

# Measuring Flashed, Pulsed, and Other *Short-Lived* *Light Phenomena*

Presented by

  
**InternationalLight**  
Technologies

A DIVISION OF LABSPHERE



# Recorded Presentation

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Or Copy and Paste this YouTube link in your browser:  
<https://youtu.be/PaJJMgrF4ZA>



For 90%+ of the flash/pulse measurement use-cases, this training leaves the customer with a prescribed method to make proper and informed measurements with the appropriate ILT system and measurement method

# Agenda

- The Problem Statement
- Energy vs power
- Short-lived light (flash, strobe) sources and applications
- ILT Meters, software, and modes for measuring short-lived light phenomena
- Measurement examples
- Appendix: Measurement Considerations

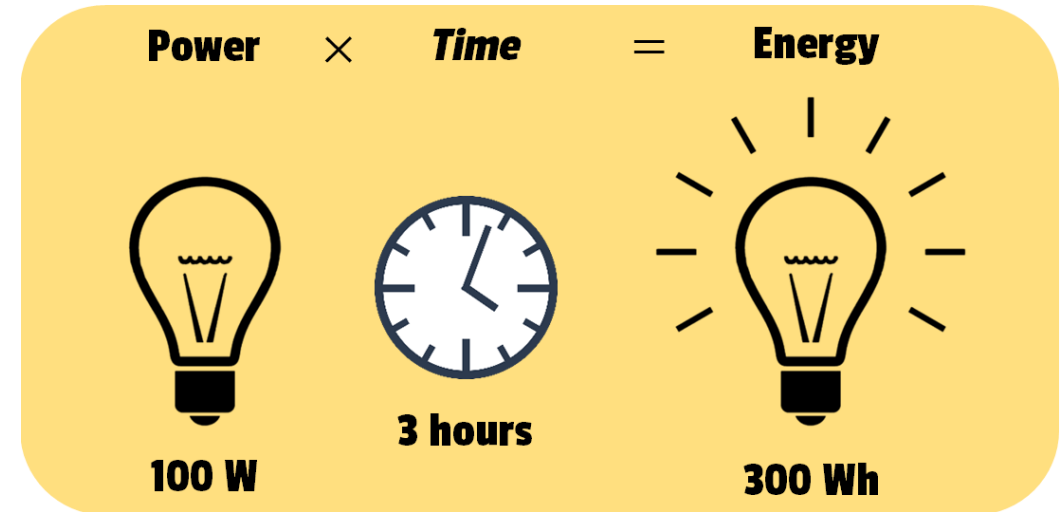
# The Problem Statement

- Measuring light can be tricky. Measuring *short-lived light* can be very difficult, requiring:
  - Coordination of the [abrupt] presence of the light power and the start of the data capture
  - High-speed data sampling to reliably capture the short-lived light occurrence with acceptable time resolution
  - Wide or selectable dynamic range to properly capture momentary peaks in power
  - The ability to comprehend the measurement results, understanding the [potential] difference between physical phenomena and measured results



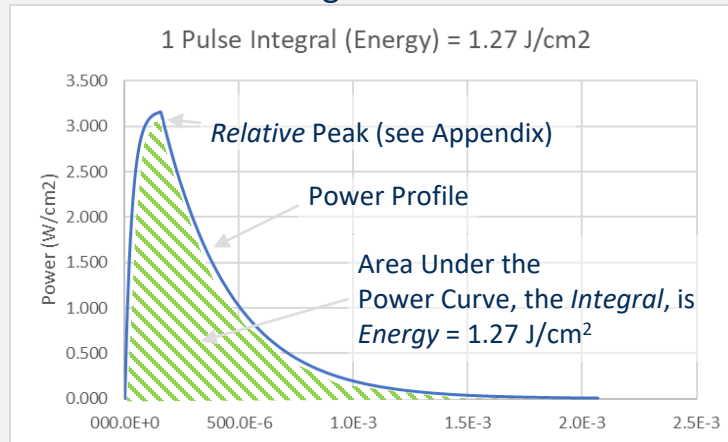
# Energy vs Power

- Energy is the integral, over time, of power
- There is electrical power and radiant power
  - Don't confuse these!
- For short-lived light (flashed and pulsed):
  - Energy can be reliably measured
  - Power, in some cases, can *not* be reliably measured (more later)
    - *Due to the difference between the physical world and the light meter's analog front end (AFE)*

