

HALOGEN™ DE2x12

2D Bar Code Scan Engine



Integration Guide

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Patents

This product is covered by one or more of the following 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™ DE2x12 scan engines (designated as “scan engine” or “OEM scan engine” in this manual) specifically into equipment-integrated scanning applications.

DE2x12 family includes 5 different engines:

- DE2012-DL: Driver License focus position with parallel video port.
- DE2012-SR: Standard Range focus position with parallel video port.
- DE2112-DL: Driver License focus position with MIPI video port.
- DE2112-SR: Standard Range focus position with MIPI video port.
- DE2012-WA-DL: Wide Angle Model, Driver License focus position with parallel video port.

In the following all the models will be generically referred to as DE2x12 engines, except when specific description (i.e. electrical interface, power consumption etc...) is required to differentiate PARALLEL or MIPI engines.

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 DE2x12

The Datalogic DE2x12 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 DE2x12 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.

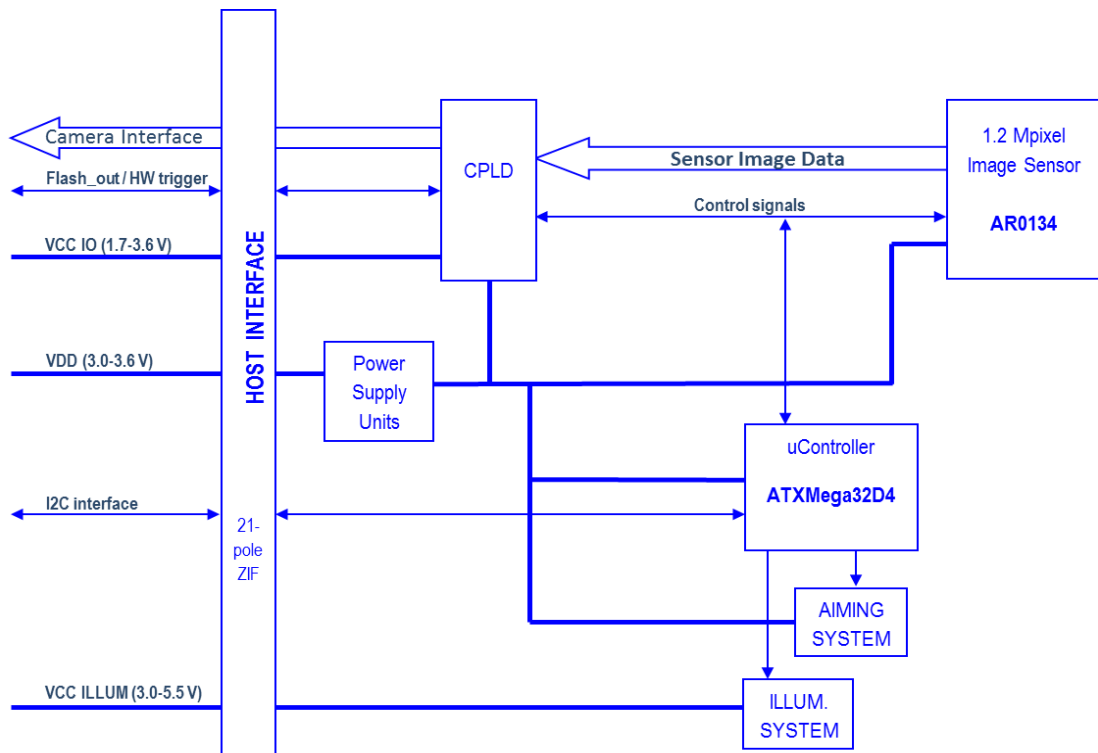
System Overview

The Datalogic DE2x12 scan engine features a global shutter sensor having 1280x960 pixels, able to capture images up to 54 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.

Electrical interface on the connector is different for parallel and MIPI video port.

Figure 1. Scan Engine block diagram



Illumination System

The Illumination System is composed 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

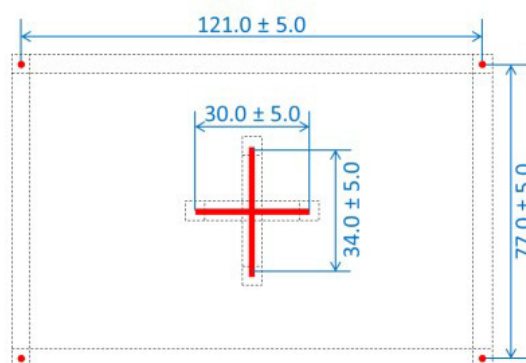
The aiming system is based on a 650nm laser diode and related optics. It projects a highly visible 4-Dot aimer with center-cross for targeted scanning.



