SCIENTECH®

Models H410 & H410D Laser Power and Energy Meters Setup and Operating Procedures

Serial Number_____

P/N 10795L

Thank you for choosing a Scientech laser power and energy meter. Scientech, an ISO 9001 registered company, and our employees are pleased to provide you with a product designed for years of reliable service. Please read this manual completely before using your indicator. This information will enable you to fully utilize the equipment and should be located nearby for reference. The indicator is intended to be used only in the manner outlined in this manual. Misuse of the equipment may cause product failure.

Note: 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.

DETECTOR OPERATING PARAMETERS:

Note: 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.

Calorimeter 1:

Model No: _____
Serial No: _____
Calibration Wavelength _____nm
Output Sensitivity (S): _____V/W
Time Constant (1/e): _____sec.
Calibration Temp: _____°C
Sub. Heater Resistance (R_c): _____ohms
Sub. Heater Voltage (V_h): _____volts
Sub. Heater Wattage (W_h) _____watts

Calorimeter 2:

Model No: _____
Serial No: _____
Calibration Wavelength: _____nm
Output Sensitivity (S): _____V/W
Time Constant (1/e): _____sec.
Calibration Temp: _____°C
Sub. Heater Resistance (R_c): _____ohms
Sub. Heater Voltage (V_h): _____volts
Sub. Heater Wattage (W_h): _____watts

Pyroelectric Detector 1:

Model No: _____
Serial No: _____
Calibration Wavelength: _____nm or µm
Output Sensitivity: _____V/J or _____V/mJ S_____ I_____ L_____
Calibration Temp: _____°C

Pyroelectric Detector 2:

Model No: _____
Serial No: _____
Calibration Wavelength: _____nm or µm
Output Sensitivity: _____V/J or _____V/mJ S_____ I_____ L_____
Calibration Temp: _____°C

Photodiode Detector 1:

Model No: _____
Serial No: _____
Calibration wavelength _____nm or µm
Output Sensitivity _____V/W
Calibration Temp: _____°C

Photodiode Detector 2:

Model No: _____
Serial No: _____
Calibration Wavelength _____nm or µm
Output Sensitivity _____V/W
Calibration Temp: _____°C

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CE MARK CERTIFICATION:

The H410 indicator and all of the detectors listed in this manual have been certified for the European CE mark.

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.

VECTOR™ H410 INDICATOR SPECIFICATIONS:

Model	H410	H410D
Display	4digit LCD with Selectable Analog Meter Movement	4 Digit LCD
Full Scale Ranges with Astral 25mm Calorimeter	10.00 m, 100.0 m, 1.000, 10.00, AUTO (Watts only)	
Full Scale Ranges with Astral 50mm Calorimeter	300.0 m, 3.000, 30.00, AUTO (Watts only)	
Full Scale Ranges with Vector Pyroelectric Detector	3.000 m, 30.00 m, 300.0 m, 3.000, AUTO	
Full Scale Ranges with Photodiode Detector - Watts only	30.00 µ, 300.0 µ, 3.000 m, 30.00 m, AUTO	
Maximum Repetition Rate with Calorimeter in Joules Mode	Calorimeter Dependent - 1 pulse every 60 to 90 seconds	
Maximum Repetition Rate with Calorimeter in Watts Mode	Unlimited	
Maximum Repetition Rate for Collecting Data in Statistics Mode with a Pyroelectric Detector	300 pps	
Response Time with Calorimeter in Joules Mode	Calorimeter Dependent - 1 to 3 seconds	
Response Time with Calorimeter in Watts Mode	Calorimeter Dependent - 3 to 10 seconds	
Operating Temperature	5°C to 40°C	
Power Requirement	4 ea. Rechargeable Batteries	
AC Charger Input Requirements	120 Volts, 60 Hz ± 10 % or 220 Volts, 50 Hz ± 10 %	
Dimensions H x W x D - inches/cm	8.25 x 4.0 x 1.5/20.96 x 10.16 x 3.81	
Weight - pounds/kgs	1.23/0.56	

ABSORPTION OF HD ABSORBING MATERIAL:

Warning: You must exercise caution when using HD detectors. They exhibit spectral reflection of between 7% and 18%, of the input power, back out of the aperture. Please refer to Figure 1 to determine the reflectance for the wavelength you are measuring. These detectors should be treated as a partial mirror or any other type of reflective optic and the appropriate caution level observed, especially at the CO_2 wavelength. Detailed wavelength information is contained in the chart at the end of this manual.

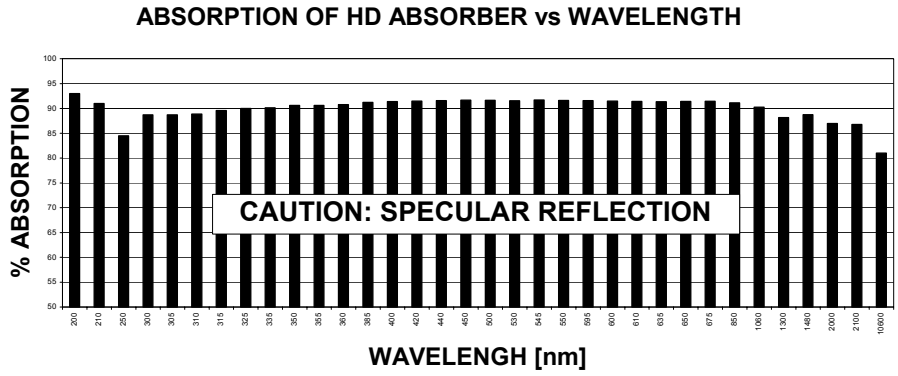


Figure 1

Note: HD detectors might show "beam" marks on the absorbing surface. These marks are characteristic of the material and do not affect the performance of the detector. Do not rub off or remove the marks. Polishing or cleaning the absorbing surface might change the performance of the detector.

VECTOR™ PYROELECTRIC DETECTOR SPECIFICATIONS:

Model	**P 25**	**PHF 25**	**PHD 25**	**PHDX 25**	**PHDX25UV**	**SP 25**	**SPHF 25**	**SPHD 25**
Aperture Diameter	25.4 mm	25.4 mm	25.4 mm	7mm	7mm	25.4 mm	25.4 mm	25.4 mm
Spectral Response	.193-26µm		.193-10.6µm	.4-2µm	.193-2µm	.193-26µm		.193-10.6µm
Maximum Average Power	5 W with full illumination of the detector							
Minimum Energy	7% of selected range							
Noise Equivalent Energy	4 µJ							
Maximum Energy Density	Note 1		Note 2	Note 3	Note 4	Note 1		Note 2
Accuracy	5%	5%	8%^	8%^	8%^	5%	5%	8%^
Output Sensitivity	8 V/J	8 V/J	2 V/J	2 V/J	2 V/J	8 V/J	8 V/J	2 V/J
Maximum Repetition Rate	100 pps	400 pps	40 pps	40 pps	40 pps	100 pps	400 pps	40 pps
Maximum Pulse Duration	0.2 msec	0.045 msec	0.2 msec	0.2 msec	0.2 msec	0.2 msec	0.045 msec	0.2 msec
Dimensions D x L - inches	2.4 x 2.3	2.4 x 2.3	2.4 x 2.3	2.4 x 3.9	2.4 x 3.9	2.3x2.3x0.6	2.3x2.3x0.6	2.3x2.3x0.6
cm	6.1 x 5.8	6.1 x 5.8	6.1 x 5.8	6.1 x 9.9	6.1 x 9.9	5.8x5.8x1.4	5.8x5.8x1.4	5.8x5.8x1.4
Weight - pounds/kgs	0.9/1.4	0.9/1.4	0.9/1.4	1.1/0.5	1.1/0.5	0.3/0.14	0.3/0.14	0.3/0.14
Indicator Compatibility	H410, H410D, S310, S310D, D200PC, D200P							

Model	**P 50**	**PHF 50**	**PHD 50**	**PHDX 50**	**PHDX50UV**	**SP 50**	**SPHF 50**	**SPHD 50**
Maximum Beam Diameter	50.8 mm	50.8 mm	50.8 mm	15 mm	15 mm	50.8 mm	50.8 mm	50.8 mm
Spectral Response	.193-26µm		.193-10.6µm	.4-2µm	.193-2µm	.193-26µm		.193-10.6µm
Maximum Average Power	10 W with full illumination of the detector							
Minimum Energy	7% of selected range							
Noise Equivalent Energy	16 µJ							
Maximum Energy Density	Note 1		Note 2	Note 3	Note 4	Note 1		Note 2
Accuracy	5%	5%	8%^	8%^	8%^	5%	5%	8%^
Output Sensitivity	2 V/J							
Maximum Repetition Rate	50 pps	400 pps	20 pps	20 pps	20 pps	50 pps	400 pps	20 pps
Maximum Pulse Duration	0.4 msec	0.045 msec	0.4 msec	0.4 msec	0.4 msec	0.4 msec	0.045 msec	0.4 msec
Dimensions D x L - inches	3.5 x 2.3	3.5 x 2.3	3.5 x 2.3	3.5 x 3.9	3.5 x 3.9	3x3x0.6	3x3x0.6	3x3x0.6
cm	8.8 x 5.8	8.8 x 5.8	8.8 x 5.8	8.8 x 9.9	8.8 x 9.9	7.6x7.6x1.5	7.6x7.6x1.5	7.6x7.6x1.5
Weight - pounds/kgs	1.5/0.68	1.5/0.68	1.5/0.68	1.7/0.77	1.7/0.77	0.4/0.18	0.4/0.18	0.4/0.18
Indicator Compatibility	H410, H410D, S310, S310D, D200PC, D200P							

^Beam centered on absorber

Note 1: Max J/cm2 =316 x (pulse width)1/2

Note 2: HD models Max J/cm^2 = 4500 x (pulse width)$^{1/2}$ to a maximum of 1.4 J/cm^2.
Maximum pulse width of the pyroelectric detector must be observed.

