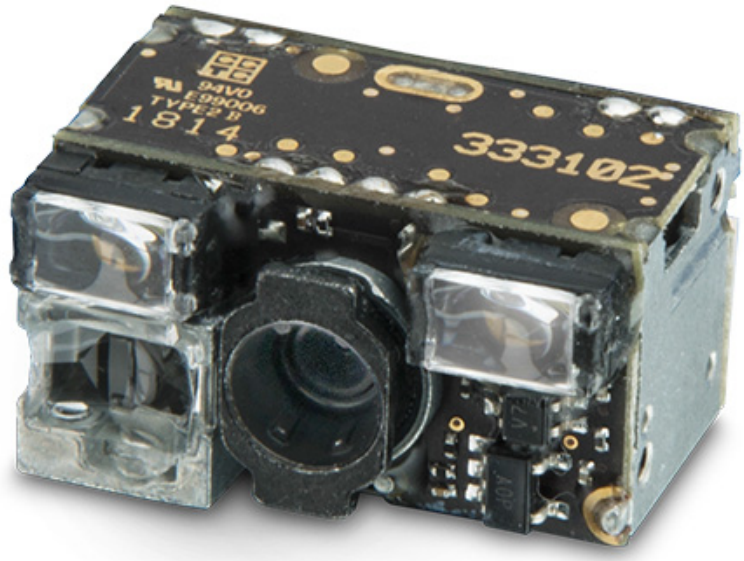
DATALOGIC

HALOGEN™ DE2011-DL
2D Bar Code Scan Engine



Integration Guide

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Patents

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

Table of Contents

INTRODUCTION **1**
About this Manual **1**
Manual Conventions 1
Outline 1
Technical Support **2**
Datalogic Website Support 2
Reseller Technical Support 2
Telephone Technical Support 2
About the DE2011-DL **2**
Unpacking the Scan Engine 2
Scan Engine Care 2
External Optics 2
System Overview 3
Illumination System 3
Regulatory 3
Aiming System 3
Aiming Pattern 4
Aiming System Parameters 4
Regulatory 4
INSTALLATION **6**
Mounting the Scan Engine **6**
General Considerations 6
Mechanical Size 6
Mounting Holes 8
Housing Design 8
Positioning the exit window 8
Avoiding scratched windows 9
Window material 9
Exit window properties 10
Optical paths and exit window clearance 11
Environment 12
ELECTRICAL INTEGRATION **13**
Electrical Connections **13**
Grounding 13
ESD 13
Electrical Interface **13**
Connector and Flat cable 14
Powerup sequence 15
Engine latency at powerup 15
Supply Voltages and I/O levels 15
Power supply noise 15
Heat Dissipation 15
SOFTWARE INTERFACE **16**
Communication Protocol **16**
Command Format 16
Engine Response Format 17
I2C Command Codes 18
Command Parameters 18
Camera System Parameters 22
TECHNICAL SPECIFICATIONS **24**
Definition of Scanning Angles 26
Power Consumption Details 27
I2C COMMAND SPECIFICATIONS **28**
I2C Command Specifications **29**
AIM TIME (0x4E) 29

AIM ENABLE (0x35) 29
AUTO LOW POWER (0x44) 29
BOOTLOADER START (0x42) 29
CAMERA MODE (0x3B) 29
CAMERA RESET (0x37) 30
CAMERA START (0x38) 30
GET CAMERA PARAM (0x40) 30
GET SENSOR REGISTER (0x31) 30
ILLUMINATION DELAY (0x34) 31
ILLUMINATION ENABLE (0x39) 31
ILLUMINATION TIME (0x48) 31
RESTORE FACTORY DEFAULT (0x23) 31
RUN CMD LIST (0x47) 31
SET AUTO POWER TIME (0x45) 31
SENSOR BINNING (0x3C) 31
SET CAMERA PARAM (0x41) 32
SET CMD LIST (0x46) 32
SET LOW POWER (0x3F) 33
SET SENSOR REG (0x30) 33

ENGINE VIDEO FORMAT 34
Sensor Data Format 34
Output Data Timing 35
Sensor Registers Settings 36

ACCESSORIES 37
Green Spot Projector 37
Green Spot Projector - Left side mounting 39
Green Spot Projector - Right side mounting 40
Green Spot Projector – Electrical Interface 41
Anode Pin (connector PIN 1): 41
Cathode Pin (connector PIN 2): 41
Chassis Electrical Connection Pin (connector PIN 3): 41
Electrical Characteristics 41
Typical electrical driver 42

Chapter 1
Introduction

About this Manual

This Integration Guide is provided to give instruction, opto-mechanical details, and design considerations to integrate the Halogen™ DE2011-DL model (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 and an overview of the engine, 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 I^2C Commands.

TECHNICAL SUPPORT

Support Through the Website

Datalogic provides several services as well as technical support through its website. Log on to (www.datalogic.com).

For quick access, from the home page click on the search icon, and type in the name of the product you're looking for. This allows you access to download Data Sheets, Manuals, Software & Utilities, and Drawings.

Hover over the Support & Service menu for access to Services and Technical Support.

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 at (541) 349-8283 or check the back cover of your manual for more contact information.

About the DE2011-DL

The Datalogic DE2011-DL is a very compact, high performance undecoded imager used to capture digital images to be transferred to an external digital platform, to provide 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 for the following:

- scan engine
- interface cable (if ordered)

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 DE2011-DL scan engine.

External Optics

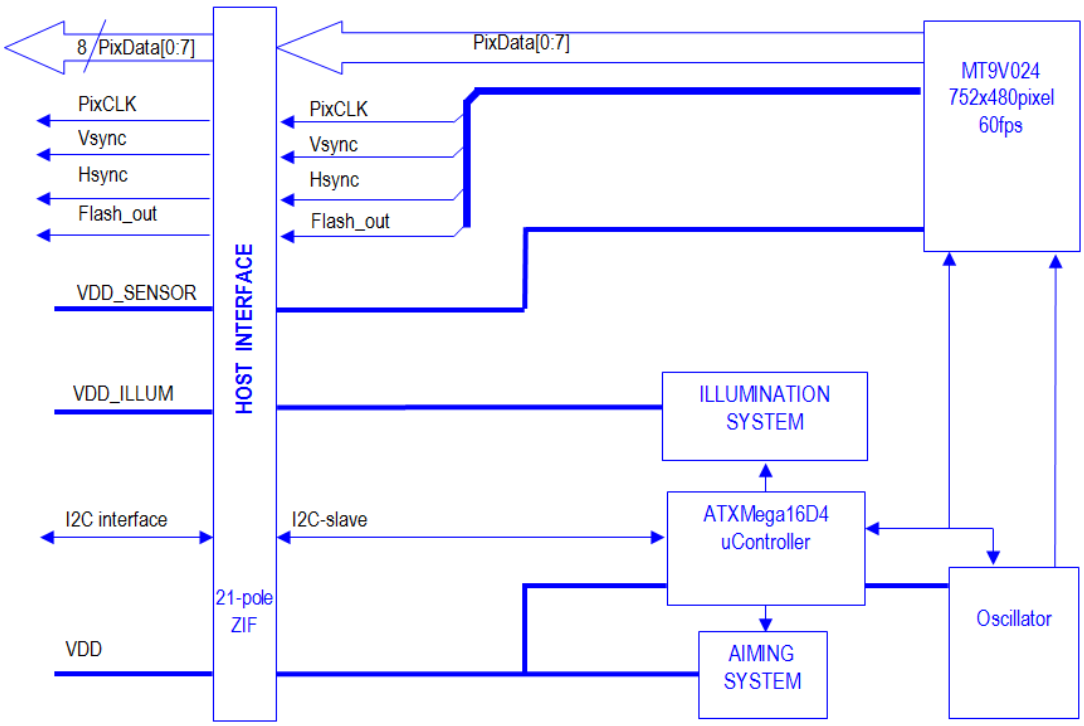
The engine has an exposed illumination system and aiming lenses on the outer surfaces. Take care of these optical components, preserving the lenses from mechanical stresses that can damage them. Avoid touching the optical surfaces to preserve the optical performance.

System Overview

The Datalogic DE2011 scan engine features a global shutter sensor having 752x480 pixels, able to capture images at 60 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. Scan Engine block diagram



Illumination System

The Illumination System is comprised of two white LEDs and non-imaging optics designed to provide first-class reading performances, even in total darkness.

Regulatory

- EN/IEC 62471 (exempt)

Aiming System

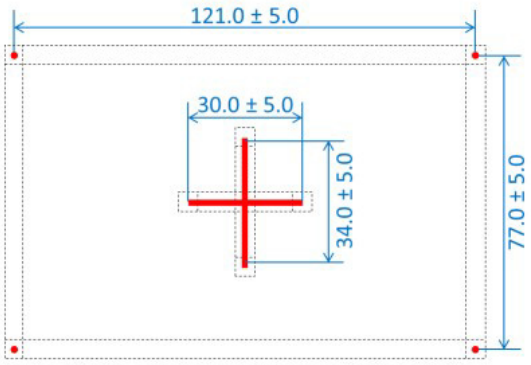
The aiming system is based on a 650nm laser diode and related optics. It projects a highly visible 4-Dot aimer with center-cross for targeted scanning.



Aiming Pattern

The central cross represents the center of the field of view, while the four dots show the boundaries of the field of view.