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 11 and Figure 10 on page 11
Maximum pulse duration	17ms
Repetition rate	18.6ms
Maximum output power	1mW
Laser aperture	See Figure 11 on page 12

Regulatory

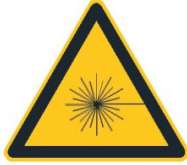
- IEC/EN 60825-1: 2007 and IEC/EN 60825-1:2014 (class 2)
- 21 CFR 1040 (CDRH) (class II)



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.

WARNING

Figure 3. DE2x12 Regulatory label

LASER LIGHT - DO NOT STARE INTO BEAM CLASS 2 LASER PRODUCT OUTPUT RADIATION 1 mW MAX. EMITTED WAVE LENGTH 630~680 nm 17 ms PULSE IEC60825-1:2007 and IEC60825-1:2014	DO NOT STARE INTO BEAM  This product complies with FDA rule 21 CFR Subchapter J in effect at date of manufacture
CAUTION-CLASS 2 LASER LIGHT WHEN OPEN AVOID EXPOSURE-LASER LIGHT IS EMITTED FROM THE APERTURE	

 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 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 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)

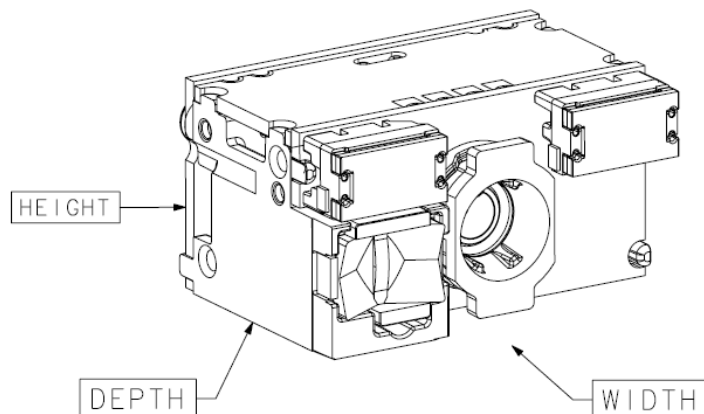
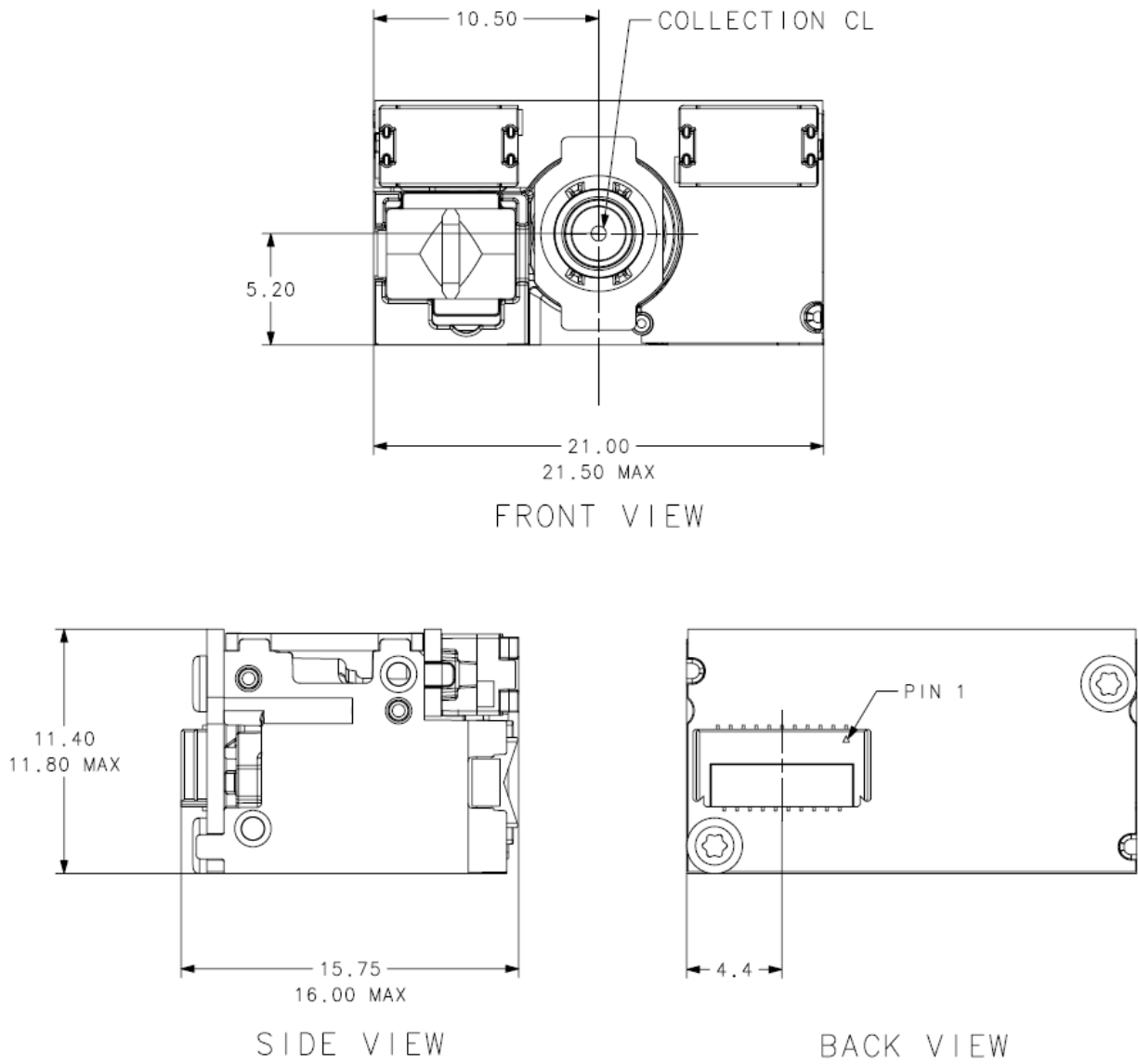


