OPTI-SCIENCES

8 Winn Ave.
Hudson, NH 03051
Phone 603-883-4400
Fax: 603-883-4410
Email: sales@optisci.com
Website: www.optisci.com

NEW

OS5p

Pulse Modulated Chlorophyll Fluorometer

The New Standard in Portable Fluorometers

Detection of Almost All Types of Plant Stress - The Most Advanced Portable System Available.

Wider Range of Automated Programmable Testing Protocols – More Than Any Other Portable Fluorometer

New Technology – Dramatic Innovations Improve Measurement Reliability

Rugged Field Portable – Designed for Extended Field Studies and Remote Locations

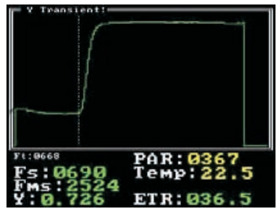
Better tests allow better science

Test parameters and protocols offered with the OS5p

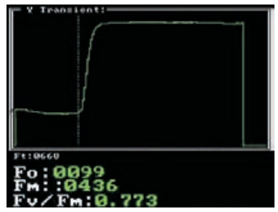
The Most Popular Tests:

Y: (or ΔF/Fm' or (Y(II)) quantum photosynthetic yield of PSII (light adapted)
Fv/Fm: Maximum quantum yield - Photochemical efficiency of PSII (dark-adapted)
ETR: Electron Transport Rate (w/optional PAR clip)
PAR: Photosynthetically Active Radiation value
(with optional PAR clip)
T: Leaf temperature (with optional PAR clip)

ΔF/Fm'



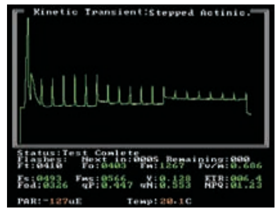
Fv/Fm



New Tests:

FRFex360/FRFex440 for nitrogen stress testing. This test separates nitrogen and sulfur stress (with optional Universal PAR Clip).
Stepped Actinic test for light curves, rapid light curves and non-sequential light curves
Multi-flash Fm' correction for more reliable photosynthetic yield and ETR measurements under high light stress conditions
Automated Programmable Quenching tests for stress testing, evaluation of photoprotective mechanisms, state transitions, and photoinhibition. The OS5p includes both Kramer and Klughammer Lake model parameters

Light Curves



Advanced lake and puddle model quenching parameters

Kramer Lake model quenching parameters (2004)

Y(II) Quantum photosynthetic yield
qL Photochemical quenching
Y(NPQ) Photoprotective non-photochemical quenching
Y(NO) All other non-photo-protective non-photochemical quenching

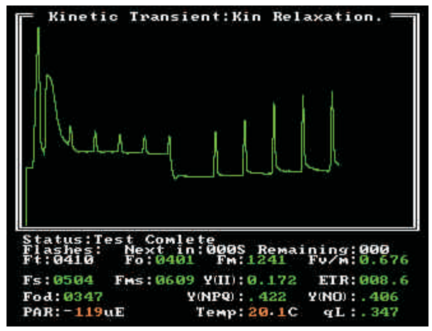
Kughammer simplifed lake model parameters (2008)

Y(II) Quantum photosynthetic yield
Y(NPQ) Photoprotective non-photochemical quenching
Y(NO) All other non-photo-protective non-photochemical quenching
NPQ: Non-photochemical quenching NPQ=Y(NPQ)//Y(NO)

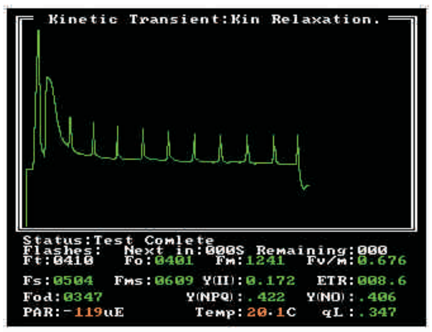
Puddle model quenching parameters

qP: Photochemical quenching
qN: Non-photochemical quenching
NPQ: Non-photochemical quenching
- q_E Photoprotective non-photochemical quenching
- q_T The portion of NPQ related to state transitions
- q_I The portion of NPQ due to photo-inhibition and photodamage

