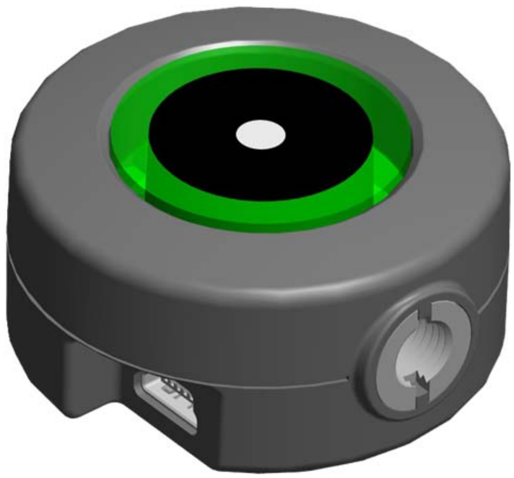
Isolight Puck Color Light Meter

User Manual

Rev 1.0



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1 Introduction

Congratulations on your purchase of an Isolight Puck color light meter. Your Isolight Puck light meter is designed to be the ideal companion for many types of image quality testing, analysis and imaging demonstrations. The Isolight Puck features a CIE XYZ accurate color sensor, a multicolored LED status indicator ring, and a USB interface.

1.1 Features

Each Puck includes the following features:

- Cosine-corrected illuminance and color sensor
- Sensor spectral response that closely matches standard CIE XYZ curves for accurate color and luminance readings under most light sources
- The sensor provides automatic gain control to cover a range from 1 lux to 1Mlux. No manual range setting is required
- Color measurements can be reported as:
    - Correlated color temperature (CCT) in Kelvin
    - Yxy format, with Y reported in lux and x and y reported in normalized CIEXYZ coordinates
    - Yuv format, with Y reported in lux and u and v reported in CIELUV coordinates
- User selectable reading update rates let the user balance responsiveness with reading stability
- User-programmable RGB LED indicator around the light sensor can be programmed to indicate when light level or color meets any lighting conditions
- LED indicator brightness can be set manually or automatically from the ambient light level
- A USB port provides power and remote operation
- ¼”-20 thread for tripod mounting
- Integrated magnet for mounting to magnetic surfaces, such as light booth walls or white boards
- 18% gray case with matte finish to avoid disturbing auto exposure and auto white balance algorithms
- Dimensions: 1.6 in x 1.6 in x 0.8 in (40 mm x 40 mm x 21 mm)

2 System Description

2.1 Front View

Figure 1 shows the front view of the device.

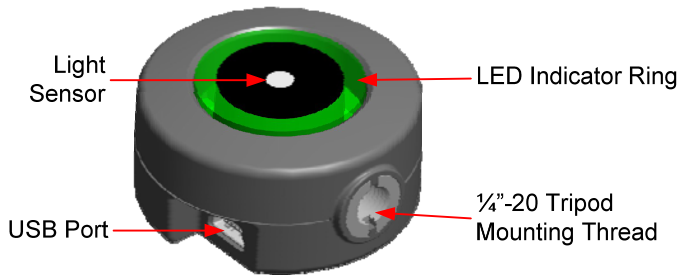

Figure 1. Front view

2.2 Rear View

Figure 2 shows the device rear view.

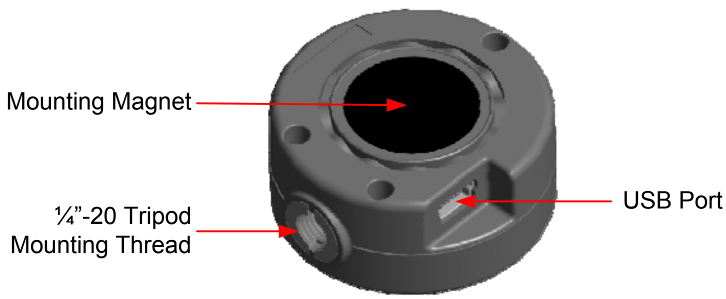

Figure 2. Rear view

3 Setting Up

3.1 Powering the Meter

The Isolight Puck color light meter is powered from the USB connection. Once connected, the Puck is always on as long as the USB power remains powered and does not enter a sleep state.

3.2 Mounting the Light Meter

The Isolight Puck color light meter can be mounted either on a tripod or against a ferrous metal surface.

The back magnet allows the Puck to be mounted on iron and steel surfaces, such as light booth walls and white boards. A non-slip rubber pad prevents the Puck from sliding or shifting during use and protects the surface from damage.