Note 3: HDX models Max J/cm^2 = 36,000 x (pulse width)$^{1/2}$ to a maximum of 12.6 J/cm^2.
Maximum pulse width of the pyroelectric detector must be observed.

Note 4: HDXUV models Max J/cm^2 = 18,000 x (pulse width)$^{1/2}$ to a maximum of 5.6 J/cm^2.
Maximum pulse width of the pyroelectric detector must be observed.

ASTRAL™ CALORIMETER SPECIFICATIONS:

Model	**AC2500**	**AC25HD**	**ACX25HD**	**AC2501**	**ACX2501**	**AC25UV**	**AC2504**
Type of Absorber	Surface	Surface	Surface	Volume	Volume	Volume	Volume
Aperture Diameter	25.4 mm	25.4 mm	8 mm	25.4 mm	8 mm	25.4 mm	25.4 mm
Spectral Response	.25-35 µm	.193-12 µm	.4-2 µm	.266-1.2 µm	.4-1.2 µm	.193-.36 µm	.85-4.2 µm
Average Power Maximum	10 W						
Average Power Minimum	1 mW when installed in an Isoperibol Enclosure						
Noise Level	10 µW or µJ						
Maximum Power Density	200 W/cm²	1.5 kW/cm²	12 kW/cm²	Note 1	Note 2	Note 3	Note 4
Maximum Peak Power Density	1 MW/cm²	100 MW/cm²	800 MW/cm²	Note 5	8.5 GW/cm²	Note 6	Note 7
Maximum Single Pulse Energy	10 J						
Maximum Energy Density	Note 8	Note 9	Note 10	Note 11	Note 12	Note 13	Note 14
Precision	< 1 %						
Accuracy	± 3 %						
Response Time	3 sec when connected to a Scientech Indicator in Watts Mode						
Dimensions DxL - inches	3.75 x 2.2	3.75 x 2.2	3.75 x 3.82	3.75 x 2.2	3.75 x 3.82	3.75 x 2.2	3.75 x 2.2
cm	9.53 x 5.6	9.53 x 5.6	9.53 x 9.7	9.53 x 5.6	9.53 x 9.7	9.53 x 5.6	9.53 x 5.6
Weight - pounds/kg	1.5/0.68	1.5/0.68	1.7/0.77	1.5/0.68	1.7/0.77	1.5/0.68	1.5/0.68
Indicator Compatibility	H410, H410D, S310, S310D, D200PC, D200C						

Model	**AC5000**	**AC50HD**	**ACX50HD**	**AC5001**	**ACX5001**	**AC50UV**	**AC5004**
Type Absorber	Surface	Surface	Surface	Volume	Volume	Volume	Volume
Aperture Diameter	50.8 mm	50.8 mm	16 mm	50.8 mm	16 mm	50.8 mm	50.8 mm
Spectral Response	.25-35 µm	.193-12 µm	.4-2 µm	.266-1.2 µm	.4-1.2 µm	.193-.36 µm	.85-4.2 µm
Average Power Maximum	30 W						
Average Power Minimum	40 mW						
Noise Level	400 µW or µJ						
Maximum Power Density	200 W/cm²	1.5 kW/cm²	12 kW/cm²	Note 1	Note 2	Note 3	Note 4
Maximum Peak Power Density	1 MW/cm²	100 MW/cm²	800 MW/cm²	Note 5	8.5 GW/cm²	Note 6	Note 7
Maximum Single Pulse Energy	30 J						
Maximum Energy Density	Note 8	Note 9	Note 10	Note 11	Note 12	Note 13	Note 14
Precision	< 1 %						
Accuracy	± 3 %						
Response Time	3 sec when connected to a Scientech Indicator in Watts Mode						
Dimensions DxL - inches	4.75 x 2.3	4.75 x 2.3	4.75 x 3.92	4.75 x 2.3	4.75 x 3.92	4.75 x 2.3	4.75 x 2.3
cm	12.07 x 5.8	12.07 x 5.8	12.07 x 9.96	12.07 x 5.8	12.07 x 9.96	12.07 x 5.8	12.07 x 5.8
Weight pounds/kgs	2.9/1.3	2.9/1.3	3.1/1.4	2.9/1.3	3.1/1.4	2.9/1.3	2.9/1.3
Indicator Compatibility	H410, H410D, S310, S310D, D200PC, D200C						

Note 1: AC2501, AC5001 — 30W/cm^2 @ 1064nm, 23W/cm^2 @ 532nm, 8.5W/cm^2 @ 355nm, 175mW/cm^2 @ 266nm

Note 2: ACX2501, ACX5001 — Note 1 specs x 8 for 400nm to 1.2µm

Note 3: AC25UV, AC50UV — 50W/cm^2 @ 355nm

Note 4: AC2504, AC5004 — 35W/cm^2 @1064nm

Note 5: AC2501, AC5001 — 100GW/cm^2 @ 1064nm, 78GW/cm^2 @532nm, 29GW/cm^2 @ 355nm, 580MW/cm^2 @266nm

Note 6: AC25UV, AC50UV — Repetitive pulses: 101MW/cm^2 @ 355nm
Single pulses: 3.5GW/cm2 @ 355nm

Note 7: AC2504, AC5004 — 125GW/cm^2 @ 1064nm

Note 8: AC2500, AC5000 — Max J/cm^2 = 1,000 x (pulse width)$^{1/2}$ to a maximum of 200J/cm^2.

Note 9: AC25HD, AC50HD — Max J/cm^2 = 4,500 x (pulse width)$^{1/2}$ to a maximum of 14J/cm^2.

Note 10: ACX25HD, ACX50HD — Max J/cm^2 = 36,000 x (pulse width)$^{1/2}$ to a maximum of 42.5J/cm^2.

Note 11: AC2501, AC5001 — Repetitive pulses: 4.1J/cm^2@1064nm, 3.2J/cm^2@532nm, 1.2J/cm^2@355nm, 24mJ/cm^2@266nm
Single pulses: 8J/cm^2@1064nm, 6.2J/cm^2@532nm, 2.3J/cm^2@355nm, 46mJ/cm^2@266nm

Note 12: ACX2501, ACX5001 — Note 11 specs x 8 for 400nm to 1.2µm

Note 13: AC25UV, AC50UV — Repetitive pulses: 1.1J/cm^2 @ 355nm
Single pulses: 40J/cm2 @ 355nm

Note 14: AC2504, AC5004 — Repetitive pulses: 4.8J/cm^2 @ 1064nm
Single pulses: 10J/cm2 @ 1064nm

LARGE APERTURE (100MM & 200MM) CALORIMETER SPECIFICATIONS:

Model	**360401**	**380401**	**380402**	**384UV5**	**360801**	**380801**	**380802**	**384UV5**
Type of Absorber	Surface	Volume	Volume	Volume	Surface	Volume*	Volume	Volume
Aperture Diameter	100mm				200mm			
Minimum Beam Diameter	5cm				7.5cm			
Spectral Response	.25 - 35µm	.266 - 1.2µm	9 -11µm	.193 - .36µm	.25 - 35µm	.266 - 1.2µm	9 -11µm	.193 - .36µm
Maximum Average Power	50W with full illumination of absorbing surface				100W with full illumination of absorbing surface			
Minimum Average Power	150mW				700mW			
Noise Level	1.5mJ - mW				7mJ - mW			
Maximum Power Density	200W/cm²	See Note 1	4W/cm²	Note 2	200W/cm²	See Note 3	4W/cm²	Note 2
Maximum Peak Power Density	1MW/cm²	See Note 4	100MW/cm²	See Note 5	1MW/cm²	See Note 6	100MW/cm²	See Note 5
Maximum Single Pulse Energy	150J				300J			
Maximum Energy Density	Note 7	Note 8	4J/cm^2	Note 9	Note 7	Note 10	4J/cm^2	Note 9
Precision	< 1%							
Accuracy	5%							
Response Time	5 sec when connected to a Scientech Indicator in Watts Mode							
Dimensions DxL - inches/cm	6.00 x 8.00/15.24 x 20.32				9.00 x 10.00/22.86 x 25.40			
Weight - pounds/kgs	6/2.72				16.27/7.26			
Indicator Compatibility	H410, H410D, S310, S310D							