Figure 2. Projected pattern at 200 mm



Aiming System Parameters

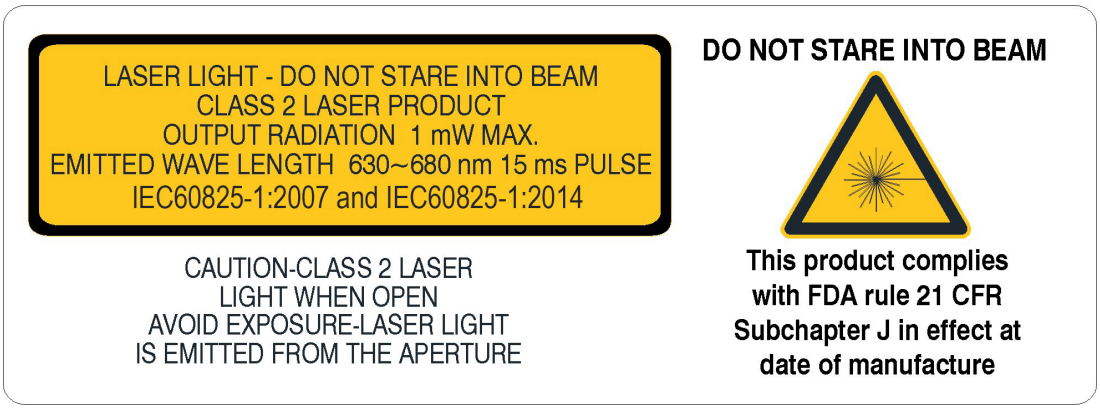
Wavelength	630–680 nm
Beam Divergence	35° (horizontal) x 25° (vertical) – see Figure 9 on page 2–11 and Figure 10 on page 2–11
Maximum pulse duration	15ms
Repetition rate	16.6ms
Maximum output power	1mW
Laser aperture	See Figure 11 on page 2–12

Regulatory

- IEC/EN 60825–1:2007 and IEC/EN 60825–1:2014 (class 2)
- 21 CFR 1040 (CDRH) (class II)

WARNING	**Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100mm may pose an eye hazard.**

Figure 3. DE2011-DL Regulatory label



 WARNING	**STANDARD LASER SAFETY REGULATIONS** **This product conforms to the applicable requirements of both CDRH 21 CFR 1040 and EN 60825-1 at the date of manufacture. For installation, use and maintenance, it is not necessary to open the device.** **Use of controls or adjustments or performance of procedures other than those specified herein may result in exposure to hazardous visible laser light.** **The product utilizes a low-power laser diode. Although staring directly at the laser beam momentarily causes no known biological damage, avoid staring at the beam as one would with any very strong light source, such as the sun. Avoid that the laser beam hits the eye of an observer, even through reflective surfaces such as mirrors, etc.**
 ATTENTION	**NORMES DE SECURITE LASER** **Ce produit est conforme aux normes de sécurité laser en vigueur à sa date de fabrication: CDRH 21 CFR 1040 et EN60825-1. Il n'est pas nécessaire d'ouvrir l'appareil pour l'installation, l'utilisation ou l'entretien.** **L'utilisation de procédures ou réglages différents de ceux donnés ici peut entraîner une dangereuse exposition à lumière laser visible.** **Le produit utilise une diode laser. Aucun dommage aux yeux humains n'a été constaté à la suite d'une exposition au rayon laser. Eviter de regarder fixement le rayon, comme toute autre source lumineuse intense telle que le soleil. Eviter aussi de diriger le rayon vers les yeux d'un observateur, même à travers des surfaces réfléchissantes (miroirs, par exemple).**

Chapter 2
Installation

This section describes how to design the mounting for optimum scan engine 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 to read 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 4. Nominal Engine Size

Nominal size:

21.0mm (width) x 11.40mm (height) x 15.75mm (depth)

Maximum size:

21.50mm (width) x 11.80mm (height) x 16.00mm (depth)

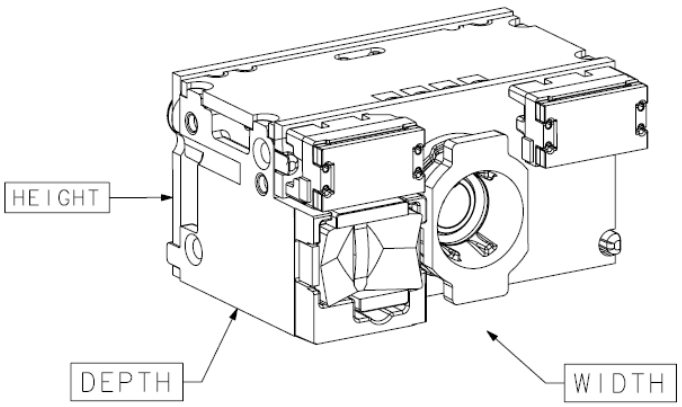
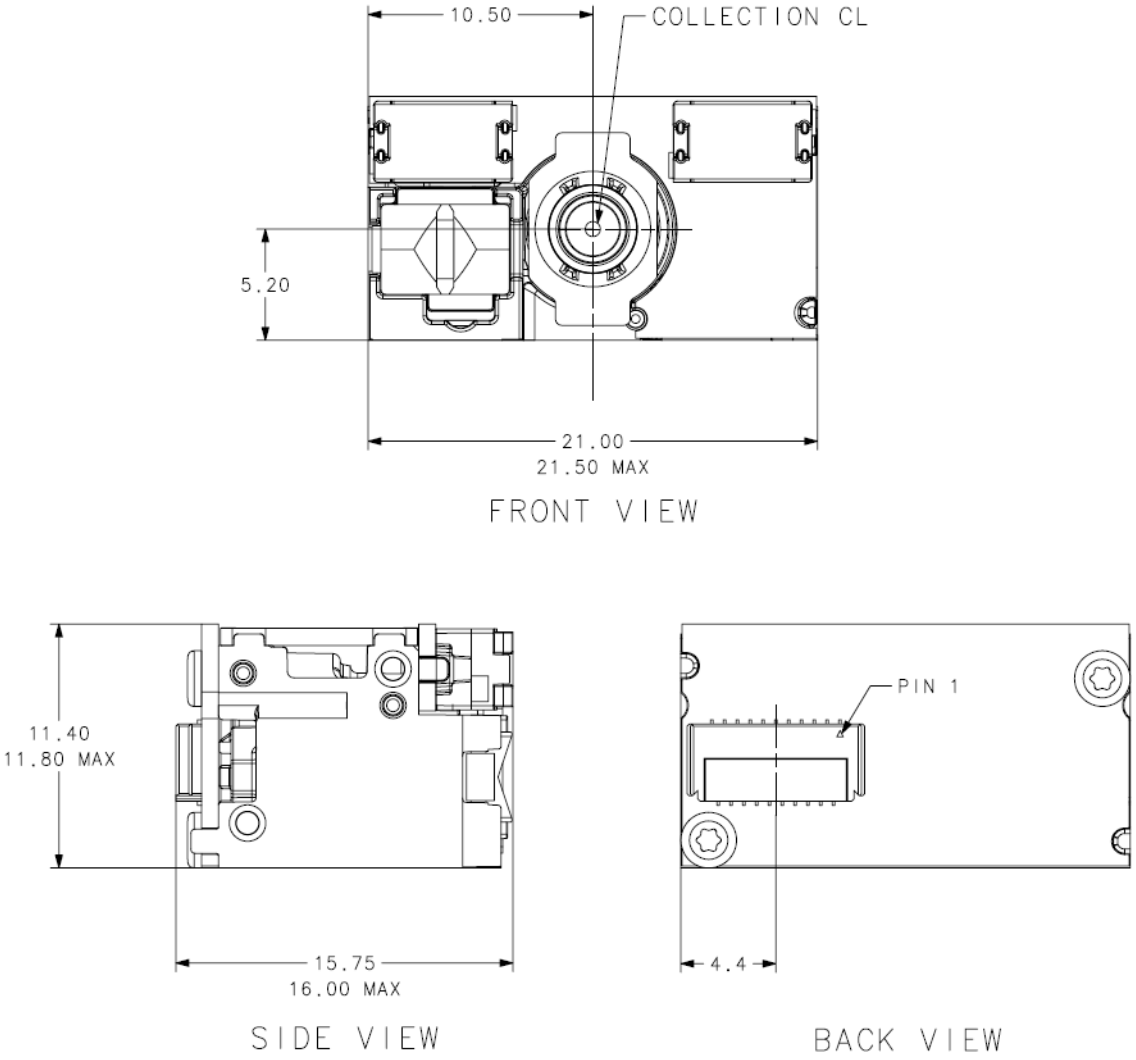


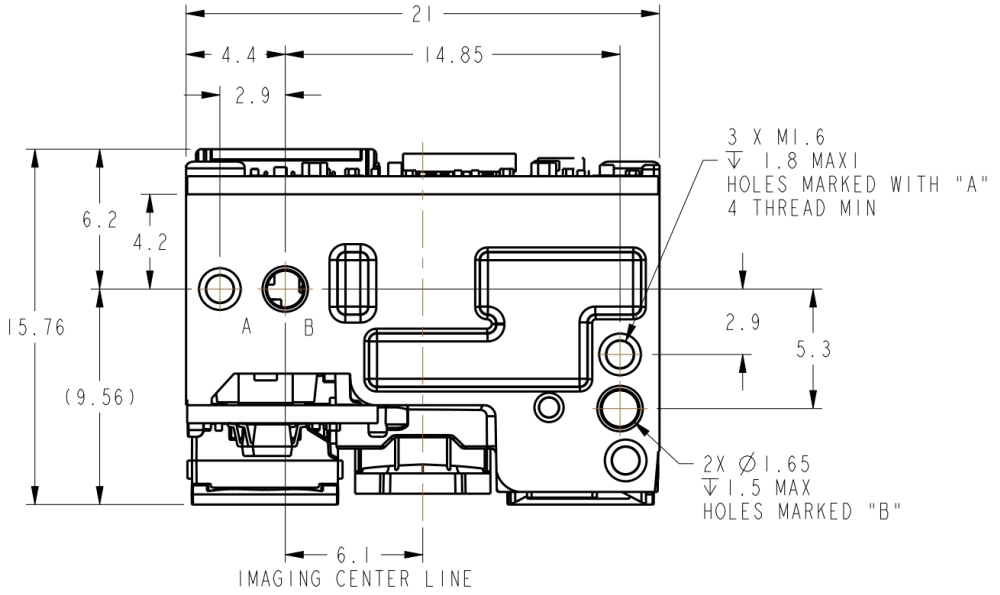
Figure 5. Engine Size and Connector Position



Mounting Holes

There are three mounting holes M1.6x0.35mm located on the bottom of the chassis. The recommended thread engagement for the screws is 1.7mm (holes marked with “A”), with a mounting torque of 0.15Nm.