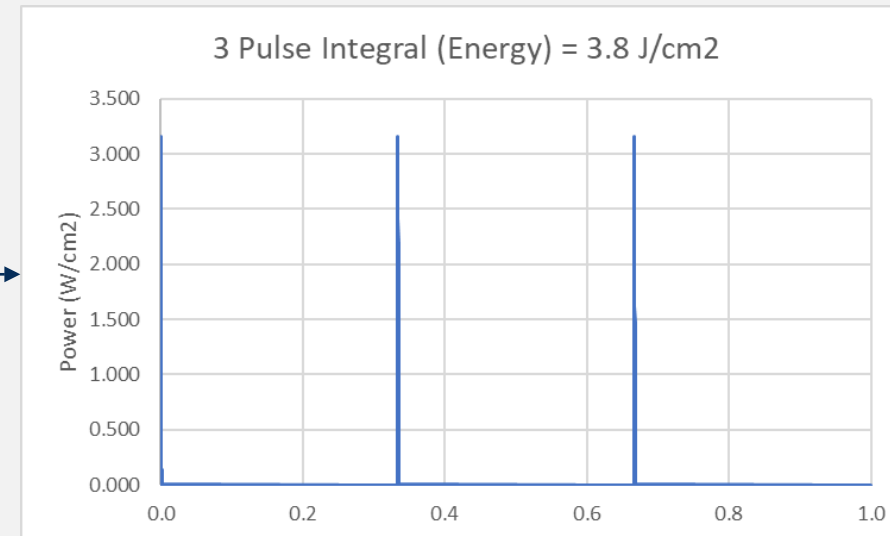


# Energy as the Integral of Power

Single Pulse



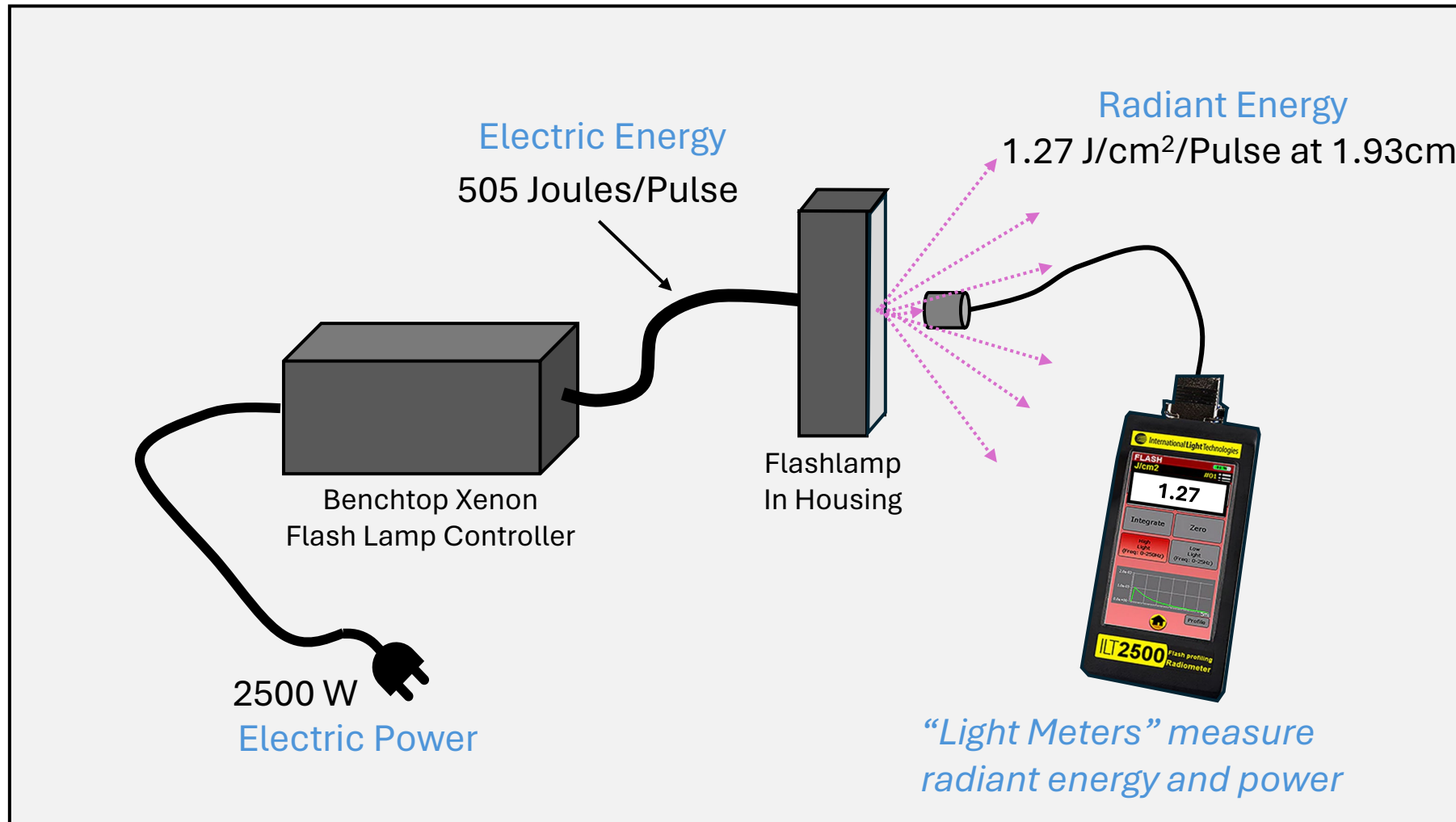
Three Pulses per Second (3 Hz)



Note change in X-axis time scale required to depict all three pulses. The area under each curve, the integral or total energy, is still 1.27 J/cm<sup>2</sup>

# Energy vs Power

Electric power supplies electric energy input to a lamp which, in turn, produces radiant energy





# Common Power and Energy Units

Application	Power Units	Energy Units
UV-C Disinfection	W/cm <sup>2</sup>	J/cm <sup>2</sup>
Camera Flash	Lux (Lumen/m <sup>2</sup> )	Lux-Seconds
Warning/Indicator Strobes	Candela/m <sup>2</sup>	Candela-Seconds/m <sup>2</sup>
Laser Safety	W/cm <sup>2</sup>	J/cm <sup>2</sup>

Power and Energy  
*also known as...*



## Power

- Irradiance
- Intensity
- Fluence Rate

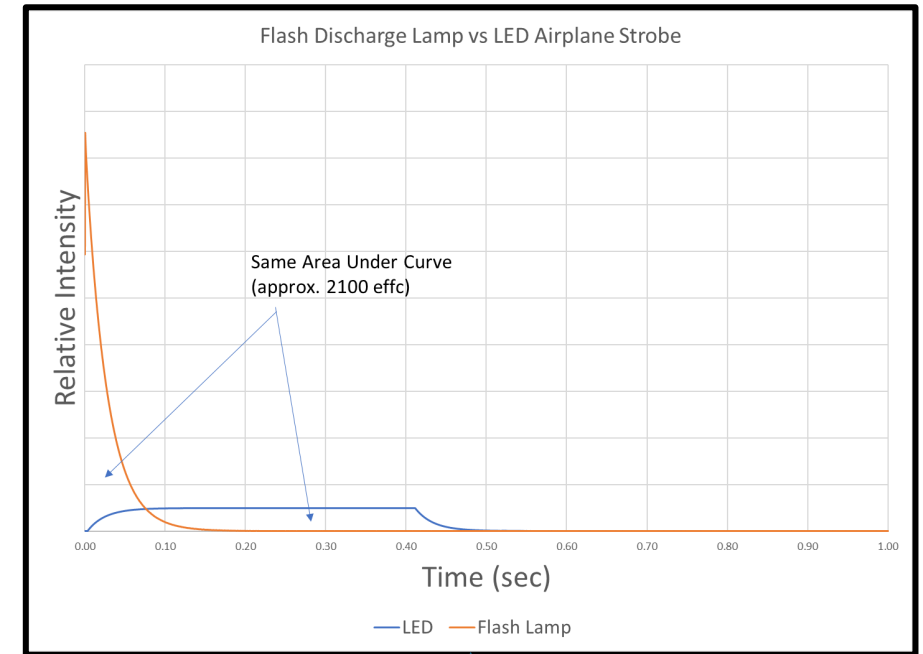


## Energy

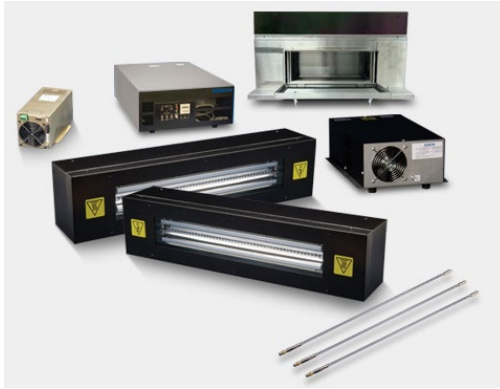
- Exposure
- Dose
- Fluence

# Energy: Discharge vs LED Flash

- Discharge flash
  - Abrupt, brief, high-power output
  - Pulse duration is typically 10s of microseconds
- LED “flash”
  - More gradual, longer, lower-power output
  - Pulse duration is typically on the order of 100s of milliseconds
- But the *energy* can be equivalent
  - Energy is the area under the curve