* This is a segmented absorber

Note 1: 380401 — 27W/cm^2 @ 1064 nm, 21W/cm^2 @ 532 nm, 7.7W/cm^2 @ 355 nm, 158mW/cm^2 @ 266nm

Note 2: 384UV5, 388UV5 — 50W/cm^2 @ 355nm

Note 3: 380801 — 13.5W/cm^2 @ 1064 nm, 10.5W/cm^2 @ 532 nm, 3.85W/cm^2 @ 355 nm, 79mW/cm^2 @ 266nm

Note 4: 380401 — 90GW/cm^2 @ 1064 nm, 71GW/cm^2 @ 532 nm, 27GW/cm^2 @ 355 nm, 530MW/cm^2 @ 266nm

Note 5: 384UV5, 388UV5 — Repetitive pulses: 101MW/cm^2 @ 355nm
Single pulses: 3.5GW/cm^2 @ 355nm

Note 6: 380801 — 45GW/cm^2 @ 1064 nm, 35.5GW/cm^2 @ 532 nm, 13.5GW/cm^2 @ 265 nm, 265MW/cm^2 @ 266nm

Note 7: 360401, 360801 — Max J/cm^2 = 1000 x (pulse width)$^{1/2}$ to a maximum of 200J/cm^2

Note 8: 380401 — Repetitive pulses:
3.7J/cm^2 @ 1064nm, 2.9J/cm^2 @ 532nm, 1J/cm^2 @ 355nm, 20mJ/cm^2 @ 266nm
Single pulses:
7J/cm^2 @ 1064nm, 5.6J/cm^2 @ 532nm, 2.1J/cm^2 @ 355nm, 41mJ/cm^2 @ 266nm

Note 9: 384UV5, 388UV5 — Repetitive pulses: 1.1J/cm^2 @ 355nm
Single pulses: 40J/cm2 @ 355nm

Note 10: 38-0801 — Repetitive pulses:
1.85J/cm^2 @ 1064nm, 1.45J/cm^2 @ 532nm, 0.5J/cm^2 @ 355nm, 10mJ/cm^2 @ 266nm
Single pulses:
3.5J/cm^2 @ 1064nm, 2.8J/cm^2 @ 532nm, 1.05J/cm^2 @ 355nm, 20.5mJ/cm^2 @ 266nm

ASTRAL™ PHOTODIODE DETECTOR SPECIFICATIONS:

Model	**AP30**	**AP30UV**
Type of Absorber	Silicon	
Aperture Diameter	7.9 mm	
Spectral Response	400 nm - 1.1 µm	200 nm - 1.1 µm
Maximum Power	30 mW	2 mW
Minimum Power	100 nW	
Maximum Power Density	170 mW/cm^2	5 mW/cm^2
Noise Level	1 nW	
Accuracy	± 5 %	
Response Time	1 second	
Dimensions D x L - inches/cm	2.5 x 1.1/6.35 x 2.79	
Weight - pounds/kgs	0.25/0.114	
Indicator Compatibility	H410, H410D	

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 indicator and the appropriate electrical outlet. Allow 16 to 20 hours for a full charge.

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 indicator.

Note: Dispose of used batteries according to local regulations.

To install batteries refer to Figure 3 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.

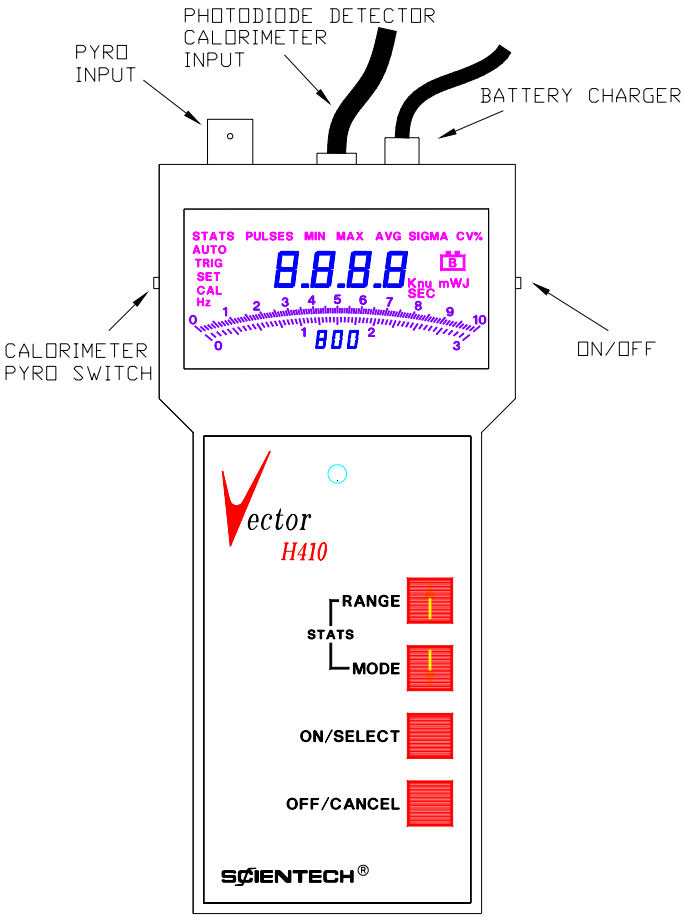


Figure 2

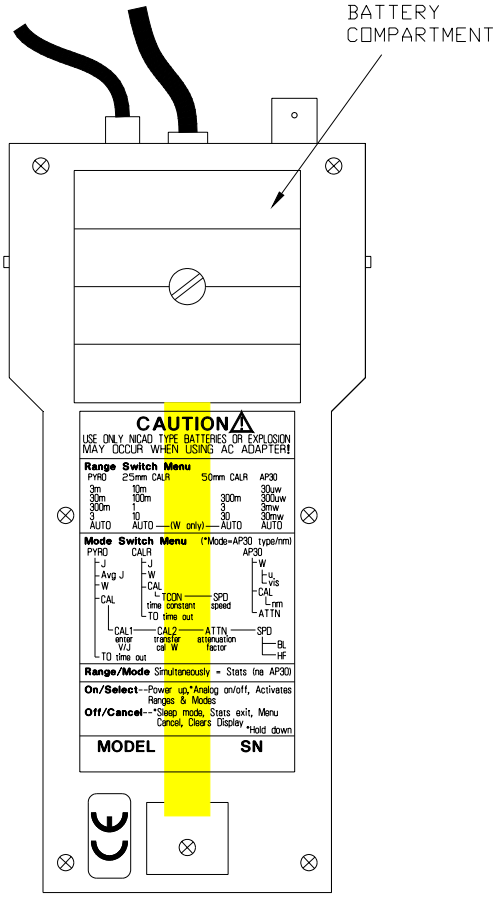


Figure 3

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 indicator 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 indicator'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 indicator'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 2. 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 Figure 2. Slide the CAL/PYRO switch, located on the upper left side of the H410, into the CAL (up) position for use with Astral and Large Aperture calorimeters and Astral 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 Astral and Large Aperture calorimeters and Astral 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. Also included with each detector is a 1/2" diameter mounting post for installing the detector to your working surface. An optional mounting base, Scientech Model 301-019, is also available for holding the detector/post assembly upright.

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.

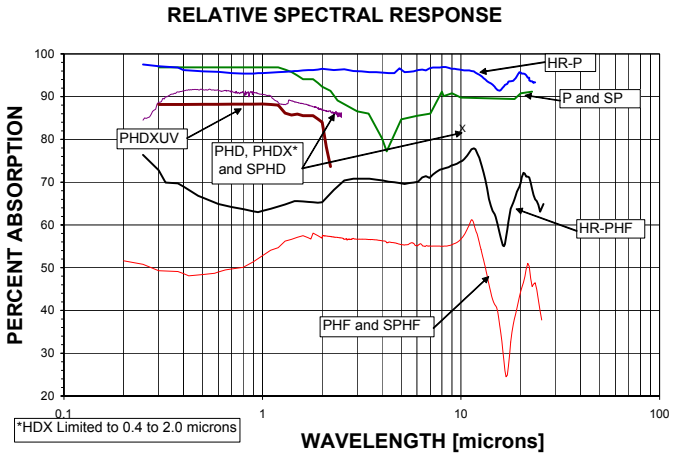
7. Take your measurement:

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.



Before using your Vector joulemeter system, 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 indicator 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 indicator'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 indicator'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 2. 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:

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

Refer to Figure 2. 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 indicator'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 indicator 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 following chart.

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 indicator 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.

D. 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).

A. 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.

B. 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.

C. 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.

8. 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 indicator 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 indicator 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 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 indicator 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.

9. 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 indicator 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.

10. 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 0.1 to 999.9 may be selected.

E. Press the ON/SELECT button. The attenuation factor is now active and the indicator 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.

11. 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.

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 indicator 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:

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:

$$\frac{\text{absorption rate of the new wavelength}}{\text{absorption rate of calibration wavelength}} \times \text{output sensitivity from serial tag} = \text{output sensitivity for new wavelength}$$

This new output sensitivity can be used in step 5 below or when using the pyroelectric detector without a H410 indicator as discussed later in this manual.

