DATALOGIC

HALOGEN™ DE2101 MICRO

2D Bar Code Scan Engine



Integration Guide

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Patents

See www.patents.datalogic.com for patent list.

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Chapter 1
Introduction

About this Manual

This Integration Guide is provided to give instructions, opto-mechanical details and design considerations for integrating the Halogen™ DE2101-DL MICRO scan engine (designated as "scan engine" or "OEM scan engine" in this manual) specifically into equipment-integrated scanning applications.

Manual Conventions

The following conventions are used in this document:
The symbols listed below are used in this manual to notify the reader of key issues or procedures that must be observed when using the reader:



Notes contain information necessary for properly diagnosing, repairing and operating the reader.



CAUTION

The CAUTION symbol advises you of actions that could damage equipment or property.

Outline

Chapter 1, Introduction (this chapter) presents information about manual conventions, an overview of the engine and its features and operation.

Chapter 2, Installation provides information about unpacking, cable connection information and setting up the scan engine for optimum scan engine performance.

Chapter 3, Electrical Integration offers information about electrical components.

Chapter 4, Software Interface describes software commands.

Appendix A, Technical Specifications lists physical and performance characteristics, as well as environmental and regulatory specifications.

Appendix B, I²C Command Specifications offers additional information about I²C Commands.

Appendix C, Engine Video Format details signal characteristics and timing of the parallel and MIPI-CSI2 camera interfaces.

Appendix D, Accessories describes a set of accessories that can be connected to the engine to extend its functionalities.

Technical Support

Datalogic Website Support

The Datalogic website (www.datalogic.com) is the complete source for technical support and information for Datalogic products. The site offers product support, warranty information, product manuals, product tech notes, software updates, demos, and instructions for returning products for repair.

Reseller Technical Support

An excellent source for technical assistance and information is an authorized Datalogic reseller. A reseller is acquainted with specific types of businesses, application software, and computer systems and can provide individualized assistance.

Telephone Technical Support

If you do not have internet or email access, you may contact Datalogic technical support or check the back cover of your manual for more contact information.

About the DE2101

The Datalogic DE2101 is a very compact, high performance undecoded imager used to capture digital images to be transferred to an external digital platform, providing the ability to decode any kind of bar code symbols.

Unpacking the Scan Engine

The scan engine is shipped in custom packaging. Carefully open the package, and inspect the scan engine.

If any parts are damaged or you need additional hardware, please contact Technical Support.

Scan Engine Care

The scan engine contains sensitive components which require special handling. Datalogic may not warrant damage due to improper handling.

- Do not disassemble the scan engine. Doing so will void the warranty.
- Use standard ESD precautions & policies when handling the DE2101 scan engine.

External Optics

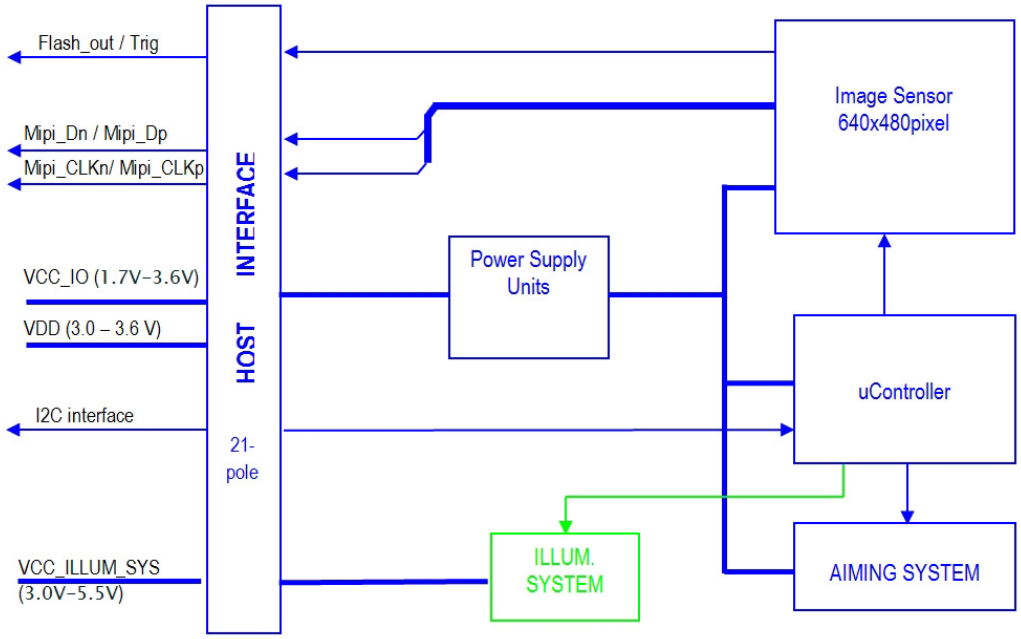
The engine has an exposed illumination system and aiming lenses on the outer surfaces. Take care of these optical components, preserving the lenses from mechanical stresses that can damage them. Avoid touching the optical surfaces to preserve the optical performance.

System Overview

The Datalogic DE2101 scan engine features a global shutter sensor having 640x480 pixels, able to capture images up to 120 frames per second.

The engine contains an embedded illumination system and an aiming system. A high performance, low power micro-controller runs the engine system and handles communication with the external host. The host interface is available as a 21-pole zif connector.

Figure 1. Engine block diagram



Illumination System

The Illumination System is composed of one white LED able to provide first-class reading performances, even in total darkness.

Regulatory

- EN/IEC 62471 (exempt)

Aiming System

The aiming system is based on a blue LED and related optics. It projects a highly visible circular spot aimer for targeted scanning.

Regulatory

- EN/IEC 62471 (risk group 1)

Chapter 2
Installation

This section describes how to correctly integrate the scan engine for optimal performance.

Mounting the Scan Engine

General Considerations

A typical system uses the scan engine mounted inside a host enclosure, with an opening for the illumination system light to exit and illuminate the label and for reading bar codes. The opening should be the size of the scan engine field of view at a minimum, but only exposing as much of the scan engine as necessary.

It is important to consider the effect of the environment on the scan engine. In particular, mounting should minimize the possibility of foreign objects coming into contact with the electronics. Such contact could damage the device or reduce the scan engine's performance.