# Short-Lived Light Sources



**Pulsed Xenon Sources**



**Airplane [Wing] Strobes**



**Laser Light Show,  
“Audience Scanning”**



**Fire Alarm Strobe**



**Camera Flash**

# Power-Over-Time, Various Sources

Type	Example	Time Scale Zoomed	Time Scale 1s
LED		<p>High-Power Xenon Flash (360us FWHM)</p>	<p>High-Power Xenon Flash (360us FWHM)</p>
		<p>LED Aircraft Strobe</p>	<p>LED Aircraft Strobe</p>
		<p>LED Visual Alarm Device (VAD)</p>	<p>LED Visual Alarm Device (VAD)</p>
		<p>Camera Flash (1.3ms t.1 flash)</p>	<p>Camera Flash (1.3ms t.1 flash)</p>
		<p>Laser Show MPE (250ms scan over eye)</p>	<p>Laser Show MPE (250ms scan over eye)</p>

# ILT Light Meter SLL Measurement

Meter or Application	Measurement Method	Internal API Used	Flash Detection Method	Detects
ILT1000, 2400, 2500, 5000	Start/Stop Integrate	startintegrate	N/A	Integral (Energy)
ILT1000, 2400, 2500, 5000	FW Peak <sup>1</sup>	startpeak	N/A	Peak Power <sup>2</sup>
Windows Flash App (ILT1000, 2400, 2500, 5000)	Flash Capture, Flash Profile	captureflash	Minimum Light Level External Trigger (ILT5000)	Integral (Energy), Profile (Power-over-time)*
Windows Flash App (ILT1000, 2400, 2500, 5000)	Repeating Profile	startpeak	ILT Flash Detect Algorithm	Integral (Energy), Profile (Power-over-time)*
ILT2500	Flash Applet	startintegrate startpeak	ILT Flash Detect Algorithm	Integral (Energy), Profile (Power-over-time)*
ILT2500	Beacon Applet	startpeak	ILT Flash Detect Algorithm	Integral (Energy)

1. FW [Firmware] Peak described later on Slide 25, Note 2.

2. The power levels for high-speed sources (i.e. discharge sources) presents a relative power level (See Appendix)

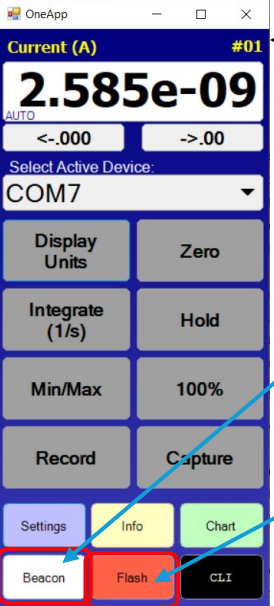
# Measurement Examples

# Measurement Setup

- Ensure the flash or strobe power level rises well above ambient power levels:
  - Dark room is recommended for visible light
  - Lighted room is acceptable when the detector is “visible blind” (the detector filters out visible light), for example when measuring UV-C flash
  - Position the detector as close as practical to the source, without saturating the detector
- Ensure the meter is configured for the following:
  - Fixed range (Auto Gain Range = OFF) to ensure the power burst is not missed during a gain range change
  - Integrating Mode = Flash and Min/Max Mode = FW Peak, both to instruct the meter’s CPU to favor measurement over monitoring user UI activity
  - 5V Bias = ON, to ensure fastest possible detector response to the power burst (See Appendix for more information)



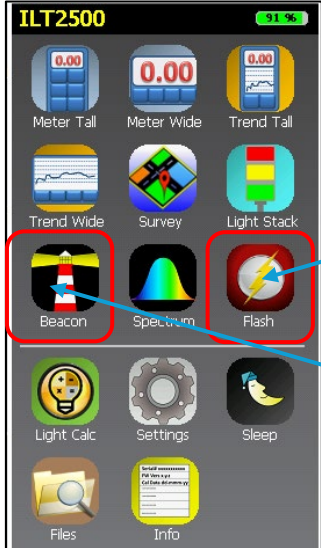
# App Reference



“Windows Meter App”  
(ILT1000,2400,  
2500,5000)

“Windows Meter App  
Beacon Applet”

“Meter Windows App  
Flash Applet”



ILT2500 Home Screen

“ILT2500 Flash Applet”

“ILT2500 Beacon Applet”

*ILT DataLight III Desktop Folder*

Name	Date modified	Type	Size
CLI	8/18/2022 9:41 AM	Shortcut	3 KB
Datalog	8/18/2022 9:41 AM	Shortcut	3 KB
Flash	8/18/2022 9:41 AM	Shortcut	3 KB
FW Update	8/18/2022 9:41 AM	Shortcut	3 KB
Meter	8/18/2022 9:41 AM	Shortcut	3 KB
NetConfig	8/18/2022 9:41 AM	Shortcut	3 KB

“Windows Flash App”  
(ILT1000,2400,  
2500,5000)

# Utilizing the Flash Applet

*This applet automatically configures the meter for flash measurement*

# Simple Flash Integration

**2.** Press Integrate to start integration

**1.** Select HIGH Light or LOW Light

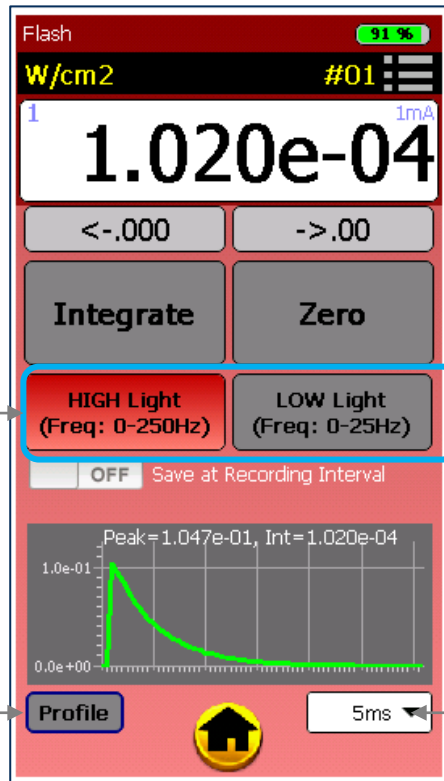
Note: When possible, the Flash Applet will count the number of detected flashes or strobes.

**3.** Press Integrate to stop integration. Note that you define the integration period based on the duration between Step 2 and 3.

