PicoP® Scanning Engine (PSE) Datasheet: RagenTek Model PSE-0403-103

DA0140002

June 2017 Revision D

ABSTRACT

This document summarizes in detail the mechanical, optical and electrical characteristics of MicroVision's PicoP® Scanning Engine (PSE-0403-103) for RagenTek.

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LASER SAFETY NOTICE

MicroVision's PicoP® Scanning Engine is configured during manufacturing to meet Class 3R laser safety requirements as defined in IEC 60825-1, ed.3. The PSE is intended to be embedded inside a host system, therefore the system integrator must ensure that the end product meets all applicable laser safety requirements and must obtain any needed product certifications.

Contents

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1. Introduction

This datasheet describes the mechanical, optical and electrical characteristics and interfaces for MicroVision's PicoP® Scanning Engine model PSE-0403-103. This PSE implements a MEMS based Laser Beam Scanning (LBS) display engine based on MicroVision's patented PicoP® Scanning Technology. This PSE is intended to be used by RagenTek to embed a small, thin, full-color laser projector inside its product(s).

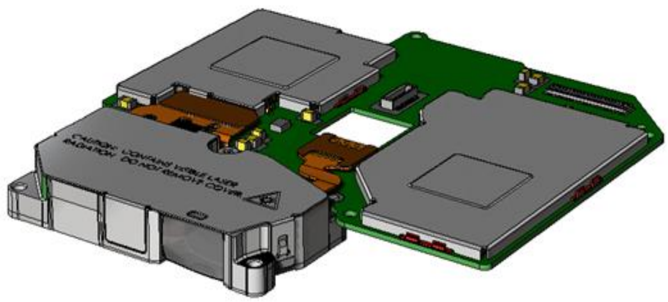

Figure 1. PSE-0403-103 PicoP® Scanning Engine (PSE).

The PSE consists of an Integrated Photonics Module (IPM) and Electronics Platform Module (EPM). *The IPM and EPM are a matched pair and may not be exchanged between different PSEs.*

The PSE block diagram is illustrated in Figure 2 below.

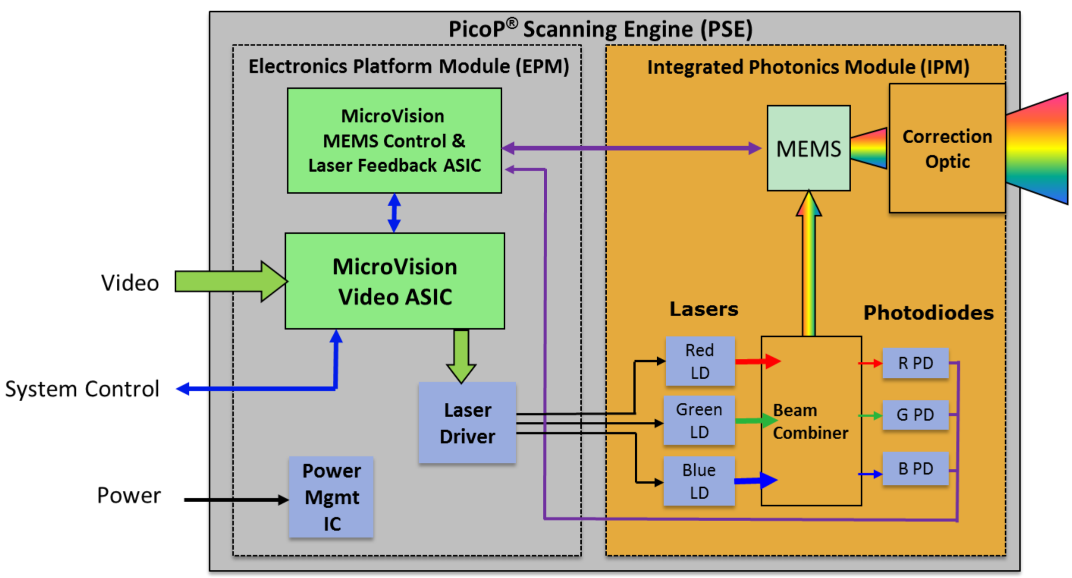

Figure 2. PSE block diagram.

2. Specifications

Parameter	Specification[1]	
Display Performance	Display Technology	Laser Beam Scanning Technology
	Input Resolution	1280x720[2]
	Output Resolution	1280x720
	Brightness / Enhanced Brightness	30 lumens / 40 Lumens[3] (Video content)
	Color Depth	64K colors
	Aspect Ratio	16:9
	Throw Ratio	1.2:1
	Focus Range	Infinite focus
	Display Refresh Rate	60Hz
	Input Frame Rate	60fps
	Sequential Contrast	80,000:1
	White Point	x=0.3122, y=0.3247[3]
	Color Gamut	>200% depending on mode
	Start-up Time	<6.5 sec
Physical	Scanning Engine Size	61.0x63.2x6.0mm
	Integrated Photonics Module (IPM) size	36.2x21.4x6.0mm
	Weight	<20g
	Video Interface	Digital RGB (16bit 5:6:5, 1.8-3.4V)
	Control Interface	USB 1.1, UART
Power	Single Supply Input Voltage	3.0-4.5V
	Power @ 27% Video Image	2.0W (at 25°C)
	Power @ 100% (Full White) Image	4.0W (at 25°C)
Environmental	Operating Temperature	0-60°C[4]
	Storage Temperature	-30°C ...+70°C
Light Source	3 Lasers	Red: ~638nm Green: ~520nm Blue: ~450nm
	Laser Safety Classification	Class 3R Laser Product IEC60825 Ed. 2
Model	Model Number	PSE-0403-103

Notes:

[1] Specifications subject to change without notice
[2] For other resolutions, please contact your MicroVision representative
[3] For definition, please see Section 2.1 "Display Performance Specifications"
[4] For temperature limits see Section 5.1 "Operating Temperature Limits"

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2.1 Display Performance Specifications

Brightness

The Brightness is measured at 25-30°C module temperature using a pattern with 9 rectangles. The light emission in lux is first measured at the center of each rectangle. The measurement locations are identified by the red dots in Figure 3 below. The 9 measurements are then averaged and normalized to the screen size to provide the brightness measurements in Lumens. This pattern can be accessed through the SDK by calling “9 Point Pattern”.