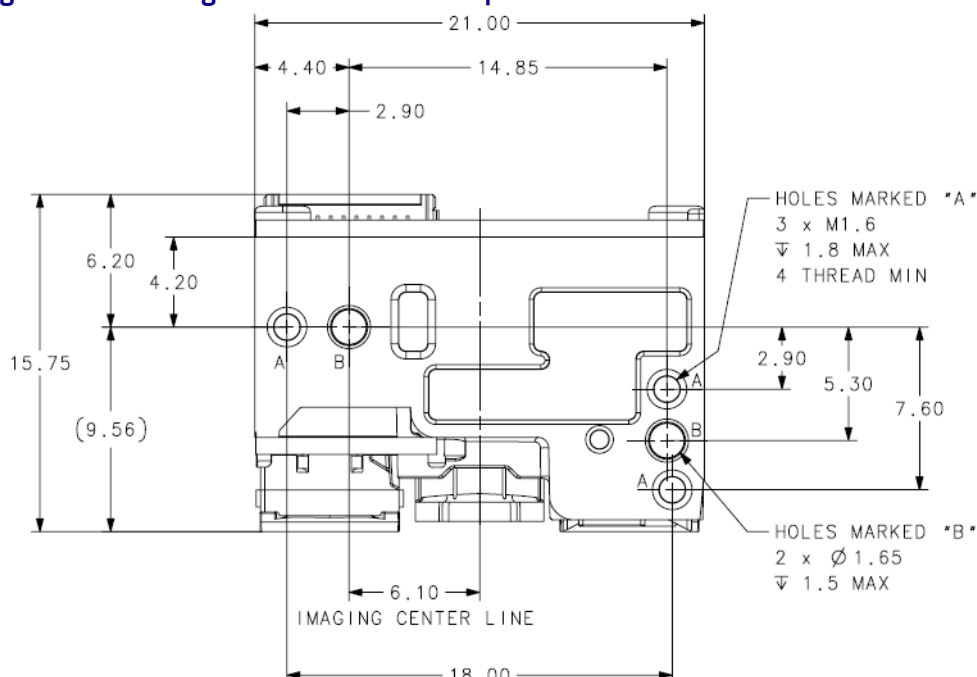
Figure 5. Engine Size and Connector Position