USING THE H410 WITH ASTRAL™ SERIES OR LARGE APERTURE CALORIMETERS

The calorimeter selected needs to be the appropriate model for the planned laser measurements. Please familiarize yourself with the operating specifications which are given in the front of this manual.

Note: Astral and Large Aperture 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 Astral calorimeter for measuring average power levels below 30mW and single pulse energy levels below 30mJ, a Scientech Model 36-0203A, 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 indicator 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 indicator'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 indicator'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 2. 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:

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

Refer to Figure 2. 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 Astral calorimeters. For large aperture calorimeters the interconnect cables for both the calorimeter and the indicator are hard wired to the interface module. Connect the cable(s) to the detector and the indicator'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 Astral calorimeter or interface module for large aperture calorimeters.

D. Press the ON/SELECT button. The time constant is now active and the indicator 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 indicator'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, AC25HD, ACX25HD	103.0
AC2501, ACX2501, AC25UV, AC2504	136.0
AC5000, AC50HD, ACX50HD	100.0
AC5001, ACX5001, AC50UV, AC5004	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 indicator 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, AC25HD	60 seconds
AC2501, AC25HD, AC2504	60 seconds
AC5000, AC50HD	90 seconds
AC5001, 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 9.

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 the following table:

Model	Astral 25mm		Astral 50mm		Large Aperture 100mm with PN10735 Interface Module*		Large Aperture 200mm with PN10747 Interface Module**	
Mode	Power	Energy	Power	Energy	Power	Energy	Power	Energy
Range	10mW 100mW 1W 10W AUTO	10mJ 100mJ 1J 10J	300mW 3W 30W AUTO	300mJ 3J 30J	300mW 3W 30W AUTO	300mJ 3J 30J	300mW 3W 30W AUTO	300mJ 3J 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.

7. To Select a Measurement Mode:

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

A. 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 9. 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.

B. To Measure Power (W):

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

Note: 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. The power will be displayed.

8. 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 9. 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 indicator 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 indicator 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 indicator 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.

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

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 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 0.1 to 999.9 may be selected.

E. Press the ON/SELECT button. The attenuation factor is now active and the indicator 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.

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, 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 indicator 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 ASTRAL™ SERIES HD CALORIMETERS OPERATING PARAMETERS FOR USE AT DIFFERENT WAVELENGTHS:

Scientech calorimeters in general have a flat response to all wavelengths within their specified spectral response. HD and HDX 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 HD or HDX calorimeter is used at a wavelength other than the calibration wavelength, the indicator'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:

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

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

USING THE H410 WITH ASTRAL™ 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 indicator 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 indicator'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 indicator'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 2. 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:

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

Refer to Figure 2. 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 Astral photodiode detectors. Connect the cable to the indicator'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.

E. 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.

C. 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.

F. 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. 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.

D. Press the ON/SELECT button. The attenuation factor is now active and the indicator 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.

9. 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 indicator 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 ASTRAL™ CALORIMETERS USING ELECTRIC SUBSTITUTION HEATING:

For Astral 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.

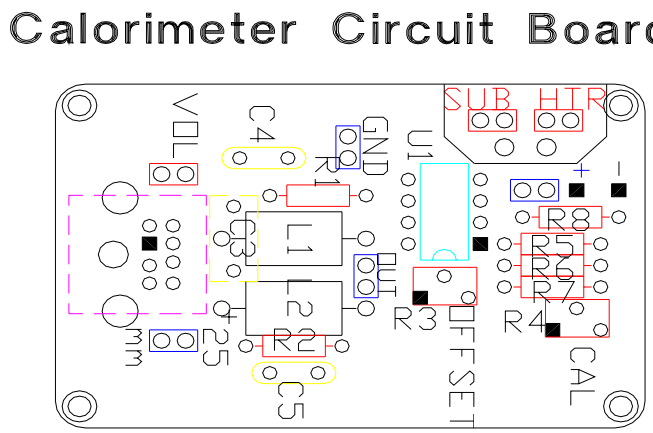


Figure 4

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 indicator, 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 indicator 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 indicator.

CALIBRATION OF LARGE APERTURE CALORIMETERS USING ELECTRIC SUBSTITUTION HEATING:

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

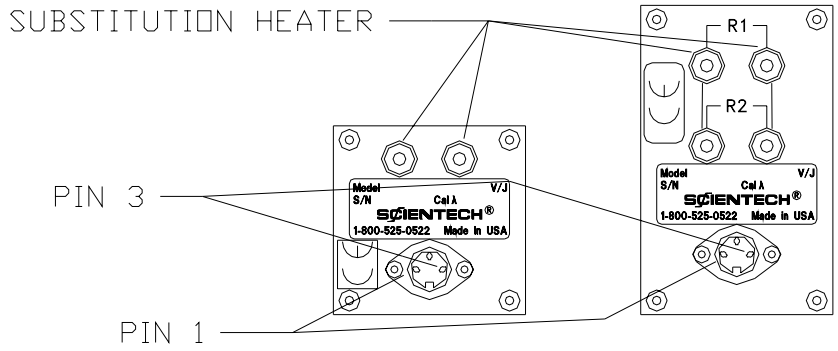


Figure 5

Calibration with an Interface Module and H410 Indicator:

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 indicator 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 indicator.

Calibration without an Interface Module and H410 Indicator:

Note: Whenever a large aperture calorimeter is used without an indicator 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 4.

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:

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

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:

$$S = V_c/W$$

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 calorimeters original sensitivity value.

DETECTOR OPERATION WITHOUT AN INDICATOR:

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.

Astral ™ and Large Aperture Calorimeters:

Cable Requirements:

Astral calorimeters are powered up by the indicators. To use an Astral calorimeter without a Scientech indicator, 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.

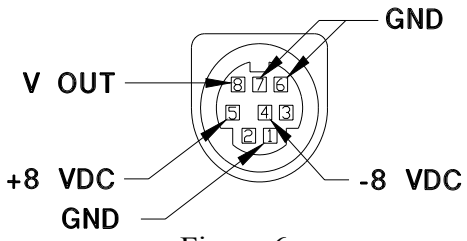


Figure 6

When large aperture calorimeters are used without an indicator 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 Astral™ and Large Aperture Calorimeters with a Digital Volt Meter:

Note: Whenever a large aperture calorimeter is used without an indicator 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.

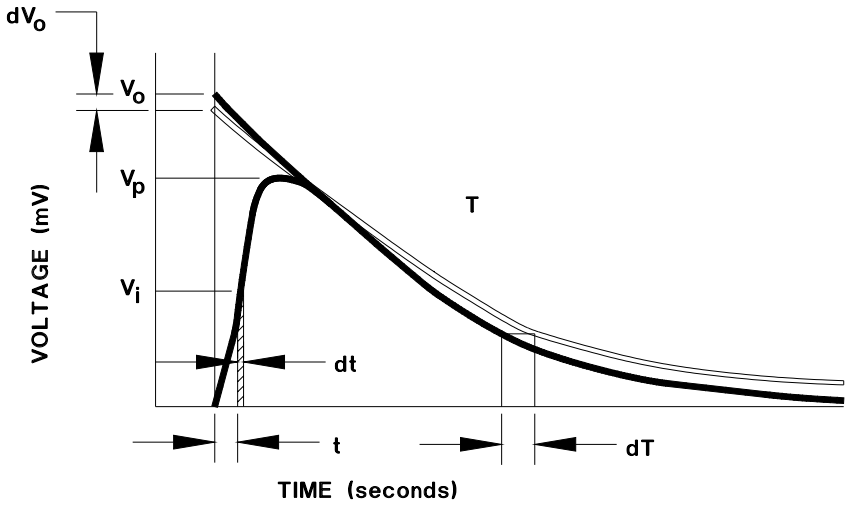
D. When the display of the DVM has stabilized (about 2 minutes), calculate the laser power using the formula: W = V/S
   where:
   W = Laser power in watts
   V = Voltage reading of the DVM in volts
   S = Sensitivity of the calorimeter from page 2.

Operation of Astral™ and Large Aperture Calorimeters with an Analog Chart 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:

$$dE = (dt/S) \sum_{i=1}^{N} dV_i$$

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.

Astral ™ Photodiode Detectors:

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

Cable Requirements:

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

Operation of Astral™ 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.

FACTORY RECALIBRATION:

Scientech recommends that a complete calibration be performed annually to verify system accuracy. Please contact our Product Service Department at (800)525-0522 or (303)444-1361 or Fax (303)444-9229 or email inst@scientech-inc.com to arrange for a NIST traceable, factory calibration.

LIMITED WARRANTY:

All Scientech Laser Power and Energy Measurement Systems are warranted against defects in materials and workmanship for two (2) years from date of delivery. During the warranty period, Scientech will repair, or at its option replace at no charge, components that prove to be defective. The equipment must be returned, shipping prepaid, to Scientech's product service facility. This limited warranty does not apply if the equipment is damaged by accident or misuse or as a result of service or modification by other than a Scientech service facility. The foregoing warranty is in lieu of all other warranties expressed or implied including but not limited to any implied warranty of merchantability, fitness, or adequacy for any special incidental or consequential damages whether in contract, tort, or otherwise.