Magnets may corrupt magnetic storage media such as credit cards, desktop and notebook computer hard drives, and floppy disks. Please keep the light meter away from any susceptible devices.

4 Measuring Brightness and Color

Having the correct lighting brightness, color, and uniformity is critical to obtaining the most accurate image quality test results. Your Isolight Puck color light meter is designed to make setting up and verifying scene lighting quick, accurate, and simple.

The two most common goals for lighting are; (1) achieve a specific illumination level (ambient brightness), and (2) to achieve uniform lighting across the test chart. Many image quality tests require specific lighting levels and color, such as low light tests or tests that mimic ambient room lighting. Uneven lighting or color across a test chart can introduce significant measurement errors. In many cases, the error due to uneven lighting can be much larger than performance errors from the equipment under test.

4.1 Measuring Illumination Brightness

The light sensor measures the light level incident on the sensor surface and reports the level in Lux (lx). The sensor is cosine corrected, which means the photoresponse follows a $cos^4(\theta)$ law as the angle of incidence (θ) increases from normal to the sensor surface.

The sensor has several gain settings and automatically selects the gain setting that provides the best accuracy and signal-to-noise ratio. Higher gain settings require integration times as long as one second. In low light, the sensor sample rate (section 4.2.3) may be temporarily increased to give the sensor sufficient time to complete the measurement.

4.2 Measuring Illumination Color

The light sensor measures color by three separate red, green, and blue channels. Color measurements can be reported, in three formats:

- Correlated color temperature (CCT) in Kelvin (K)
- CIE Yxy
- CIE $Yu'v'$

4.2.1 Introduction to Color

Some background information on color and color formats is useful to known when each is useful or appropriate.

4.2.1.1 CIEXYZ and Yxy

The human eye has three types of color receptors. Each detects either long (red), medium (green), or short (blue) wavelengths of light. Color is thus most naturally represented as a set of three values. Though much research and international consensus, a set of standard spectral basis functions were defined to closely match average human color sensitivity. These basis functions form the CIEXYZ color standard color space.

The CIEXYZ coordinate values, denoted by the capital letters X, Y, and Z, represent the perceived optical power of red, green, and blue light. Note that the levels are weighted by the human eye response functions, and are not measured in physical units such as W. The XYZ values vary with both optical brightness and color. This is inconvenient when one wishes to compare only color and ignore brightness. To describe color independent of brightness, the XYZ values are normalized as follows:

$$x = \frac{X}{X+Y+Z}$$

$$y = \frac{Y}{X+Y+Z}$$

$$z = \frac{Z}{X+Y+Z}$$

The lowercase x, y, and z values are brightness normalized color coordinates. The z coordinate is usually omitted, since it can be recovered using the relationship:

$$z = 1 - x - y$$

The xy values are useful for comparing colors. Any two colors with the same xy coordinates should be perceived as identical, regardless of their spectral content.

Brightness information is still often useful, so the Y, x, and y values are usually reported together. The Y value is a measure of the perceived brightness, while the x and y provide color information. The Isolight Puck color reports the Y value in lux, while the x and y values are dimensionless, ranging in value from 0.0 to 1.0.

4.2.1.2 $Yu'v'$ Colorspace

While CIEXYZ space defines color in terms of the human eye spectral response, it has some drawbacks. Notably, the perceived difference between any two colors varies greatly in xy space. Thus, xy space is not useful for comparing colors in a perceptual sense. In that case, the $Yu'v'$ color space is more suitable.

The Y component is the same as the Yxy space, again representing the lighting brightness in lux. The $u'v'$ coordinates can be determined from the CIEXYZ values using the following formulae:

$$u' = \frac{4X}{X + 15Y + 3Z}$$

$$v' = \frac{6Y}{X + 15Y + 3Z}$$

The transform between coordinate spaces is one-to-one and reversible.

4.2.1.3 Correlated Color Temperature

All objects emit electromagnetic radiation in a manner directly related to their temperature. The simplest theoretical object is a perfectly black, non-reflecting object held as a constant, known temperature. The entire spectrum of radiation from this “black body” is correlated to its temperature. This correlated color temperature (CCT) is usually reported in degrees Kelvin (K). Thus, a single temperature value can be used to describe the color of radiated light.

