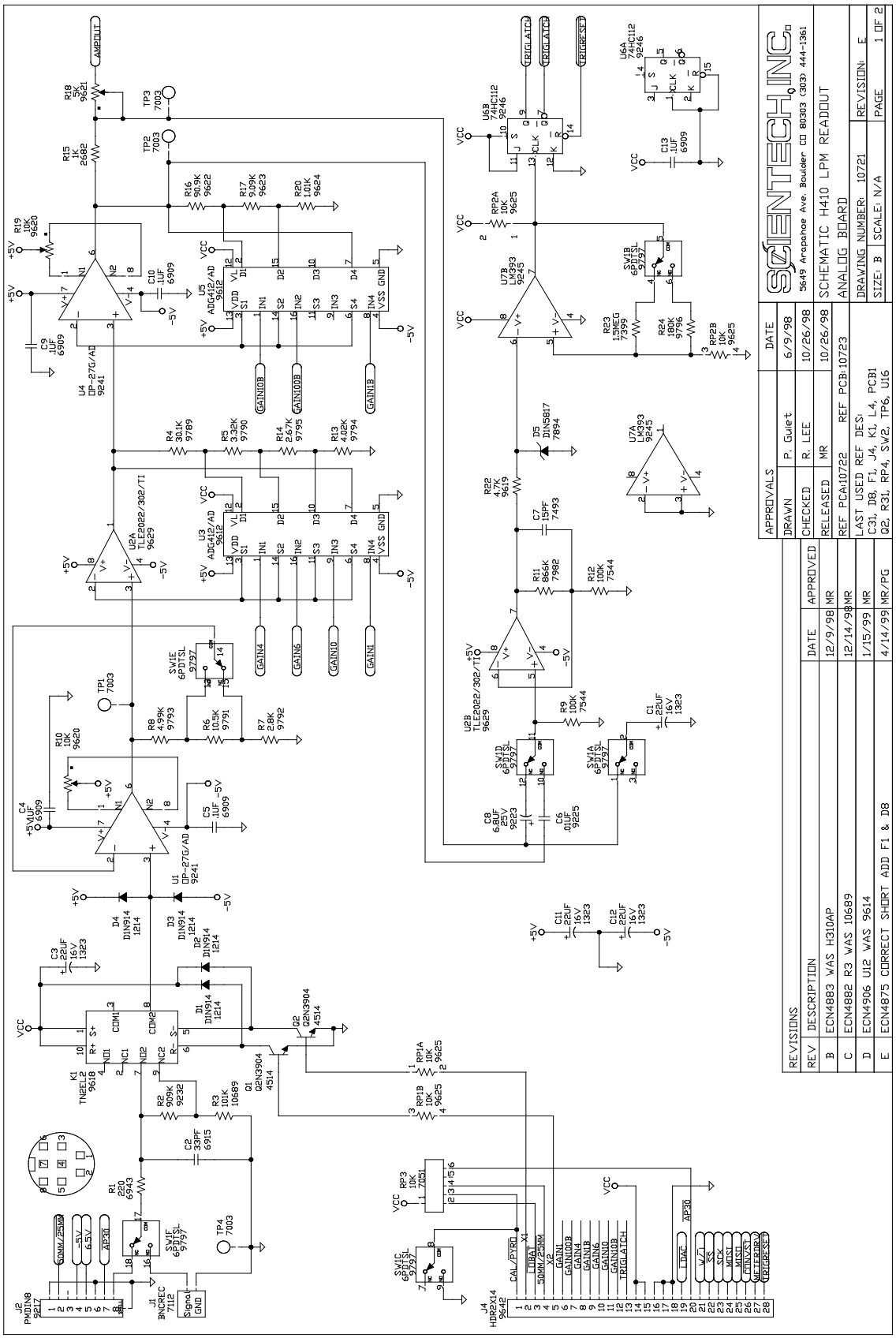
Product Service Department
5649 Arapahoe Ave.
Boulder, Colorado 80303 U.S.A.

## DISPOSAL OF ELECTRONIC EQUIPMENT

Scientech recommends the following for disposal of electrical and electronic equipment:

1. The best option is to reuse the equipment in its entirety.
2. Where the equipment cannot be reused in its entirety, priority should be given to reuse of its subassemblies and components.
3. Where reuse is not appropriate, electrical and electronic equipment, including batteries, should be recycled according to local ordinances.