**Notables:**

1. ILT2500 screens shown. The Windows Meter App Flash Applet has similar screens.
2. Entering the Flash Applet sets the appropriate meter configuration automatically.
3. The HIGH Light is equivalent to the 1mA fixed range, and LOW Light is equivalent to the 3uA fixed range.

# Simple Flash Profile



1. Select HIGH Light or LOW Light

2. Select Profile

## Optionally

Select a profiling time (X-axis duration)

Notables:

1. Notables on the previous slide apply.
2. It is important to ensure that the ambient conditions allow the flash or strobe to rise considerably above ambient such that the flash detect algorithm can sense the start of the power rise. If the algorithm fails to detect a flash or strobe, because it either rises too slowly or too little above the ambient levels, the applet will report "Timeout looking for peak". Note that some flashes or strobes can not be detected with this algorithm. In those cases the Windows Flash App is a better solution.

# Utilizing the Beacon Applet

*This applet automatically configures the meter for  
strobe measurement*

# Strobe Measurement

1. Select the number of strobos to measure.

2. Select HIGH Light or LOW Light. Note the frequency limitations show for each.

3. Press START to start sensing, counting and analyzing the strobos.

Note: Known bug. This should read energy units, J/cm<sup>2</sup> in this case.

## Notables:

1. ILT2500 screens shown. The Windows Meter App's Flash Applet has similar screens.
2. Entering the Beacon Applet sets the appropriate meter configuration automatically.
3. The HIGH Light is equivalent to the 1mA fixed range, and LOW Light is equivalent to the 3uA fixed range.
4. It is important to ensure that the ambient conditions allow the flash or strobe to rise considerably above ambient such that the flash detect algorithm can sense the start of each strobe.

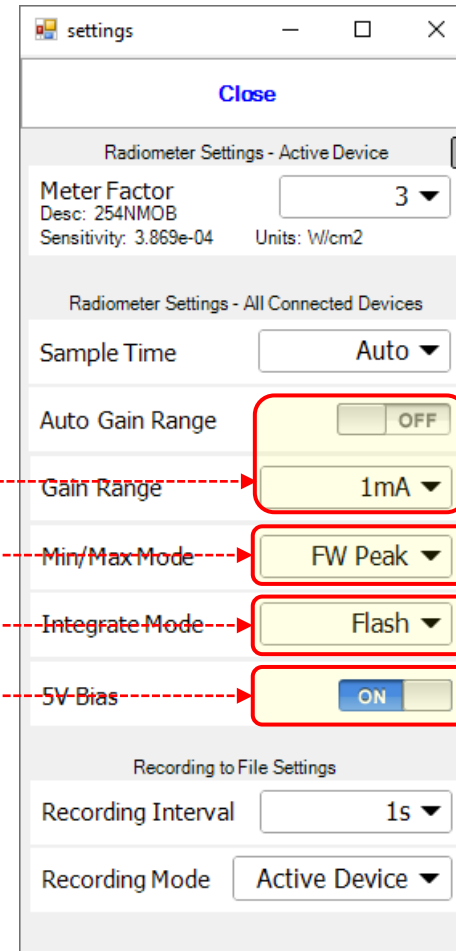
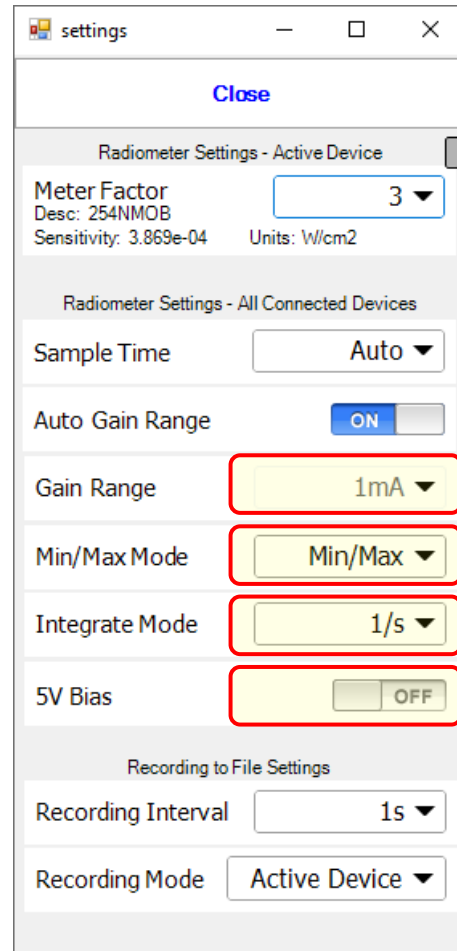
# Utilizing the standard meter functions

*These methods require YOU to configure the meter for flash measurement*

# Meter Configuration

Note:  
Windows Meter App  
shown. Press the *Settings*  
button to see these  
screens. ILT2400/2500  
screens are similar.

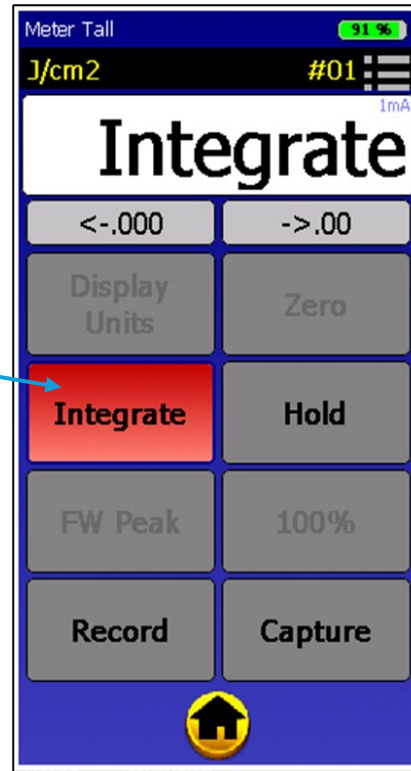
Defaults -----> Flash Measurement



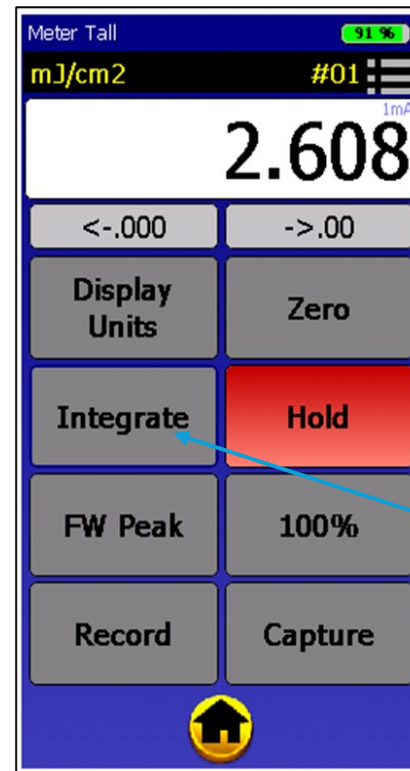


# Simple Flash Integration

**1.** Press Integrate to start integration. Note that the gain settings will match what was configured in the earlier *Meter Configuration* slide.