Figure 6. 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.

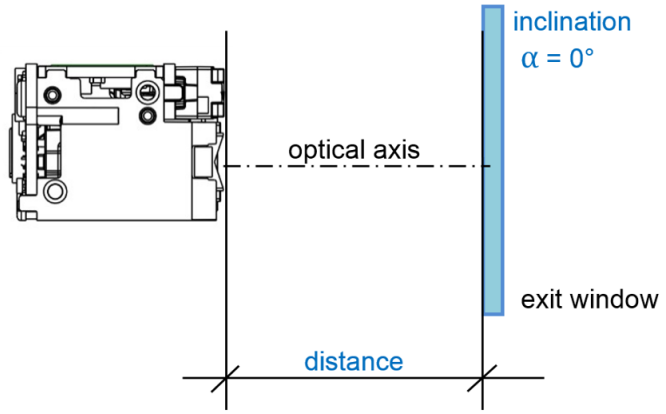
The use of a double-sided AR coated exit window is strongly recommended both for perpendicular and tilted windows.



NOTE

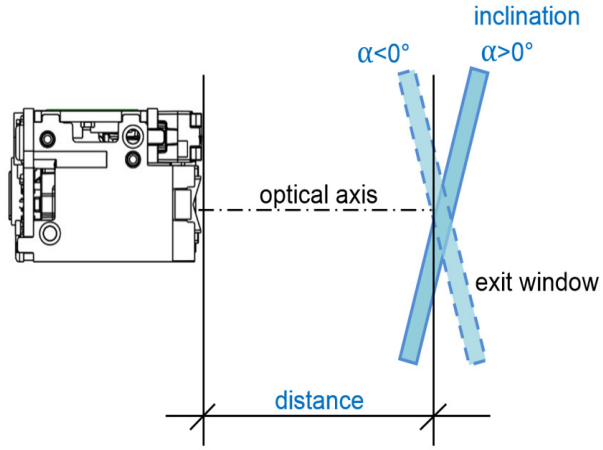
- **Do not place the exit window between the maximum distance allowed for a parallel window (Figure 7) and the minimum distance for a tilted window (Figure 8).**
- **Integration tolerances are not included.**

Figure 7. Exit window positioning – perpendicular window



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

Figure 8. Exit window positioning – tilted window



		Distance [mm]					
		5	10	15	20	25	30
No Coating	+α	42°	42°	40°	35°	30°	25°
	−α	30°	30°	30°	30°	30°	30°
AR coating (2 sides)	+α	42°	32°	26°	24°	22°	22°
	−α	20°	24°	24°	24°	24°	24°

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 1on 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

Figure 9 and Figure 10 show the optical paths for the imaging system, the aiming system and the illumination system.

Declared imaging system Field Of View is 40° x 26° (see Appendix A, Technical Specifications). Due to fabrication and assembly tolerances, the optical path to be considered for mechanical integration is 42° x 28°.

Figure 9. Top view - Aiming, imaging and illumination optical paths

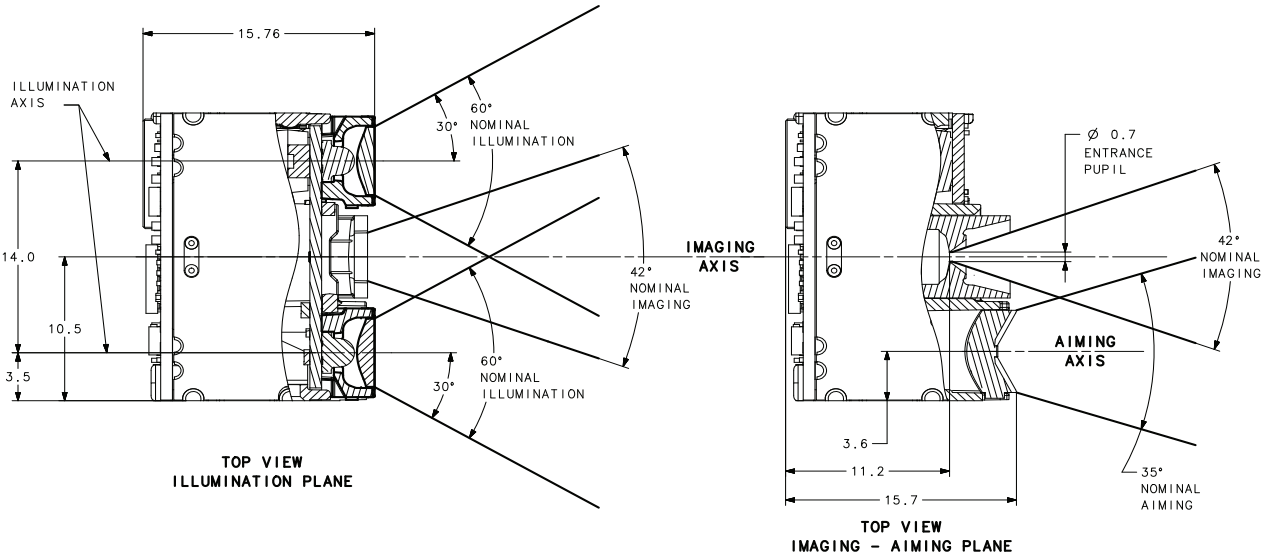


Figure 10. Side View - Aiming, imaging and illumination optical paths

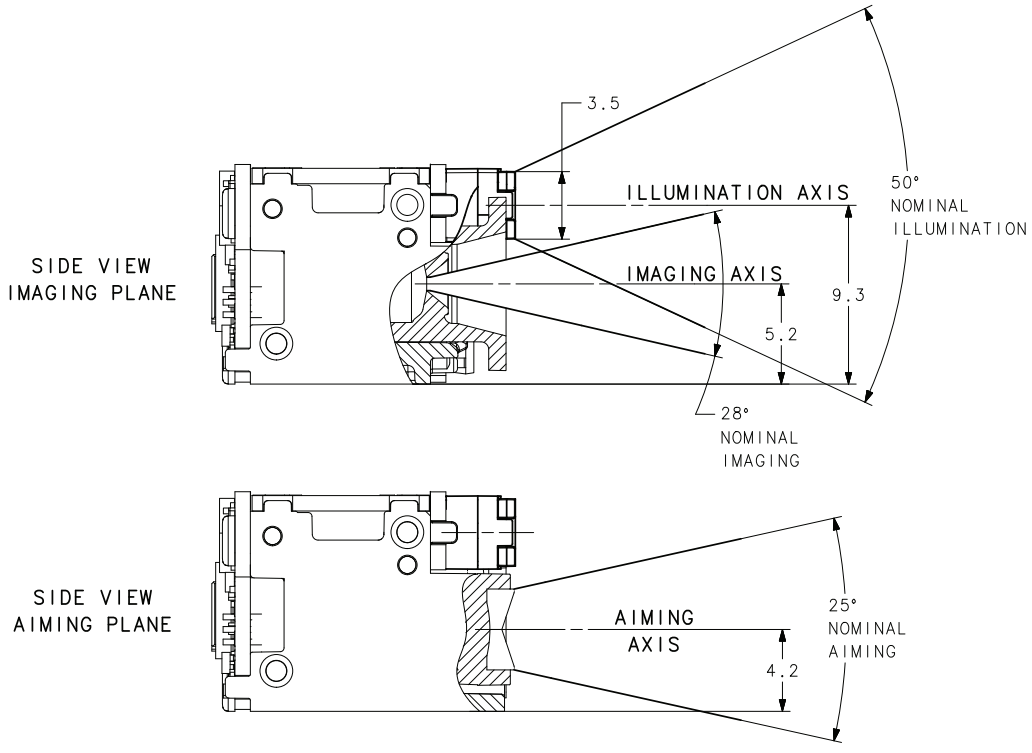
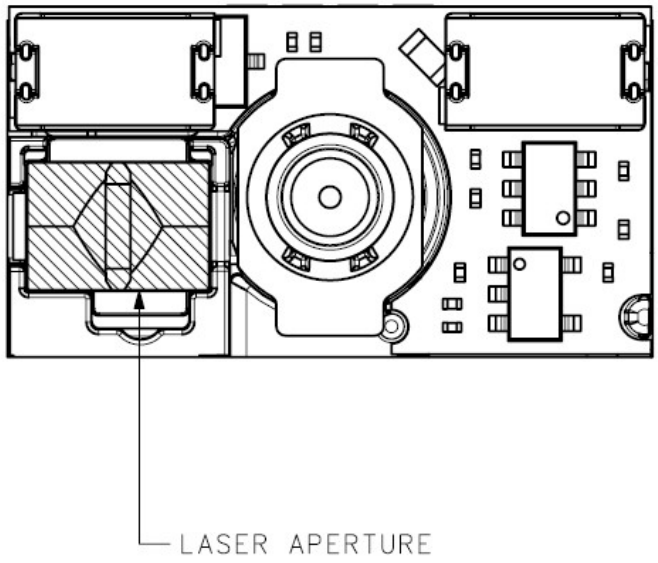


Figure 11. Front View - Laser aperture



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

Grounding

The chassis of the engine is at ground. Mounting screws can be used to implement additional connections to the host ground.

Based on the host characteristics, the additional ground connections can affect:

- the engine performance (if noise is injected into the scan engine)
- the radiated emission (depending on current loops)

It is suggested to investigate these topics at the beginning of the integration.