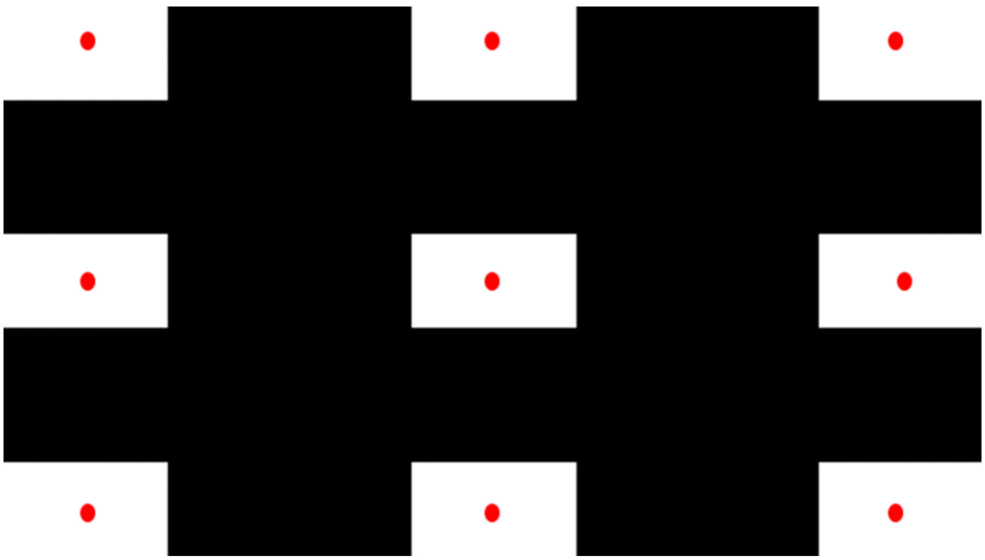

Figure 3. 9 point brightness measurement locations.

The Enhanced Brightness specification is achieved by boosting the brightness of video codes around code level 0.3, which are the most common video code values in typical pictures and movie frames. The brightness of these video codes is boosted up to 30% to correspond to a brightness of a 40 lumen projector displaying typical pictures or movies.

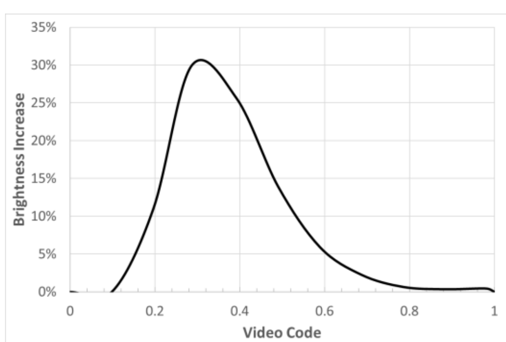

Figure 4. Brightness boost of lower video codes.

The brightness boost can be enabled or disabled through the PSE control interface.

Brightness vs. Temperature

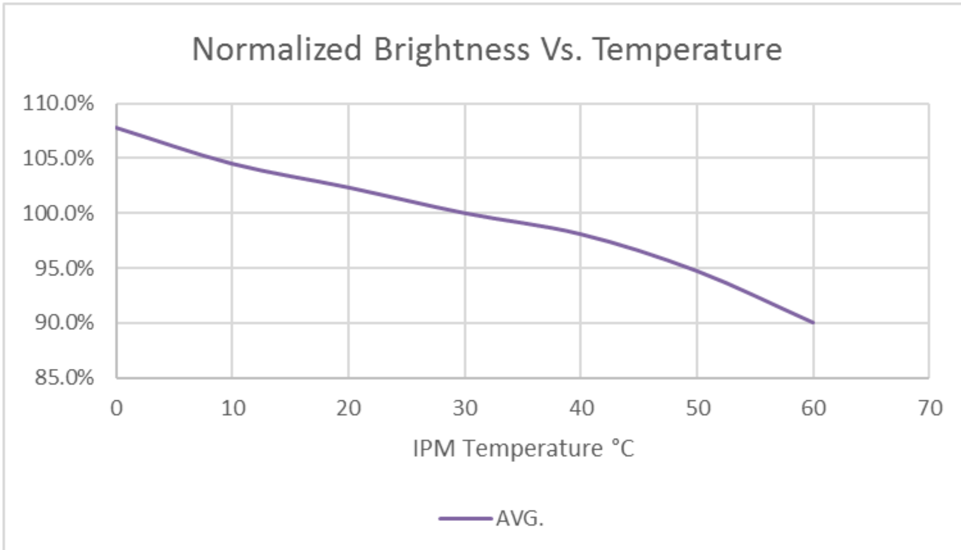

Figure 5. Normalized Brightness vs. Temperature.

The brightness of the display is affected by the module temperature. While system calibration and measurements are done at 25-30°C, measurements made at different temperatures will produce different results. The curve in Figure 5 shows the increased and decreased percentage of brightness from the 30°C module temperature baseline measurement.

Color Depth

The PSE Color Depth is 16-bit High Color, with 5 bits for red, 6 bits for green, and 5 bits for blue.

Throw Ratio

The Throw Ratio is defined as the distance between the projector and the screen divided by the horizontal width of the projected image.

Sequential Contrast

Sequential Contrast is measured as the ratio of the luminance values at the center of the image between a constant 100% white image and a constant 0% black image.

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White Point

The White Point, as set during the manufacturing process, is x=0.3122, y=0.3247, ±0.02. White Point is set at an IPM temperature (as measured by the IPM thermistor) of 28±2°C, while displaying the Test Image "9 Point Pattern" shown above in Figure 3.

White Point is confirmed using an external RGB video from host platform feeding the same 9 Point Pattern test image shown above in Figure 3. We recommend using one of the following Chroma Meters: Konica Minolta CL-500A or Gigahertz Optik P9801 for White Point measurement. The image is displayed on a white screen 600±10mm from the front of the PSE and the Chroma Meter's diffuser window should be facing the PSE, and should be placed in the center of the image center white square, while the bottom cover of the meter is set flat against the screen. At the same time the PSE IPM temperature shall be maintained at 45 ±2 °C.

At the 45 ±2 °C temperature, the Chroma Meter should measure white point coordinates at x=0.3057 and y=0.3284 ±0.02.

2.2 Power Specifications

The PSE accepts a single supply input voltage within a range of 3.0 – 4.5V. The PSE power management has been designed to be compatible with a typical Lithium-Ion battery voltage of 3.7V.

The Power consumption is measured at 25°C. At a higher operating temperature, the power consumption will increase, as shown in Table 1 below:

Table 1. Power consumption over temperature.

PSE Module Temp	Power @ 27% Video Image (Typical)	Power @ 100% (Full White) Image (Typical)
25°C	2.0W	4.0W
50°C	2.2W	4.4W

2.3 Environmental Specifications

The Operating Temperature range indicates the range of module temperatures that the PSE will operate across. The end product needs to be designed thermally to keep the PSE within this range regardless of the end product's ambient operating temperature. Thermal interface requirements are discussed in Section 5 of this document.

2.4 Contamination

The PSE assembly does not provide any inherent protection against contamination from environmental dust, outgassing materials, vapor contamination, or other sources of contamination that may affect system performance. Such protection must be provided by the end product; IEC 60529 IP57 is recommended.

3. Mechanical Interface

3.1 PSE Mechanical Dimensions

The PSE mechanical dimensions are shown below in Figure 6. The envelope shown in Figure 6 provides the nominal dimensions of the PSE. Please see document DC0140000 for more details on mechanical tolerances.