Objects and normal room temperature (approximately 300K) emit only invisible infrared radiation. But once an object is heated to about 800K, it starts to emit light in the visible spectrum. The first visible color is a deep red. As the object’s temperature is increased, the emitted color changes from red to orange, yellow, white, blue, and eventually becomes invisible ultraviolet light. Figure 3 shows the approximate blackbody color at various temperatures.

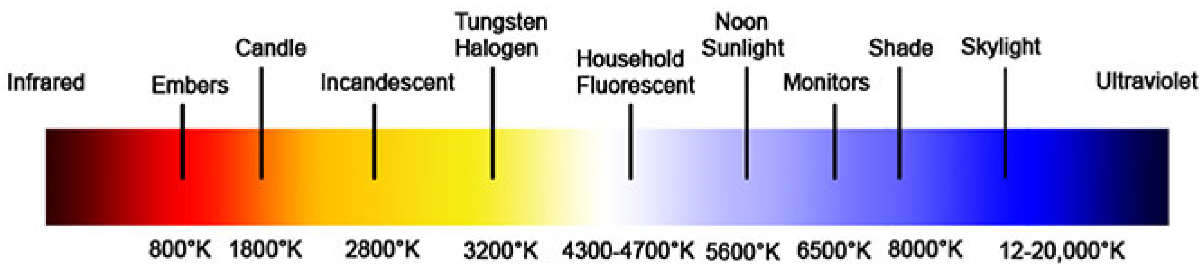

Figure 3. Approximate visible color as a function of color temperature (Color Temperature & Color Rendering Index DeMystified)

Figure 4 shows the line of CCT colors plotted on a CIEXYZ xy chromaticity diagram.

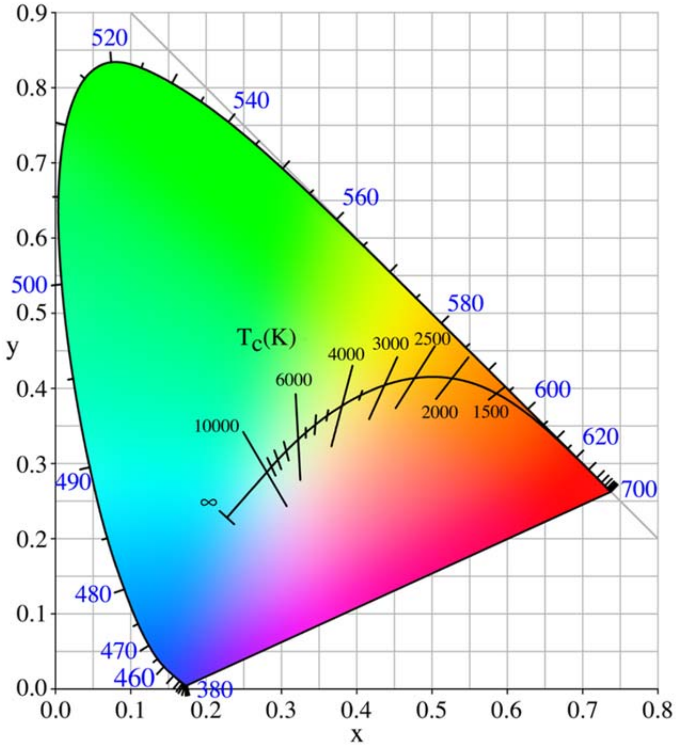

Figure 4. Plot of correlated color temperature colors in x-y chromaticity space (Chromaticity)

Many real world light sources are blackbody radiators (candles, tungsten lights, tungsten-halogen), or closely approximate the spectra of blackbody sources (daylight and shade sources). Photographers and the lighting industry have come to use CCT as a convenient way to describe the color of various light sources.

The color coordinates of many lights, such LED and fluorescent lighting, do not lie exactly on the black-body line shown in Figure 4. If the distance to the line isn't too large[1], such lights can still be assigned an approximate color temperature by finding the point on the blackbody curve closest to their actual chromaticity.

4.2.2 Color Readings

Under most light sources, the CCT and xy coordinate readings are displayed normally. However, if the lighting has a very strong color cast, such as bright red, or if the lighting is very dim, it may not be possible to accurately report xy color readings. As described in section 4.2.1.3, there is no valid color temperature for many saturated colors. The color temperature for these colors are reported as all zeros.

4.2.3 Sample Commands

The following command show how to read various light values and typical responses. Notice that all commands include leading zeros, so that the output is fixed width. This can simplify parsing of the returned data.

[1] The color error distance to the blackbody line must be less than 0.05 in CIELUV uv coordinate space.