Puddle Model



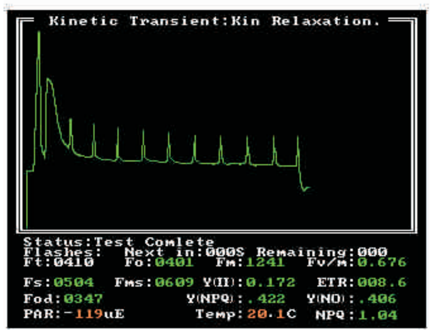
Kramer Lake Model



Other Parameters:

Fo: Dark-adapted initial fluorescence value
Fm: Maximal fluorescence
Fv: Variable fluorescence
Ft: Terminal fluorescence value
Fod: (or Fo') quenched value of the Fo used in many quenching calculations.
Fms: (or Fm') Maximal fluorescence after first saturation pulse
Fs: (or F) Fluorescence under steady state condition (prior to saturation pulse)
OJIP curves, O, J, I, P, Area above the curve, & time to P

Klughammer Simplified Lake Model



Innovative PAR Clip

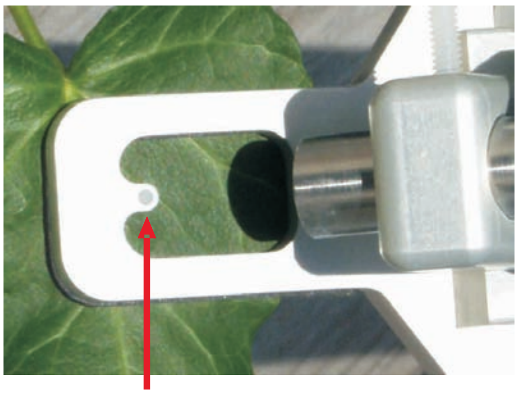
Technology Advances

The Opti-Science PAR Clip was created to improve upon previous industry designs.

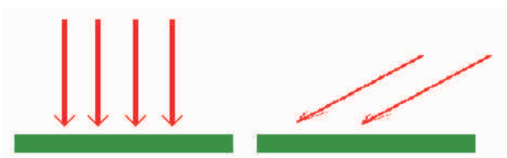
By developing a *bottom opening* PAR Clip, this new model prevents inappropriate opening when measuring leaves above the operators head, or when mounted on a tripod that occurs with some industry designs. As a result, the Opti-Science PAR Clip allows one handed operation, and eliminates two handed operation.

This PAR light sensor is positioned to allow measurement of ambient PAR as well as PAR from internal actinic light sources. Special care must be taken when using internal light sources for actinic illumination measurement. For reliable measurement, with internal light sources, cosine correction, spectral error, PAR sensor location error, lamp and instrument heat must all be take in to account, as is done with Opti-Sciences PAR Clip.

A solid state thermistor is provided for a more reliable leaf temperature solution.



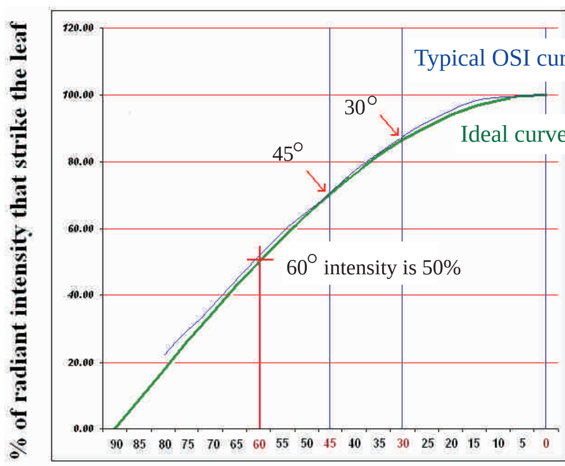
Cosine Corrected PAR Sensor



Less light strikes the leaf at steeper angles

Cosine correction When measuring PAR in ambient light or with internal illumination, one must not change the orientation of the leaf to make a measurement. Yield is a always measured at steady state photosynthesis so a change in orientation to a light source will cause an error. Cosign correction insures that leaves that are oriented at different angles to the actinic light sources will be measured reliably.