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 DE2011-DL scan engine can be connected to an external digital platform via a 21-pole ZIF connector supporting:

- a parallel video port (8 bit per pixel, vertical and horizontal synchs, pixel clock)
- a signal to synchronize an external illumination system with the exposure of the sensor (Flash_out)
- three dedicated power supplies (for sensor, digital system, illumination system)
- an I^2C communication port for controlling the scan engine

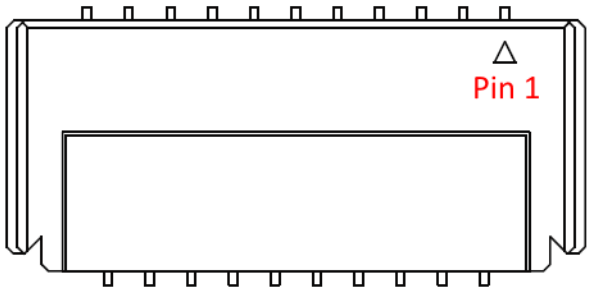
Table 3 below describes the power lines and the signals mapped on the 21-pole ZIF connector.

Table 3. Engine connector description

Pin	Signal	I/O type	Description
	GND	power	Ground
2	GND	power	Ground
3	I2C_CLK	I	I2C Clock
4	I2C_DATA	I/O	I2C Data
5	V_SYNC	O	Vertical sync
6	PIX_DATA_7	O	Video data bus, pixel 7 – MSB
7	PIX_DATA_6	O	Video data bus, pixel 6
8	PIX_DATA_5	O	Video data bus, pixel 5
9	PIX_DATA_4	O	Video data bus, pixel 4
10	PIX_DATA_3	O	Video data bus, pixel 3
11	PIX_DATA_2	O	Video data bus, pixel 2
12	PIX_DATA_1	O	Video data bus, pixel 1
13	PIX_DATA_0	O	Video data bus, pixel 0 – LSB
14	FLASH_OUT	O	External illumination system trigger
15	VDD_SENSOR	power	Sensor power supply
16	VDD	power	Digital power supply
17	VDD_ILLUM_SYS	power	Illumination system power supply
18	H_SYNC	O	Horizontal sync
19	GND	power	Ground
20	PIX_CLK	O	Sensor pixel clock
21	GND	power	Ground

Connector and Flat cable

Figure 12. Position of Pin 1 on 21-pole ZIF connector



The DE2011-DL scan engine is equipped with a Kyocera 21-pole ZIF (Zero Insertion Force) connector having a pitch of 0.3mm – series 6283 – ordering code 04 6283 021 002 868.

In order to reduce radiated emission, it is recommended to adopt an EMI-shielded flat cable. For further details and requirements related to the flat cable, please refer to the manufacturer's datasheet, available at https://global.kyocera.com/.

Powerup sequence

To guarantee the correct operation of the engine, it is mandatory to use the following powerup sequence timing constraints:

- VDD_SENSOR must be stable at 3.3V not later than 6ms after the VDD is at 2.1V.
- VDD_ILLUM_SYS must be stable at 3.3V at least 20ms before issuing any camera start command.

All three VDD lines can also ramp up/down simultaneously.

Engine latency at powerup

At powerup the engine begins executing the code when the VDD digital power supply level reaches 2.1V. To complete the boot sequence, a 12ms time is required. After this, the engine is ready to parse commands.

Supply Voltages and I/O levels

Table 4. Supply Voltages and I/O Levels

Item	Level	Description
VDD_SENSOR	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
VDD	3.3V ± 0.3	The digital and laser aiming system power supply.
VDD_ILLUM_SYS	3.0V to 5.0V	The LED illumination system power supply.
I/O level	3.3V	The typical high level for input and output signals.

Power supply noise

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

The requirement for the power supply peak-to-peak noise is ≤150mV on all three power supply lines (the lower the better).

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.

The chassis is the thermal dissipator for the scan engine.

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 will reset.

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 I^2C 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 DE2011 in I2C Command Codes, starting on page 18 or Table 5 on page 18.
Command Parameters:	Data bytes required by the command, shown in Table 5 on page 18.
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:

I²C Element	Description
Address:	Target slave address includes device address plus **read** option (0x01). For the engine, slave address is 0x5C (or 0xB8 after shifting to 7bit MSB).
STATUS:	STATUS can be one of the following: – ACK (0x80) – NAK (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 18.

I²C Command Codes

Command Parameters

The following table shows a categorized list of the DE2011-DL 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 16.

For more information on the commands, see "I2C Command Specifications" on page 29.



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 01=System Reset (except sensor)	
[0x38]	CAMERA START	Starts or stops image acquisition.	**1 Byte:** 0x00=Stop 0x01=Start	
[0x3B]	CAMERA MODE	Optimizes sensor configuration for different tasks.	**1 Byte:** 0=Barcode Decode 1=Image Capture 2=Motion Detect 3=Fast High Bin 4=LCD Read	
[0x42]	BOOTLOADER START	Stops operations and starts bootloader.	**3 Bytes:** Signature: 0xAA, 0x50, 0x5F	
[0x47]	RUN CMD LIST	Executes a user-defined sequence of commands.	**1 Byte:** List# to run (0 - 10)	
[0x46]	SET CMD LIST	Sets a user-defined sequence of commands to be executed using RUN CMD LIST	**1 Byte:** List# to set (0 - 10) + **n Bytes (max 149):** Command script(s)	

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
CAMERA SYSTEM CONFIG				
[0x23]	RESTORE FACTORY DEFAULT	Clears Camera USER CUSTOM parameters, bringing them back to FACTORY DEFAULT values	**1 Byte:** 00	
[0x3F]	SET LOW POWER	Activates system power saving mode	**1 Byte:** 0x00=Normal 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‡
[0x41]	SET CAMERA PARAM	Sets desired value to chosen Camera USER CUSTOM parameter (stored in EEPROM).	**2 Bytes:** Parameter ID Code + **n Bytes:** parameter data‡	**2 Bytes:** Parameter ID Code
[0x44]	AUTO LOW POWER	System automatic power saving mode.	**1 Byte:** 00=Disabled 01=Enabled	
[0x45]	SET AUTO POWER TIME	Sets the time to power saving mode when camera is idle (AUTO LOW POWER must be active).	**1 Byte:** 0x01 – 0x0A = 10–100 ms, 10 ms increments 0x0B – 0x14 = 100–900 ms, 100 ms increments 0x15 – 0xFF = 1s – 235 s, 1 s increments 0x00 = 5 ms	
AIMING SYSTEM				
[0x35]	AIM ENABLE	(when camera is running) Switches the aiming system ON/OFF.	**1 Byte:** 00=Off 01=On	

‡ **See Table 6 on page 22 and Table 7 on page 23 for details on parameter length and ID code.**

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
[0x4E]	AIM TIME	Sets the aim pattern lighting time for each frame (determines brightness).	**1 Byte:** 0x00 = sets Aim "on" time to default (=8500ms), or to user custom if previously modified. (per Frame) 0x01-0xFF = aim "on" time set to *value**0.5ms. (per Frame) Note: pulse duration might be trimmed by sensor exposure time variations	
LED ILLUMINATION SYSTEM				
[0x34]	ILLUMINATION DELAY	Sets the time from sensor exposure start to LED lighting start.	**1 Byte:** 0x00-0xFF = delay time from start of exposure to start of illumination set to *value**30us. Default value is 30us.	
[0x39]	ILLUMINATION ENABLE	(when camera is running) Switches ON/OFF the LED illumination system.	**1 Byte:** 00=Off 01=On	
[0x48]	ILLUMINATION TIME	Sets the illumination lighting time for each frame (determines brightness).	**1 Byte:** 0x00 = OFF 0x01-0x14 = illumination time set to *value**50us. (per Frame). Default value is 0x0C = 600us.	
IMAGE SENSOR				
[0x30]	SET SENSOR REG	Writes new value to the On Semiconductor MT9V024 desired register.	**1 Byte:** Register address + **2 Bytes:** Register new value	
[0x31]	GET SENSOR REG	Gets On Semiconductor MT9V024 desired register value.	**1 Bytes:** Register address	**2 Bytes:** Register current value

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
[0x3C]	SENSOR BINNING	Sets the binning operated by the Sensor.	**1 Byte:** 0x00=Normal Row binning codes: 0x00 = No Row Bin 0x01 = Row Bin 2 0x02 = Row Bin 4 Column Binning codes: 0x00 = No Column Bin 0 x04 = Column Bin 2 0x08 = Column Bin 4 **Resulting Parameter for Image Binning =** (Row binning code) + (Column Binning code)	



See Table 6 on page 22 **and** Table 7 on page 23 **for details on parameter length and ID code.**

Camera System Parameters

The following tables list DE2011-DL system Parameters. Table 6 below shows the camera system information, while Table 7 on page 23 shows the user customizable parameters, which will be used as default value by the engine. See commands GET CAMERA PARAM, SET CAMERA PARAM and RESTORE FACTORY DEFAULT for instructions.

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
Hardware Version	Camera hardware version	0x4E26	1
Device Class	Camera device class	0x4E27	18
GUID	Generally Unique ID	0x000E	32
Family ID	Halogen1 Family ID	0x03F7	7
PCB Number	PCB Number	0x0BD6	10

Table 7. User Custom Parameters ID codes and length

The following parameters are READABLE and WRITABLE.

Parameter	Description	ID Code (HEX)	Length (Bytes)	FACTORY VALUE
Illumination Time Default	Customizable default/startup value for the illumination pulse time (per frame) **1 Byte**: 0x00-0x14 = illumination time set to value*50us.	0x00B7	1	600us (0x0C)
Illumination Delay Default	Customizable default/startup value for the delay time from start of exposure to start of illumination **2 Bytes**: value in us	0x00B8	2	30us (0x001E)
Aim Time Default	Customizable default/startup value for the AIM pattern "on" time (per frame) **2 Bytes**: value in us	0x00B9	2	8500us (0x2134)
Aim Delay Default	Customizable default/startup value for the delay time from end of exposure to start of AIM pattern projection. **2 Bytes**: value in us	0x00B0	2	100us (0x0064)
Max Exposure Reg	Customizable default/startup value for the On Semiconductor MT9V024 Max exposure register, which determines the maximum sensor exposure time per frame. Each unit corresponds to one row time. **1 Byte**: Register Address (0xAD) + **2 Bytes**: Register Value	0x00B1	3	Address: 0xAD Value: 0x00C0

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 DE2011-DL engine, including reading performance.