Mechanical Size

Figure 2. Nominal Engine Size (see appendix D details about engine with green spot)

Nominal size:

21.00mm (width) x 6.50mm (height) x 14.00mm (depth)

Maximum size:

21.30mm (width) x 6.80mm (height) x 14.50mm (depth)

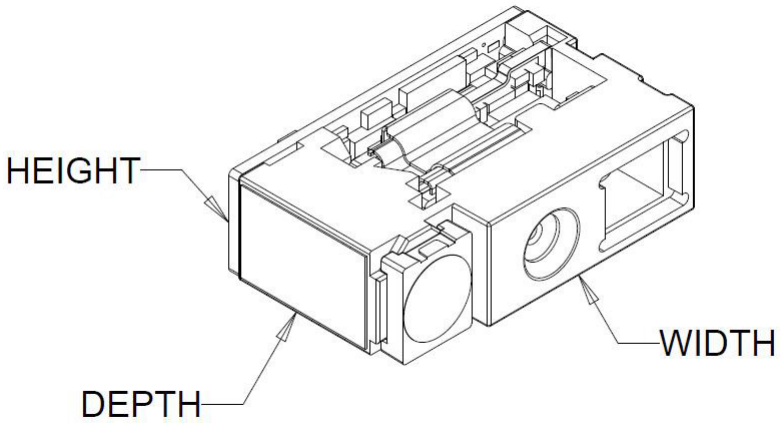
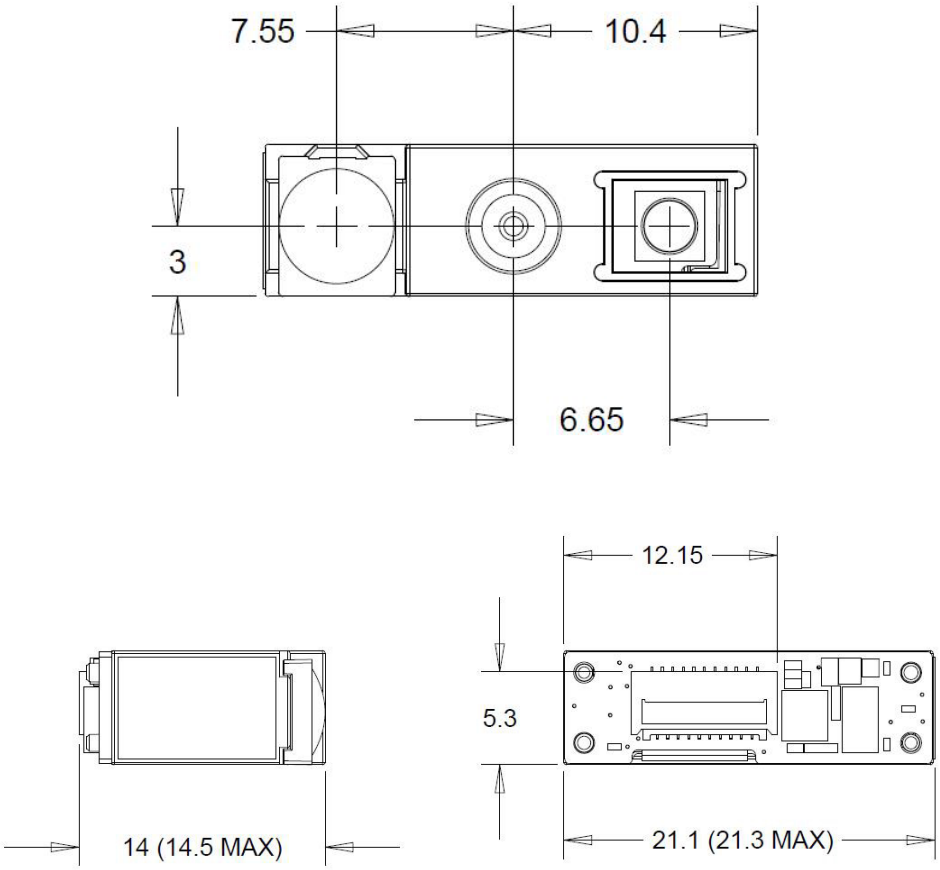


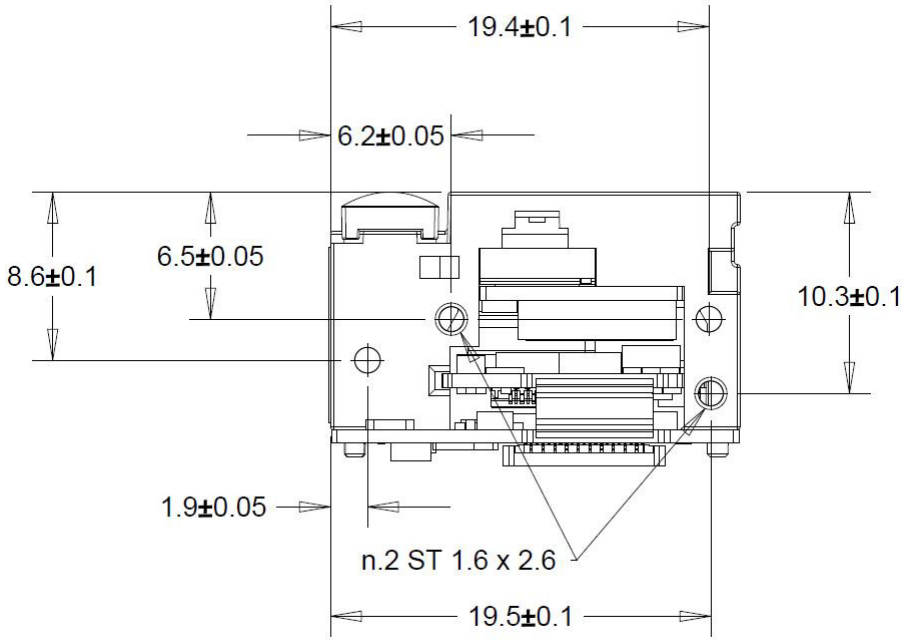
Figure 3. Engine Size and Connector Position (values without tolerances are for reference only)



Mounting Holes

There are two mounting holes M1.6x0.35mm located on the bottom of the chassis. The recommended engagement for the screws is 5.5 threads, with a mounting torque of 16±0.9 cNm.

Figure 4. Mounting holes and related requirements



Housing Design

The enclosure must be designed to prevent internal reflections from illumination and aiming systems into the receiving optics. The exit window must be properly positioned and tilted to avoid reflections that could limit engine performance, both for decoding and image capture.

Positioning the exit window

There are two options for positioning the exit window with respect to the engine optical axis:

- Perpendicular
- Tilted

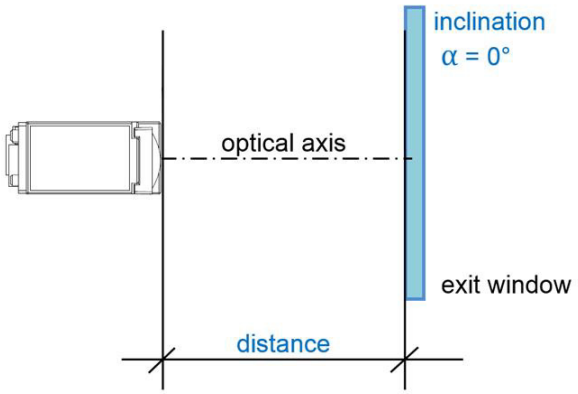
Distances are measured from the illumination lenses to the first face of the exit window (the nearest to the engine). Window thickness should be smaller or equal to 1.5mm.

The use of a double-sided AR coated exit window is strongly recommended both for perpendicular and tilted windows.