Lambert's Cosine Law
Comparison of an ideal response from a cosign corrected sensor and an OSI sensor

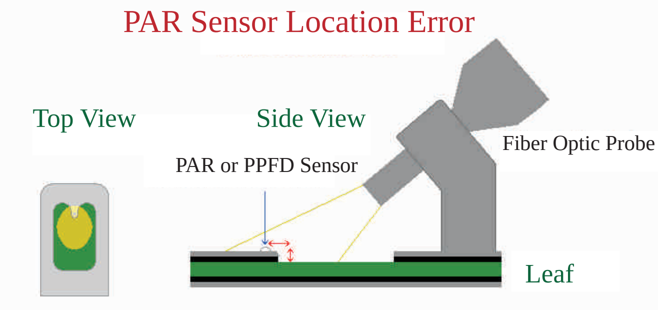


Angle variation from perpendicular (or normal)
As the angle of irradiation increases from perpendicular, the irradiation per unit area per second decreases.

Innovative PAR Clip

Sensor Location error In 2000, a researcher found that having a PAR sensor at a different plane from the leaf plane, and that is also laterally displaced from the center of measuring field, can produce an error in PAR measurement of up to 10%.

To correct for this error, Opti-Sciences calibrates the PAR sensor using a Licor 190 PAR meter at the leaf plane in the center of the measuring field.



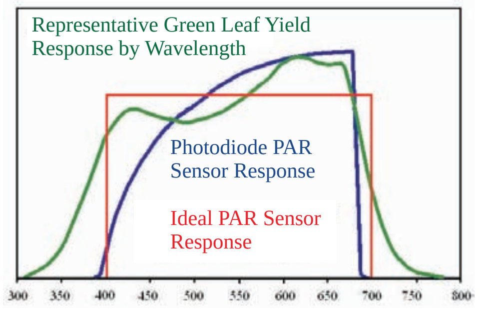
There is no significant error when measuring sun light. However, when internal actinic illuminators are used to drive photosynthesis at an angle, and through a fiber optic bundle, the error can be as much as 10% (Rascher 2000).

When making light curves, rapid light curves, non-sequential light curves, quenching measurements, and Yield measurements with internal illuminators, one should correct for this error. Opti-Sciences does the correction automatically.

Spectral Error Different light sources produce different spectrums. Opti-Sciences calibrates it's PAR sensors to different light sources to minimize the error using a Licor 190 series PAR meter at the leaf plane.

The Opti-Sciences PAR clip is Calibrated to sunlight, the internal actinic halogen light source, and the internal LED actinic light source. Correction factors may also be added for external light sources found in laboratories.

The correct calibration is automatically selected when a light source is chosen.



Stable Actinic Light Source

To make reliable quenching measurements, light curves, rapid light curves, and non-sequential light curves, a stable actinic light source is required. If the intensity of a light source changes dramatically during the measuring process, a significant error can be introduced.

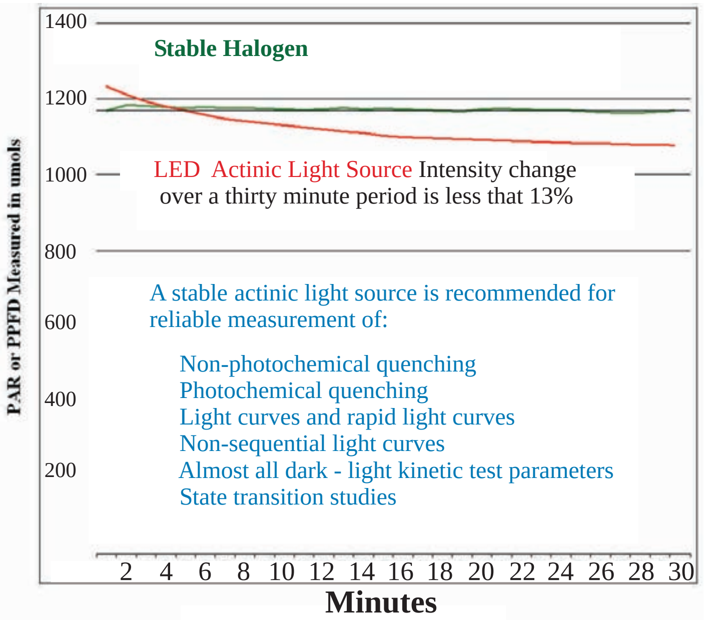
Most internal actinic light sources decrease in intensity over time due to heat build up created by the lamp it self.

One manufacture states that their internal actinic light source should not be used for more than two minutes because heat can cause a change in lamp intensity of up to 20%.