Item	Description
PHYSICAL CHARACTERISTICS	
Dimensions	**Nominal size:** Width 0.83”/21 mm Height 0.45”/11.4 mm Depth 0.62”/15.75 mm **Maximum size:** Width 0.85”/21.50 mm Height 0.46”/11.80 mm Depth 0.63”/16.00 mm
Weight	9 g / 0.32 ounces
Interface	Camera port on a 21 pin ZIF Connector
ELECTRICAL CHARACTERISTICS See "Power Consumption Details" on page 27 for more information.	
Current	Max. Operating: < 200mA (RMS) Standard Operation: 160mA (RMS) Idle (Typical): 21mA (RMS) Low power: <0.2mA (RMS) Surge Current Peak: <400mA for t<0.15ms (might occur at startup or camera start)
Input Voltage	Values at 23°C: - VDD_SENSOR: 3.3 ± 0.3V - VDD: 3.3 ± 0.3V - VDD_ILLUM_SYS: from 3.0V to 5.0V See "Supply Voltages and I/O levels" on page 15 for details.
PERFORMANCE CHARACTERISTICS	
Image Sensor	WVGA : 752x480 pixels

Item	Description
Light Source	Illumination: White LEDs Aiming: 650nm VLD
Field of View	40° Hx26° V
Print Contrast Minimum	25% minimum contrast
SCANNING ANGLES See Definition of Scanning Angles on page 26 for additional information.	
Roll Angle	Up to ± 180°
Pitch Angle	± 60°
Skew Angle	± 60°
Minimum Element Width	1D Linear: 0.0762mm / 3mils PDF: 0.127mm / 5mils Datamatrix: 0.195mm / 7.5mils

Depth of Field[a]		Typical		Guaranteed	
	Resolution [mils]	Dmin [mm]	Dmax [mm]	Dmin [mm]	Dmax [mm]
Code 39	3	80	175	85	130
Code 39	5	55	260	70	220
PDF	10	(-)[b]	200	(–)[b]	180
EAN13	13	45	420	50	380
Datamatrix	15	35	265	45	245
Code 39	20	(–)[b]	590	(–)[b]	500

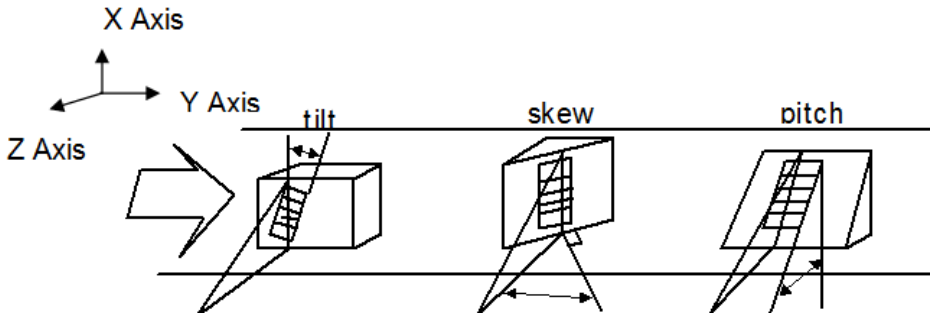
a. All labels grade A, ambient light level 300lux, pitch angle 10°, tilt angle 10°, skew angle 0°, room temperature 20°C.
b. Limited by field of view

Item	Description
User Environment Refer to "Heat Dissipation" on page 15 for more information.	
Operating Temperature	Operating : -30 to 55ºC / -22 to 131ºF
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	±2.0kV @ connector
Regulatory	
Aiming System (laser)	IEC/EN 60825-1:2007 and IEC/EN 60825-1:2014 (class 2) 21 CFR 1040 (CDRH) (class II)
Illumination System (white LEDs)	IEC 62471 Exempt risk group
Environmental	RoHS compliant

Definition of Scanning Angles

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

Figure 13. ISO15423 angle definition



Reading distances are measured along Z-axis.

Power Consumption Details

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

Low power	The engine is in sleep mode (minimum power consumption)
Idle	The engine is active, waiting for commands and ready to start an acquisition
Running	The engine is acquiring and streaming images to the host. Power consumption depends on the configuration of the engine

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 8. Typical RMS current consumption

DE2011 status	Current Consumption	Conditions
Low power	<0.2mA	Temperature 23°C Illumination flash duration 600us AIM laser pulse duration 8500us VDD = 3.3V VDD_SENSOR = 3.3V VDD_ILLUM = 3.3V
Idle	21mA	
Image Acquisition	70mA	
Illumination Enabled flash duration 600us – factory default	150mA	
Illumination Enabled and AIM Enabled factory default timing	160mA	
Maximum Operating Current AIM enabled at factory default time and illumination is enabled with flash duration 1000us (maximum value)	200mA	

Appendix B
I²C Command Specifications

This section provides additional information about I²C Commands.

I2C COMMAND SPECIFICATIONS starting on page 29

- AIM TIME (0x4E)
- AIM ENABLE (0x35)
- AUTO LOW POWER (0x44)
- BOOTLOADER START (0x42)
- CAMERA MODE (0x3B)
- CAMERA RESET (0x37)
- CAMERA START (0x38)
- GET CAMERA PARAM (0x40)
- GET SENSOR REGISTER (0x31)
- ILLUMINATION DELAY (0x34)
- ILLUMINATION ENABLE (0x39)
- ILLUMINATION TIME (0x48)
- RESTORE FACTORY DEFAULT (0x23)
- RUN CMD LIST (0x47)
- SET AUTO POWER TIME (0x45)
- SENSOR BINNING (0x3C)
- SET CAMERA PARAM (0x41)
- SET CMD LIST (0x46)
- SET LOW POWER (0x3F)
- SET SENSOR REG (0x30)

I²C Command Specifications

This section contains a complete description of the DE2011-DL possible I²C supported commands in alphabetical order. For a summary list and more information, see Command Format, starting on page 16.

AIM TIME (0x4E)

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

Accepts values from 0x1 to 0xFF; each unit corresponds to a 0.5 ms time increment.

If set to 0x0, sets the time to a default value, which can be optionally customized by the user modifying the parameter AIM TIME DEFAULT (see Table 7 on page 23).



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

AIM ENABLE (0x35)

With the value set to 0x01 the aim pattern will turn on whenever the camera is acquiring images. Setting the value to 0x00 will always turn it off.

The aim pattern will not be visible in the acquired images.

AUTO LOW POWER (0x44)

Activates system automatic power saving mode, turning the system into low power mode after a timeout.

When the camera is continuously idle for a time, previously determined using the SET AUTO POWER TIME command, the system enters a power reduction state. When an I²C command is issued the system wakes up and executes the command.

BOOTLOADER START (0x42)

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

CAMERA MODE (0x3B)

Sets up the engine system and the image sensor for better performance of a specific task: Barcode Decoding, Image Capture, Motion Detection, Fast High Bin or LCD screen Read modifying sensor internal register values, LED illumination and aiming pattern on/off timing.

This command modifies only some key engine and sensor parameters, leaving others unchanged. The parameters changed by this command are:

CAMERA MODE (continued)

ILLUMINATION TIME
ILLUMINATION DELAY
AIM TIME
AIM DELAY
IMAGE BINNING
SENSOR CONTEXT
SENSOR AEC MAX EXPOSURE
DESIRED BIN
SENSOR ACTIVE CONTEXT (A/B)

Barcode Decoding, *Image Capture* and *LCD Screen Read* operate using sensor Context A, while *Motion Detection* and *Fast High Bin* operate using sensor Context B with a 2xColumn+2xRow binning.

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. If parameter is 0x01, all elements of the system except for the sensor will be reset.

For a complete system reset send this command with parameter 0x00 first and then send this command with parameter 0x01



The 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 of 16.6ms) the system will not compute any I^2C command.

GET CAMERA PARAM (0x40)

Reads camera system factory parameters or user custom parameters stored in non-volatile memory. Details can be found in Table 6 on page 22, and Table 7 on page 23.

GET SENSOR REGISTER (0x31)

Returns the desired register value of the On Semiconductor MT9V024 image sensor. Further details on the sensor can be found in the MT9V024 manual.

ILLUMINATION DELAY (0x34)

Sets the illumination delay time taking as a starting point Sensor Exposure start. Accepts values from 0x00 to 0xFF with a time unit of 30us.

ILLUMINATION ENABLE (0x39)

With the value set to 0x01 the illumination LEDs will turn on whenever the camera is acquiring images. Setting the value to 0x00 will always turn it off.

ILLUMINATION TIME (0x48)

Sets the illumination light duration within each frame, with a 50us time increment. Values are from 0x00 (0us) to 0x14 (1ms).

RESTORE FACTORY DEFAULT (0x23)

The following User Custom Parameters values are restored to their Factory Default:

ILLUMINATION TIME DEFAULT

ILLUMINATION DELAY DEFAULT

AIM TIME DEFAULT

AIM DELAY DEFAULT

SENSOR AEC MAX EXPOSURE

See Table 7 on page 23 for Factory Default values.

RUN CMD LIST (0x47)

Executes the sequence of commands previously memorized using the SET CMD LIST command.

SET AUTO POWER TIME (0x45)

Sets the timeout value after which power saving mode is activated. When camera is idle and AUTO LOW POWER is active the timer starts counting; whenever any command is issued the timer resets.

SENSOR BINNING (0x3C)

Modifies sensor register values for image binning: merging of adjacent pixels with a consequent change of resolution and variation in output image signals timing.