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

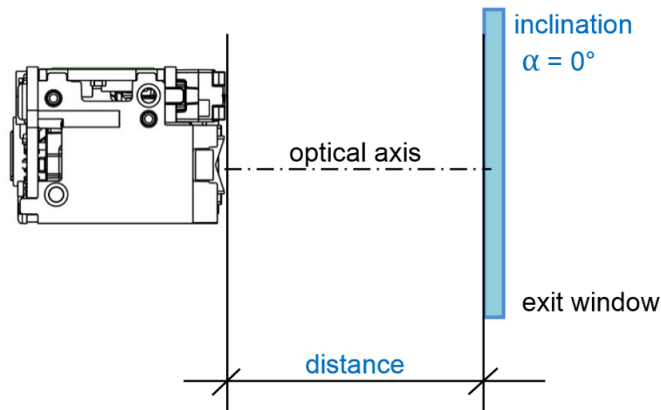
Distances are measured from the illumination lenses to the first face of the exit window (the nearest to the engine). Window thickness should be smaller or equal to 1.5mm.

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



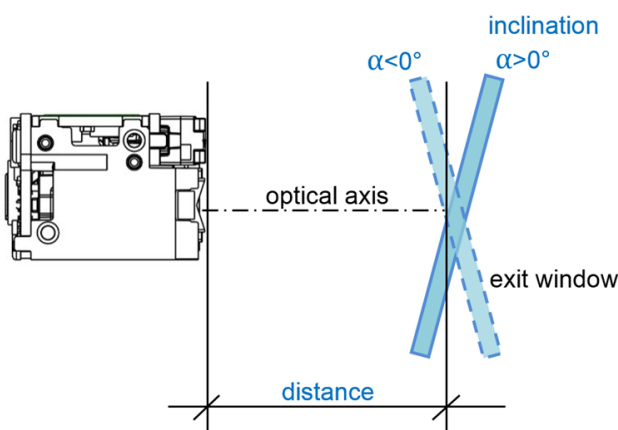
- Do not place the exit window between the maximum distance allowed for a parallel window (Figure 7) and the minimum distance for a tilted window (Figure 8).
- Integration tolerances are not included.

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



Standard FOV		Distance [mm]					
		5	10	15	20	25	30
No Coating	+ α	50°	46°	42°	38°	34°	28°
	- α	34°	32°	32°	32°	32°	32°
AR coating (2 sides)	+ α	46°	36°	34°	32°	30°	30°
	- α	24°	28°	28°	28°	28°	28°

Wide Angle FOV		Distance [mm]					
		5	10	15	20	25	30
No Coating	+ α	54°	46°	42°	38°	34°	32°
	- α	42°	42°	42°	38°	38°	36°
AR coating (2 sides)	+ α	52°	42°	40°	36°	34°	34
	- α	30°	34°	34°	32°	32°	32°

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 0,04 λ 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 9 and Figure 10 show the optical paths for the imaging system, the aiming system and the illumination system for standard models (DE2x12-DL and DE2x12-SR).

Declared imaging system Field Of View is $42^\circ \times 32^\circ$ (see Appendix A on page A-26). Due to fabrication and assembly tolerances, the optical path to be considered for mechanical integration is $44^\circ \times 34^\circ$.