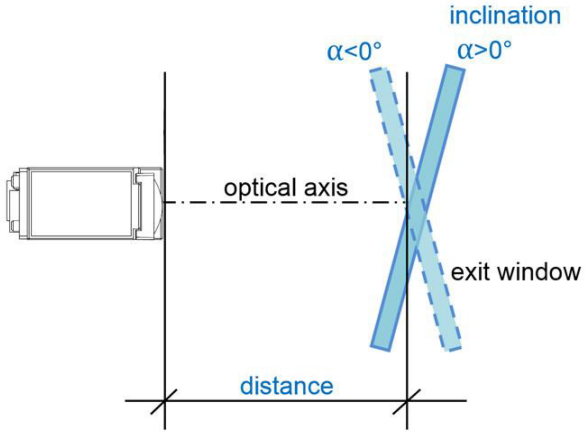
- **Do not place the exit window between the maximum distance allowed for a parallel window (Figure 5) and the minimum distance for a tilted window (Figure 6).**
- **Integration tolerances are not included.**

Figure 5. Exit window positioning – perpendicular window



	Distance [mm]
No Coating	< 1 mm
AR coating (2 sides)	< 1 mm

Figure 6. Exit window positioning – tilted window



		Distance [mm]					
		5	10	15	20	25	30
No Coating	+α	44	38	38	36	34	34
	−α	44	38	38	36	34	34
AR coating (2 sides)	+α	40	34	34	32	30	30
	−α	40	34	34	32	30	30

Avoiding scratched windows

Scratches on the exit window can strongly affect the reading performance. It is recommended to use an exit window having a scratch-resistant coating and to position the engine window in a recessed position.

Window material

The exit window is an integral part of the imaging system and should be designed and selected to preserve the optical quality of the system. It is recommended to use only cell-cast plastics or optical glass.

Common materials and their characteristics are shown in Table 1 on the following page.

Table 1. Exit window materials

Properties	PMMA (cell cast acrylic or polymethyl methacrylic)	CR39 (Allyl Diglycol Carbonate)
Optical Quality	Very good	Very good
Surface Hardness	Hard coating required	Hard coating required
Impact Resistance	Good	Good
Chemical / UV Resistance	Susceptible	Susceptible
Ultrasonically Welding	Compatible	Compatible

Exit window properties

Recommended properties/performance of the exit window are reported in Table 2 below.

Table 2. Exit Window Properties

Characteristics	Requirement
Material	PMMA or CR39 or equivalent
Thickness	1.5mm
Wavefront distortion	0.2 wavelengths peak-to-valley maximum and 0,04λ maximum rms over any 2.0mm diameter within the clear aperture
Clear aperture	To extend to within 1.0mm of edges all around
Surface quality	60/20 scratch/dig
AR coating	• double sided • transmittance > 97% minimum within spectrum range 400nm-750nm. • reflections max 0,4% per side in the range 620nm-640nm

Optical paths and exit window clearance for standard models

Figure 7 and Figure 8 show the optical paths for the imaging system, the aiming system and the illumination system.

Declared imaging system Field Of View is 48°x34° (see Appendix A). Due to fabrication and assembly tolerances, the optical path to be considered for mechanical integration is 54°x43°.

Figure 7. Top view - Aiming, imaging and illumination optical paths

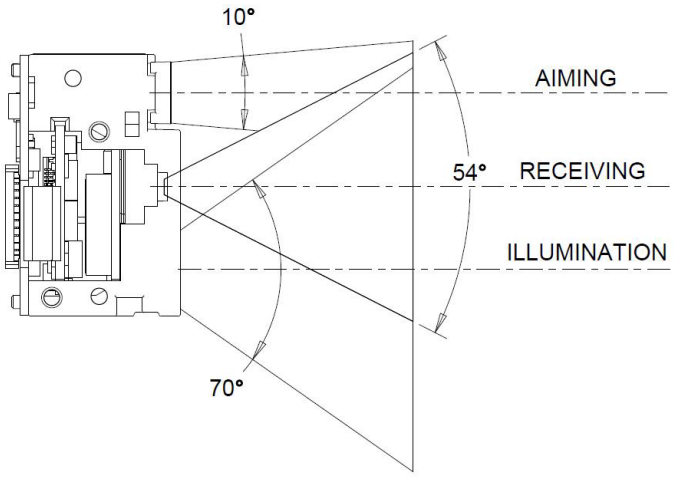
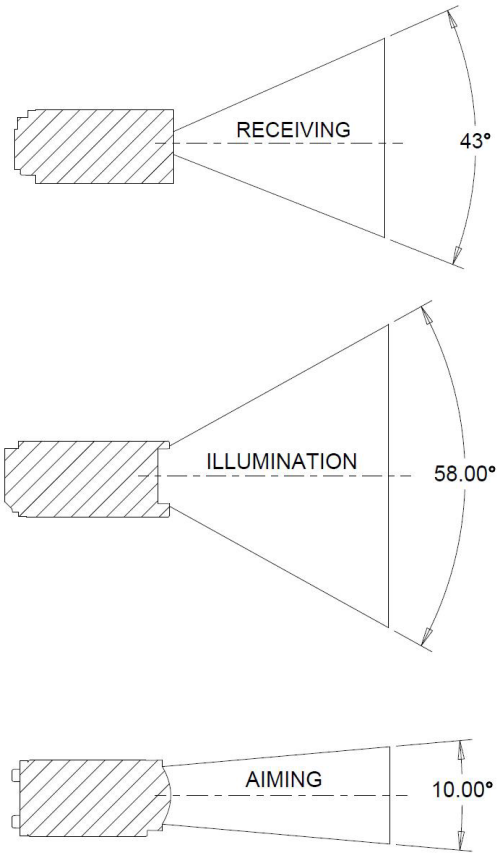


Figure 8. Side View - Aiming, imaging and illumination optical paths



Environment

Dust on the optical parts of the engine can badly affect the performance of the scan engine. Ensure the engine is clear of dust and water when integrating it inside the housing.

Chapter 3
Electrical Integration

Electrical Connections

ESD

The engine is protected from ESD up to ±2.0Kv@ connector.

During installation it is recommended to apply standard ESD handling procedures, such as operating in a properly grounded working area using wrist straps.

Electrical Interface

The DE2101 scan engine can be connected to an external digital platform via a 21-pole ZIF connector supporting:

- a camera interface (MIPI-CSI2)
- a signal to synchronize an external illumination system with the exposure of the sensor (FLASH_OUT); this signal can also be configured as an input for triggering the camera (HW_TRIGGER). Default behavior is FLASH_OUT. Pin is in open drain configuration with a 4.7K pullup to VCC_IO.



If HW_TRIGGER mode is used connect this pin in open drain configuration.

- three dedicated power supplies (sensor and digital system, I/O, illumination system)
- an I^2C communication port for controlling the scan engine

Table 3 below describes the power lines and the signals mapped on the 21-pole ZIF connector for parallel camera interface.