The OS5p offers a stable halogen actinic light source that varies less than 2% over a thirty minute period. Furthermore, the OSI PAR Clip will measure and record PAR values from the built in actinic light sources while longer quenching measurements and various types of light curves are produced.

The Stable Actinic light source produces more reliable measurements.

Opti-Sciences - **Stable Halogen Actinic Light Source** Intensity change over a thirty minute period. ***Less than 2%***



Light source intensity change over time

Multi-flash

Saturation pulses used with modulated fluorometers are designed close all PSII reaction centers.
The fluorescence intensity value of the saturation flash is used in most measurements including photosynthetic quantum yield, ETR, Fv/Fm, and quenching parameters.

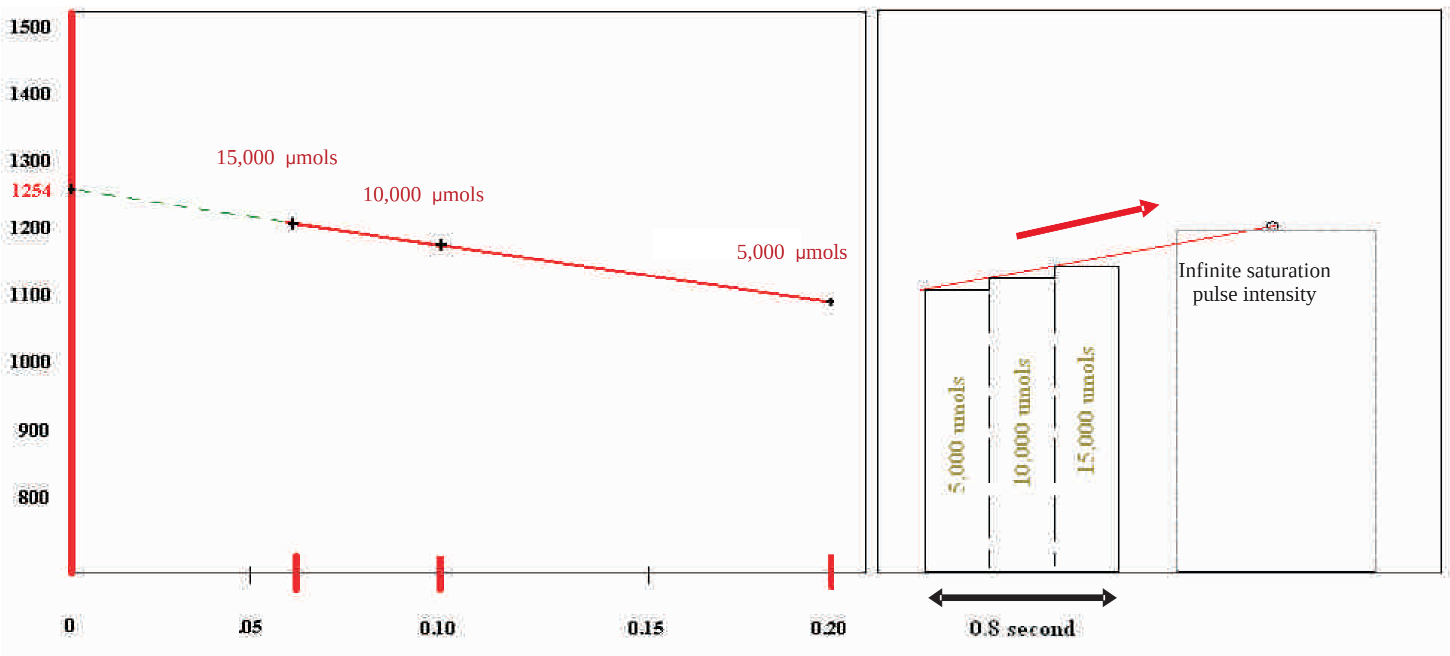
While it is possible to close all reaction centers in a properly dark adapted sample with a relatively low amount of light, it has been found that in light adapted samples with a high light history, complete closure of all PSII reaction centers becomes problematic with any amount of saturation light. With this in mind, Yield and ETR measurements taken under these conditions are underestimated.

Studies by (Earl 2004) and others have compared chlorophyll fluorescence measurement results with gas exchange measurements and found that by using very short multiple saturation flashes, and regression analysis, an infinite fluorescent saturation light flash intensity can be determined and used to correct Yield and ETR measurements.