4. Waste electrical and electronic equipment should never be mixed with municipal waste.


# SCHEMATICS:


SCIENTECH INC
5649 Arapahoe Ave. Boulder CO 80303 (303) 444-1361
SCHEMATIC H410 LPM READOUT
ANALOG BOARD
DRAWING NUMBER: 10721
REVISION: E
SIZE: B
SCALE: N/A
PAGE 1 OF 2
APPROVALS
DRAWN P. Guiet 6/9/98
CHECKED R. LEE 10/26/98
RELEASED MR 10/26/98
REF PCA:10722 REF PCB:10723
LAST USED REF DES:
C31, D8, F1, J4, K1, L4, PCB1
Q2, R31, RP4, SW2, TP6, U16
REVISIONS
REV DESCRIPTION DATE APPROVED
B ECN4883 WAS H310AP 12/9/98 MR
C ECN4882 R3 WAS 10689 12/14/98 MR
D ECN4906 U12 WAS 9614 1/15/99 MR
E ECN4875 CORRECT SHORT ADD F1 & D8 4/14/99 MR/PG
AMPOUT
TP1 7003
TP2 7003
TP3 7003
TP4 7003
R18 5K 9621
R15 49.9K 9622
R16 909K 9622
R17 909K 9623
R20 101K 9624
R19 10K 9620
R10 10K 9620
R4 301K 9789
R5 3.32K 9790
R14 2.67K 9795
R13 4.02K 9794
R8 4.99K 9793
R6 10.5K 9791
R7 2.8K 9792
R22 4.7K 9619
R11 866K 7982
R12 100K 7544
R9 100K 7544
R23 13.3MEG 9795
R24 680K 9796
RP2A 10K 9625
RP2B 10K 9625
RP1A 10K 9625
RP1B 10K 9625
RP3 10K 7051
R1 220 6943
R2 909K 9232
R3 101K 10689
C1 22UF 16V 1323
C2 33PF 6915
C3 22UF 16V 1323
C4 .5UF 6909
C5 1UF -5V 6909