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

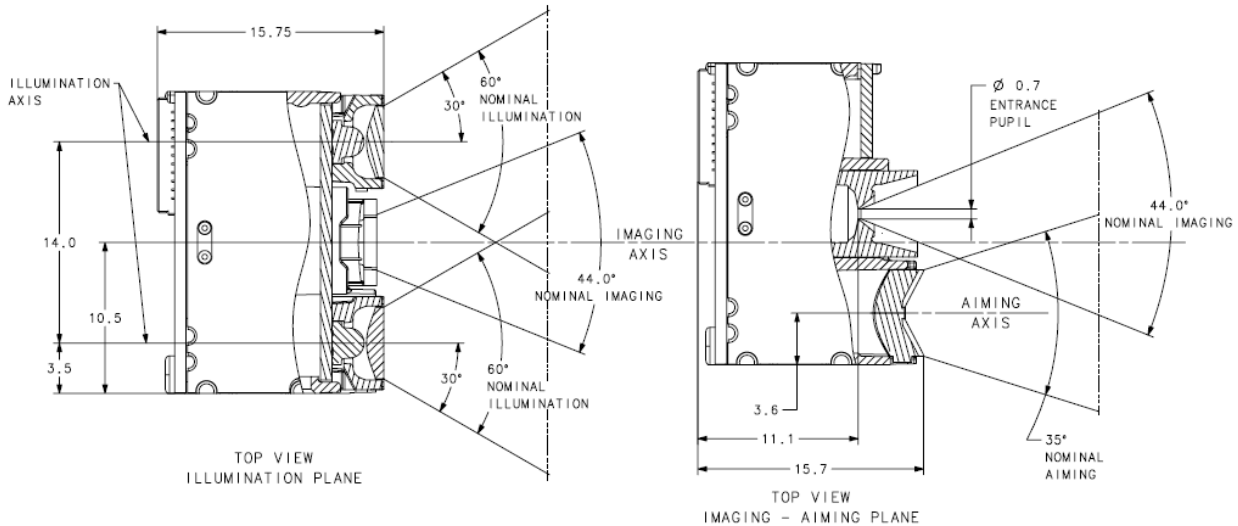


Figure 10. Side View - Aiming, imaging and illumination optical paths

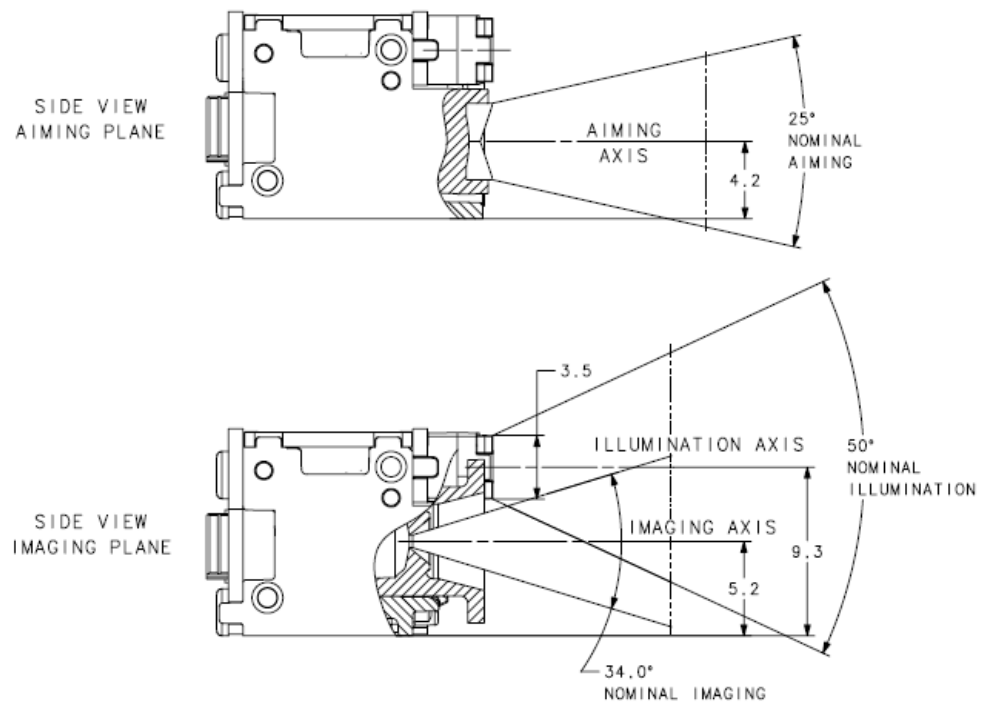
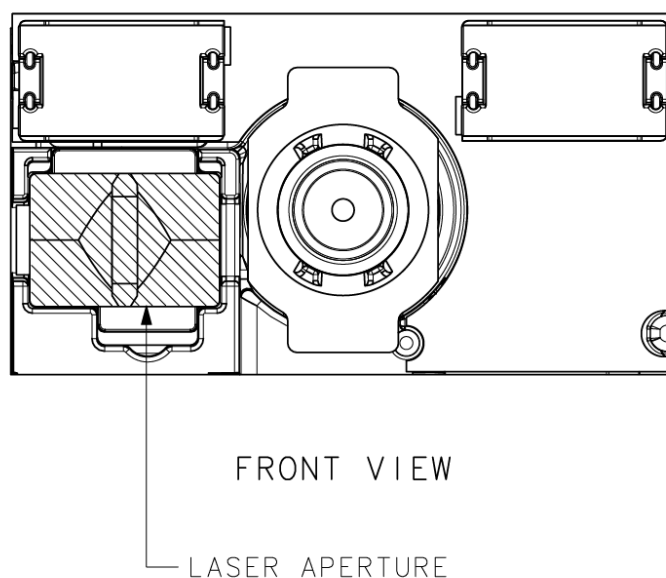


Figure 11. Front View - Laser aperture

Optical paths and exit window clearance for Wide Angle models

Wide angle models (DE2x12-WA-DL) only differ from the standard ones for illumination and imaging optical paths. Declared imaging system Field Of View is $52^{\circ} \times 40^{\circ}$ (see [Appendix A on page A-26](#)).