This standard option can be turned on and off by the user for comparative results.

Correction of photosynthetic yield measurements under high light conditions.

By using the Earl method, strong correlation between ETR and carbon fixation measurements are restored. (Maize R^2 0.97 and Cotton R^2 0.97)



1/ (PAR x 1000) is graphed on the x axis and machine values for fluorescence intensity are plotted on the Y axis. Using the equation y=mx+b, linear regression analysis determines fluorescence intensity using an infinite saturation pulse intensity (Earl 2004).

Increasing saturation pulses at three intensity levels are used for regression analysis to determine the infinite saturation pulse.

FRFex360/FRFex440

For Nitrogen Stress Testing

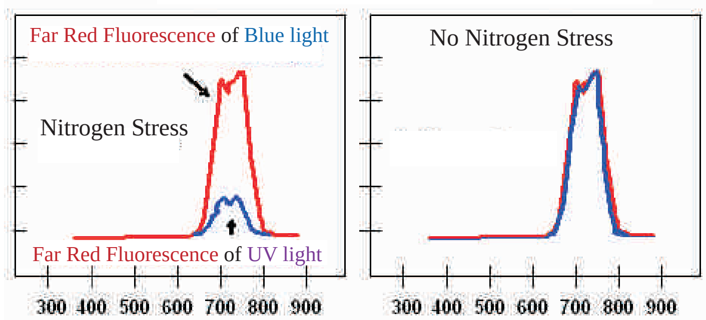
Measuring nitrogen plant stress rapidly and with high resolution has been a goal of researchers for many years. Standard photosynthesis yield measurements don't provide high enough resolution to measure nitrogen stress at a usable level.

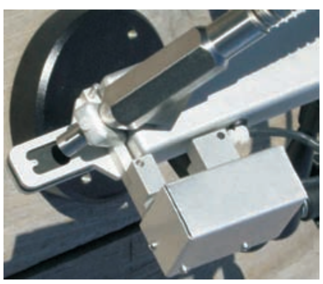
Cheng (2002) found that by combining light stress and nitrogen stress, the necessary resolution could be obtained for usable fluorescent nitrogen stress measurements. However, plants must be exposed to high light levels until steady state photosynthesis can be achieved which can take between fifteen and twenty minutes, or measurement must be taken in sunlight near mid-day.

In the year 2000, a group with extensive experience in the use of fluorescent ratio measurements discovered a test that removed an important variable from previous attempts to solve the nitrogen test problem. By comparing the far red fluorescence of UV with the far red fluorescence of Blue light excitation light sources, the Sampson group improved on previous tests that used not only separate excitation wavelengths, but also separate emission wavelengths.

Nitrogen Stress in plants can be determined by the ratio of UV excited and blue excited far red fluorescence, (FRFex360/FRFex440). Unlike leaf absorption techniques used for nitrogen testing, nitrogen stress can be distinguished from sulfur stress with this measurement (Sampson 2000). Fluorescence measurements are also less sensitive that leaf absorption techniques to leaf water content issues. FRFex360/FRFex440 measures the concentration of UV absorbing compounds in the leaf epidermis which are higher in nitrogen stressed plants.

Based on the Carbon/nutrient balance hypothesis, excess fixed carbon in the presence of a nitrogen deficit stimulates the Shikimate acid pathway. Under nitrogen stress conditions, the Shikimate acid pathway produces flavonoids and other carbon based compounds that reside primarily in the epidermis (Cerovic 1999), (Price 1989), (Waterman and Mole 1994). A decrease in the FRFex360/FRFex440 ratio indicates higher concentrations of flavonoid compounds due to nitrogen stress. Flavonoids absorb UV light and cause a decrease in excitation of chlorophyll molecules in the mesophyll. The blue light fluorescence acts as a measuring standard because it passes through the epidermis unaffected by these compounds. Therefore a ratio of far red fluorescence excited by UV and far red fluorescence of excited by blue light provides a sensitive test for nitrogen deficiency.