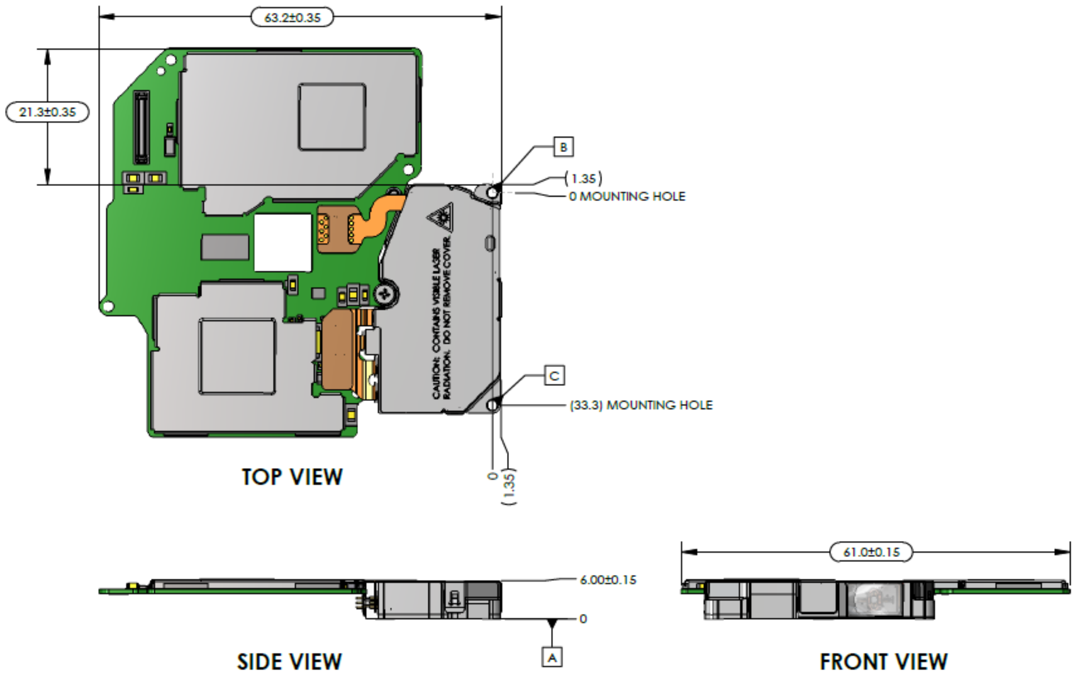

Figure 6. PSE sketch showing dimensions and mount points.

In addition to the overall dimensions of the assembly, Figure 6 also shows the exit position of the chief ray, the position of the scanning MEMS mirror, and the primary mounting points on the PSE. Housing datums, identified as A, B, and C are also included for reference.

Two primary mount points are provided to mechanically mount the PSE to a host system. Figure 6 shows the position of these mount points. Additional mounting points are available in the PCB, see document PB0140000 for more details. The IPM is rigidly mounted to the electronics board and shields and the system connector on the PSE may provide additional stability. Further mechanical support should be provided at the thermal interface areas shown in Figure 14.

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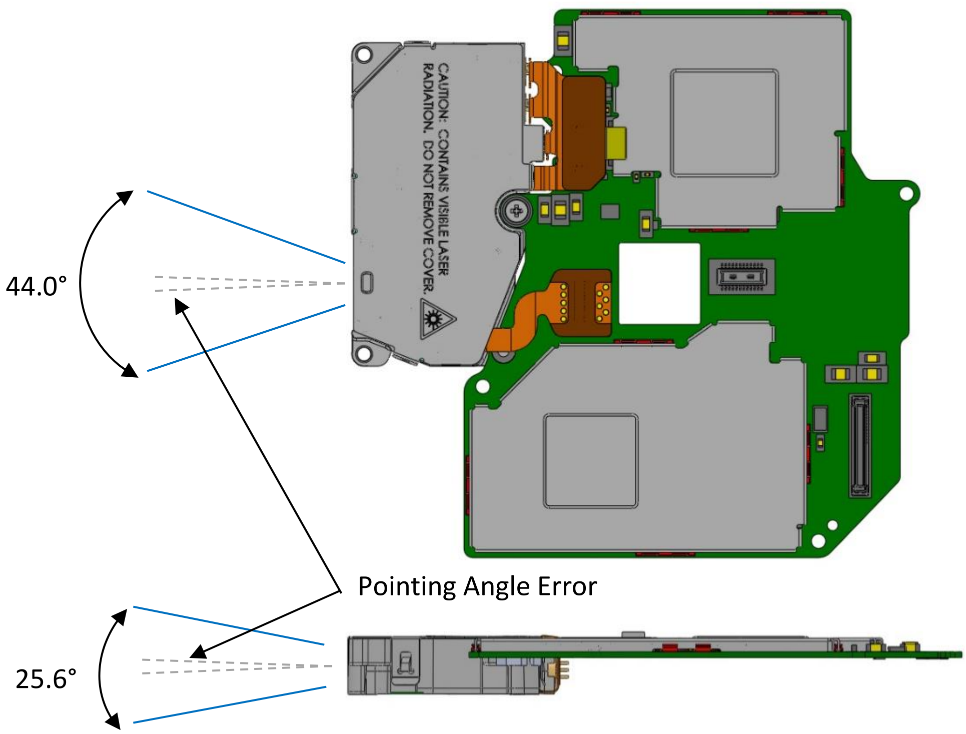
3.2 Field of View (Scan Cone)

The field of view dimensions are detailed in Figure 7.



Pointing Angle Error	± 2.0°
Horizontal Field of View	44.0°
Vertical Field of View	25.6°

Figure 7. PSE field of view dimensions.

3.3 Shock

The PSE is designed and tested to survive a 1500G shock. The customer is responsible for developing mechanical mounting of the PSE inside the host device such that acceleration during a drop event is minimized and does not exceed the 1500G limit.

4. Electrical Interface

The PSE provides electrical connectivity through a single board to board connector, as shown above in Figure 6 (Top View). The PSE electrical interface consists of power, power enable, a digital video interface (5-6-5 R-G-B), PSE control and communication signals, and optional MEMS position feedback, as illustrated in Figure 8 below.