A bin of x means that x adjacent pixels are merged (column or row wise), which means that resolution is (current resolution)/x (on columns for “Column Binning” or rows for “Row Binning”). Column Binning also divides pixel clock frequency by x; row binning also multiplies by x the camera FPS. Binning is applied to the context A or B, depending on the current active CAMERA MODE (see command).

SENSOR BINNING (continued)

The parameter to be sent can be calculated by summing the number corresponding to the desired Row Binning, with the number corresponding to the desired Column Binning, as in the following table:

Row Binning codes:

0x00 = No Row Bin

0x01 = Row Bin 2

0x02 = Row Bin 4

Column Binning codes:

0x00 = No Column Bin

0x04 = Column Bin 2

0x08 = Column Bin 4

Total Image Binning code = (Row Binning code) + (Column Binning code). A value of "0" disables Binning.

SET CAMERA PARAM (0x41)

Writes the chosen parameter to the camera's non-volatile memory area User Custom Parameters. The stored values will be used as new defaults, replacing the Factory Default Values. For example, after a camera reset or startup the user custom values will be applied. The customizable parameters are:

ILLUMINATION TIME DEFAULT

ILLUMINATION DELAY DEFAULT

AIM TIME DEFAULT

AIM DELAY DEFAULT

SENSOR AEC MAX EXPOSURE

See Table 7 on page 23 for details.

To roll back the memory to factory default (losing the custom values), use RESTORE FACTORY DEFAULT command.

SET CMD LIST (0x46)

Sets a user-defined sequence of commands to be executed using RUN CMD LIST. Up to ten lists (0 to 9) can be saved; each can store up to 149 bytes (command codes + command parameters). NAK response is issued by the camera if limits are not respected.

Possible commands for the list are:

AIM ENABLE

CAMERA START

ILLUMINATION ENABLE

SET SENSOR REG

Command format:

(0x46)(List#)(Total Length) + (Command1 Length) (Command1) +[…]+(Command n Length) (Command n) +(Checksum)

Where:

"Total Length" is total list length, including all bytes following "Total length" byte itself (excluded) and also excluding "Checksum" byte.

"Command<x> Length" is total command length, including command code and all parameters bytes, but excluding "Command<x> Length" itself.

SET CMD LIST (continued)

"Command<x>" is the normal byte sequence of the desired command;

Example: (0x46)(0x02)(0x06) (0x02)(0x39)(0x01) (0x02)(0x35)(0x01) <(CHECKSUM)>

Will store in list number 2 the sequence: "illumination Enable=1" and "Aim Enable=1".



CAUTION

Unpredictable camera behavior may occur. Modifying registers manually 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.

SET LOW POWER (0x3F)

Activates system power saving mode. This command can only be used when the camera is stopped (no image acquisition is in progress), since it puts both the microcontroller and the image sensor into sleep mode. The system wakes up and returns to normal power mode each time a command is issued.

SET SENSOR REG (0x30)

Stores the new chosen value for the desired register of the On Semiconductor MT9V024 image sensor. Further details on the sensor can be found on the MT9V024 manual.



CAUTION

Unpredictable camera behavior may occur. Modifying registers manually 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 DE2011-DL engine is based on the WVGA monochrome image sensor.

Figure 14 below and Figure 15 on page 35 show the pixel array description and the spatial illustration of image readout.

Figure 14. Pixel array description

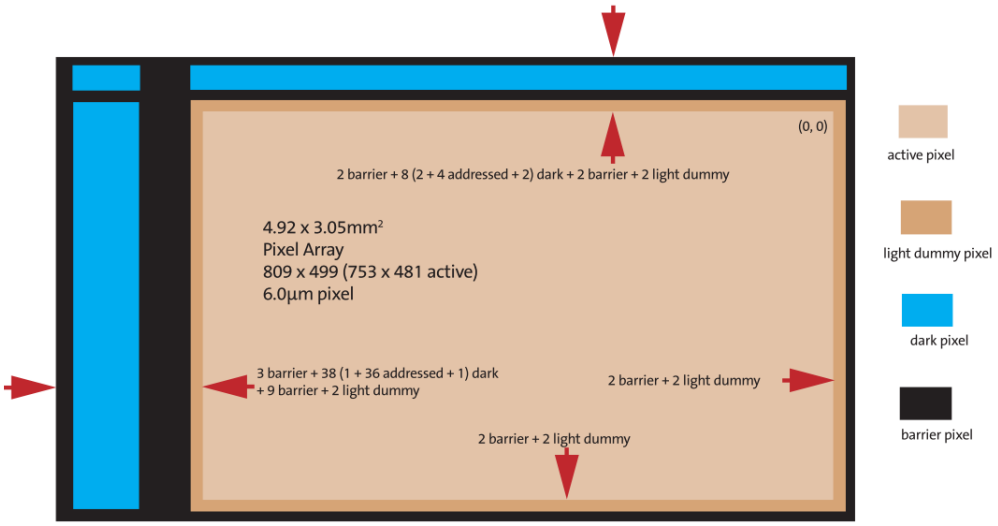
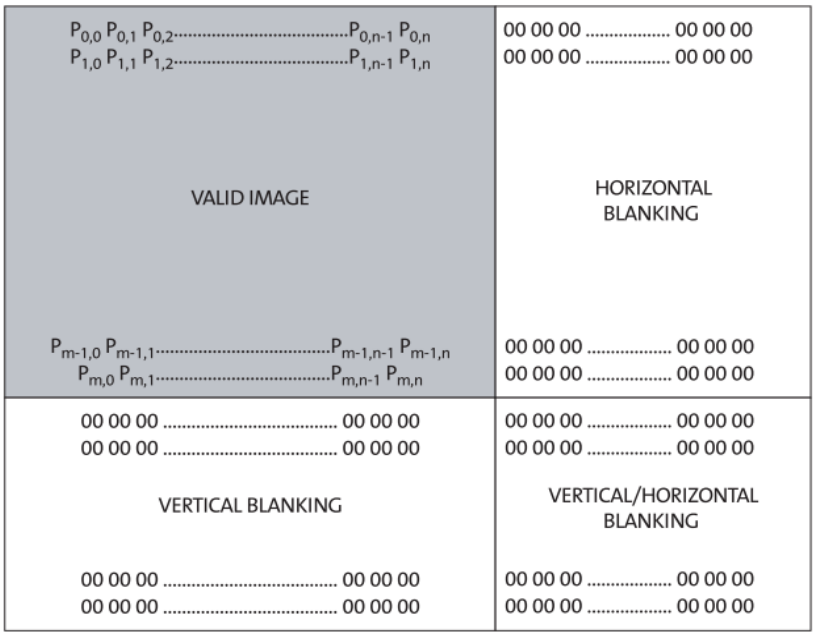


Figure 15. Spatial illustration of image readout characterizing the progressive scan mode



Output Data Timing

The data output of the sensor is synchronized with the PIXCLK output. When LINE_VALID (LV) is HIGH, one 10-bit pixel datum is output every PIXCLK period. Figure 16 shows an example of pixel data timing, and Figure 17 on page 36 shows basic timing for a complete frame readout.

Figure 16. Timing example of pixel data

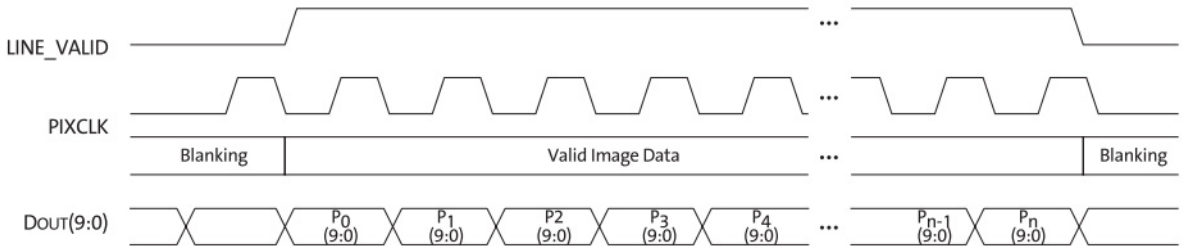
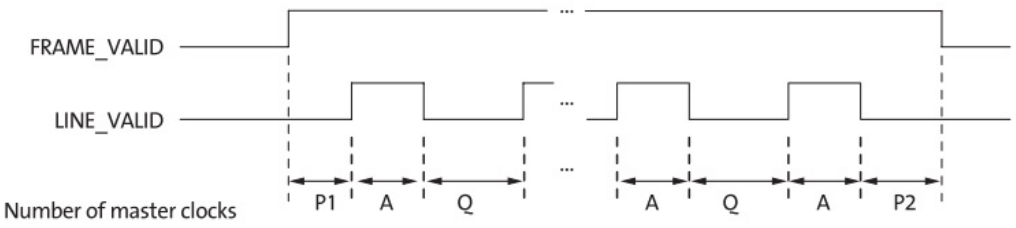


Figure 17. Row Timing and FRAME_VALID/LINE_VALID Signals



Parameter	Name	Equation	Pixel Clock	Timing at 26,66MHz
A	Active data time	Sensor register defined	752	28.20us
P1	Frame start blanking	Sensor register defined	71	2.66us
P2	Frame end blanking	23 (fixed)	23	0.86us
Q	Horizontal blanking	Sensor register defined	94	3.52us
A+Q	Row time	A+Q	846	31.72us
V	Vertical blanking	Sensor register defined	37,228	1.39ms
Nrows(A+Q)	Frame valid time	Sensor register defined	406,080	15.23ms
F	Total frame time	V+(Nrows(A+Q))	443,308	16.62ms

Sensor Registers Settings

For information on register settings, refer to the On Semiconductor MT9V024 monochrome WVGA Image Sensor Datasheet, available at http://www.onsemi.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 either the left or right side of the engine. The following drawings provide information for mounting.

Two variants of the green spot projector are available:

- Green Spot with soldering holes
- Green Spot with connector

Both variants have the same performance and driving requirements. The only difference is related to the PCBA that may include or not a connector (see Figure 18 and Figure 19).