Table 3. MIPI video port: Engine connector description

Pin	Signal	I/O type	Description
	GND	power	Ground
2	GND	power	Ground
3	MIPI DN	I	MIPI-CSI2 differential data lane (negative)
4	GND	power	Ground
5	MIPI DP	O	MIPI-CSI2 differential data lane (positive)
6	GND	power	Ground
7	GND	power	Ground
8	GND	power	Ground
9	MIPI CLKP	O	MIPI-CSI2 differential clock lane (positive)
10	GND	power	Ground
11	MIPI CLKN	O	MIPI-CSI2 differential clock lane (negative)
12	GND	power	Ground
13	VCC_IO	power	I/O reference and power supply
14	FLASH_OUT / HW TRIGGER[a]	I/O	External illumination system trigger (OUTPUT)/ Camera HW Trigger (INPUT)
15	Reserved	-	-
16	VCC	power	Digital and sensor power supply
17	VCC_ILLUM_SYS	power	Illumination system power supply
18	VCC_ILLUM_SYS	power	Illumination system power supply
19	I2C_CLK[b]	I	I2C Clock
20	I2C_DATA[b]	I/O	I2C Data
21	GND	power	Ground

a. Internal 4,7K pullup to VCC_IO, pin is in open drain driving mode. FLASH_OUT is default behavior; when used as HW TRIGGER host pin should be open drain.

b. Internal 10K pullup to VCC_IO, pin is in open drain driving mode. 4.7K additional external pullup is suggested.

Connector and Flat Cable

The DE2101 scan engine is equipped with a Kyocera 21-pole ZIF connector having a pitch of 0.3mm - series 6283 - ordering code 04 6283 021 002868.

For further details and requirements related to the flat cable, please refer to the manufacturer's datasheet.

In order to reduce radiated emission it is strongly recommended to adopt an EMI-shielded flat cable.

Power-up Sequence

In order to guarantee the correct operation of the engine, it is mandatory to use the following power-up sequence timing constraints:

VCC, VCC_IO and VCC_ILLUM_SYS can be given to the engine at the same time. It is possible to give the VCC_ILLUM_SYS and VCC_IO before VCC that shall be the last one. Given the VCC as last applied the order for VCC_ILLUM_SYS and VCC_IO does not matter.

The power off sequence is the opposite order. VCC, VCC_IO and VCC_ILLUM_SYS can be switched off at the same time or the first to be switched off shall be the VCC and then VCC_ILLUM_SYS and VCC_IO switch off order does not matter.

Engine Latency at Power-up

At power up the engine begins executing the code when the power supply level reaches about 1.8 V. To complete the boot sequence about 40 mSec are required; after this period the engine is ready to parse commands.

Supply Voltages and I/O levels

Table 4. Supply Voltages and I/O Levels

Item	Level	Description
VCC	3.3V ± 0.3	The image sensor power supply, from which the analog power supply is also generated. The value of 3.0V has to be considered as an inferior limit, but for having superior power supply noise immunity, a value above 3.15V is recommended.
VCC_IO	1.7V to 3.6V	The IO stage power supply; determines I/O reference level for input and output signals.
VDD_ILLUM_SYS	3.0V to 5.5V	The LED illumination system power supply.
I/O level	same as VCC_IO	The typical high level for input and output signals.
LP signals	1.2V	The typical high level for MIPI lines (MIPI CLKP, CLKN, DP, DN) when in MIPI Low Power mode.
HS signals, Peak to peak	0.2V	The typical signal peak to peak level for MIPI lines (MIPI CLKP, CLKN, DP, DN) when in MIPI High Speed mode.
HS signals, Common Mode	0.2V	The typical signal common mode level for MIPI lines (MIPI CLKP, CLKN, DP, DN) when in MIPI High Speed mode.



Units must be supplied by a separately certified NEC Class 2 (LPS) or PS2 limited power unit or equivalent.

Power Supply Noise

To preserve image quality (both for decoding and image capture applications), a low-noise power supply is required, particularly for VCC supply.

The requirement for the power supply peak-to-peak noise is ≤150mV on all three power supply lines (the lower the better). This noise level is supposed to allow normal module operation. Note that Image quality depends also on the noise frequency.

Heat Dissipation

If the scan engine is operated in a closed environment where the temperature can rise significantly, particular care must be taken to properly dissipate the heat generated by an intensive operative condition, like using RUNNING mode with AIM and LED at full power continuously for an extended time.

Chapter 4
Software Interface

Communication Protocol

The engine provides a bidirectional control interface for the communication with the integrating platform based on the I^2C communication. This is a master/slave and host-initiated command/response type of protocol, and the engine always acts as a slave.

It does not support unsolicited responses, meaning that all transactions that involve sending a command and receiving a response are always initiated by the host system.

The time needed for execution depends on the command sent. If the engine does not respond when requested by the host, it is possible that the command is still being processed. In this case, the master will be forced into a wait state until the slave is ready.

The maximum waiting time between receiving a command and the response request is 1 second. After this time a system timeout occurs and the engine is ready for a new command.

Command Format

Commands sent via I^2C from host (master) to engine (slave) should have the following format:

Start bit	**Address**	**Command** (hex code)	Command Parameters	...	Checksum	Stop bit

I^2C Element	Description
Start bit:	Start bit as I2C standard specification.
Address:	Target slave address includes device address plus write option (0x00). For the engine, slave address is 0x5C (or 0xB8 after shifting to 7bit MSB).
Command:	See list of possible command codes for DE2101 in Table 5 on page 15
Command Parameters:	Data bytes required by the command, shown in Table 5 on page 15.
Checksum::	1 byte for data integrity check. Checksum is calculated by: Summing all command bytes, including command code and following data. Performing 2's complement of the resulting least significant byte (LSB).
Stop bit:	Stop bit as I^2C standard specification.

Engine Response Format

When the host requests a response from the engine, the response format will be:

Start bit	**Address**	**Command** (hex code)	**STATUS**	**Response Data**	**...**	Stop bit

Same as for sent Command Format, plus:

I^2C Element	Description
Address:	Target slave address includes device address plus read option (0x01). For the engine, slave address is 0x5C (or 0x88 after shifting to 7bit MSB).
STATUS:	STATUS can be one of the following: • ACK (0x80) • NACK (0x82) • CHECKSUM ERROR (0X84)
Response Data:	Data returned by the issued command (can be one or multiple bytes or none), LSB first. See Table 5 on page 15

I²C Command Codes

Command Parameters

The following table shows a categorized list of the DE2101 possible I²C commands in hexadecimal code, including a brief description, with corresponding parameters and response bytes. All bytes are intended as Least Significant Byte (LSB) first, both in send and receive transactions.

This table only describes the parameters to be used with each command, not including the checksum byte or STATUS response byte. For a complete description of the I²C protocol see "Communication Protocol" on page 13.

For more information on the commands, see "I²C Command Specifications" on page 25.