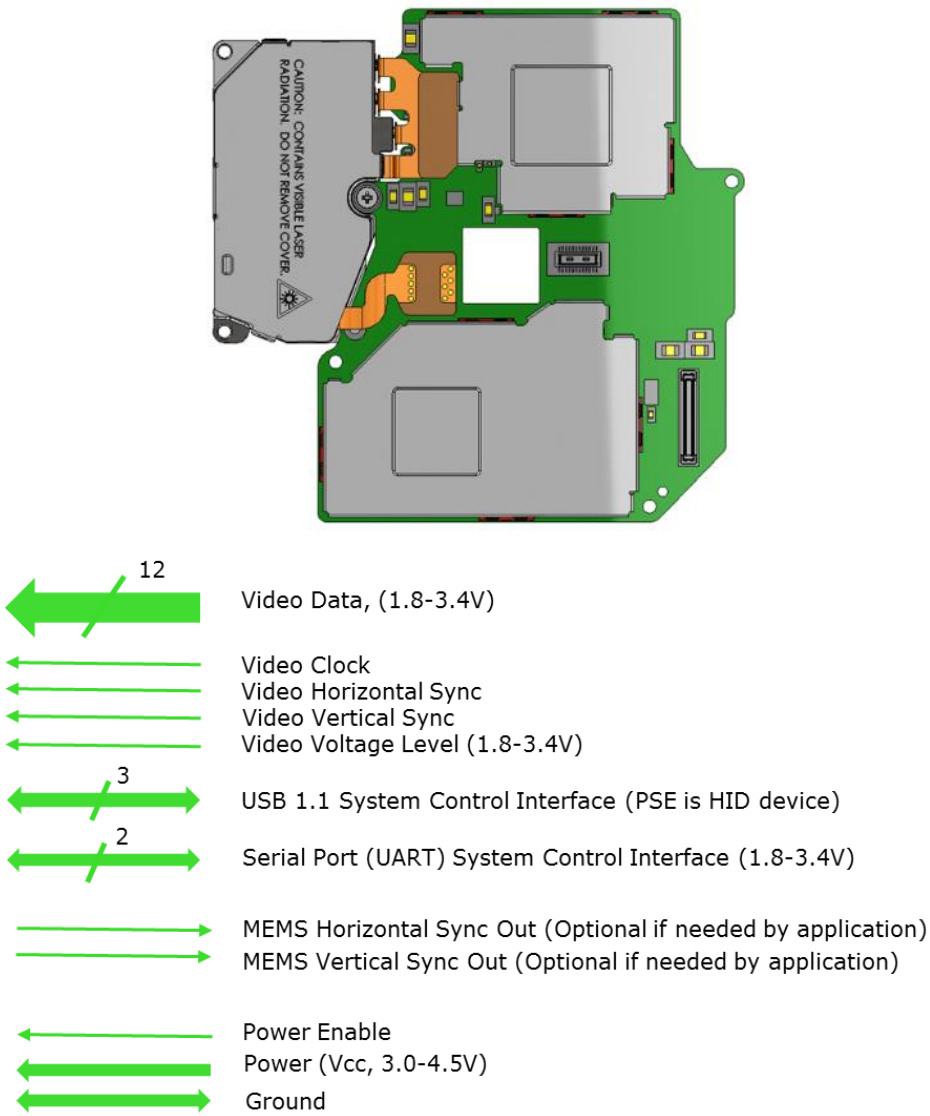


Figure 8. PSE electrical interface overview.

4.1 PSE Electrical Signals

The PSE provides a Kyocera 5861 Series 50-position, 0.35 mm contact pitch, dual row board to board connector with a female end (Kyocera 24-5861-050-004-829). The signals carried by the PSE connector cable are described in Table 2 below. The pin assignment for the 50 pin interface connector is provided in Table 4.

Table 2. PSE signals and signal characteristics.

Signal	Type	Signal level	
			Video Signals
D0	I	V_{VID-IO}	Carries B0 (ignored) at rising edge of CLK, G4 at falling edge
D1	I	V_{VID-IO}	Carries B1 (ignored) at rising edge of CLK, G5 at falling edge
D2	I	V_{VID-IO}	Carries B2 (ignored) at rising edge of CLK, G6 at falling edge
D3	I	V_{VID-IO}	Carries B3 at rising edge of CLK, G7 at falling edge
D4	I	V_{VID-IO}	Carries B4 at rising edge of CLK, R0 (ignored) at falling edge
D5	I	V_{VID-IO}	Carries B5 at rising edge of CLK, R1 (ignored) at falling edge
D6	I	V_{VID-IO}	Carries B6 at rising edge of CLK, R2 (ignored) at falling edge
D7	I	V_{VID-IO}	Carries B7 at rising edge of CLK, R3 at falling edge
D8	I	V_{VID-IO}	Carries G0 (ignored) at rising edge of CLK, R4 at falling edge
D9	I	V_{VID-IO}	Carries G1 (ignored) at rising edge of CLK, R5 at falling edge
D10	I	V_{VID-IO}	Carries G2 at rising edge of CLK, R6 at falling edge
D11	I	V_{VID-IO}	Carries G3 at rising edge of CLK, R7 at falling edge
CLK	I	V_{VID-IO}	Video clock used to sample data, HSYNC, and VSYNC.
HSYNC_Vid	I	V_{VID-IO}	Horizontal sync signal.
VSYNC_Vid	I	V_{VID-IO}	Vertical sync signal.
LSV	I	1.8 – 3.4V	Sets V_{VID-IO}, the voltage level for the video input signals. Must be between 1.8V to 3.4V. Supply must be able to source 20mA.
			Power Enable Interface
PE	I	3.3V	Power enable [Note 1] and [Note 3]. On low side, driver must maintain < 0.2V while sinking 1mA. Absolute maximum: -0.3V to Vcc+0.3V.
			Communication Interface
USB_VBUS	I	5V	USB VBUS [Note 2]
USB_DP	I/O	V_{USB}	USB D+. Follow the USB 1.1 specification.
USB_DM	I/O	V_{USB}	USB D-. Follow the USB 1.1 specification.
UART_Tx	O	3.3V	UART Transmit data. 8 bit data, negative parity, 1 stop bit with no RTS/CTS flow control. Baud rate 57600. Driver capable of sourcing/sinking 2 mA current.
UART_Rx	I	3.3V	UART Receive data. Typical input capacitive load 22 pF. V_{ILO} < 0.8V, V_{IHI} > 2.0V. 8 bit data, negative parity, 1 stop bit with no RTS/CTS flow control. Baud rate 57600.

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			Miscellaneous Signals
Reserved	--	--	Reserved for future use – Do not connect to these pins
VSYNC_MEMS	O	3.3V	Vertical Sync synchronized to MEMS. Used for synchronizing camera with display frame. Driver capable of sourcing/sinking 16 mA current
HSYNC_MEMS	O	3.3V	Horizontal Sync synchronized to MEMS. Driver capable of sourcing/sinking 16 mA current
			Power Supply
VCC	--	3.0–4.5V	Power supply. 2.2 W typical power draw (27% video), 4.7 W max (@50°C).
GND	--	--	--

Notes:

[1] The PSE will draw 35µA (maximum 50 µA) of current unless PE is asserted. All other input signals must remain at 0 V when PE is de-asserted.

[2] Used for USB interface detection only. The PSE does not attempt to draw power from USB_VBUS. Follow the USB specification for range.

[3] Caution: PE signal level must be < or = VCC+0.3V at all times.

The V_{VID-IO} video signal voltage levels defined above are described in Table 3 below. Typical input capacitance of 12 pF.

Table 3. PSE Video input voltage levels.

	V_{VID-IO}	Min	Max
High level input voltage V_{VID-IO} (1.8 to 3.4 V)	1.8 2.5 3.3	1.2 1.6 2.0	-- -- --
Low level input voltage V_{VID-IO}	1.8 2.5 3.3	-- -- --	0.6 0.7 0.8

Figure 9 shows the pin number convention for the Kyocera (24-5861-050-004-829) 50-position, 0.35 mm contact pitch, board to board connector.