Due to fabrication and assembly tolerances, the optical path to be considered for mechanical integration is $54^{\circ} \times 42^{\circ}$. Nominal illumination FOV to be considered for mechanical integration is $75^{\circ} \times 70^{\circ}$.

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 $\pm 2.0\text{Kv}$ @ 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 DE2x12 scan engine can be connected to an external digital platform via a 21-pole ZIF connector supporting:

- a camera interface (parallel RAW8 format or 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.



CAUTION

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 I²C communication port for controlling the scan engine

Signals on connector are mapped in a different way for parallel and MIPI video port.

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

Table 4 below describes the power lines and the signals mapped on the 21-pole ZIF connector for MIPI-CSI2 camera interface.

Table 3. Parallel video port: Engine connector description

Pin	Signal	I/O type	Description
1	GND	power	Ground
2	GND	power	Ground
3	I2C_CLK ^a	I	I ² C Clock
4	I2C_DATA ¹	I/O	I ² C Data
5	V_SYNC	O	Vertical sync
6	PIX_DATA_7	O	camera interface bus, pixel 7 – MSB
7	PIX_DATA_6	O	camera interface bus, pixel 6
8	PIX_DATA_5	O	camera interface bus, pixel 5
9	PIX_DATA_4	O	camera interface bus, pixel 4
10	PIX_DATA_3	O	camera interface bus, pixel 3
11	PIX_DATA_2	O	camera interface bus, pixel 2
12	PIX_DATA_1	O	camera interface bus, pixel 1
13	PIX_DATA_0	O	camera interface bus, pixel 0 – LSB
14	FLASH_OUT / HW TRIGGER ^b	I/O	External illumination system trigger (OUTPUT)/ Camera HW Trigger (INPUT)
15	VCC_IO	power	I/O reference and power supply
16	VCC	power	Digital and sensor power supply
17	VCC_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

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

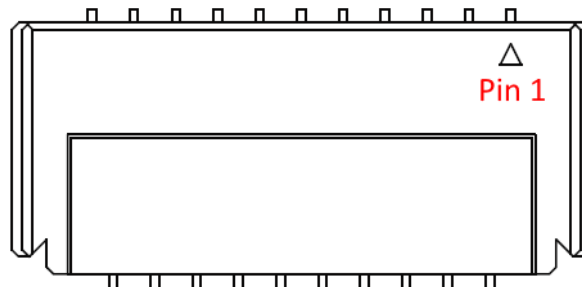
b. Internal 4.7K pullup to VCC_IO, pin is in open drain driving mode. FLASH_OUT is default behavior; when used as HW TRIGGER host pin should be open drain.

Table 4. MIPI video port: Engine connector description

Pin	Signal	I/O type	Description
1	GND	power	Ground
2	GND	power	Ground
3	MIPI DN	I	MIPI-CS12 differential data lane (negative)
4	GND	power	Ground
5	MIPI DP	O	MIPI-CS12 differential data lane (positive)
6	GND	power	Ground
7	GND	power	Ground
8	GND	power	Ground
9	MIPI CLKP	O	MIPI-CS12 differential clock lane (positive)
10	GND	power	Ground
11	MIPI CLKN	O	MIPI-CS12 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	I ² C Clock
20	I2C_DATA ²	I/O	I ² C 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

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

The DE2x12 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.

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.