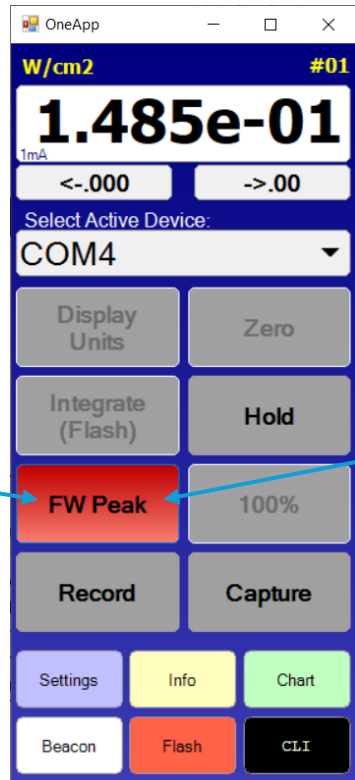


**2.** Press Integrate to stop integration. Note that you define the integration period based on the duration between Step 1 and 2.



# Simple Peak Detection

**1.** Press FW Peak to start peak detection. Note that the gain settings will match what was configured in the earlier *Meter Configuration* slide.



**2.** The peak value will be displayed on the screen. Press FW Peak to return to live sampling mode.

## Notables:

1. The Windows Meter App screen shown. ILT2400/2500 models have a similar screen.
2. FW peak is shorthand for “Firmware Peak” and indicates that the peak is being detected at the speed of firmware (several thousand samples per second) as opposed to the sampling rate (typically a few samples per second).
3. The peak detection is a good exercise prior to using the Windows Flash App, which has the option to use a power level to sense the start of a flash or strobe. This value provided by FW Peak can be used to set that power level.

# Utilizing the Windows Flash App

# Windows Flash App

- Most feature-rich solution for capturing short-lived light occurrences
- Many “knobs” provide flexibility but also adds complexity
  - Consult the user manual for full details
- Detects the start of a flash or strobe with one of two mechanisms:
  - Detection of a rise above a configured minimum light level
  - Detection of an external trigger (ILT5000 only)
    - Not covered here

# Windows Flash App

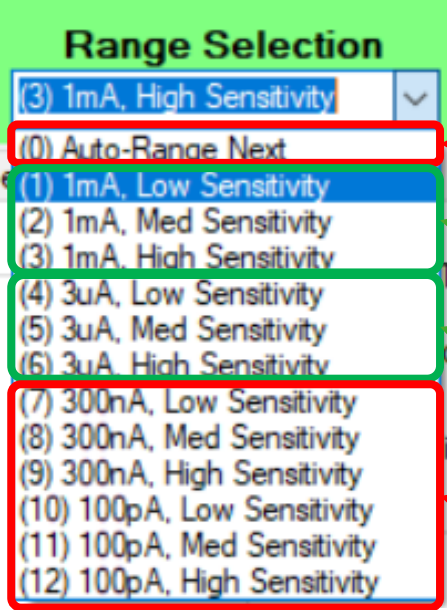
The screenshot shows the Windows Flash App interface. The main window is titled "Flash" and has a menu bar with "File" and "Help". The selected device is "00101". The interface is divided into several sections:

- Light Level:** Includes buttons for "Low", "Zero", and "Data Display". A "Factor Select" dropdown is set to "3".
- Range Selection:** Includes a "Range Selection" dropdown set to "(1) 1mA, Low Sensitivity".
- Flash Setup:** A tabbed interface with "Flash Setup", "Flash Capture", "Flash Profile", "Repeating Profile Setup", and "Repeating Profile".
- Flash Capture Trigger:** Includes radio buttons for "Trigger In", "Trigger Out", "Light Level", and "Manual". Each has a "Preplay" (sample time ahead of trigger) field set to "0" ms and a "Signal Transition" dropdown. The "Manual" option is selected.
- Integration Time:** Includes an "Integration Time" field set to "40" and radio buttons for "Milliseconds" (selected) and "Seconds".
- Range and Sensitivity Settings:** Includes an "Auto-Set Fixed Range Selection (based on Selected Device)" button.
- On-Device Data Capture During Profile:** Includes a checkbox for "Only Save Above Minimum Light Level".

Four callout boxes with arrows point to specific elements:

- Factor Select:** Points to the "Factor Select" dropdown menu.
- Range Select:** Points to the "Range Selection" dropdown menu.
- Setup, Capture, Profile:** Points to the "Flash Setup" tab.
- Trigger Select:** Points to the "Manual" radio button in the "Flash Capture Trigger" section.

# A Note on Range Selection



The screenshot shows a dropdown menu titled "Range Selection" with the following options:

- (3) 1mA, High Sensitivity
- (0) Auto-Range Next
- (1) 1mA, Low Sensitivity
- (2) 1mA, Med Sensitivity
- (3) 1mA, High Sensitivity
- (4) 3uA, Low Sensitivity
- (5) 3uA, Med Sensitivity
- (6) 3uA, High Sensitivity
- (7) 300nA, Low Sensitivity
- (8) 300nA, Med Sensitivity
- (9) 300nA, High Sensitivity
- (10) 100pA, Low Sensitivity
- (11) 100pA, Med Sensitivity
- (12) 100pA, High Sensitivity

Annotations with arrows point to specific options:

- Red arrow pointing to (0) Auto-Range Next: Not Recommended, fixed ranges preferred.
- Green arrow pointing to (1) 1mA, Low Sensitivity: Recommended, supporting signals up to 250 Hz
- Green arrow pointing to (4) 3uA, Low Sensitivity: Recommended, supporting signals up to 20 Hz
- Red arrow pointing to (10) 100pA, Low Sensitivity: Not Recommended, with supported bandwidth < 1Hz

\* See Technical Note on Page 42

# Flash Capture

- Work in an environment where the ambient background power (intensity level) is “dark” relative to the radiant energy being measured
- Learn the [relative] peak power level, either with:
  - Peak Detection mechanisms demonstrated above
  - By using a *Manual* Flash Capture Trigger
    - In cases where a repeating flashed source can reliably detect a flash within the configured *Integration Time*.
- Use a *Light Level* Flash Capture Trigger
  - Set the Minimum Light Level to a fraction (typically 1/4<sup>th</sup>) of the measured peak power level

# Light Level Trigger

The screenshot shows the 'Flash' software interface. The 'Selected Device' section is highlighted in green and contains the following information:

- Light Level**: A text input field with 'Low' entered.
- Factor Select**: A dropdown menu showing '3'.
- Range Selection**: A dropdown menu showing '(2) 1mA, Med Sensitivity'.
- 5V Bias**: A checked checkbox.