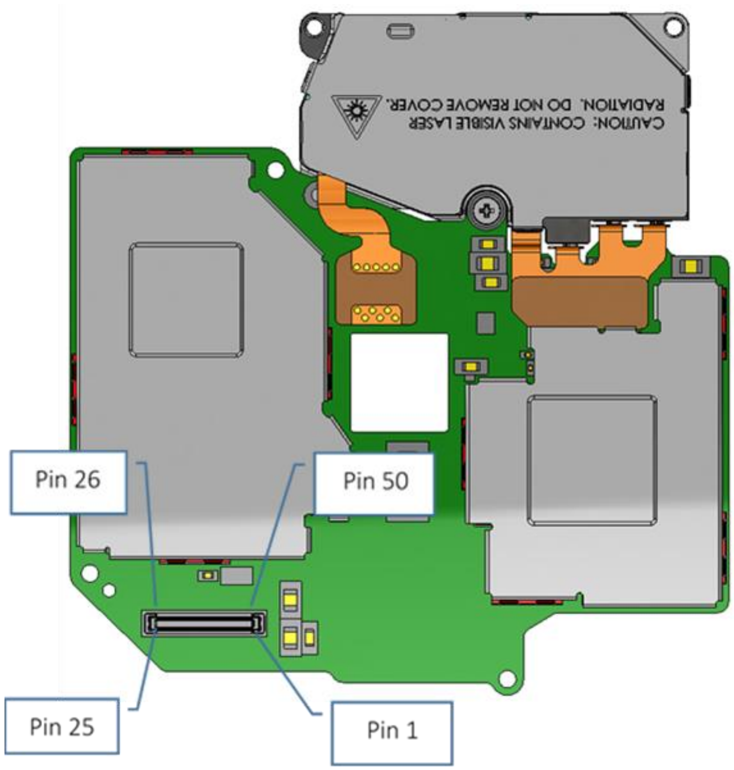

Figure 9. PSE connector pin numbering orientation.

Table 4 on the following page shows the pin assignments for the 50 pin Kyocera connector.

Table 4. PSE connector pin assignments.

PSE connector pin #	Signal
1	GND
2	-
3	D5
4	-
5	-
6	D1
7	D3
8	D8
9	D10
10	GND
11	VSYNC_Vid
12	HSYNC_Vid
13	GND
14	-
15	VCC
16	VCC
17	VCC
18	VCC
19	FLASH_N
20	FLASH_N
21	FLASH_P
22	HSYNC_MEMS
23	GND
24	LSV
25	GND
26	GND
27	-
28	PE
29	VSYNC_MEMS
30	FLASH_P
31	FLASH_P
32	FLASH_N
33	VCC
34	VCC
35	VCC
36	VCC
37	UART_Tx
38	UART_Rx
39	GND
40	CLK
41	GND
42	D11
43	D9
44	D7
45	D2
46	D0
47	-
48	D6
49	D4
50	GND

4.2 Digital Video Interface

The PSE expects to receive a progressive stream of video frames, lines, and pixels, according to Figures 10 - 12 below. The exact video parameters are configured using the control interface described in section 4.6 below.

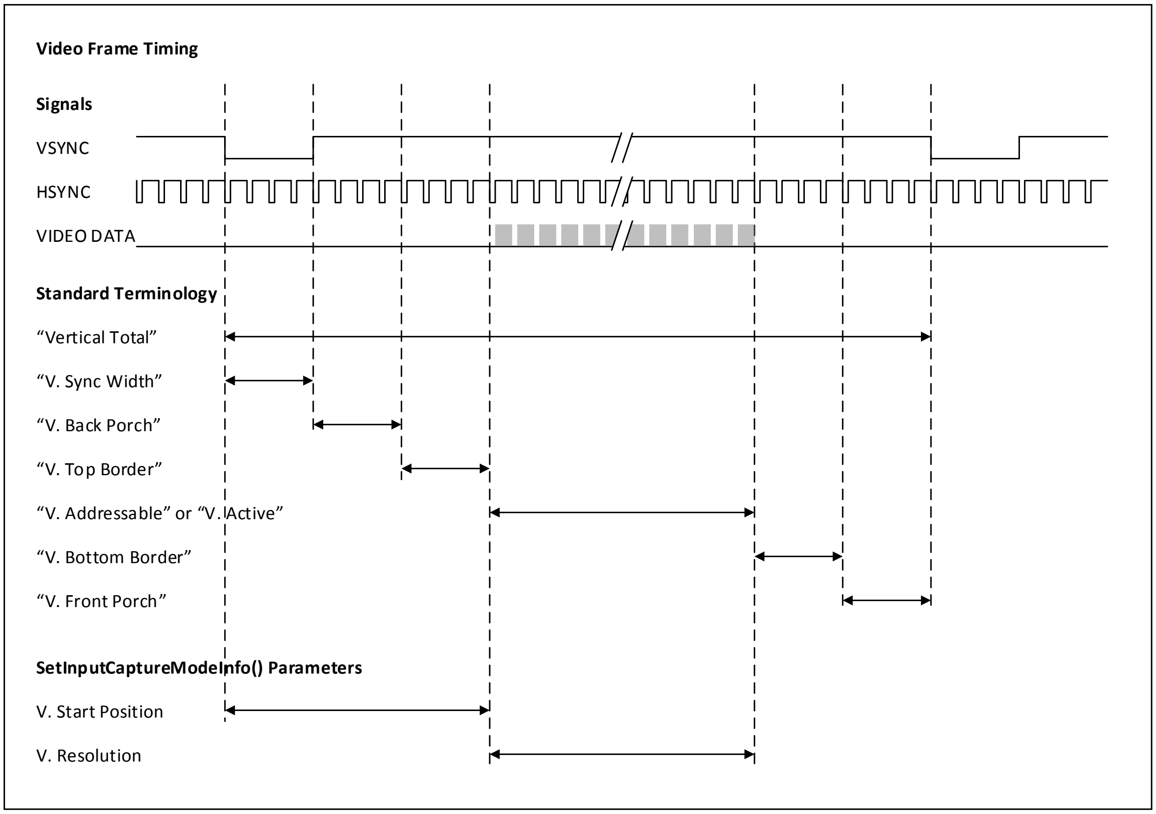

Figure 10. PSE video frame timing.

Figure 10 shows a typical video frame. The PSE counts a certain number of HSYNC pulses after the leading edge of VSYNC before capturing the active video lines. The VSYNC polarity, HSYNC polarity, V. Start Position, and V. Resolution are configurable. Figure 10 shows inverted polarity for both VSYNC and HSYNC.