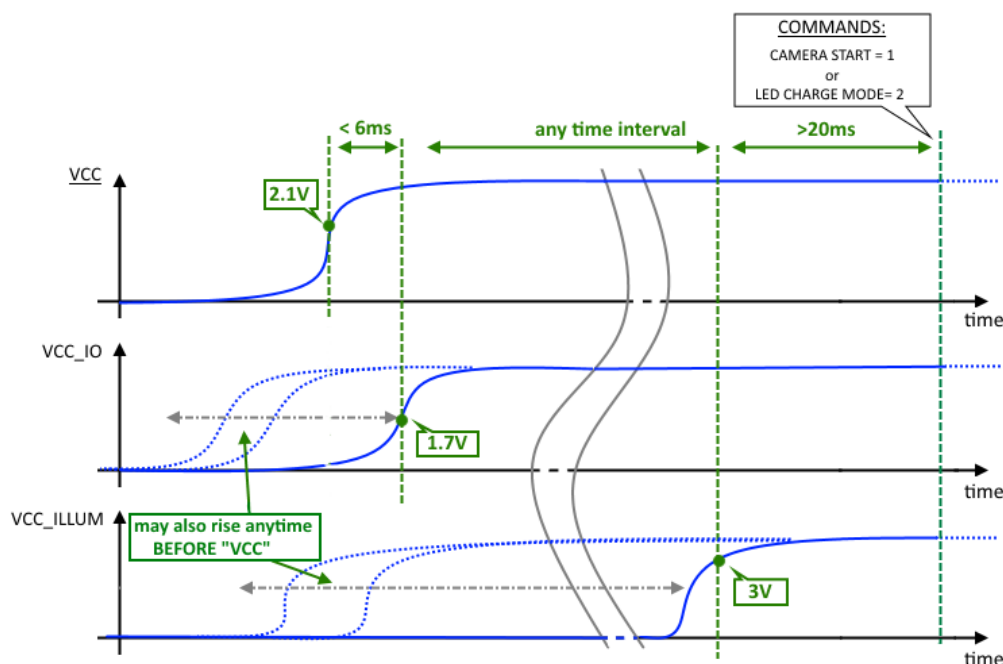
Powerup sequence

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

- VCC_IO must be at least at the minimum value of 1.7 V not later than 6ms after VCC is at 2.1V.
- VCC_ILLUM_SYS must be at least at the minimum value of 3V not later than 20ms before issuing any CAMERA START or LED CHARGE MODE command.

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

Figure 13. Power-up sequence timing constraints



Engine latency at power-up

At power up the engine begins executing the code when the power supply level reaches 2.1V. To complete the boot sequence about 36ms are required; after this period the engine is ready to parse commands.

Supply Voltages and I/O levels

Table 5. Supply Voltages and I/O Levels

Item	Level	Description
VCC	$3.3V \pm 0.3$	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.
MIPI only: LP signals	1.2V	The typical high level for MIPI lines (MIPI CLKP, CLKN, DP, DN) when in MIPI Low Power mode.
MIPI only: 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.
MIPI only: 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.

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 $\leq 150\text{mV}$ 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.

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 I²C 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 I²C from host (master) to engine (slave) should have the following format:

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

I ² C Element	Description
Start bit:	Start bit as I ² C 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 DE2x12 in I²C Command Codes , starting on page 20 or Table 6 on page 20.

I ² C Element	Description
Command Parameters:	Data bytes required by the command, LSB first, shown in Table 6 on page 20 .
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 ² C 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 ² C 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 6 on page 20 .

I²C Command Codes

Command Parameters

The following table shows a categorized list of the DE2x12 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 18.

For more information on the commands, see "I²C Command Specifications" on page 32.



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

Table 6. 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 (excluding sensor)	
[0x38]	CAMERA START	Starts or stops image acquisition.	1 Byte: <u>0x00</u> =Stop 0x01=Start	
[0x3B]	CAMERA MODE	Configures the scan engine for performing different tasks.	1 Byte: 0= <u>Barcode Decode</u> 1=LCD Read 2=Snapshot Mode	
[0x42]	BOOTLOADER START	Stops operations and starts bootloader.	3 Bytes: Signature: 0xAA, 0x50, 0x5F (LSB FIRST)	
[0x46]	SET CMD LIST	Sets a user-defined sequence of commands to be executed using RUN CMD LIST.	1 Byte: List# to program (0 – 9) + n Bytes (max 149): Command script(s)	
[0x47]	RUN CMD LIST	Executes a user-defined sequence of commands.	1 Byte: List# to run (0 – 9)	