The 'All Checked Devices' section is highlighted in yellow and contains:

- Zero**: A button.
- 5V Bias**: An unchecked checkbox.
- Range Selection**: A dropdown menu showing '(0) Auto-Range Next'.

The 'Flash Capture Trigger' section is selected in the tabs. It contains:

- Trigger In**: Radio button, 'Preplay' (sample time ahead of trigger) set to 0 ms, Signal Transition dropdown.
- Trigger Out**: Radio button, Delay (after trigger, before sampling) set to 0 ms, Signal Transition dropdown.
- Light Level**: Radio button (selected), 'Preplay' (sample time ahead of trigger) set to 2 ms, **Minimum Light Level** set to 0.02 (highlighted in yellow and circled in red).
- Manual**: Radio button.
- Trigger Timeout**: A dropdown menu showing 2 secs.

The 'Integration Time' section contains:

- Integration Time**: A dropdown menu showing 10.
- Milliseconds**: Selected radio button.
- Seconds**: Unselected radio button.

The 'Range and Sensitivity Settings' section contains:

- Auto-Set Fixed Range Selection (based on Selected Device)**: A button.

The 'On-Device Data Capture During Profile' section contains:

- Only Save Above Minimum Light Level**: An unchecked checkbox.

A callout box with a blue background and black border points to the 'Minimum Light Level' field with the text: 'Minimum Light Level based on previous Peak Detection'.



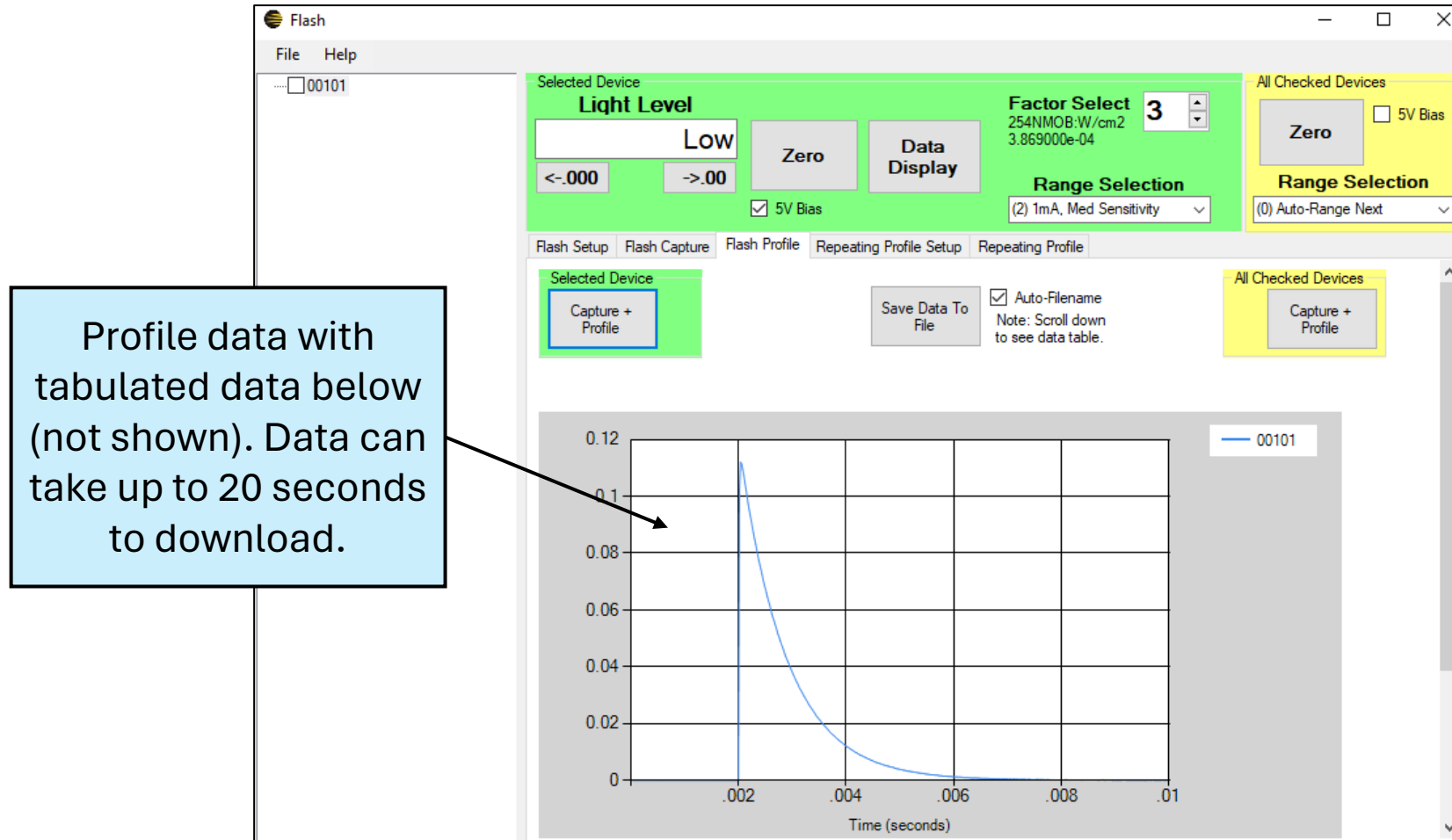
# Capture Once Results

Fast results (no need to download profile data), including:

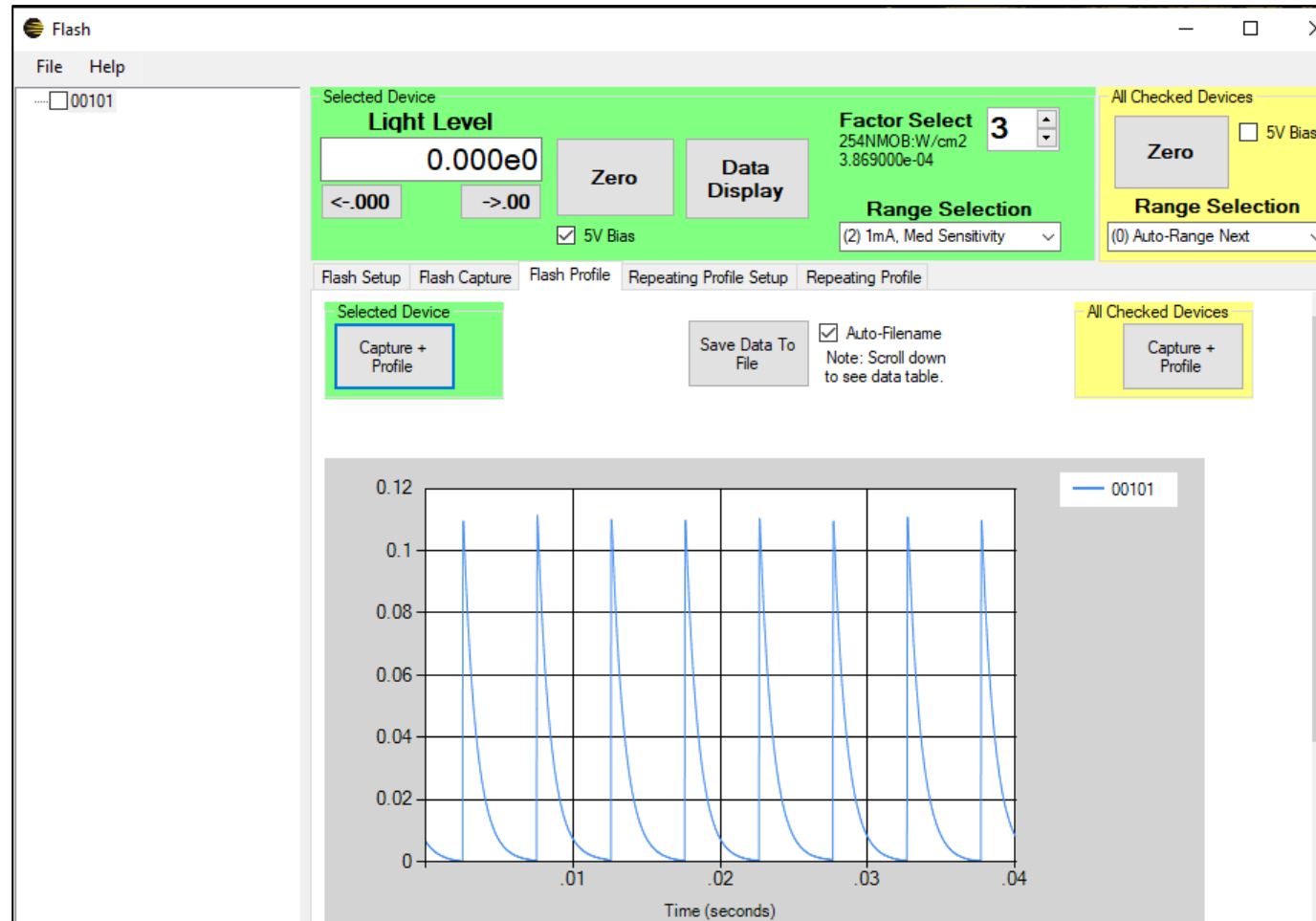
- Average Power
- Peak Power
- Integral (energy)

	Meter	Average	Peak	Integral	Time over 10% of Peak	Peak % of Range	Range	Sensitivity
*	00101	1.036e-2	1.120e-1	1.036e-4	2.060e-3	67	1mA	Med

# Capture + Profile (Single Pulse)



# Capture + Profile (Pulse Stream)



# Appendix

# Measurement Consideration

- Detector Covers
- Detector BIAS
- Relative Peak
- Other References

# Remove the protective cover!

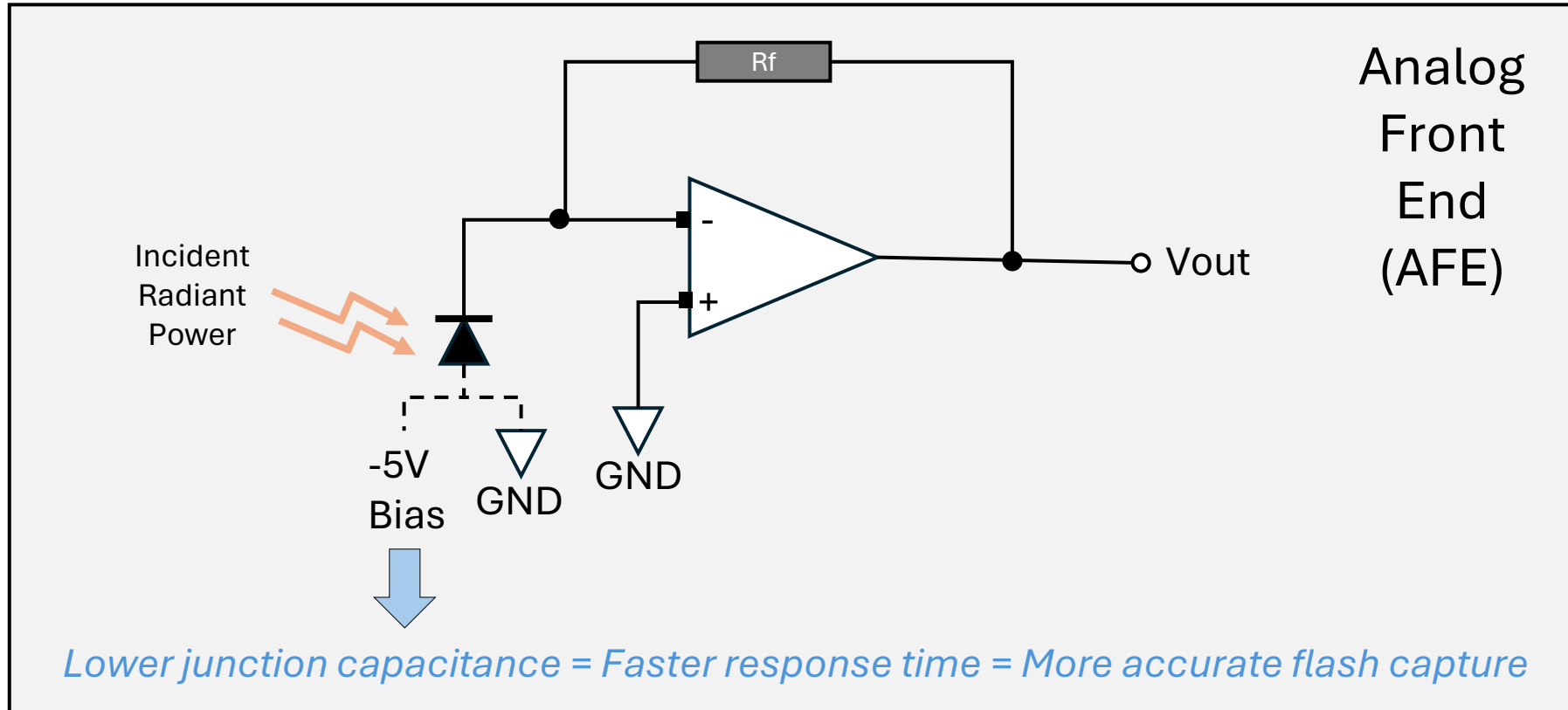
Protective cover. This must be removed.