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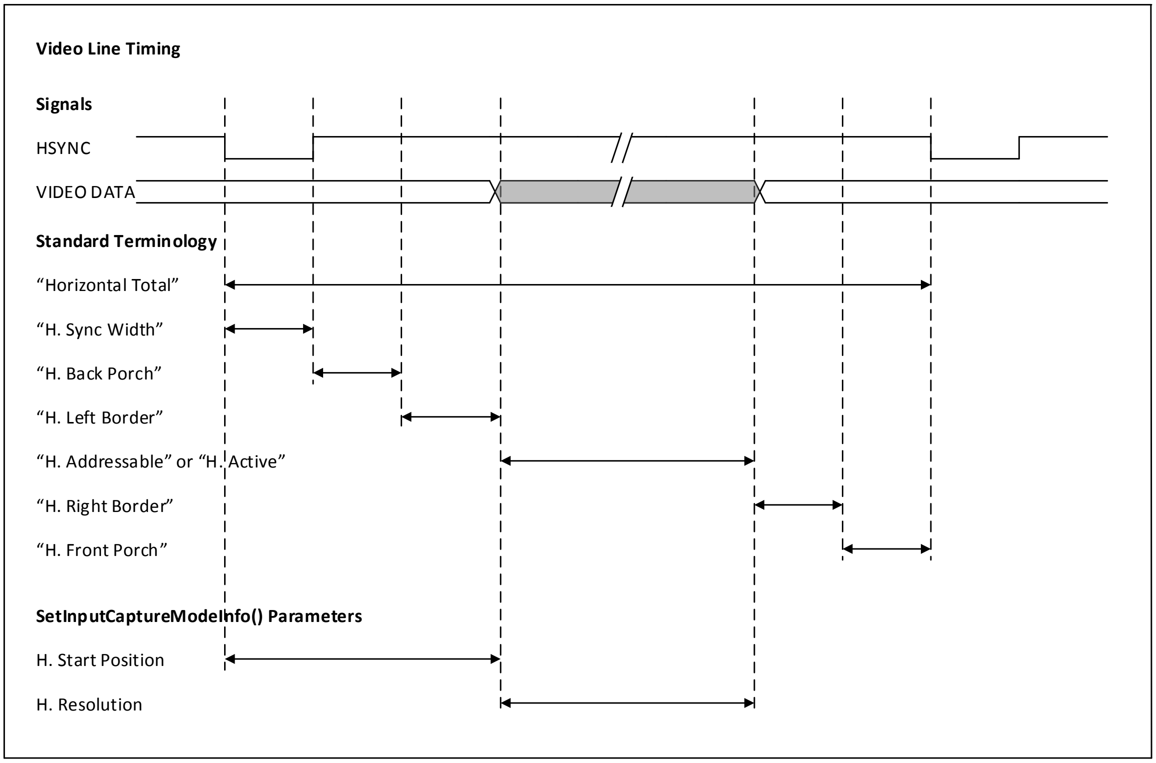

Figure 11. PSE video line timing.

Figure 11 shows a typical video line. The PSE counts a certain number of CLK pulses after the leading edge of HSYNC before capturing the active video pixels. The HSYNC polarity, H. Start Position, and H. Resolution are configurable. Figure 11 shows inverted polarity for HSYNC.

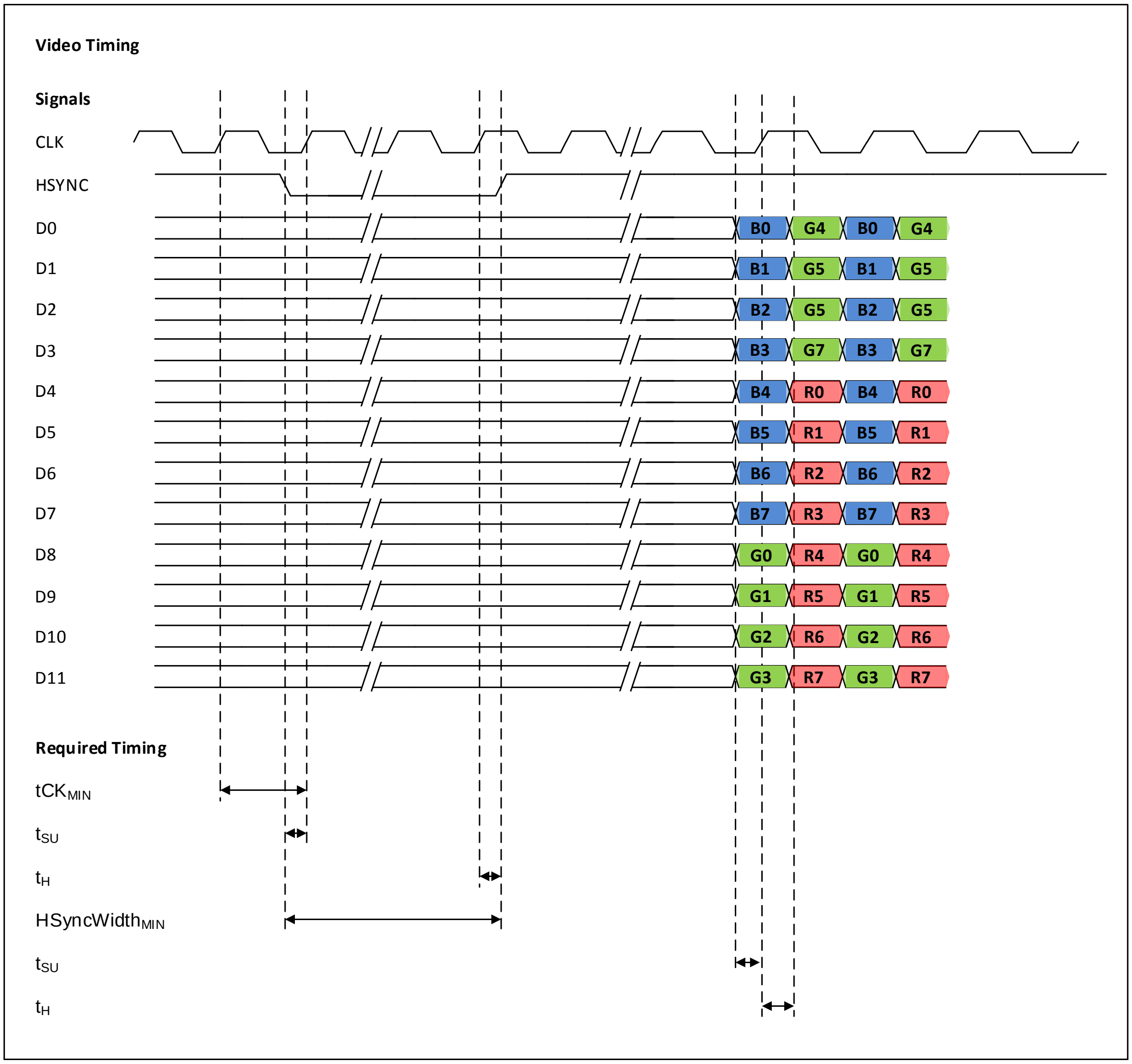

Figure 12. PSE video sample timing.

Figure 12 shows pixel-level video timing. The DDR digital interface is synchronous to the CLK input and during each clock cycle it “clocks-in” two video data bits: first one is clocked-in by the rising edge and the second by the falling edge of the clock.