RETURNED GOODS PROCEDURE:

Should it become necessary to return any item to Scientech for any reason, please contact our Product Service Department at (800)525-0522 or (303)444-1361 or Fax (303)444-9229 or email inst@scientech-inc.com. When you call, please be ready to provide model number, serial number, and a description of the problem. Frequently we can provide self-help information which will eliminate the need for returning the unit(s).

If equipment 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 under packed items.

Please include the name and phone number of the person we should contact regarding repair questions.

Normally, products are repaired and shipped within 5 working days after their arrival at the product service facility. This is an average time and could vary depending on the workload.

Shipping Address:

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

HD CALORIMETER AND PYROELECTRIC ABSORPTION VS. WAVELENGTH:

Use this table for all HD calorimeters and HD pyroelectric detectors.

Wavelength µm	Absorption %
0.200	93.00
0.210	91.00
0.220	88.00
0.230	85.00
0.240	82.00
0.250	84.48
0.255	85.03
0.260	84.90
0.265	85.08
0.270	85.26
0.275	85.84
0.280	86.56
0.285	86.86
0.290	87.06
0.295	88.28
0.300	88.68
0.305	88.68
0.310	88.84
0.315	89.57
0.320	89.42
0.325	90.01
0.330	89.91
0.335	90.14
0.340	90.31
0.345	90.52
0.350	90.59
0.355	90.60
0.360	90.76
0.365	90.75
0.370	91.03
0.375	91.10
0.380	91.06
0.385	91.20
0.390	91.20
0.395	91.29
0.400	91.39
0.405	91.41
0.410	91.44
0.415	91.54
0.420	91.49
0.425	91.64
0.430	91.54
0.435	91.66
0.440	91.58
0.445	91.67
0.450	91.66
0.455	91.68
0.460	91.69
0.465	91.64
0.470	91.67
0.475	91.61

Wavelength µm	Absorption %
0.480	91.54
0.485	91.63
0.490	91.74
0.495	91.67
0.500	91.63
0.505	91.57
0.510	91.52
0.515	91.57
0.520	91.63
0.525	91.54
0.530	91.55
0.535	91.63
0.540	91.74
0.545	91.71
0.550	91.60
0.555	91.53
0.560	91.56
0.565	91.58
0.570	91.57
0.575	91.46
0.580	91.52
0.585	91.49
0.590	91.51
0.595	91.59
0.600	91.46
0.605	91.41
0.610	91.40
0.615	91.31
0.620	91.20
0.625	91.31
0.630	91.29
0.635	91.33
0.640	91.41
0.645	91.46
0.650	91.40
0.655	91.47
0.660	91.28
0.665	91.38
0.670	91.36
0.675	91.43
0.680	91.28
0.685	91.32
0.690	91.30
0.695	90.99
0.700	91.37
0.705	91.16
0.710	91.08
0.715	91.02
0.720	90.88
0.725	90.96
0.730	91.16

Wavelength µm	Absorption %
0.735	90.77
0.740	91.22
0.745	90.79
0.750	90.80
0.755	90.99
0.760	90.90
0.765	90.67
0.770	90.83
0.775	90.99
0.780	90.82
0.785	91.05
0.790	90.92
0.795	91.19
0.800	91.12
0.805	90.92
0.810	90.73
0.815	90.24
0.820	91.32
0.825	90.40
0.830	91.00
0.835	90.93
0.840	90.82
0.845	91.15
0.850	91.10
0.855	89.92
0.860	90.44
0.865	91.04
0.870	91.04
0.875	91.21
0.880	91.03
0.885	91.10
0.890	90.47
0.895	91.19
0.900	90.70
0.905	90.96
0.910	90.87
0.915	90.97
0.920	90.91
0.925	90.89
0.930	90.82
0.935	90.95
0.940	90.80
0.945	90.83
0.950	90.66
0.955	90.64
0.960	90.67
0.965	90.60
0.970	90.57
0.975	90.60
0.980	90.57
0.985	90.59

Wavelength µm	Absorption %
0.990	90.51
0.995	90.52
1.000	90.49
1.005	90.48
1.010	90.49
1.015	90.50
1.020	90.45
1.025	90.44
1.030	90.44
1.035	90.39
1.040	90.37
1.045	90.30
1.050	90.29
1.055	90.25
1.060	90.25
1.065	90.27
1.070	90.31
1.075	90.31
1.080	90.28
1.085	90.30
1.090	90.28
1.095	90.20
1.100	90.12
1.105	90.10
1.110	90.08
1.115	89.75
1.120	89.62
1.125	89.54
1.130	89.51
1.135	89.43
1.140	89.39
1.145	89.29
1.150	89.21
1.155	89.13
1.160	89.11
1.165	89.05
1.170	88.99
1.175	88.98
1.180	88.91
1.185	88.91
1.190	88.90
1.195	88.79
1.200	88.62
1.205	88.54
1.210	88.42
1.215	88.36
1.220	88.35
1.225	88.29
1.230	88.29
1.235	88.22
1.240	88.23
1.245	88.19
1.250	88.23

Wavelength µm	Absorption %
1.255	88.20
1.260	88.20
1.265	88.21
1.270	88.26
1.275	88.15
1.280	88.12
1.285	88.16
1.290	88.19
1.295	88.13
1.300	88.15
1.305	88.11
1.310	88.14
1.315	88.20
1.320	88.32
1.325	88.32
1.330	88.35
1.335	88.30
1.340	88.34
1.345	88.46
1.350	88.71
1.355	89.17
1.360	89.19
1.365	89.22
1.370	89.22
1.375	89.12
1.380	89.08
1.385	89.11
1.390	89.11
1.395	89.02
1.400	88.97
1.405	88.99
1.410	89.04
1.415	88.96
1.420	88.91
1.425	88.92
1.430	88.95
1.435	88.91
1.440	88.84
1.445	88.82
1.450	88.74
1.455	88.74
1.460	88.79
1.465	88.74
1.470	88.71
1.475	88.72
1.480	88.72
1.485	88.67
1.490	88.61
1.495	88.61
1.500	88.61
1.505	88.66
1.510	88.61
1.515	88.59

Wavelength µm	Absorption %
1.520	88.50
1.525	88.52
1.530	88.51
1.535	88.49
1.540	88.48
1.545	88.44
1.550	88.44
1.555	88.40
1.560	88.40
1.565	88.44
1.570	88.44
1.575	88.40
1.580	88.38
1.585	88.43
1.590	88.40
1.595	88.35
1.600	88.33
1.605	88.35
1.610	88.38
1.615	88.28
1.620	88.24
1.625	88.23
1.630	88.23
1.635	88.25
1.640	88.22
1.645	88.24
1.650	88.19
1.655	88.20
1.660	88.24
1.665	88.16
1.670	88.20
1.675	88.12
1.680	88.05
1.685	88.06
1.690	88.11
1.695	88.07
1.700	88.06
1.705	88.00
1.710	87.99
1.715	87.91
1.720	87.99
1.725	87.94
1.730	87.89
1.735	87.80
1.740	87.83
1.745	87.88
1.750	87.85
1.755	87.82
1.760	87.79
1.765	87.73
1.770	87.75
1.775	87.72
1.780	87.77

Wavelength µm	Absorption %
1.785	87.73
1.790	87.64
1.795	87.62
1.800	87.66
1.805	87.64
1.810	87.59
1.815	87.58
1.820	87.56
1.825	87.58
1.830	87.67
1.835	87.49
1.840	87.58
1.845	87.52
1.850	87.62
1.855	87.50
1.860	87.56
1.865	87.48
1.870	87.52
1.875	87.42
1.880	87.44
1.885	87.38
1.890	87.38
1.895	87.32
1.900	87.29
1.905	87.18
1.910	87.11
1.915	87.41
1.920	87.06
1.925	87.10
1.930	87.08
1.935	87.06
1.940	87.13
1.945	87.02
1.950	86.97
1.955	87.06
1.960	87.07
1.965	87.20
1.970	87.04
1.975	87.12
1.980	87.10
1.985	86.91
1.990	86.98
1.995	86.92
2.000	86.96
2.005	86.81
2.010	86.85
2.015	86.75
2.020	86.90
2.025	86.89
2.030	86.82
2.035	86.79
2.040	86.77
2.045	86.78

Wavelength µm	Absorption %
2.050	86.86
2.055	86.83
2.060	86.72
2.065	86.71
2.070	86.71
2.075	86.60
2.080	86.63
2.085	86.62
2.090	86.69
2.095	86.66
2.100	86.74
2.105	86.58
2.110	86.48
2.115	86.59
2.120	86.59
2.125	86.62
2.130	86.60
2.135	86.57
2.140	86.59
2.145	86.46
2.150	86.62
2.155	86.58
2.160	86.56
2.165	86.66
2.170	86.67
2.175	86.65
2.180	86.65
2.185	86.69
2.190	86.71
2.195	86.63
2.200	86.65
2.205	86.44
2.210	86.42
2.215	86.30
2.220	86.30
2.225	86.17
2.230	86.33
2.235	86.38
2.240	86.38
2.245	86.15
2.250	86.39
2.255	86.25
2.260	86.17
2.265	86.13
2.270	86.39
2.275	86.22
2.280	86.28
2.285	86.20
2.290	86.32
2.295	85.99
2.300	86.31
2.305	86.17
2.310	86.09

Wavelength µm	Absorption %
2.315	86.25
2.320	86.07
2.325	86.04
2.330	86.01
2.335	85.97
2.340	85.96
2.345	86.54
2.350	85.94
2.355	86.02
2.360	86.01
2.365	85.68
2.370	85.87
2.375	86.30
2.380	85.77
2.385	85.68
2.390	85.97
2.395	85.99
2.400	85.26
2.405	85.40
2.410	85.84
2.415	85.64
2.420	86.09
2.425	85.77
2.430	86.26
2.435	85.72
2.440	85.41
2.445	86.02
2.450	85.92
2.455	85.46
2.460	85.77
2.465	85.96
2.470	85.87
2.475	85.29
2.480	86.08
2.485	85.59
2.490	86.26
2.495	85.54
2.500	85.12
10.600	82.10

P MODEL PYROELECTRIC DETECTOR ABSORPTION VS. WAVELENGTH:

Use this table for standard and slim profile painted (P) model pyroelectric detectors.