Sent Command	Response String
GRL<LF>	GRL 0000100.000<LF>
GRCCT<LF>	GRCCT 02935.200<LF>
GRYXY<LF>	GRYXY 0001100.143 000000.300 000000.450<LF>

4.3 Setting Sensor Update Rate

When adjusting scene lighting, the readings should update as quickly as possible. However, under low light, long exposures are required to reduce noise in the readings. The sensor update rate can be set to achieve the optimal balance between responsiveness and reading stability.

The update rate can be set to a value between 200 and 60,000 milliseconds (0.2 to 60 seconds). To adjust the sensor update rate, use the SSR command and select the desired rate. The default sample period is 1000 ms (1.0 seconds).

Please note that the sensor rate is treated as a preferred rate, rather than a hard requirement. Under low-light conditions, the light meter need to reduce the update rate to less than the requested rate to ensures that a reasonable signal-to-noise ratio and signal resolution is maintained.

4.4 New Reading Availability

Depending on the update rate, the host may request readings faster than the sensor update rate. This will result in the host receiving duplicate readings. To avoid duplicate readings, the host can use the “New Readings Available” (“NRA”) command to poll the Puck for when a new reading is available.

The NRA command returns a 1 if a new sensor reading has been captured since then last time the host requested a reading. If the NRA command returns a 0, no new sensor reading is available.

5 LED Indicator Ring and Alarms

The LED indicator ring makes it particularly easy to achieve and verify the correct scene lighting. The LED ring can be programmed to display various colors and patterns in response to the light level and color. Thus, LED ring can indicate when the light incident on the sensor is too bright, too dark, the wrong color, or within the target property range(s). Figure 5 shows some of the possible LED indicator colors.

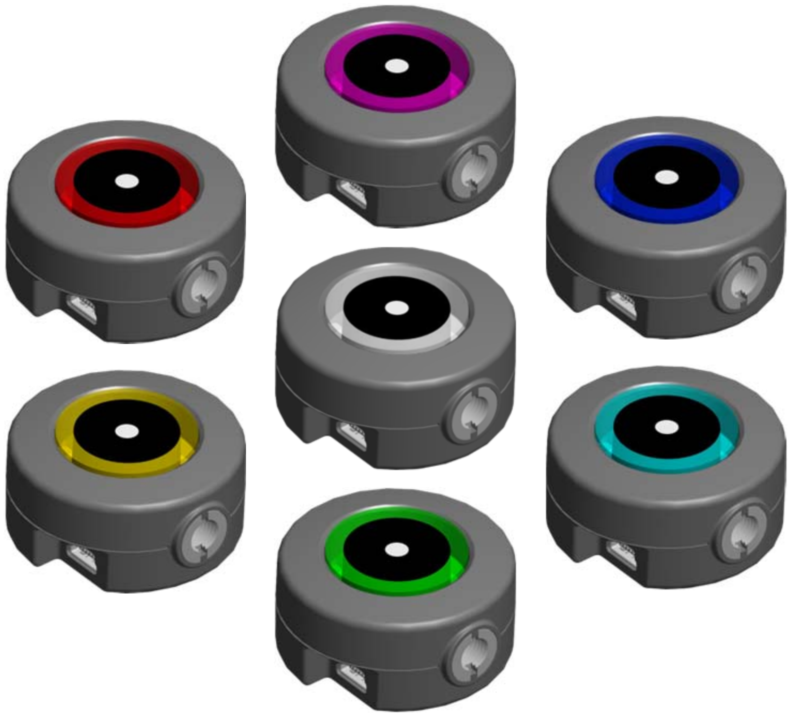

Figure 5. Examples of LED indicator display colors

The LED indicator ring brightness can be manually adjusted or set automatically. In the "auto" mode the brightness is set so that the indicator is clearly visible in ambient light, but not so bright as to create light pollution or alter the behavior of the device under test. See section 5.2 for information on adjusting the indicator ring brightness.

5.1 Setting Alarms

5.1.1 Enabling Alarms

Each alarm can be independently enabled or disabled. Disabling the alarm prevents it from becoming active, but doesn't change any of its other settings.

5.1.2 Alarm Priorities

Each alarm is independent and more than one alarm may be active at any point in time. However, the LED ring can only display one color/pattern. To determine which active alarm gets control of the LED ring, all alarms have an implicit priority. The lower the alarm number, the higher the priority. For example, if both alarms 1 and 4 are active, alarm 1 has priority and gets control of the LED ring. If alarm 1 deactivates, and alarm 4 is still active, then alarm 4 gets control of the LED ring. Alarm priorities cannot be changed.