Default values are shown as underlined text in the following table.

Table 5. Commands and response format

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
CAMERA OPERATIONS				
[0x37]	CAMERA RESET	Resets system to initial state.	**1 Byte:** 00=Sensor-Only Reset	
[0x38]	CAMERA START	Starts or stops image acquisition.	**1 Byte:** 0x00=Stop 0x01=Start	
[0x3B]	CAMERA MODE	Configures the scan engine for performing different tasks.	**1 Byte:** 0=Barcode Decode 1=LCD Read	
[0x42]	BOOTLOADER START	Stops operations and starts bootloader.	**3 Bytes:** Signature: 0xAA, 0x50, 0x5F (LSB FIRST)	

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
		CAMERA SYSTEM CONFIG		
[0x3F]	SET LOW POWER	Activates system power saving mode, switching between Low Power and Idle mode.	**1 Byte:** 0x00=Idle 0x01= Low Power	
[0x40]	GET CAMERA PARAM	Returns chosen Camera parameter (stored in EEPROM).	**2 Bytes:** Parameter ID Code	**n Bytes:** Parameter current value; number of bytes depending on parameter[1]

1. See Table 6 on page 18 and Table on page 19 for details on parameter length and ID code.

		AIMING SYSTEM		
[0x35]	AIM TOGGLE	Switches the aiming system ON/OFF.	**1 Byte:** 00=Off 01=On	
[0x36]	AIM ON IMAGE	Sets aiming laser projection syncing so that is visible on the image.	**1 Byte:** 00=Off 01=On	
[0x4E]	AIM TIME	Sets the aiming laser lighting time for each frame (determines aim pattern brightness).	**1 Byte:** 0x00 = sets Aim "on" time per Frame to default (=4000us), or to user custom if previously modified. 0x01-0x2A = aim "on" time (per Frame) set to value*0.1ms. Max value is 4.2ms. **Note:** pulse duration might be trimmed by sensor exposure time variations	

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
[0x4F]	AIM BLINK	Sets the on / off rate of the AIM pattern on a frame basis	**1 Byte:** 0x00 = sets Aim pattern ON in each frame. 0x01–0xFF = number of frames in which AIM is ON + **1 Byte:** 0x00 = sets Aim pattern ON in each frame. 0x01–0xFF = number of frames in which AIM is OFF	
LED ILLUMINATION SYSTEM				
[0x39]	ILLUMINATION ENABLE	Switches ON/OFF the LED illumination system.	**1 Byte:** 00=Off 01=On	
[0x48]	ILLUMINATION TIME	Sets the illumination LEDs lighting time for each frame (determines LEDs brightness).	**1 Byte:** 0x01–0x24 = Illumination time per Frame is set to *value**50us. If value=0x01: time=300us. Default: 0x0C: time=900us	
IMAGE SENSOR				
[0x30]	SET SENSOR REG	Writes new value to the Image Sensor desired register.	**2 Bytes:** Register address (MSB first) + **1 Byte:** Register new value	
[0x31]	GET SENSOR REG	Gets Image Sensor desired register value.	**2 Bytes:** Register address (MSB first)	**1 Byte:** Register current value



See Table 6 on page 18 for details on parameter length and ID code.

Camera System Parameters

The following tables list DE2101 system Parameters. Table 6 below shows the camera system information.

All values must be sent and are received via I^2C with LSB first.

Table 6. Parameter ID codes and length

The following parameters are READ ONLY

Parameter	Description	ID Code (HEX)	Length (Bytes)
Model Number	Camera model number	0x0000	18
Serial Number	Camera serial number	0x0001	16
Date of Manufacture	Camera manufacture date	0x0002	7
Date of Service	Camera service date	0x0003	7
Firmware Version Report	Answers with “APPL<application_firmware_version>” if the application is running. Answers with “BOOT<bootloader_firmware_version>” if the bootloader is running	0x000A	12
Bootloader Firmware Version	Camera bootloader version	0x000B	8
Application Firmware Version	Camera firmware version	0x4E24	8
Camera ID	Camera ID number	0x4E25	1
Compatibility ID	Hardware / Software Compatibility Identifier	0x4E26	1
Device Class	Camera device class	0x4E27	18
GUID	Generally Unique ID	0x000E	32
Family ID	Halogen Family ID	0x03F7	7
PCB Number	PCB Number	0x0BD6	10

EXAMPLE: Getting a Scan Engine Serial Number

Cmd Name = GET CAMERA PAR
Cmd_Code = 0x40

Parameter ID Code = 0x0001
Parameter Length = 16 bytes

SEND COMMAND to the ENGINE:

<write> 0x40 0x01 0x00 0xBF



The last byte 0xBF represents the checksum.

GET RESPONSE from the ENGINE:

<read> 0x40 0x80 0x01 0x00 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x.. 0x..



The second byte 0x80 represents the status code that in this case is ACK.

The sixteen bytes 0x.. represent the serial number of the engine.

Appendix A
Technical Specifications

This section lists the technical specification of the DE2101 engine, including reading performance.

Item	Description
Physical Characteristics	
Dimensions (without Green Spot Accessory – see Appendix D)	**Nominal size:** Width 0.83"/21.00 mm Height 0.26"/6.50 mm Depth 0.55"/14.00 mm **Maximum size:** Width 0.84"/21.30 mm Height 0.27"/6.80 mm Depth 0.57"/14.50 mm
Weight	2.0 ± 0.2 g (no green spot) 2.3 ± 0.2 g (with green spot)
Interface	Camera port on a 21 pin ZIF Connector
Electrical Characteristics See "Power Consumption Details" on page 23 for more information.	
Current	Values at 23°C – VCC: 3.3 – default configuration: Max. Operating (RMS): < 300 mA Standard Operation (Typical RMS): 135 mA Idle (Typical – RMS): 12 mA Low Power (RMS): < 1 mA Surge Current Peak: < 400 mA for t < 0.15 ms that might occur in some conditions (see table 9)
Input Voltage	Values at 23°C: –VCC: 3.3 ± 0.3V –VCC_IO: 1.7V to 3.6V –VCC_ILLUM_SYS: 3.0V to 5.5V See "Supply Voltages and I/O levels" on page 18 for details.