Cover removed. Your "intake optic" may be larger, smaller, domed, etc.



# “Reverse Bias” for Speed



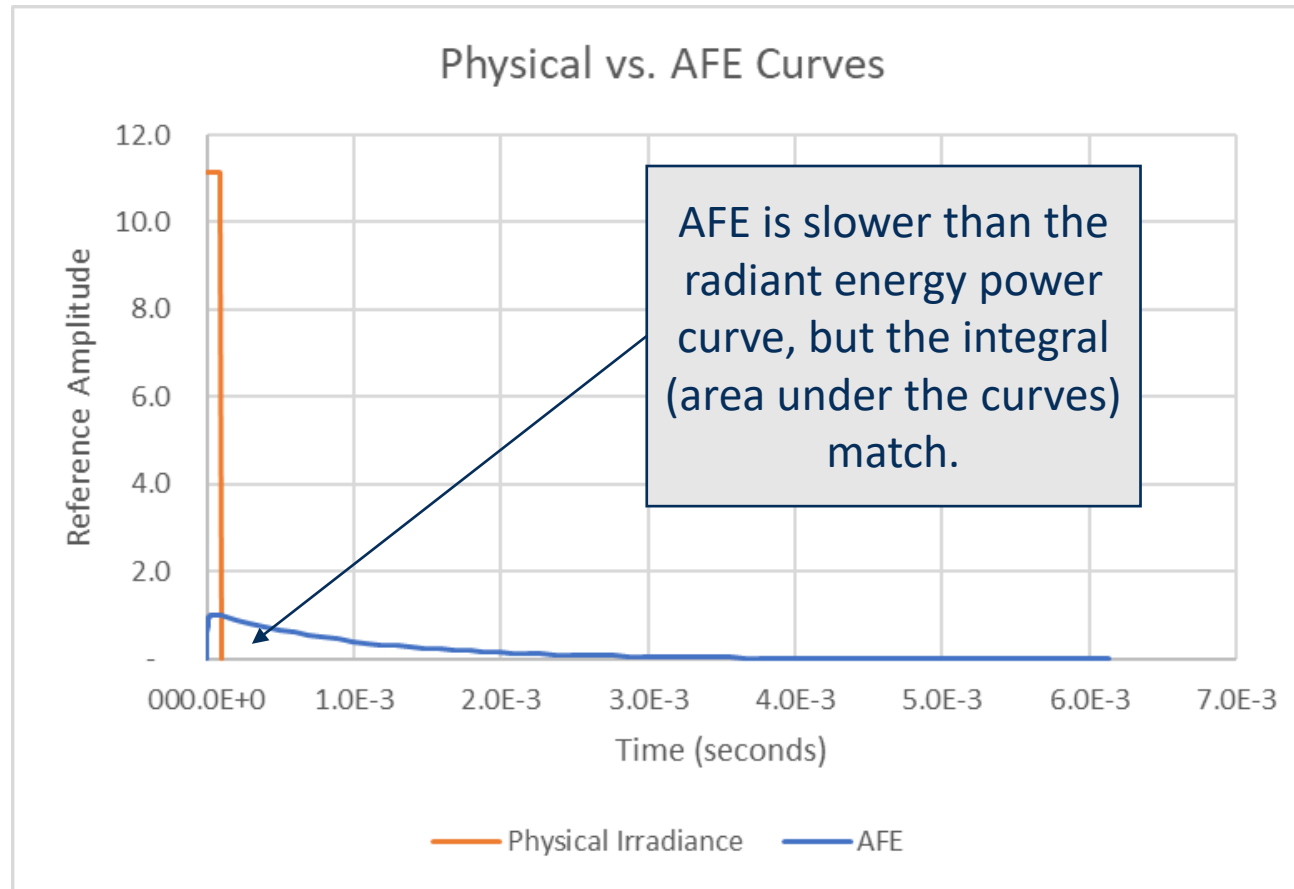
- “Reverse Biasing” the solid-state detector reduces its junction capacitance, allowing the electric signal at  $V_{out}$  to better mimic the fast-rising light phenomena.
- Setting the 5V Bias “ON” achieves this effect.

# Relative Peak

- The Analog Front End (AFE), due its own capacitance and time-constant, can potentially reshape the signal.
- *Potentially* because:
  - Incident radiant power that rises *faster* than the AFE can handle it will result in an electrical signal that is shorter and wider than the physical light signal
  - Incident radiant power that rises *slower* than the AFE is accurately represented
- The energy or integral, the area under the power curve, is accurately represented regardless of this effect
- But, for fast rising signals, the “Peak” power level must be considered relative and not absolute.



# Relative Peak



- DataLight III Windows Flash App User Manual
- DataLight III Meter User Manual
- ILT2500 User Manual
- Flash Capture App Note

Lux cal factor/ 5 /(distance in meters)<sup>2</sup>= Cal factor for **eff cd. For pulsed lights**

Lux cal factor /(distance in meters)<sup>2</sup>= Cal factor for **cd (CW light)**

If you have already measure in lux, but need to know the cd or eff. cd you can use the formula below:

converting lux to cd

Lux reading \* (distance)<sup>2</sup> = candela

Lux reading \* (distance)<sup>2</sup> \*5 = eff. candela (the human eye is five times more sensitive to a pulsed light flash.

If you have taken light reading and need to know which current range you are working in, you can easily converting calibrated light level reading to Amps using this formula:

Converting a reading to Amp. (Reading \* Calibration factor) = Current in Amps.

This is very useful when verifying proper range selection as discussed on page 29

Option	Range	Sensitivity	Recommendation	Notes
3	1mA	High Sensitivity	Not Recommended	fixed ranges preferred.
0	Auto-Range	Next	Recommended	supporting signals up to 250 Hz
1	1mA	Low Sensitivity	Recommended	supporting signals up to 20 Hz
2	1mA	Med Sensitivity	Recommended	supporting signals up to 20 Hz
3	1mA	High Sensitivity	Not Recommended	with supported bandwidth < 1Hz
4	3uA	Low Sensitivity	Recommended	supporting signals up to 250 Hz
5	3uA	Med Sensitivity	Recommended	supporting signals up to 20 Hz
6	3uA	High Sensitivity	Not Recommended	with supported bandwidth < 1Hz
7	300nA	Low Sensitivity	Not Recommended	with supported bandwidth < 1Hz
8	300nA	Med Sensitivity	Not Recommended	with supported bandwidth < 1Hz
9	300nA	High Sensitivity	Not Recommended	with supported bandwidth < 1Hz
10	100pA	Low Sensitivity	Not Recommended	with supported bandwidth < 1Hz
11	100pA	Med Sensitivity	Not Recommended	with supported bandwidth < 1Hz
12	100pA	High Sensitivity	Not Recommended	with supported bandwidth < 1Hz



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