5.1.3 Alarm Parameters

All alarm settings can be read with the "SAP" command and read back with the "GAP" command. Both commands take the alarm ID number as the first argument, followed by the parameter ID value you wish to access. Table 2 shows the parameter ID values.

Variable ID	Parameter
0	Enable
1	Test Type
2	Alarm Watch Variable
3	Parameter 1
4	Parameter 2
5	LED Pattern Select

Table 1 List of alarm parameters

5.1.4 Alarm Watch Variable

Each alarm can be set to monitor one of many light level and color variables. Each alarm can monitor only one variable. Several alarms can watch the same variable.

The alarm watch variables are shown in Table 2.

Variable ID	Watch Variable
0	Ambient luminance in lux
1	Ambient light color CIE x coordinate
2	Ambient light color CIE y coordinate
3	Ambient light color temperature in Kelvin
4	Ambient light color temperature in mired

Table 2 List of alarm watch variables

5.1.5 Alarm Test Type and Parameters

The alarms continuously test the watch variable's current value against one or two parameters using one of several test types. The test type and parameters are all user-selectable. Table 3 shows the alarm test types and parameter functions.

Alarm Test ID	Test Description	Equation	Parameter 1 Function	Parameter 2 Function
0	Equal to	$Var = P1$	Test constant	Not used
1	Not equal to	$Var \neq P1$	Test constant	Not used
2	Greater than Param1	$Var > P1$	Test constant	Not used
3	Less than Param1	$Var < P1$	Test constant	Not used
4	Greater than or equal to Param1	$Var \geq P1$	Test constant	Not used
5	Less than or equal to Param1	$Var \leq P1$	Test constant	Not used
6	Variable is between P1 and P2, excluding P1 and P2	$Var \in (P1, P2)$	Lower test boundary value	Upper test boundary value

7	Variable is between P1 and P2, including P1 and P2	Var ∈ [P1, P2]	Lower test boundary value	Upper test boundary value
8	Variable is outside the range of P1 and P2, excluding P1 and P2	Var ∉ (P1, P2)	Lower test boundary value	Upper test boundary value
9	Variable is outside the range of P1 and P2, including P1 and P2	Var ∉ [P1, P2]	Lower test boundary value	Upper test boundary value
10	Variable is between (P1-P2) and (P1+P2), excluding the boundary values	Var ∈ (P1-P2, P1+P2)	Center value	Max distance from center
11	Variable is between (P1-P2) and (P1+P2), including the boundary values	Var ∈ [P1-P2, P1+P2]	Center value	Max distance from center
12	Variable is outside the range (P1-P2) and (P1+P2), excluding the boundary values	Var ∉ (P1-P2, P1+P2)	Center value	Max distance from center
13	Variable is outside the range (P1-P2) and (P1+P2), including the boundary values	Var ∉ [P1-P2, P1+P2]	Center value	Max distance from center
14	Always true	1	Not used	Not used
15	Always false	0	Not used	Not used
16	Param1 equal to Param2	P1 = P2	Test value	Test value
17	Copy Param1 to output	P1 = 1	Test value	Not used

Table 3 List of alarm tests and parameter functions

5.1.6 Alarm LED Patterns

An active alarm can indicate its status on the LED ring through the display of a user-selectable solid color or pattern. Any alarm can display any pattern, and the same pattern can be used by more than one alarm. If no alarm is active, the LED ring defaults to all off. Table 3 shows the available LED ring display patterns.

LED Color	**LED Pattern**		
	Solid	Blinking	Spinning
White	0	8	16
Red	1	9	17
Orange	2	10	18
Yellow	3	11	19
Green	4	12	20
Cyan	5	13	21
Blue	6	14	22
Magenta	7	15	23
Rainbow cycle	24	-	-

Table 4 List of alarm LED display patterns

5.1.7 Example Alarm Commands

The following commands set alarm 0 to flash red when the ambient light level falls below 1000 lux:

```
SAP 0 0 0<LF>     // disables alarm 0 while we update settings
SAP 0 1 0<LF>     // watch the luminance variable (see Table 2)
SAP 0 2 3<LF>     // Select “less-than” test type (see Table 3)
SAP 0 3 1000.0<LF>      // Set parameter 1 to 1000.0
SAP 0 5 9<LF>     // Set the red blinking LED pattern (see Table 4)
SAP 0 0 1<LF>     // Enable the alarm
```