C6 .01UF 9225
C7 15PF 7493
C8 6.8UF 25V 9223
C9 .1UF 6909
C10 1UF 6909
C11 22UF 16V 1323
C12 22UF 16V 1323
C13 1UF 6909
U1 OP-27G/AD 9241
U2A TLE2022/302/TI 9629
U2B TLE2022/302/TI 9629
U3 ADG412/AD 9612
U4 OP-27G/AD 9241
U5 ADG412/AD 9612
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SW1A 6PDTSL 9797
SW1B 6PDTSL 9797
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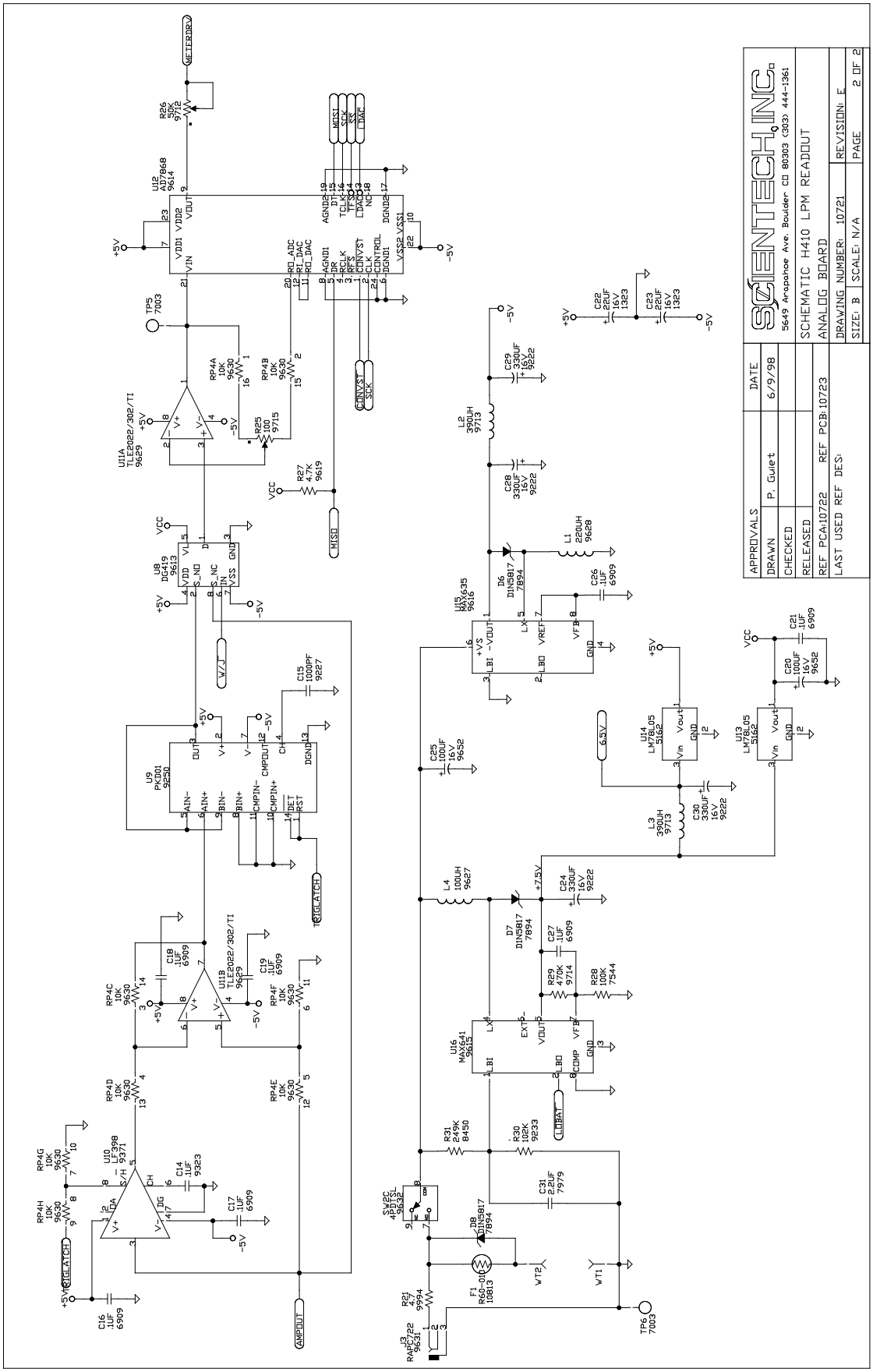
SW1D 6PDTSL 9797
SW1E 6PDTSL 9797
SW1F 6PDTSL 9797
J1 BNC-PEC 7112
J2 PMDIN8 9217
J4 HDR2X14 9624
GAIN10B
GAIN100B
GAIN1B
GAIN4
GAIN6
GAIN10
GAIN1
TRIGLATCH
TRIGRESET
LDAC
AP30
SCK
MOSI
MISO
CAL/PYRO
LDRAT
50MM/25MM
5V
-5V
6.5V
Signal
GND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SCHEMATIC H410 LPM READOUT
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SIZE: B
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PAGE 2 OF 2
APPROVALS
DRAWN P. Guiet 6/9/98
CHECKED
RELEASED
REF PCA:10722 REF PCB:10723
LAST USED REF DES:
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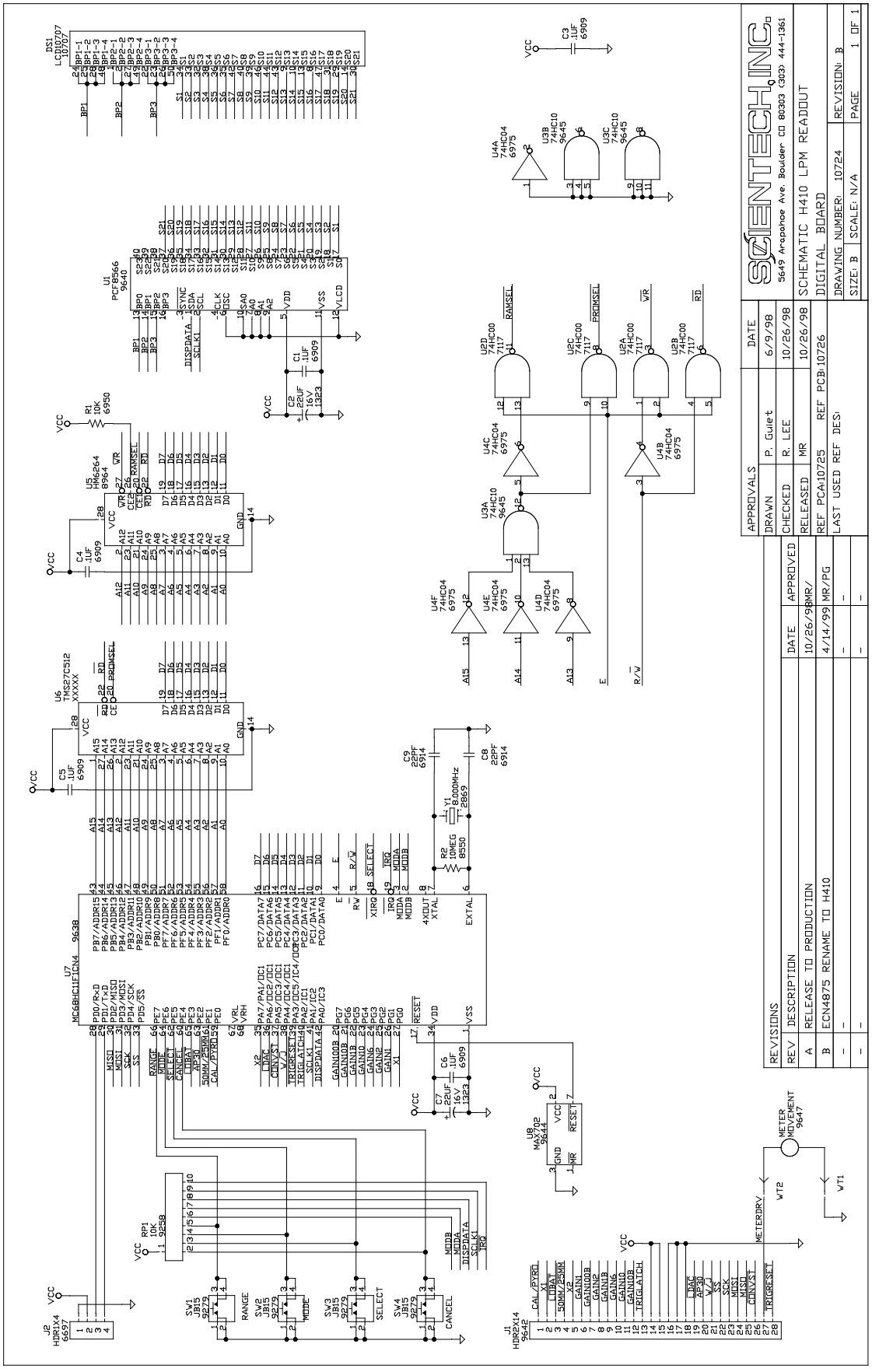
MISO
SCK
CONVST
WIGLATCH
AMPOUT
+5V
-5V
VCC
+7.5V
6.5V


SCHEMATIC H410 LPM READOUT
DIGITAL BOARD