Wavelength µm	Absorption %
0.30	96.850
0.40	96.850
0.50	96.850
0.60	96.850
0.70	96.850
0.80	96.850
0.90	96.850
1.00	96.850
1.10	96.850
1.20	96.850
1.30	96.309
1.40	95.768

Wavelength µm	Absorption %
1.50	94.931
1.60	94.094
1.70	94.094
1.80	94.094
1.90	93.209
2.00	92.323
2.00	92.323
2.10	91.831
2.20	91.339
2.39	89.092
3.00	86.542
3.42	86.032

Wavelength µm	Absorption %
4.00	80.251
4.22	77.191
5.00	84.672
6.00	85.522
7.00	86.032
8.00	91.133
8.17	90.113
9.00	90.793
10.00	89.772
18.61	89.432
20.00	90.793
22.80	91.133

HF Model Pyroelectric Detector Absorption vs. Wavelength:

Use this table for standard and slim profile high frequency (HF) model pyroelectric detectors.

Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %
0.200	51.600	2.087	57.426	2.273	57.191	2.496	56.996
0.250	50.800	2.090	57.412	2.277	57.168	2.501	56.989
0.300	49.300	2.094	57.416	2.281	57.167	2.506	56.966
0.375	49.100	2.097	57.419	2.285	57.171	2.511	56.943
0.400	48.600	2.100	57.401	2.289	57.178	2.516	56.931
0.425	48.100	2.104	57.406	2.293	57.185	2.520	56.935
0.500	48.400	2.107	57.423	2.297	57.174	2.525	56.934
0.575	48.700	2.111	57.407	2.301	57.151	2.530	56.912
0.600	49.000	2.114	57.390	2.306	57.137	2.535	56.891
0.650	49.500	2.117	57.385	2.310	57.136	2.540	56.878
0.700	49.700	2.121	57.389	2.314	57.136	2.545	56.849
0.800	50.100	2.124	57.398	2.318	57.135	2.550	56.849
0.900	51.400	2.128	57.398	2.322	57.143	2.555	56.829
1.000	52.800	2.131	57.391	2.326	57.146	2.560	56.736
1.100	54.100	2.135	57.374	2.330	57.139	2.565	56.709
1.200	54.700	2.138	57.369	2.335	57.135	2.570	56.720
1.300	56.200	2.142	57.367	2.339	57.134	2.575	56.694
1.400	56.600	2.145	57.342	2.343	57.121	2.581	56.670
1.500	57.100	2.149	57.329	2.347	57.098	2.586	56.643
1.600	57.500	2.153	57.332	2.352	57.093	2.591	56.618
1.700	57.000	2.156	57.343	2.356	57.104	2.596	56.638
1.750	56.700	2.160	57.349	2.360	57.103	2.601	56.636
1.800	58.100	2.163	57.337	2.364	57.103	2.607	56.637
1.900	57.500	2.167	57.322	2.369	57.102	2.612	56.655
2.000	56.900	2.171	57.301	2.373	57.093	2.617	56.663
2.003	57.515	2.174	57.288	2.377	57.078	2.622	56.693
2.006	57.552	2.178	57.305	2.382	57.068	2.628	56.685
2.009	57.559	2.182	57.328	2.386	57.081	2.633	56.741
2.012	57.544	2.185	57.331	2.390	57.088	2.638	56.809
2.016	57.514	2.189	57.323	2.395	57.073	2.644	56.797
2.019	57.475	2.193	57.309	2.399	57.057	2.649	56.773
2.022	57.479	2.196	57.295	2.404	57.049	2.655	56.728
2.025	57.521	2.200	57.296	2.408	57.047	2.660	56.601
2.028	57.533	2.204	57.283	2.413	57.038	2.665	56.448
2.031	57.502	2.208	57.276	2.417	57.029	2.671	56.440
2.034	57.473	2.211	57.286	2.422	57.038	2.676	56.534
2.038	57.452	2.215	57.278	2.426	57.044	2.682	56.641
2.041	57.439	2.219	57.259	2.431	57.033	2.687	56.675
2.044	57.443	2.223	57.254	2.435	57.019	2.693	56.668
2.047	57.473	2.226	57.255	2.440	57.002	2.699	56.712
2.051	57.489	2.230	57.236	2.445	56.998	2.704	56.696
2.054	57.475	2.234	57.221	2.449	57.011	2.710	56.646
2.057	57.468	2.238	57.230	2.454	57.018	2.716	56.586
2.060	57.447	2.242	57.225	2.458	57.022	2.721	56.571
2.064	57.420	2.246	57.189	2.463	57.019	2.727	56.691
2.067	57.439	2.250	57.173	2.468	57.008	2.733	56.653
2.070	57.443	2.254	57.201	2.472	56.994	2.739	56.565
2.073	57.411	2.257	57.230	2.477	56.971	2.744	56.663
2.077	57.408	2.261	57.225	2.482	56.964	2.750	56.668
2.080	57.410	2.265	57.222	2.487	56.978	2.756	56.595
2.083	57.420	2.269	57.220	2.491	56.990	2.762	56.572

Wavelength µm	Absorption %
2.768	56.594
2.774	56.654
2.780	56.646
2.786	56.642
2.792	56.693
2.798	56.666
2.804	56.648
2.810	56.698
2.816	56.705
2.822	56.709
2.828	56.715
2.834	56.707
2.840	56.726
2.847	56.746
2.853	56.776
2.859	56.837
2.866	56.876
2.872	56.864
2.878	56.821
2.885	56.772
2.891	56.729
2.897	56.699
2.904	56.694
2.910	56.697
2.917	56.688
2.924	56.684
2.930	56.689
2.937	56.687
2.943	56.686
2.950	56.688
2.957	56.685
2.964	56.680
2.970	56.680
2.977	56.683
2.984	56.679
2.991	56.674
2.998	56.676
3.005	56.679
3.012	56.675
3.019	56.666
3.026	56.657
3.033	56.656
3.040	56.657
3.047	56.657
3.054	56.665
3.062	56.665
3.069	56.655
3.076	56.657
3.083	56.667
3.091	56.672
3.098	56.665
3.105	56.657
3.113	56.664

Wavelength µm	Absorption %
3.120	56.676
3.128	56.676
3.135	56.676
3.143	56.681
3.151	56.677
3.158	56.672
3.166	56.674
3.174	56.680
3.182	56.685
3.189	56.684
3.197	56.677
3.205	56.674
3.213	56.671
3.221	56.666
3.229	56.671
3.237	56.677
3.245	56.673
3.253	56.669
3.262	56.665
3.270	56.665
3.278	56.665
3.286	56.661
3.295	56.661
3.303	56.663
3.312	56.664
3.320	56.664
3.328	56.661
3.337	56.656
3.346	56.652
3.354	56.646
3.363	56.632
3.372	56.620
3.381	56.616
3.389	56.610
3.398	56.594
3.407	56.580
3.416	56.571
3.425	56.572
3.434	56.583
3.443	56.592
3.452	56.596
3.462	56.596
3.471	56.595
3.480	56.591
3.490	56.580
3.499	56.567
3.508	56.567
3.518	56.581
3.528	56.592
3.537	56.593
3.547	56.593
3.557	56.591
3.566	56.584

Wavelength µm	Absorption %
3.576	56.576
3.586	56.571
3.596	56.569
3.606	56.570
3.616	56.568
3.626	56.562
3.636	56.559
3.646	56.555
3.657	56.545
3.667	56.533
3.677	56.528
3.688	56.528
3.698	56.526
3.709	56.518
3.720	56.509
3.730	56.501
3.741	56.494
3.752	56.489
3.763	56.482
3.774	56.476
3.785	56.470
3.796	56.460
3.807	56.447
3.818	56.436
3.829	56.428
3.841	56.421
3.852	56.415
3.864	56.407
3.875	56.403
3.887	56.399
3.898	56.388
3.910	56.376
3.922	56.366
3.934	56.356
3.946	56.348
3.958	56.339
3.970	56.330
3.982	56.320
3.994	56.311
4.007	56.303
4.019	56.293
4.032	56.284
4.044	56.277
4.057	56.271
4.070	56.263
4.082	56.252
4.095	56.243
4.108	56.234
4.121	56.222
4.134	56.211
4.148	56.204
4.161	56.195
4.174	56.182