This example sets alarm 1 to spin magenta whenever the color temperature is outside the range 6400K to 6600K:

```
SAP 1 0 0<LF>     // disables alarm 0 while we update settings
SAP 1 1 3<LF>     // watch the color temp variable (see Table 2)
SAP 1 2 8<LF>     // Select “min-max” test type (see Table 3)
SAP 1 3 6400.0<LF>      // Set parameter 1 to 6400K
SAP 1 4 6600.0<LF>      // Set parameter 2 to 6600K
SAP 1 5 23<LF>    // Set the magenta spin LED pattern (see Table 4)
SAP 1 0 1<LF>     // Enable the alarm
```

Between these two examples, the first has higher priority since it is the lower alarm ID (ID 0 vs. 1). If both alarms are active, alarm 0 will be given control of the LED ring.

5.2 LED Brightness

The LED brightness can be controlled either automatically or manually. In automatic mode, the brightness is determined from the ambient light level.

In manual mode, the LED brightness can be set from 0 (off) to 255 (full brightness).

In automatic mode, the LED brightness is calculated from the ambient brightness using a scaling factor. The default factor is 0.005. I.e. at a light level of 1000 lux, the LED brightness is set to 2.

The LED brightness commands are shown in Table 5.

Command	Function	Options	Example
SLM	Set LED brightness mode	0 for	SLM 0
GLM	Get current LED brightness mode	None	
SLB	Set LED manual brightness level	0 to 255	SLB 128
GLB	Get current LED manual brightness	None	
SLF	Set the LED brightness factor. The default is 0.005	Any float value	SLF 0.005
GLF	Get current LED brightness factor	None	

Table 5. LED brightness commands

6 System Settings

This section describes the various system settings.

6.1 User Parameters

To facilitate using multiple Pucks in the same system, the Puck includes eight non-volatile user-settable parameters. The user parameters are not used by the Puck for any other purpose. They are entirely under user control.

The parameters can hold any floating point value. The user parameters can be used to store any information, such as:

- Puck physical location (e.g., x and y coordinates in the test scene)
- A device-specific ID number
- Number of the test chart or system with which the Puck is associated
- Test station or test fixture number

User parameters are automatically saved in non-volatile memory. There is no need to issue a 'save' or 'store' command.

6.2 Identify Device

When multiple Pucks are incorporated into a test system, it may become difficult to keep track of each Puck's physical location and corresponding serial port. Fortunately, the "Identify Device" ("ID") command can be used to visually locate a particular Puck sensor. When the ID command is activated, the Puck will start flashing the LED ring in a slow blue on-off pattern. This command overrides any other alarm display.

Use the "`SID`" command to activate the ID mode. Use "`GID`" to determine if the ID mode is active.

7 Serial Communication

Your Isolight Puck color light meter can be remotely controlled via a serial-over-USB interface. It appears as a COM port on Windows PCs and as a `/dev/ttyUSB` device on Linux systems.

The communication protocol details are:

- 115200 baud
- 8 bits, no parity, one stop bit (8N1)
- Command strings are terminated with a line feed (LF) character (0x0A)
- The “>” symbol is used as a command prompt
- Sent characters are not remotely echoed

7.1 Command Format

All serial commands are in the form:

```
<Command> [<parameter list>] <LF>
```

For `SET` commands, if successful, the device will respond with:

```
OK<LF>
```

For `GET` commands, if successful, the device will response with

```
<Command> [<parameter list>] [response]<LF>
```

If the command is unsuccessful, the system will return a brief error message.

7.2 System Commands

The following commands are for global system settings parameters.

Command	Description	Format	Return Type	Return Value
***IDN?**	Query device ID	`*IDN?`	String	Device identification string
?	Displays help screen	`?`	String	Text help screen
GFV	Get firmware revision number	`GFV`	Float	Returns the major (whole value) and minor (fractional part) revision number
GFB	Get firmware build number	`GFB`	String	Returns an ASCII string containing the firmware build number.
SID	Set device ID mode	SID <0|1>	n/a	0 to disable device ID mode or 1 to active it
GID	Get device ID mode	`GID`	Integer	1 if device ID mode is active; 0 otherwise
GSN	Get device serial number	`GSN`	Integer	Returns device serial number
HELP	Displays help screen	`HELP`	String	Text help screen
RESET	Perform hard reset	`RESET`	n/a	Resets device to power-on state.