Item	Description
Performance Characteristics	
Image Sensor	VGA: 640x480
Light Source	Illumination: white LED Aiming: blue LED
Field of View	48°H x 34°V
Print Contrast Minimum	25% minimum contrast
Scanning Angles See Definition of Scanning Angles on page 22 for additional information.	
Roll Angle	Up to ± 180°
Pitch Angle	± 60°
Skew Angle	± 60°
Minimum Element Width	1D Linear: 4 mils PDF: 6.6 mils Datamatrix: 7.5 mils

DE2101-DL Depth of Field1[1]		Typical		Guaranteed	
	Resolution [mils]	**Dmin [mm]**	**Dmax [mm]**	**Dmin [mm]**	**Dmax [mm]**
Code 39	5	50	190	60	160
Datamatrix	10	50	130	60	110
EAN13	13	(–)[2]	330	(–)[2]	270
Code 39	20	(–)[2]	460	(–)[2]	370

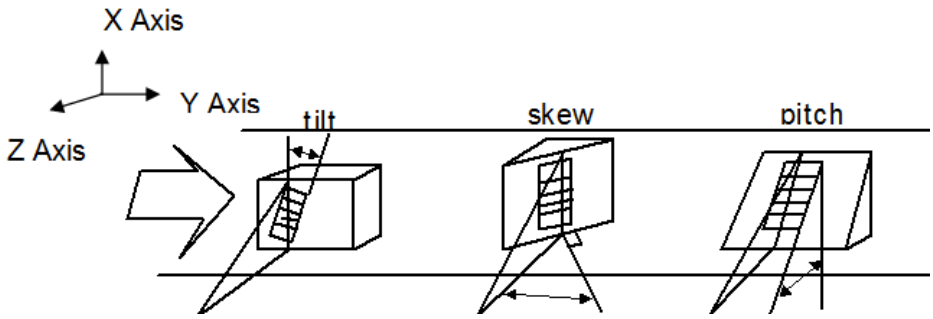
1. All labels grade A, ambient light level 300lux, pitch angle 10°, tilt angle 10°, skew angle 0°, room temperature 20°C.
2. Limited by field of view

Item	Description
User Environment	
Operating Temperature	Operating: -30 to 55ºC / -22 to 140ºF
Storage Temperature	Storage / Transport: -40 to 70ºC / -40 to 158ºF
Humidity (non-condensing)	95%
Mechanical Shock	2000 G ± 5% applied via any mounting surface at -30° and 70° C for a period of 0.85 ± 0.05 msec 2500 G ± 5% applied via any mounting surface at 23° C for a period of 0.85 ± 0.05 msec
Ambient Light Immunity	Up to 100,000 Lux
ESD Level	EN 61000-4-2 +/-2.0KV Air Discharge @ connector +/-1.0KV Contact Discharge @ chassis
Regulatory	
Aiming System (blue LED)	IEC 62471 Risk group 1
Illumination System (white LED)	IEC 62471 Exempt risk group
Environmental	RoHS compliant

Definition of Scanning Angles

Skew, Pitch, Roll Angle testing is based on ISO 15423 specifications.

Figure 9. ISO15423 angle definition



Reading distances are measured along Z-axis.

Power Consumption Details

While operating, the engine switches between different working modes. Each mode is characterized by a specific power consumption level.

Low Power	The engine is in deep sleep (minimum power consumption). The microcontroller is in stop mode and all other peripherals are switched off. The system wake up only after receiving an i2c valid transaction.
Idle	The engine is active, waiting for commands and ready to start an acquisition. Only the microcontroller is running in active mode. All the peripherals involved on the acquiring system are in standby mode (image sensor and control logic). The illumination system is switched off.
Running	The engine is acquiring and streaming images to the host. The image sensor and control logic is active and running at full power The overall Power consumption depends on the configuration of the engine, the AIM and Illumination enable and duration.

Assuming the system is at 23°C and all three power supplies are at 3.3V, the typical current absorption is reported in the table below (engine parameters set at factory default).

Table 7. - Typical RMS current consumption

DE2101 status	Current Consumption	Conditions
Low power	< 1 mA	Temperature 23°C – Illumination lamp duration 900 us – AIM laser-on duration 4 ms VCC = 3.3V VCC_IO = 3.3V VCC_ILLUM = 3.3V
Idle	12 mA	
Image Acquisition (Running)	65 mA	
Illumination Enabled	115 mA	
Illumination Enabled and AIM Enabled factory default timing	135 mA	
Maximum Operating Current	155 mA	
Maximum Surge Current	Peak < 400 mA for less than 150 us	At the beginning of each frame.

Appendix B
I²C Command Specifications

This section provides additional information about I²C Commands.

I²C COMMAND SPECIFICATIONS on page 25

- **AIM BLINK (0x4F)** on page 25
- **AIM ON IMAGE (0x36)** on page 25
- **AIM TIME (0x4E)** on page 25
- **AIM TOGGLE (0x35)** on page 25
- **BOOTLOADER START (0x42)** on page 25
- **CAMERA MODE (0x3B)** on page 25
- **CAMERA RESET (0x37)** on page 26
- **CAMERA START (0x38)** on page 26
- **GET CAMERA PARAM (0x40)** on page 26
- **GET SENSOR REGISTER (0x31)** on page 26
- **ILLUMINATION ENABLE (0x39)** on page 26
- **ILLUMINATION TIME (0x48)** on page 26
- **SET LOW POWER (0x3F)** on page 27
- **SET SENSOR REG (0x30)** on page 27

I²C Command Specifications

This section contains a complete description of the DE2101 possible I²C supported commands in alphabetical order. For a summary list and more information, see Command Format, starting on page 13.

AIM BLINK (0x4F)

Sets the on / off rate of the AIM pattern on a frame basis when camera is Running and AIM is enabled (see AIM ENABLE command).

The first Byte determines the number of frames in which AIM is turned on, the second Byte the number of frames when is off. If one of the 2 Bytes is = 0 then default value is set, with AIM pattern active every frame.

AIM ON IMAGE (0x36)

Sets wether the aiming pattern is visible on the images or not. If the 0x01 parameter is sent the AIM pattern is projected during the exposure time of the sensor when the camera is Running, so that the aim pattern is visible on the image. AIM pattern must be turned ON for this to work, see command AIM TOGGLE.

If 0x00 is sent the pattern is not visible on the image, since it is projected when the sensor is not exposing (default).

AIM TIME (0x4E)

Sets the lighting time of the AIM pattern during each frame, starting from after the sensor exposure. A longer period determines a brighter aim pattern.

Accepts values from 0x00 to 0x2A; each unit corresponds to a 0.1 ms time increment (max is 0x2A=4.2ms, min is 0x01=0.1ms).

If value 0x00 is sent, the time is set to default; default value is defined in parameter “Aim Time Default”, that if not modified has value 4000us (factory default) – see Table 8 on page 28).

Whichever value is set, for each frame the aim on time might be automatically trimmed in order to be off during the sensor exposure.

AIM TOGGLE (0x35)

Sets on or off the AIM pattern. With the value set to 0x01 the AIM pattern will turn on whenever the camera is running. Setting the value to 0x00 will always turn it off.

The AIM pattern will not be visible in the acquired images, unless AIM ON IMAGE is set to 0x01.

BOOTLOADER START (0x42)

Stops executing the engine camera application and runs the engine bootloader. Takes as input the following signature code: 0xAA, 0x50, 0x5F (LSB first).

CAMERA MODE (0x3B)

Sets up the engine system and the image sensor for a specific task: Barcode Decoding, LCD Screen Read. Modifies some sensor internal register values

plus LED illuminator and AIM pattern on/off timing, leaving other parameters unchanged.