Wavelength µm	Absorption %
4.188	56.144
4.201	56.033
4.215	55.869
4.229	55.802
4.242	55.877
4.256	55.901
4.270	55.841
4.284	55.837
4.299	55.897
4.313	55.952
4.327	55.986
4.342	56.001
4.356	55.997
4.371	55.985
4.386	55.971
4.401	55.958
4.416	55.948
4.431	55.939
4.446	55.929
4.461	55.917
4.477	55.904
4.492	55.895
4.508	55.890
4.523	55.882
4.539	55.870
4.555	55.861
4.571	55.851
4.587	55.840
4.604	55.830
4.620	55.820
4.636	55.809
4.653	55.799
4.670	55.784
4.687	55.767
4.704	55.750
4.721	55.732
4.738	55.712
4.755	55.688
4.773	55.662
4.791	55.638
4.808	55.612
4.826	55.584
4.844	55.562
4.862	55.541
4.881	55.519
4.899	55.500
4.918	55.480
4.936	55.459
4.955	55.444
4.974	55.431
4.993	55.408
5.013	55.389
5.032	55.389

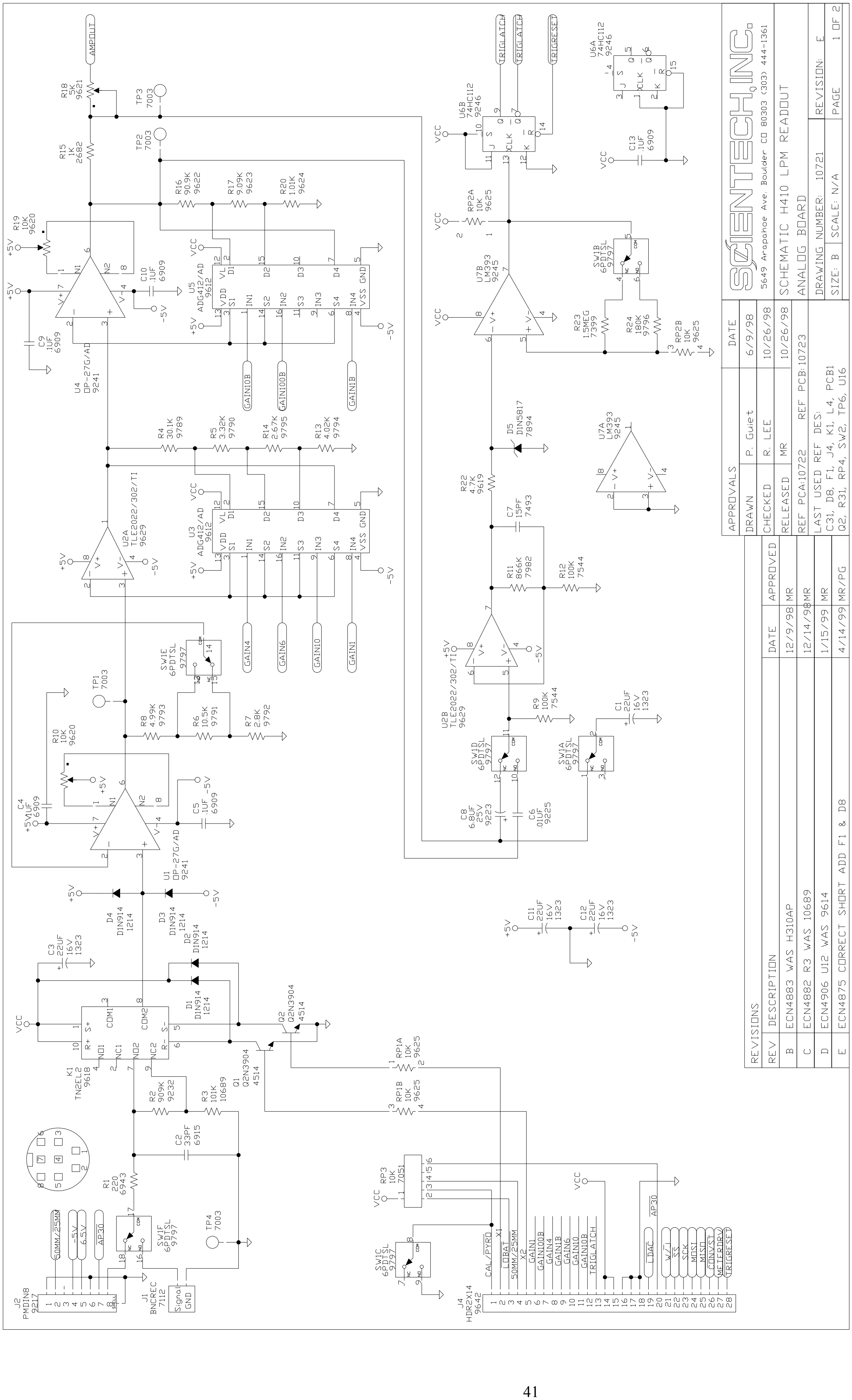
Wavelength µm	Absorption %
5.052	55.378
5.071	55.361
5.091	55.360
5.111	55.352
5.131	55.337
5.152	55.346
5.172	55.341
5.193	55.313
5.214	55.318
5.235	55.342
5.256	55.343
5.278	55.345
5.299	55.368
5.321	55.353
5.343	55.344
5.365	55.401
5.387	55.409
5.410	55.405
5.432	55.445
5.455	55.491
5.478	55.581
5.501	55.665
5.525	55.691
5.548	55.700
5.572	55.763
5.596	55.826
5.620	55.815
5.645	55.847
5.669	55.875
5.694	55.823
5.719	55.752
5.745	55.712
5.770	55.716
5.796	55.627
5.822	55.484
5.848	55.326
5.875	55.200
5.901	55.188
5.928	55.153
5.956	55.159
5.983	55.230
6.011	55.190
6.039	55.111
6.067	55.210
6.095	55.326
6.124	55.382
6.153	55.424
6.183	55.502
6.212	55.580
6.242	55.600
6.272	55.593
6.303	55.509
6.333	55.387

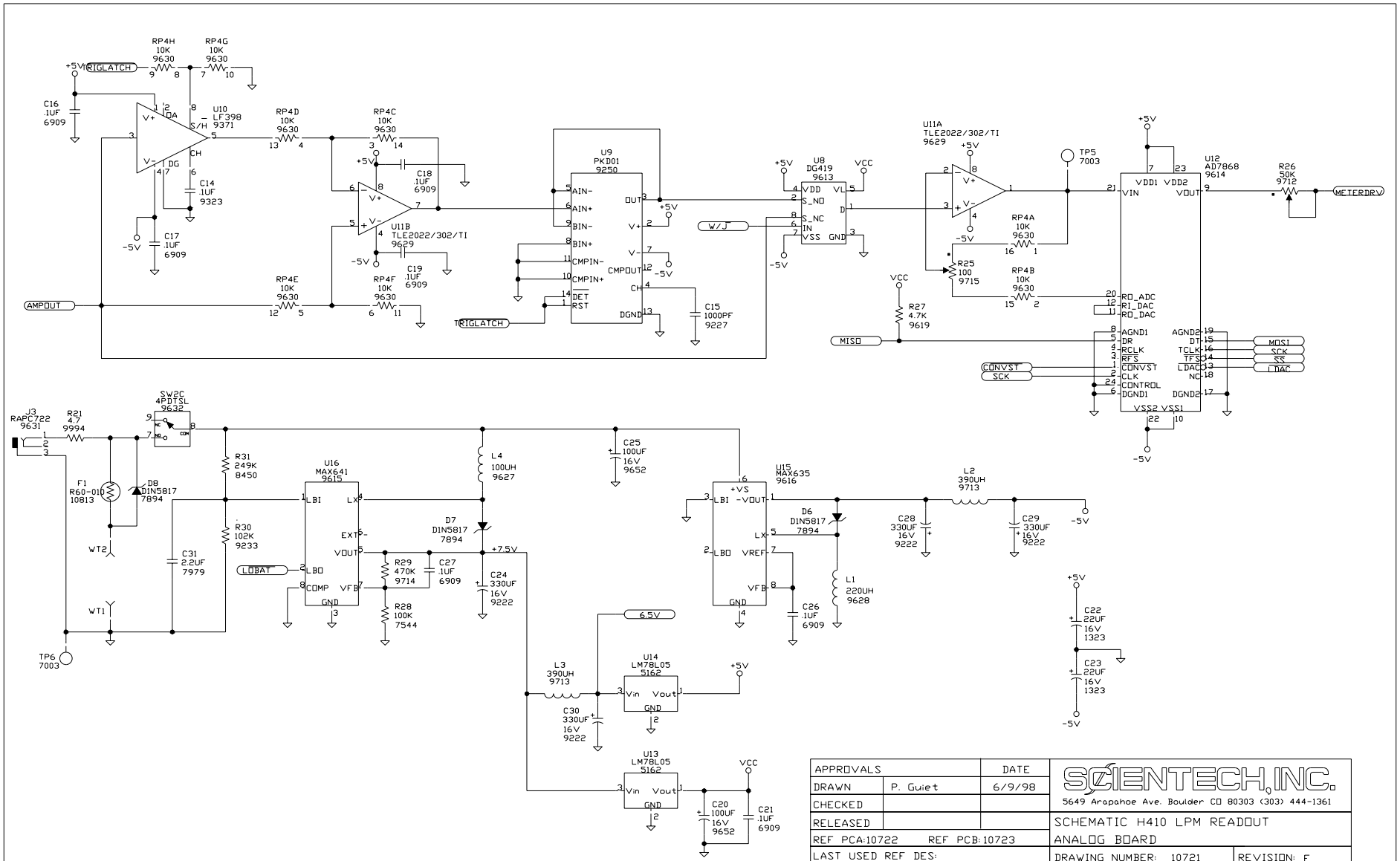
Wavelength µm	Absorption %
6.365	55.240
6.396	55.111
6.428	55.106
6.460	55.039
6.492	55.030
6.525	55.049
6.557	54.976
6.591	54.958
6.624	55.015
6.658	55.094
6.693	55.155
6.727	55.160
6.762	55.100
6.798	55.045
6.834	55.010
6.870	55.074
6.906	55.117
6.943	55.075
6.981	55.042
7.018	55.024
7.057	55.062
7.095	55.055
7.134	55.010
7.174	55.042
7.214	55.071
7.254	55.058
7.295	55.047
7.336	55.066
7.378	55.080
7.420	55.052
7.462	55.042
7.506	55.053
7.549	55.041
7.593	55.042
7.638	55.055
7.683	55.051
7.729	55.038
7.775	55.032
7.822	55.027
7.870	55.021
7.918	55.018
7.966	55.016
8.015	55.013
8.065	55.010
8.116	55.013
8.167	55.022
8.218	55.029
8.271	55.032
8.324	55.041
8.378	55.056
8.432	55.065
8.487	55.077
8.543	55.096