Table 6. System serial commands

7.3 Light Sensor Commands

The following commands for reading luminance and color data.

Command	Description	Format	Return Type	Return value
GRCCT	Read sensor correlated color temperature	GRCCT	Float	Current correlated color temperature. The value is reported as a floating point number with leading zeros to simplify parsing.
GRL	Read light level in lux	GRL	Float	Current sensor reading in lux. The value is reported as a floating point number with leading zeros to simplify parsing.
GRXYZ	Read sensor color in XYZ coordinates	GRXYZ	Three float values	Current sensor reading in in CIE XYZ coordinates. Y is reported in lux. Values are reported as a floating point number with leading zeros to simplify parsing.
GRYXY	Read sensor color in Yxy coordinates	GRYXY	Three float values	Sensor's current reading in Yxy coordinates. Y is reported in lux. Values are reported as a floating point number with leading zeros to simplify parsing.
NRA	New reading available	NRA	Integer	Returns "1" if a new reading has been captured since the last time a reading was read, "0" otherwise.
SSR	Set sample rate	SSR <rate>	n/a	Set requested sample rate in milliseconds. The default sample period is 1000 ms.
GSR	Get sample rate	GSR	Float	Current sample rate in milliseconds.

Table 7. Light sensor luminance and color serial commands

7.4 Alarm and LED Ring Commands

The following commands for setting the LED indicator target levels, tolerances, and operating modes.

Command	Description	Format	Retu rn Type	Return value
GAS	Get current alarm states	GAS	Uint1 6	The bit of each active alarm is set to "1".
GAL	Get alarm parameter limits	GAL		
GAP	Get alarm parameter	GAP <alarm ID> <parameter ID>	Float	The parameter's current value
SAP	Set alarm parameter	SAP <alarm ID> <parameter ID> <value>	n/a	n/a
SLM	Set LED brightness mode	SLM <0|1>	n/a	0 - manual brightness 1 – automatic brightness
GLM	Get LED brightness mode	GLM	Intege r	
SLB	Set LED manual brightness	SLB <0 to 255>	n/a	0 for off, 255 for maximum brightness
GLB	Get LED manual brightness	GLB	Uint8	0 for off, 255 for maximum brightness
SLF	Set LED auto brightness factor	SLF <value>	n/a	Conversion factor from lux to LED brightness. Default is 0.005
GLF	Get LED auto brightness factor	GLF	Float	Current brightness conversion factor

Table 8. Alarm and LED indicator serial commands

7.5 User Parameter Commands

The following commands are for managing user parameters.

Command	Description	Format	Return Type	Return Value
GPC	Get number of user parameters	`GPC`	Float	Number of supported user parameters
GUP	Read back user parameter	`GUP <ID>`	Float	Returns the value of the specified parameter
SUP	Set user parameter value	`SUP <ID> <value>`	n/a	n/a

Table 9. User parameter commands

8 Bibliography

Chromaticity. (n.d.). Retrieved January 10, 2014, from Wikipedia: http://en.wikipedia.org/wiki/Chromaticity

Color Temperature & Color Rendering Index DeMystified. (n.d.). Retrieved January 10, 2014, from http://lowel.tiffen.com: http://lowel.tiffen.com/edu/color_temperature_and_rendering_demystified.html

Appendix A. Specifications

General

Specification	Value	Conditions
Operating temperature	0ºC to 40ºC (32ºF to 104ºF)	
Storage temperature	-10ºC to 50ºC (14ºF to 140ºF)	
Humidity	Less than 80% RH	Non-condensing

Optical Specifications - General

Specification	Value	Conditions
Detector area	78.5 mm^2 (10mm diameter disc)	
Angular response	TBD%	Deviation from ideal cosine response
Range selection	Fully automatic	
Measurement rate	200 to 60,000 milliseconds	

Optical Specifications – Luminance

Specification	Value	Conditions
Spectral response	TBD % deviation from CIE $\bar{y}$ photopic curve	f_1' method under tungsten (A) light
Luminance measurement range	0.1 Lux to 1.0MLux	
Resolution	0.25 Lux or 1% of reading, whichever is greater	
Accuracy	TBD	Tested under standard A (2856K tungsten) light

Optical Specifications - Chrominance

Specification	Value	Conditions
Detector type	Three silicon photodiodes with color filters	
Spectral response	TBD % deviation from CIE $\overline{xyz}$ photopic curves	f_1' method under tungsten (A) light
Color measurement (CCT)	2,000K to 50,000K	CCT is valid within approx. 0.05 units from the Plankian blackbody radiator curve
Accuracy	TBD	Tested under standard A (2856K tungsten) light