SCIENTECH INC.
5649 Arapahoe Ave. Boulder CO 80303 (303) 444-1361
APPROVALS
DRAWN P. Gulet 6/9/98
CHECKED R. LEE 10/26/98
RELEASED MR 10/26/98
REF PCA:10725 REF PCB:10726
LAST USED REF DES:
DRAWING NUMBER: 10724
REVISION: B
SIZE: B
SCALE: N/A
PAGE 1 OF 1
REVISIONS
REV DESCRIPTION DATE APPROVED
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B ECN4875 RENAME TO H410 4/14/99 MR/PG
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U6 TMS27C512 XXXXX
U5 HM6264 8964
U1 PCF8566 9640
U2 74HC00 7117
U3 74HC10 9645
U4 74HC04 6975
U8 MAX702 9644
DS1 LCD10707 10707
J1 HDR2X14 9642
J2 HDR1X4 6697
SW1 JB15 9279
SW2 JB15 9279
SW3 JB15 9279
SW4 JB15 9279
RP1 10K 9288
METER MOVEMENT 9647
R1 10K 6950
R2 10MEG 8550
Y1 8.000MHz 2869
C1 1UF 6909
C2 22UF 16V 1323
C3 1UF 6909
C4 1UF 6909
C5 1UF 6909
C6 1UF 6909
C7 22UF 16V 1323
C8 22PF 6914
C9 22PF 6914
VCC
RESET
RANGE
MODE
SELECT
CANCEL
METERDRV
WT1
WT2
MISO
MOSI
SCK
SS
CONVST
TRIGRESET
DISPDATA
SCLK1
IRQ
MODA
MODB
RAMSEL
PROMSEL
RD
WR
R/W
E
A15
A14
A13
A12
A11
A10
A9
A8
A7
A6
A5
A4
A3
A2
A1
A0
D7
D6
D5
D4
D3
D2
D1
D0
BP1
BP2
BP3
S1
S2
S3
S4
S5
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