Table 5. PSE video interface timing characteristics.

Parameter	Time
tCK_{MIN} Minimum CLK period	11.8 ns
t_{SU} Minimum setup time before selected CLK edge	4.5 ns
t_H Minimum hold time after selected CLK edge	2.5 ns
$HSyncWidth_{MIN}$ Minimum duration of HSYNC pulse	3 x tCK_{MIN}
$VSyncWidth_{MIN}$ Minimum duration of VSYNC pulse	3 x HSYNC Period

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The PSE powers up configured for standard 1280 x 720 pixel input resolution. Table 6 below shows the default values.

Table 6. PSE video formats.

Resolution	VSYNC Polarity	HSYNC Polarity	Leading edge of VSYNC to first active line (V. Start Position)	Leading edge of HSYNC to first active pixel (H. Start Position)
1280 x 720 (Default)	Positive	Positive	25 HSYNC pulses	260 Pixel clocks

4.3 MEMS Sync Interface

The PSE provides output signals that are synchronized to the motion of the scanning MEMS mirror. These signals (HSYNC_O and VSYNC_O) are buffered 3.3V outputs and are capable of sourcing or sinking 16mA. HSYNC_O transitions at the middle of every scanline. The VSYNC_O pulse occurs at the middle of the vertical retrace when the MEMS sweeps back to the beginning of the raster. Note that the relation of the vertical retrace to the MEMS horizontal frequency varies between different MEMS, thus the relation of HSYNC_O and VSYNC_O timing will be different for different PSEs. Figure 13 shows details of the MEMS sync timing.

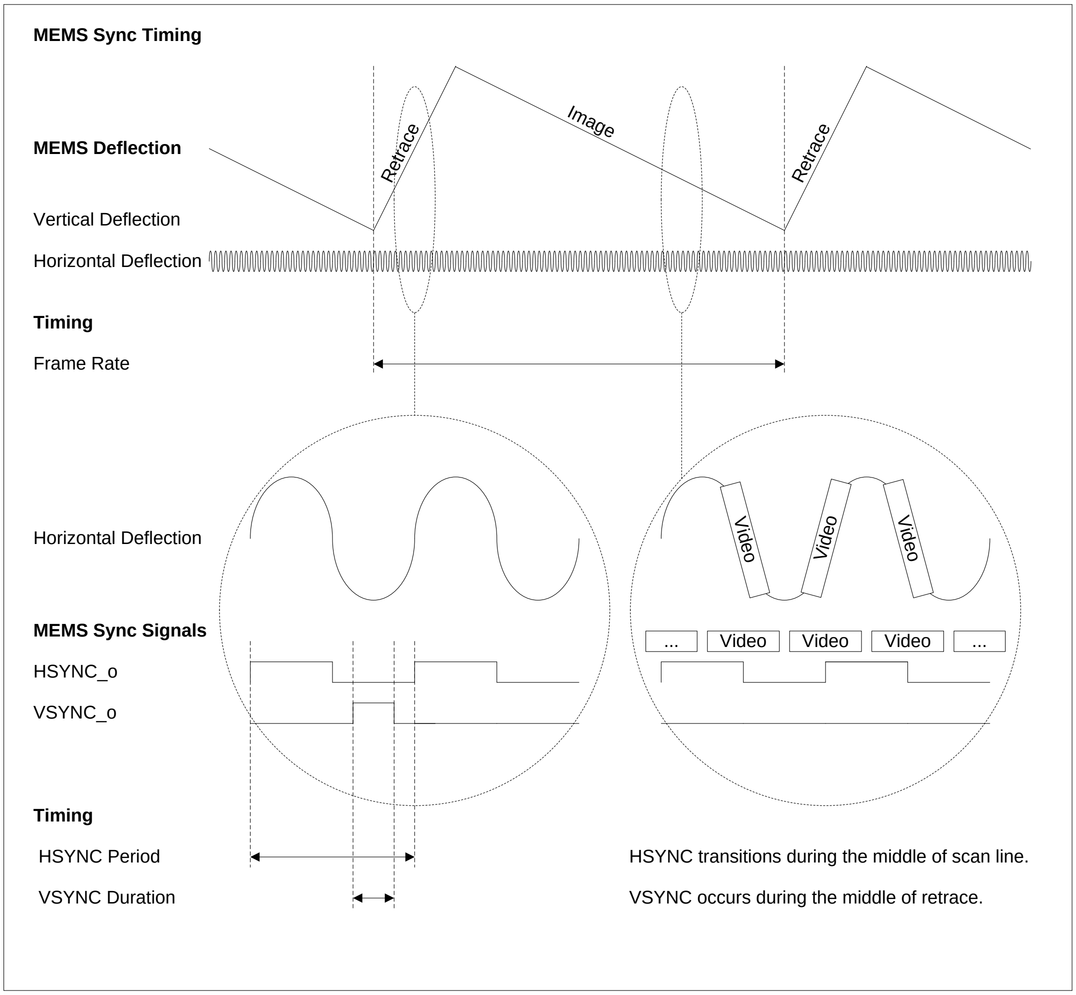

Figure 13. MEMS Synchronization Timing.

4.4 Power Interface

The PSE will typically draw less than 10 µA (maximum 50 µA) of current unless PE (power enable) is asserted. The host device must ensure that the power rail voltage supplied to the PSE exceeds 3.0V before PE is asserted. The host may then poll the PSE module to determine its status using the GetSystemStatus() function (please refer to DA0135396 and DC0124088).

An LED provides an indication that power is supplied to the PSE board.

The host device is expected to monitor the battery voltage and turn PSE off when the power rail voltage falls below 3.0V.

4.5 Electromagnetic Compatibility

The PSE is designed to be compliant with FCC electromagnetic capabilities defined by FCC Part 15 Subpart B Section 15.109 as well as EN 55032 Class B (2012) when appropriately housed inside a host device.

During integration of the PSE in customer's product, take appropriate ESD precautions to prevent ESD damage.

The maximum magnetic field external to the PSE is 2000 gauss. The field drops to less than 50 gauss 10 mm away. PSE functionality can be affected by external magnetic fields. These effects can range from image quality issues up to damage to the MEMS mirror. Functionality of the PSE in proximity to permanent magnets should be verified early in the development process.

4.6 Control & Service Interface

The PSE module Control & Service interface provides a path for the host device to:

1. Issue commands to the PSE for user control, such as
   - Brightness adjustment.
   - Keystone correction.
   - Color alignment and scanline phase delay adjustment.
2. Upgrade software.
3. Access service/manufacturing functions such as system status.

The PSE module also informs the host of exceptions that may require host intervention through this interface.

Please refer to the PSE Programmer's Guide (DA0135396) for a description of the communication interface and control functions.

This interface is implemented to support the UART and USB standards. If USB_VBUS is asserted, the PSE will communicate through USB.

In order to provide maximum flexibility for the end user, MicroVision recommends that color alignment and phase adjustments be exposed to the end user under system setup functionality in the event initial or periodic adjustments are needed.