Figure 18. Green spot with soldering holes (back and side view)

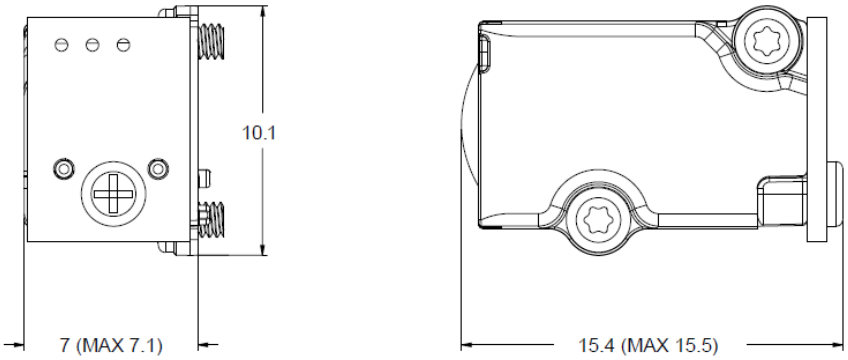
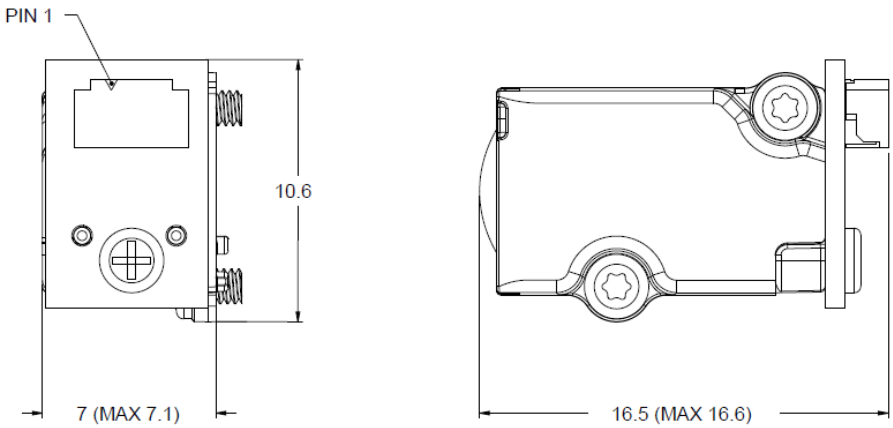


Figure 19. Green spot with connector (back and side view)



Version with connector is bigger than the other: this means that, when aligned to the engine, the connector goes out of the engine maximum depth (see Figure 20 and Figure 21).

Figure 20. Maximum depth including green spot with soldering holes

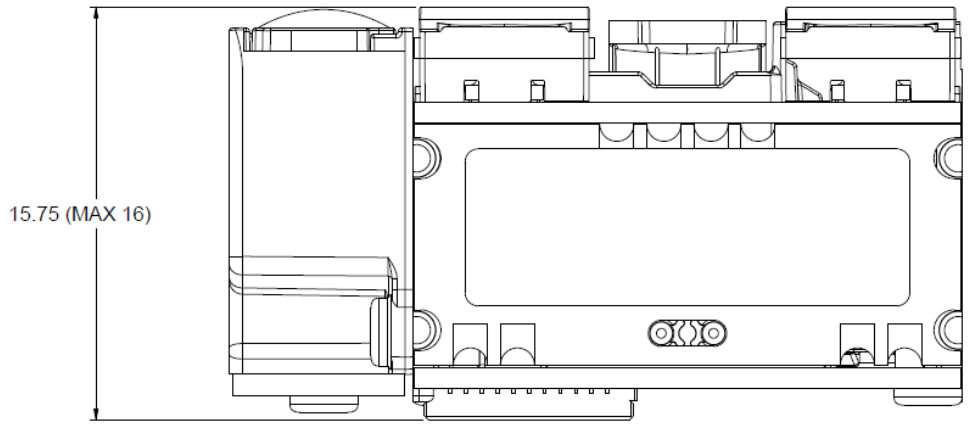
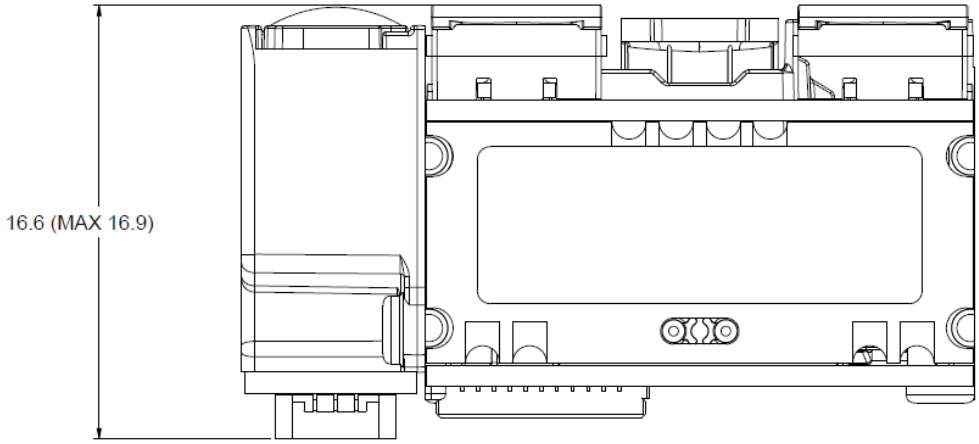


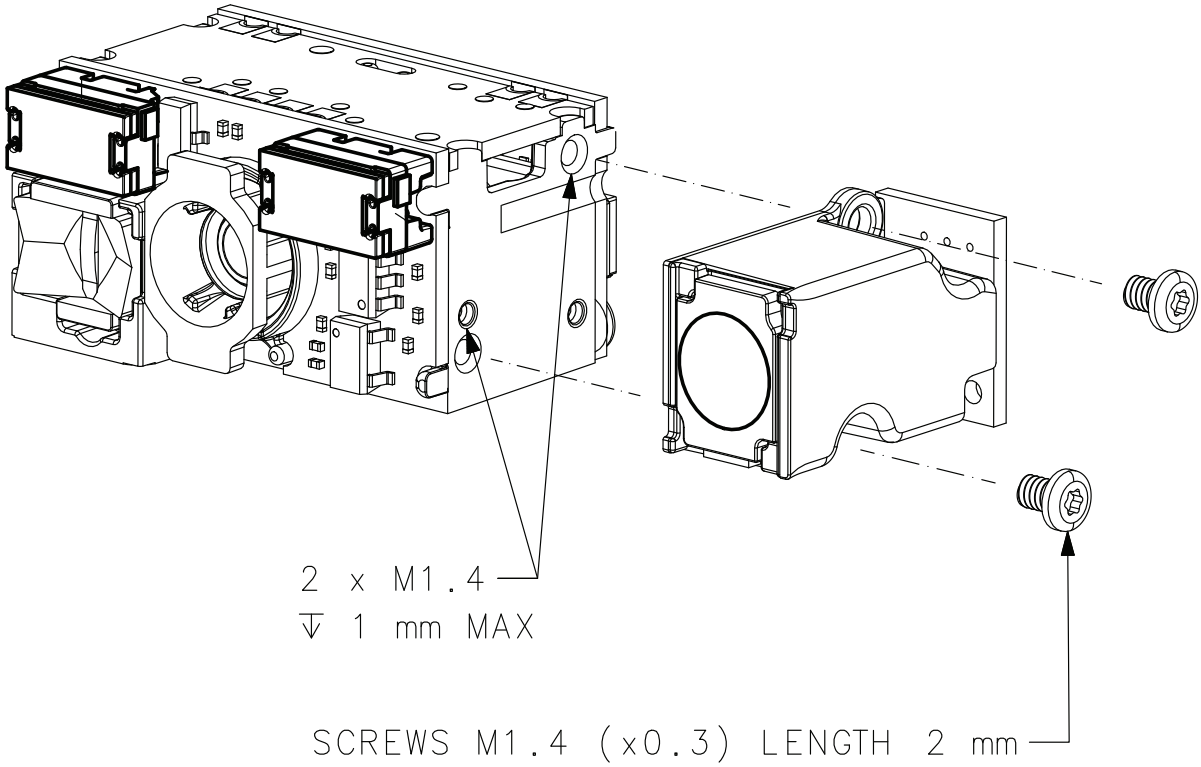
Figure 21. Maximum depth including green spot with connector

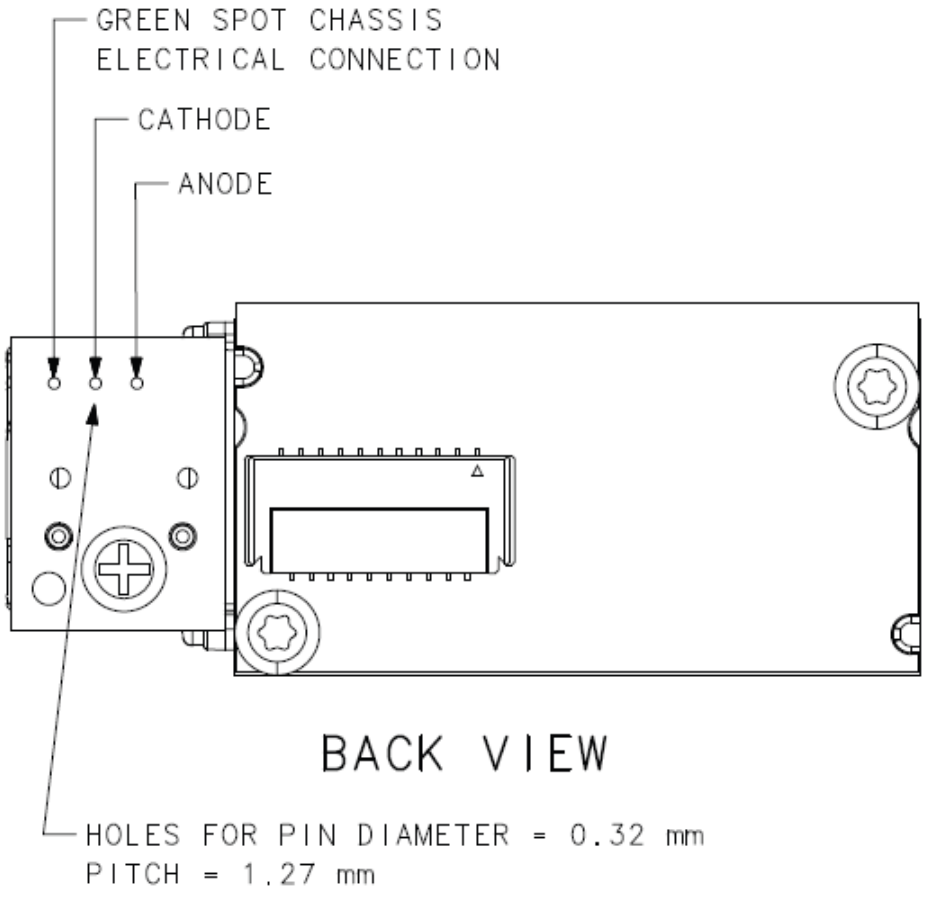


Both versions of the green spot, can be fixed to the engine on left or right side using 2 M1.4 screws. Required torque value to fix the screws is 0.06 Nm.