Here a description of the working modes:

BARCODE DECODING (0x00): this is the default mode, optimizes the sensor for standard decoding operation. Scan engine automatic analog gain algorithm and sensor automatic exposure control are enabled, LED timing is optimized for having decodable images, laser AIM pattern is clearly visible by the human eye, but not in the images.

LCD SCREEN READ (0x01): same as barcode decoding, but the LED illumination timing is optimized in order to avoid blinding the image sensor with the LED light reflection on LCD or other kind of backlit screens (such as smartphones or tablets).

CAMERA RESET (0x37)

Re-initialization of all systems. The camera returns to its initial state, except for all parameters previously stored in EEPROM using SET CAMERA PARAM, that will be retained and will be loaded back at the end of this system reset.

If parameter is 0x00, only the image sensor will be reset. About 19ms needed to complete.



Do not issue any command while the scan engine is completing reset command.

The previously made changes will not be written to non-volatile memory and User Custom Parameters will NOT be modified by this command.

CAMERA START (0x38)

Starts or stops image acquisition and image transmission.

After a stop command (CAMERA START with parameter 0x00), the engine begins the procedure for stopping the image sensor. During this time (at max one frame time= 20ms) the system will not compute any I^2C command.

GET CAMERA PARAM (0x40)

Reads camera system factory parameters stored in non-volatile memory. Details can be found in Table 6.

GET SENSOR REGISTER (0x31)

Returns the desired register value of the image sensor. Parameter is the 2 Bytes register address (MSB first), response is the 1 Byte register value.

Further details can be found on the sensor manual.

ILLUMINATION ENABLE (0x39)

Sets on or off the illumination LEDs. With the value set to 0x01 the illumination LEDs will turn on whenever the camera is in RUNNING mode. Setting the value to 0x00 will turn illumination LEDs off, anytime.

ILLUMINATION TIME (0x48)

Sets the illumination light pulse duration within each frame, with a 50us time increment. Possible values are from 0x01 (300us) to 0x2 (2ms). Default value (factory default).

SET LOW POWER (0x3F)

Instantly activates/deactivates system power saving mode, toggling the scan engine between three different power states: Idle, Fast wake up Low Power and Deep sleep Low Power. By default the power state is Idle. The user can decide to go to Fast Wake Up Low power mode 0x01 (consumption of about 15 mA) which guarantees a wakeup time of maximum 13 mSec, or to Deep Sleep Low Power mode 0x02 (consumption of about 120 uA) which takes up to 26 mSec to recover the normal operation.

This command can only be used when the camera is NOT in Running mode, since it puts both the micro-controller and the image sensor into sleep mode.

The system wakes up and returns to Idle mode each time a command is issued; it doesn't automatically go back to Low Power.

SET SENSOR REG (0x30)

Stores the newly chosen value for the desired register of the image sensor. Further details can be found on the sensor manual. Parameters are: 2bytes register address followed by one byte register value; MSB first standard is used.



Unpredictable camera behavior may occur:

Modifying registers using SET SENSOR REG bypasses the engine system control over the sensor. This could cause the image sensor to behave in a way that conflicts with the engine system working setup and normal operation.

Appendix C
Engine Video Format

This appendix describes details related to the video port of the engine, the image format and the related timing.

Sensor Data Format

The Datalogic DE2101 engine is based on the OV7251 monochrome image sensor.

The image format is RAW8 monochrome 640x480. The MIPI stream is in CSI2 format (D-PHY physical layer).

For further information please refer to the manufacturer web site.

MIPI-CSI2 Timing Parameters

The data output of the sensor is sent via MIPI-CSI2 protocol with the differential clock lane (MIPI CLKP, CLKN) and the differential data lane (MIPI DP, DN). When a data packet is to be transmitted, the MIPI interface works in differential High Speed mode (with a typical clock frequency of 320 MHz), otherwise is in single ended low power mode. High speed data packets are sent for transmitting serialized image data (start/end of frame and pixels of each line).

Clock frequency at Tamb=25°C may vary of a 2% amount with respect to the typical value; moreover, in particular condition at extreme working temperatures there can be a maximum Pixel Clock frequency variation of up to a +6% value @ Tamb=-30°C and of a -3% value @Tamb=55°C.

Table 8 - MIPI CSI2 Timing

MIPI Parameter	Description	Typical Value
HS-CLK	High Speed transmission Clock frequency.	200 MHz
THS-PREPARE	Time that the transmitter drives the Data Lane LP-00 Line state immediately before the HS-0 Line state starting the High Speed transmission.	92 ns
THS-PREPARE+THS-ZERO	THS-PREPARE + time that the transmitter drives the HS-0 state prior to transmitting the High Speed Data packet.	302 ns
THS-TRAIL	Time that Data HS-0 or HS-1 (depending on last transmitted bit) state is driven after the last payload bit of a High Speed.	139 ns
TLP-01	Transmitted length of any Low-Power LP-01 state period.	200 ns
THS-EXIT (Clock)	Time that of the Clock LP-11 state following a HS burst (varies if sensor Horizontal Blanking is modified).	347 or 11246 ns

Sensor Registers Settings

For information on register settings, refer to the Omnivision OV7251 monochrome VGA Image Sensor documentation, available at http://www.ovt.com.

Appendix D
Accessories

This section provides information about scan engine accessories and their installation.

Green Spot Projector

Optionally, a green spot projector can be installed on the side of the engine. Nominal width of the assembly composed by engine and green spot is 26mm, maximum width 26.5 mm.

Figure 10 and Figure 11 provide information about overall size and green spot optical path.