The PSE module will initiate shutdown under fault conditions that include:

- Laser over-power fault.
- MEMS under/over angle fault.
- IPM under/over temperature fault.

5. Thermal Interface

Table 7: Power Dissipation

Video Level	27% video (Typical video and pictures) at 50°C	Max 100% video (full white) at 50°C
Power Dissipation	2.2W	4.4W

The host system must provide appropriate thermal management to maintain the IPM base surface below 55°C and the PCB top EMI shield surface below 70°C. Figure 14 below indicates the primary heat generating surfaces that require heat sinking. The IPM Base surface should be connected to a surface capable of dissipating up to 3.5W. The PCB Top EMI shields should be connected to a surface capable of dissipating up to 1.2W independently. These values are for maximum possible heat generation (i.e., displaying 100% (Full White) video). The heat dissipating surfaces should also be used to provide mechanical stability for the PSE. The PSE will automatically shut down if the internal IPM (measured at the thermistor) temperature exceeds 60°C.

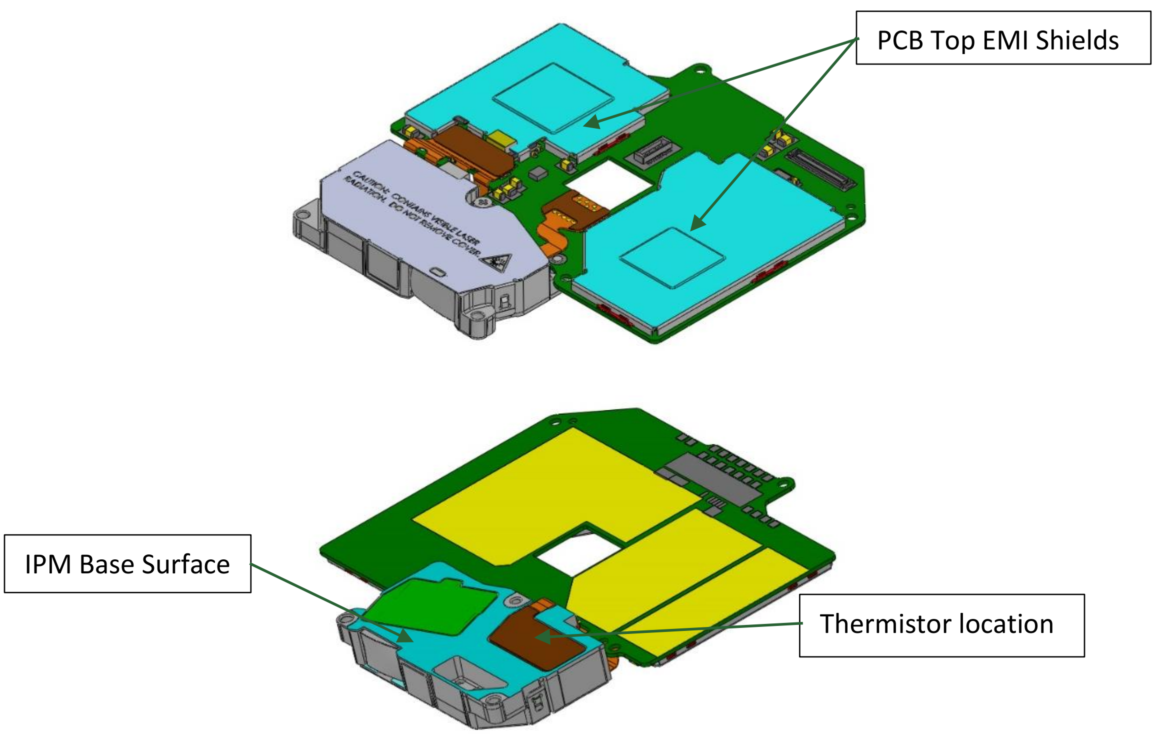

Figure 14. Heat dissipating surfaces of PSE. Shown in blue are IPM housing bottom and EPM top shield.

5.1 Operating Temperature Limits

The IPM is designed to operate at temperatures from 0-60°C as measured by the thermistor attached to the module. The optimal image quality will be achieved with a module temperature between 30-50°C. The PSE will automatically shut down if the module temperature exceeds 60°C. This temperature reading is accessible through the SDK.

6. Handling and Installation

6.1 General handling

The PSE Assembly should be handled while wearing latex or nitrile gloves or finger cots. Take care not to touch any of the lenses.

6.2 Cautions about magnets

The IPM assembly contains strong permanent magnets. The IPM assembly will be strongly attracted to ferromagnetic materials, tools, or surfaces. Impact or collision with hard surfaces or other IPM may cause damage to the IPM assembly or internal components.

6.3 Cleaning

Outer PSE Assembly surfaces may be cleaned using Isopropanol or Ethanol and a cleanroom swab. The PSE Assembly should not be cleaned using forced air or other gasses since this can damage the components.

6.4 Storage

IPMs and PSEs must be stored with reasonable care to avoid damage or contamination. Storage in the original sealed shipping packs or in dry nitrogen in a clean environment is recommended.

6.5 Assembly Packaging and Shipping

The PSE Assembly is packaged in PET trays with surface resistance characteristics between 1.0E+6and 1.0E+11 Ohms.

6.6 Mounting/Installation of the PSE Assembly

6.6.1 Mechanical mounting features

DC0140000 and MC0135383 describe the datum features for mounting the PSE assembly. The datums will be free of burrs, scratches, and contamination that affect the mounting of the PSE assembly.

Improper installation of the PSE assembly may add stresses to the module that could affect performance. The mounting method including the mounting surfaces, adhesives, adhesive volumes and contact location should be qualified by the customer across the full operating range. The mounting configuration must be capable of meeting the thermal dissipation requirements of Section 5.

6.6.2 Proximity of magnetic components

Installing the PSE assembly within a system containing ferromagnetic or electromagnetic components may affect its performance. MicroVision, Inc. can provide guidance for ensuring the functionality of the integrated system.

7. References

The following documents may be useful for reference in connection with this datasheet.

- DA0135432 PSE-0403-103 Product Brief
- DC0140000 PSE Assembly Drawing
- DA0135396 PSE Programmer's Guide
- DC0124088 PicoP® Application Layer Command Reference
- DC0120809 PicoP® Command Protocol (PPCP) Specification
- EN 55032 Electromagnetic compatibility of multimedia equipment
- FCC Part 15 Electro-Magnetic Compatibility
- IEC 60529:2013 Degrees of protection provided by enclosures (IP Code)
- IEC 60825-1:2012 Safety of Laser Products – Part 1: Equipment Classification, Requirements and User's Guide
- CDRH Laser Notice No. 50 Laser Products-Conformance with IEC 60825-1

8. Definitions

EPM	Electronics Platform Module
ESD	Electro-Static Discharge
IPM	Integrated Photonics Module
LBS	Laser Beam Scanning
PSE	PicoP® Scanning Engine
SDK	Software Development Kit