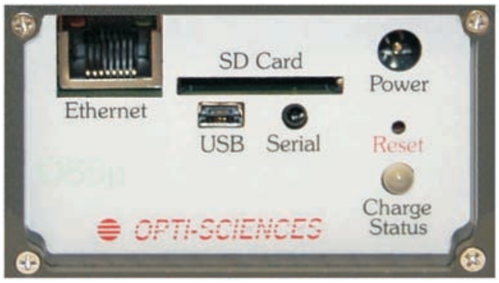
Optional - Universal Par Clip with FRFex360/FRFex440 attachment

Early Nitrogen Deficiency Test

Attention to Detail

Data Management

The OS5p provides a gigabyte of non-volatile flash memory designed to prevent data loss due to power interruption.



Data Card

The built-in MMC/SD data card system can be used with an unlimited number of fluorometer users to store individual measuring routines and individual data records. The data cards are very inexpensive and can store up to an additional gigabyte of information.

USB

A small USB port is provided on the side of the OS5p. When connected to a PC, the OS5p becomes a hard drive for a computer allowing the transfer of data, and measuring files, and allows software upgrades.

RS232 and Ethernet ports have been added for future development. They are not currently supported by software.

A single plug RS232 port is included.

Optional Blue Tooth

Blue tooth communications are available as an added cost option.

Touch Screen Menu Driven Software

To ensure that the OS5p is easy to use in the field, a high degree of automation, a touch sensitive screen, and menu driven software are provided. Even custom measuring routine functions are easily changed.

Accessories

Optional - Storage Shipping and Transport Case.

This durable abrasion resistant water tight plastic case allows storage of the OS5p with the fiber optic sensor attached. There is also room for a PAR clip, charger and leaf cuvetts.

Airline approved for carry -on luggage.

All Day Shoulder Harness

A harness designed for people that use the OS5p in the field for several hours per day. Weight is distributed to both shoulders and the torso without crossing the back of the neck.

For more casual use, the standard shoulder strap that comes with the carrying bag is more than adequate. The OS5p weighs 5 pounds. The PAR Clip and fiber Optic sensor add another 2.5 lbs.

Technical Specifications:

Light Sources:
Saturation pulse: Halogen source included.
Adjustable Halogen 0 ~ 15,000 uE, LED.
Modulated light: *Two wavelengths;*
Red: 660 nm LED with 690 nm short pass filter
Blue: 450 nm LED.
Actinic illumination: Two sources; Adjustable
LED 0 ~ 3,000 uE, Halogen 0 ~ 6,000 uE.
Far red: 735 nm LED w/ far-red filter (Fod or Fo' determination).
Intensity adjustable.
Detection Method: Pulse modulation method
Test Duration: Adjustable 2 sec. to 45 min., or 2 sec. to 16 hrs.
Time Resolution: From 1.0 μs to 0.1s, sampling is automatically set for optimal use.
Detector & Filters: A *sensitive PIN photodiode* with a 700 ~ 750 nm band pass filter.
Modulation Frequency: From 25 Hz to 1 MHz auto switched with phase of test.
Storage Capacity: 1 GB non-volatile memory, supports thousands of test data sets and traces. Standard MMC/SD storage memory media for unlimited storage.
Electronics: 32 Bit Processor w/1 GByte on board memory
Digital Output: Standard MMC/SD storage memory media, USB.
User Interface: Display: Color 320 x 240 dot LCD, w/ LED back light.
Keyboard: Soft Key pad navigation, 4 task keys, and touch screen
Power Supply: - Nickel metal hydride battery
Battery Life: Up to 15 hours with a nickel metal hydride battery.
Dimensions: (5.1ins x 9.1ins X 5.5 in)
Weight: 2.3Kg. (5 lbs.).
PAR Clip Weight 1.6 lbs

Accessories included:

1 Open Body Actinic Light Leaf Cuvette –light adapted work
10 Dark Adaption Cuvettes
Fiber Optic Probe
Battery Charger
PC Software
USB Cable
Carrying bag with shoulder strap
Data Card Reader and 1 GByte Data Card

Optional features & accessories:

PAR Clip - for Photosynthetically Active Radiation and leaf temp.
Universal PAR Clip - for PAR, leaf temp, and FRFex360/FRFex440
Algae Cuvette
Storage and Transport Case
All Day shoulder harness
70 hour battery belt
Tripods

OPTI-SCIENCES
8 Winn Avenue • Hudson, NH 03051 • USA
Phone: 603-883-4400 Fax: 603-883-4410
Email: sales@optisci.com Website: www.optisci.com