Wavelength µm	Absorption %
8.600	55.119
8.657	55.151
8.715	55.183
8.774	55.216
8.834	55.253
8.894	55.292
8.956	55.343
9.018	55.403
9.081	55.462
9.145	55.520
9.210	55.581
9.276	55.641
9.343	55.701
9.410	55.772
9.479	55.849
9.549	55.931
9.620	56.027
9.691	56.141
9.764	56.262
9.838	56.393
9.913	56.544
9.990	56.711
10.067	56.885
10.146	57.065
10.226	57.264
10.307	57.489
10.390	57.740
10.473	58.013
10.559	58.301
10.645	58.621
10.733	58.973
10.823	59.327
10.914	59.674
11.006	60.048
11.100	60.512
11.196	60.976
11.294	61.227
11.393	61.171
11.494	60.830
11.596	60.291
11.701	59.605
11.807	58.914
11.916	58.408
12.026	57.969
12.139	57.388
12.253	56.654
12.370	55.856
12.489	55.044
12.611	54.230
12.734	53.420
12.860	52.603
12.989	51.767
13.120	50.912

Wavelength µm	Absorption %
13.254	50.028
13.391	49.105
13.531	48.136
13.673	47.138
13.819	46.140
13.968	45.150
14.120	44.205
14.275	43.355
14.434	42.615
14.596	41.947
14.762	41.404
14.932	41.115
15.106	40.710
15.284	39.712
15.466	38.254
15.652	36.607
15.843	34.810
16.039	32.791
16.240	30.540
16.446	28.176
16.657	25.938
16.873	24.525
17.095	24.855
17.324	26.997
17.558	29.907
17.799	32.631
18.046	34.907
18.301	36.682
18.563	38.001
18.832	39.192
19.109	40.501
19.395	41.883
19.689	43.268
19.992	44.500
20.305	45.515
20.628	46.556
20.961	47.950
21.305	49.687
21.661	51.005
22.028	50.312
22.409	47.489
22.802	45.586
23.210	46.163
23.633	46.509
24.071	44.911
24.526	42.487
24.998	39.856
25.489	37.772
26.000	36.255

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
DATE
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



APPROVALS		DATE
DRAWN	P. Guiet	6/9/98
CHECKED		
RELEASED		
REF PCA:10722	REF PCB:10723	
LAST USED REF DES:		

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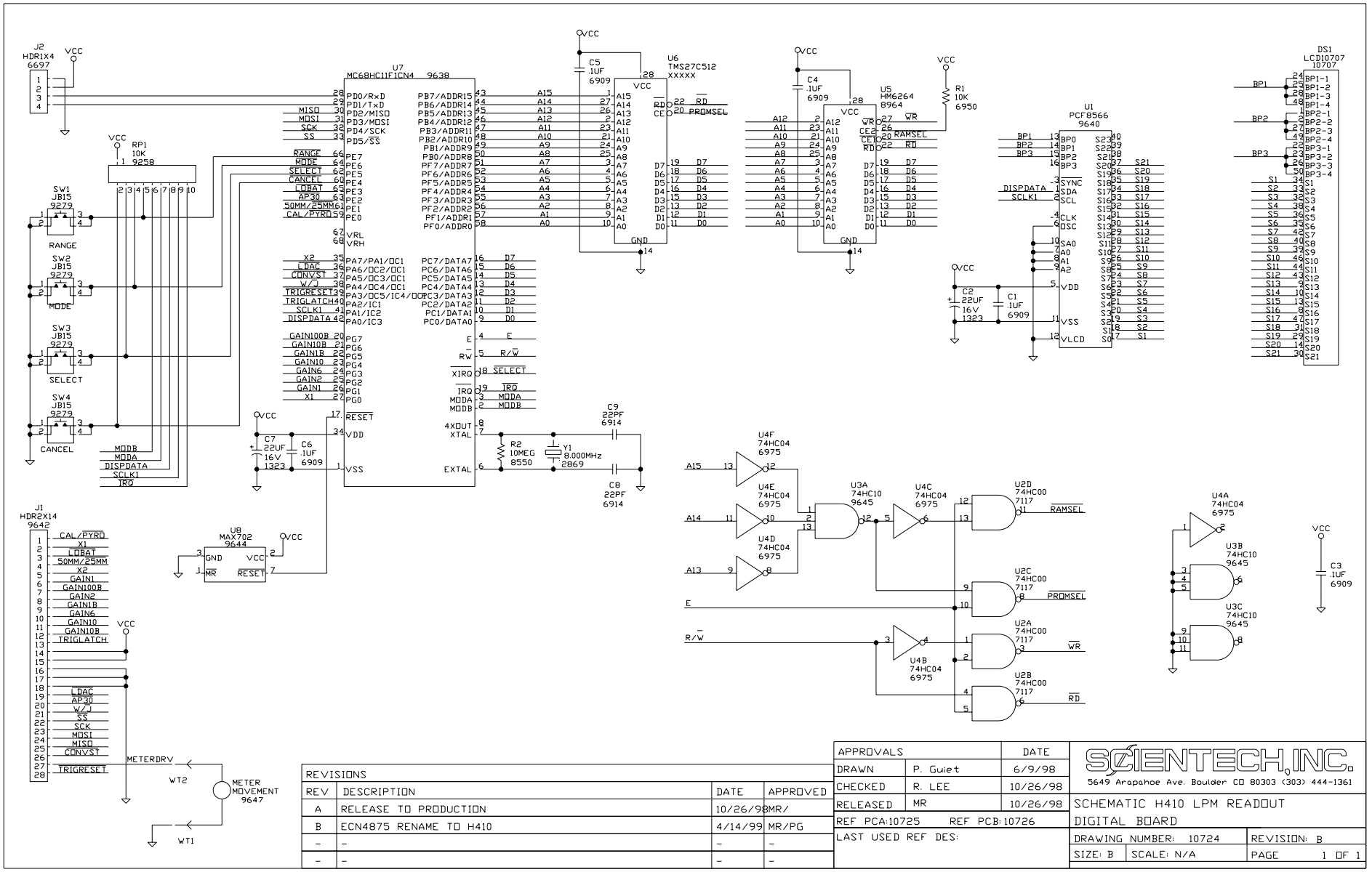
SCHEMATIC H410 LPM READOUT
ANALOG BOARD

DRAWING NUMBER: 10721 | REVISION: E
SIZE: B | SCALE: N/A | PAGE 2 OF 2



REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	RELEASE TO PRODUCTION	10/26/98	MR/
B	ECN4875 RENAME TO H410	4/14/99	MR/PG
–	–	–	–
–	–	–	–

APPROVALS		DATE
DRAWN	P. Guiet	6/9/98
CHECKED	R. LEE	10/26/98
RELEASED	MR	10/26/98
REF PCA:10725	REF PCB:10726	
LAST USED REF DES:		

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SCHEMATIC H410 LPM READOUT
DIGITAL BOARD

DRAWING NUMBER: 10724 | REVISION: B
SIZE: B | SCALE: N/A | PAGE 1 OF 1