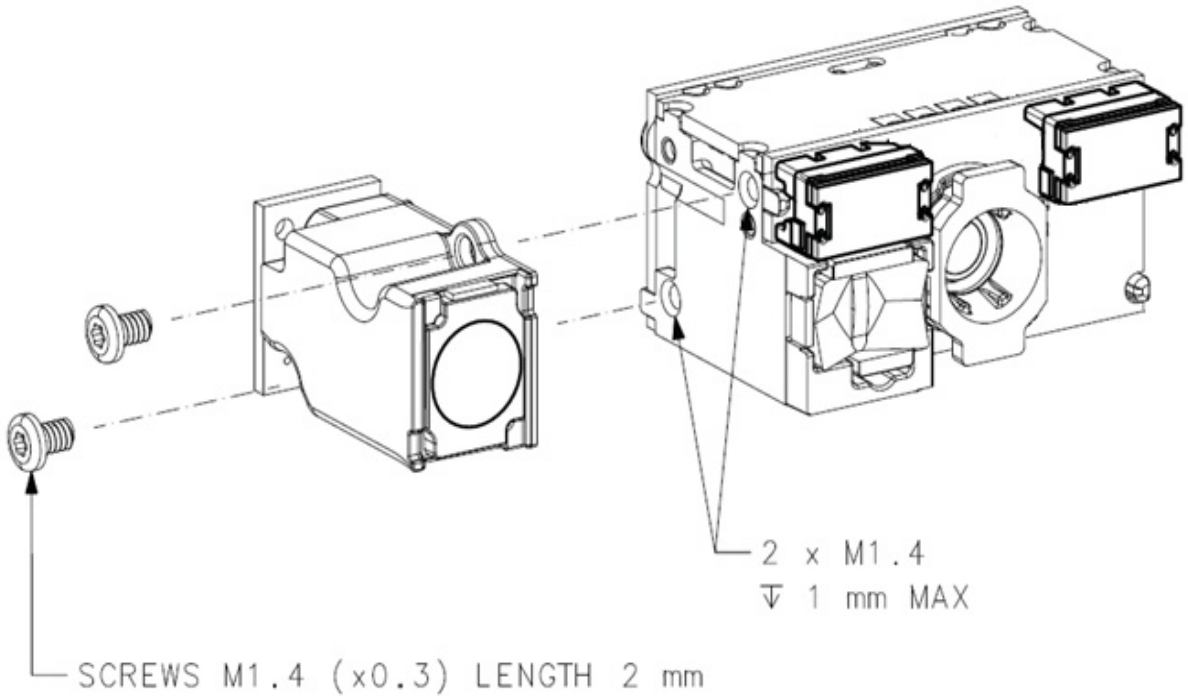
In the following all the drawings refer to the model with soldering holes, but mechanical interface is the same also for connector version.

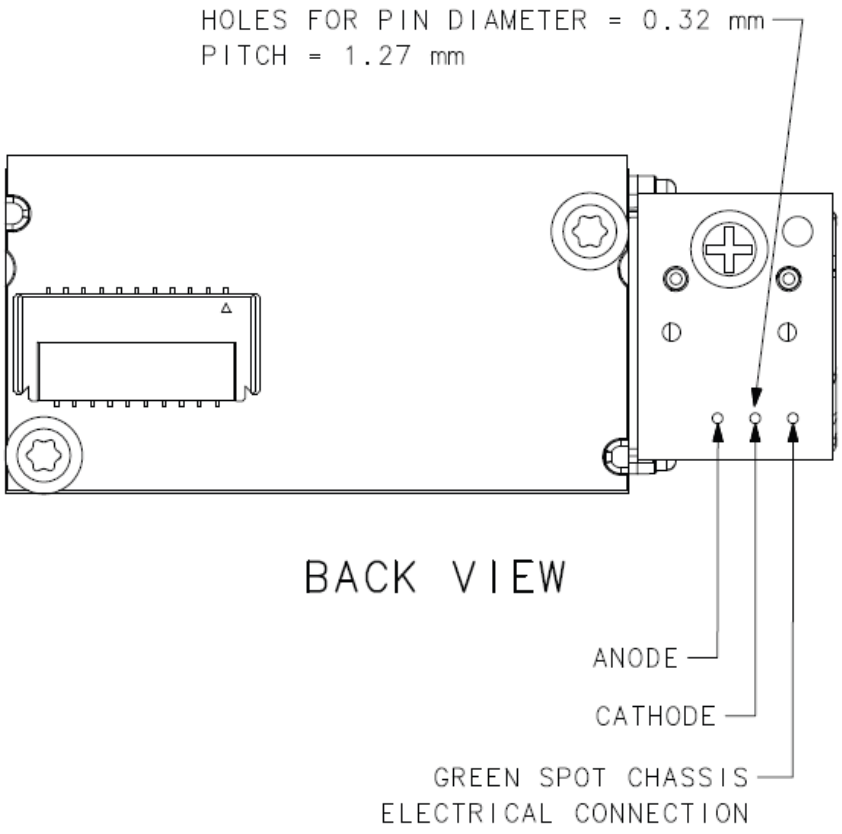
Green Spot Projector - Left side mounting





Green Spot Projector - Right side mounting





Green Spot Projector – Electrical Interface

Anode Pin (connector PIN 1):

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

Cathode Pin (connector PIN 2):

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

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

Chassis Electrical Connection Pin (connector PIN 3):

Ground connection (GND).

Electrical Characteristics

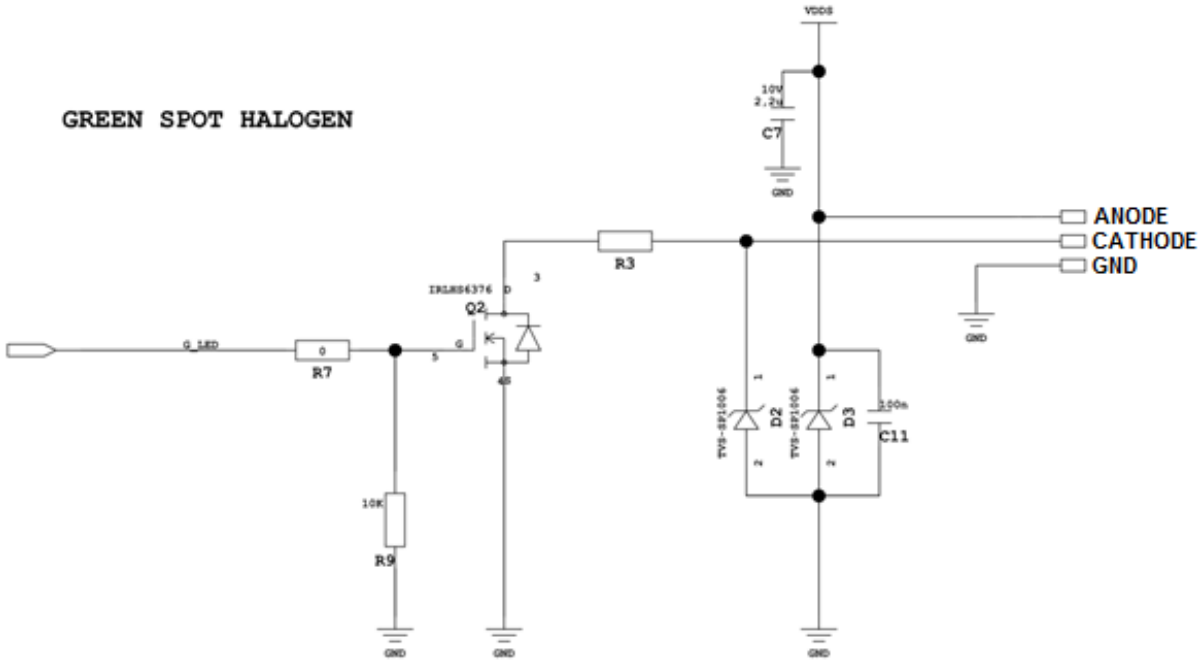
Operating temperature range	Top	– 40 ... + 85	°C
Storage temperature range	Tstg	– 40 ... + 85	°C
Junction temperature	Tj	+ 100	°C
Forward current (TS = 25 °C)	IF	20	mA
Surge current = 10 µs, D = 0.1, TA=25°C	IFM	100	mA
Reverse voltage (TS = 25 °C)	VR	5	V
Wavelength at peak emission IF = 20 mA	λpeak	523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

Typical electrical driver

The figure below shows an example of electrical driver for the green spot.

Be sure to match the connection between the green spot PCBA and the host board.

Figure 22. Electrical driver example



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