Electrical Specifications

Specification	Value	Conditions
Input voltage	5.0 VDC	
Power requirements	TBD W	See note 2

Mechanical Specifications

Specification	Value	Conditions
Dimensions	40 mm x 40 mm x 21 mm (1.6 in x 1.6 in x 0.83 in)	
Mass	TBD g	

[2] Varies depending on system settings

Appendix B. Warranty

Peripheral Vision, Inc. (“PV”) warrants to the original purchaser of the Isolight Light Meter with which this **Limited Warranty** (the “Product”) is included that the Product will be free from defects in materials and workmanship under normal use (“Defects”) for a period of **one (1) year** from the date of purchase (the “Warranty Period”). During the Warranty Period, the Product will be repaired or replaced, at PV’s choice without charge to you for parts or labor.

The Limited Warranty does not apply to:

- Normal wear and tear
- Any Product opened or repaired by someone not authorized by PV
- Any Product or part thereof damaged by misuse, moisture, liquids, proximity or exposure to heat
- Accident, abuse, non-compliance with the instructions supplied with the Product, neglect or misapplication
- Physical damage to the surface of the Product
- Any software that may accompany or be installed on the Product
- Installation, removal or maintenance of the Product or any costs related thereto.

To make a claim of a Defect, the purchaser must contact PV during the Warranty Period at 408-588-1928 or via email at custsupport@pv-imaging.com to explain the Defect and to obtain a RMA number (Return Materials Authorization), if necessary. The Product must be returned during the Warranty Period, along with an explanation of the Defect, to the address provided to you by PV. If a defect arises and a valid claim under this Limited Warranty is received by PV after the first one hundred eighty (180) days of the Warranty Period, PV is entitled to charge the purchaser for reasonable shipping and handling costs made in connection with the repair or replacement of the Product. Purchaser must comply with any other return procedures stipulated by PV, if any.

This Limited Warranty gives the original purchaser specific legal rights. Additional legal rights may vary from state to state and jurisdiction to jurisdiction.

If any part of this Limited Warranty is held to be invalid or unenforceable, the remainder of the Limited Warranty shall nonetheless remain in full force and effect.

This Limited Warranty is the only express warranty made by PV and is provided in lieu of any other express warranties or similar obligations (if any) created by any advertising, documentation, packaging, or other communications.

Except for the Limited Warranty, and to the maximum extent permitted by applicable law, PV and its suppliers provide the Product “AS IS AND WITH ALL FAULTS”, and hereby disclaim all other warranties and conditions, whether express, implied or statutory, including, but not limited to, any implied warranties, duties or conditions of: merchantability, non-infringement, quiet enjoyment, system integration, satisfactory quality, fitness for a particular purpose, reliability or availability, accuracy or completeness or responses, results, workmanlike effort, lack of viruses, and reasonable care and skill, all with regard to the Product, and the provision of or failure to provide support or other services, information, software, and related content through the Product, or otherwise arising out of the use of the Product. This exclusion does not apply to (i) any implied condition as to title and (ii) any implied warranty as to conformity with description. If applicable law requires any implied warranties with respect to the Product, all such warranties are limited in duration to ninety (90) days. Some states and/or jurisdictions do not allow limitation on how long an implied warranty lasts, so the above may not apply to you.

This Limited Warranty may not be transferred to any other person.

Limitation Of Warranty

Neither Peripheral Vision, Inc. (“PV”) nor its suppliers shall be liable to Purchaser or to any third party for any indirect, incidental, consequential, special or exemplary damages (including in each case, but not limited to, damages for the inability to use the equipment or access data, loss of data, loss of business, loss of profits, business interruption or the like) arising out of the use or inability to use the Product, even in PV has been advised of the possibility of such damages.

Notwithstanding any damages that Purchaser or any third party might incur for any reason whatsoever, including without limitation, all damages referenced herein and all direct or general damages in contract, or anything else, the entire liability of PV and any of its suppliers shall be limited to the amount actually paid by the Purchaser for the Product.

The above exclusions or limitations of incidental or consequential damages are applicable only to the extent permitted by applicable law.

Notwithstanding the above, neither PV’s nor any of its suppliers’ liability for death or personal injury resulting from its own negligence shall be limited.

Appendix C. Document Revision History

Revision	Date	Changes
1.0	April 6, 2016	Initial release.