Figure 10. Maximum size including green spot

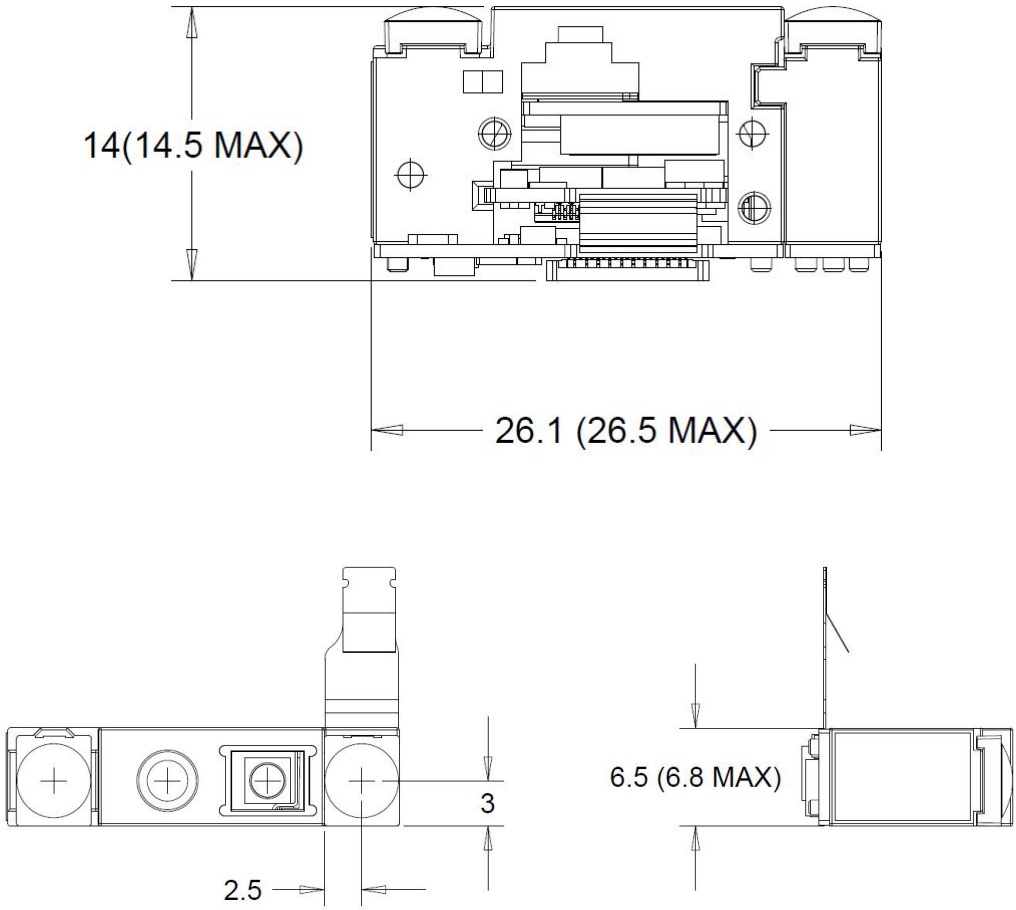
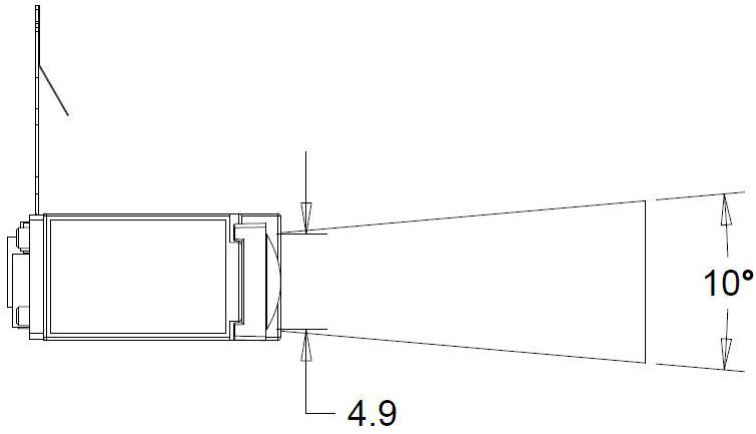


Figure 11. Green spot optical path



Green Spot Projector - Electrical Interface

Anode Pin

Provide power supply of 5V (VAIM); a minimum of 2,2uF (10V rated) bypass capacitor is suggested on driving circuit. ESD protection diode is recommended.

Cathode Pin

Connect here a LED driving circuit for driving GREEN SPOT LED.

With a 220 Ohm series resistance (R1) and a nMOSFET connecting to ground, a max current of 15mA will be drained from GREEN SPOT LED, sufficient for driving it correctly.

Electrical Characteristics

Operating temperature range	Top	– 40 … + 85	°C
Storage temperature range	Tstg	– 40 … + 85	°C
Junction temperature	Tj	+ 100	°C
Forward current (TS = 25 °C)	IF	20	mA
Surge current = 10 µs, D = 0.1, TA=25°C	IFM	100	mA
Reverse voltage (TS = 25 °C)	VR	5	V
Wavelength at peak emission IF = 20 mA	λpeak	523	nm
Forward voltage IF = 20 mA (typ.) (max.)	VF	3.3 3.8	V
Reverse current VR = 5 V (typ.) (max.)	IR	0.01 10	µA

Green Spot Connection Options

Contacts are on the back side of the green spot accessory, the opposite one with respect to LED.

Figure 12. Green Spot with flex tail (back view)

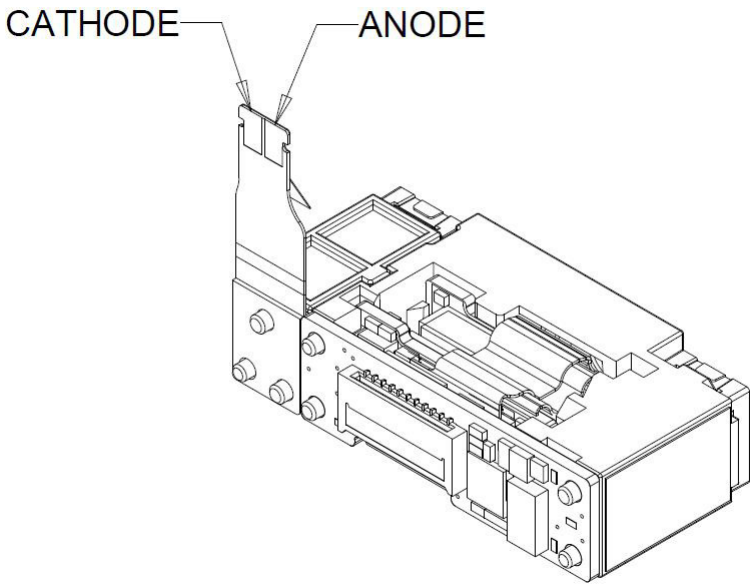
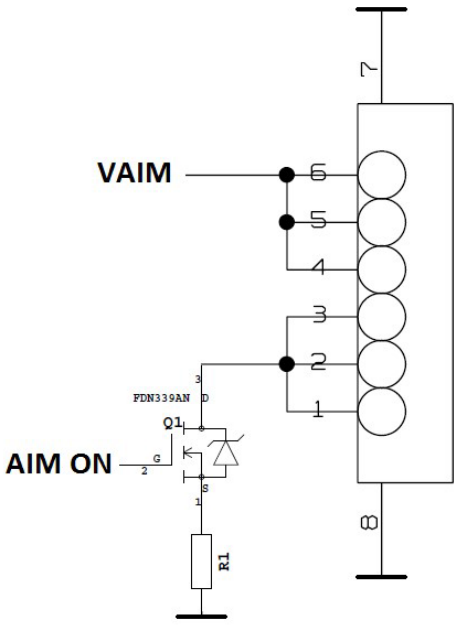


Figure 13 shows an example of driver on host side for flex cable options. It is based on 6 pin connector ZF1-AB06F10A by HONGRIDA ELECTRONIC TECHNOLOGY CO,LTD (datasheet available at http://www.hongrida.com).

- Connector PIN 1-3 = LED cathode
- Connector PIN 4-6 = LED anode

Figure 13 - Example of green spot driver



NOTES

NOTES

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820111900 (Rev. A) August 2019