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
CAMERA SYSTEM CONFIG				
[0x23]	RESTORE FACTORY DEFAULT	clears Camera USER CUSTOM parameters, setting them back to FACTORY DEFAULT values.	1 Byte: 00	
[0x3F]	SET LOW POWER	Activates system power saving mode, switching between Low Power and Idle mode.	1 Byte: <u>0x00=Idle</u> 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
[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 ¹	2 Bytes: Parameter ID Code
[0x44]	AUTO LOW POWER	System automatic power saving mode.	1 Byte: <u>00=Disabled</u> 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: 0x00 = 5 ms 0x01 – 0x0A = 10–100 ms, 10 ms increments 0x0B – 0x15 = 200–1200 ms, 100 ms increments 0x16 – 0xFF = 2s – 235s, 1s increments <u>Default is 0x05=50ms</u>	
[0x5B]	LED CHARGE MODE	Determines the charging mode of the LED illumination circuitry.	1 Byte: <u>0x01</u> = pre-charge mode 0x02 = constant charging mode	

1. See Table 7 on page 24 and Table 8 on page 25 for details on parameter length and ID code.

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
AIMING SYSTEM				
[0x35]	AIM ENABLE	Switches the aiming system ON/OFF.	1 Byte: <u>00=Off</u> 01=On	
[0x36]	AIM ON IMAGE	Sets aiming laser projection syncing so that is visible on the image.	1 Byte: <u>00=Off</u> 01=On	
[0x4E]	AIM TIME	Sets the aiming laser lighting time for each frame (determines aim pattern brightness).	1 Byte: <u>0x00</u> = sets Aim “on” time per Frame to default (=8500us), or to user custom if previously modified. 0x01–0xAA = aim “on” time (per Frame) set to value*0.1 ms. Max value is 17ms. Note: pulse duration might be trimmed by sensor exposure time variations	
[0x4F]	AIM BLINK	Sets the on / off rate of the AIM pattern on a frame basis	1 Byte: <u>0x00</u> = sets Aim pattern ON in each frame. 0x01–0xFF = number of frames in which AIM is ON + 1 Byte: <u>0x00</u> = sets Aim pattern ON in each frame. 0x01–0xFF = number of frames in which AIM is OFF	

Cmd Code	Cmd Name	Description	Parameters	Response Data (if present)
LED ILLUMINATION SYSTEM				
[0x34]	ILLUMINATION DELAY	Sets the time from sensor exposure start to LED lighting start.	1 Byte: 0x00–0xFF = illumination delay time: from start of exposure to start of illumination. Sets delay equal to $value * 30\mu s$; if value=0x00: <u>delay=4μs</u> .	
[0x39]	ILLUMINATION ENABLE	Switches ON/OFF the LED illumination system.	1 Byte: <u>00=Off</u> 01=On	
[0x48]	ILLUMINATION TIME	Sets the illumination LEDs lighting time for each frame (determines LEDs brightness).	1 Byte: 0x00–0x14 = Illumination time per Frame is set to $value * 50\mu s$. If value=0x00: time=30 μs . Default: <u>0x0C</u> : <u>time=600μs</u>	
IMAGE SENSOR				
[0x30]	SET SENSOR REG	Writes new value to the Image Sensor desired register.	2 Bytes: Register address + 2 Bytes: Register new value	
[0x31]	GET SENSOR REG	Gets Image Sensor desired register value.	2 Bytes: Register address	2 Bytes: Register current value
[0x3C]	SENSOR BINNING (DE2012 models ONLY)	Sets the binning operated by the Sensor: normal – Horizontal only – Horizontal and Vertical.	1 Byte: 0x00=Normal 0x01=Horizontal binning 0x02=Horizontal and Vertical binning	
[0x3D]	IMAGE ROI (DE2012 models ONLY)	Sets the image region of interest to be output for each frame, removing the undesired borders.	1 Byte: Edge selection: 0=top, 1=right, 2=bottom, 3=left + 1 Bytes: pixel coordinate of the selected edge	



See Table 7 on page 24 and Table 8 on page 25 for details on parameter length and ID code.

Camera System Parameters

The following tables list DE2x12 system Parameters. Table 7 below shows the camera system information, while Table 8 on page 25 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 I²C with LSB first.

Table 7. 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

Table 8. 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) – See also “ILLUMINATION TIME” command 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 – See also “ILLUMINATION DELAY” command 2 Bytes: value in us	0x00B8	2	4us (0x0004)
Aim Time Default	Customizable default/startup value for the AIM pattern “on” time (per frame) – See also “AIM TIME” command 2 Bytes: value in us	0x00B9	2	8500us (0x2134)
Aim Delay Default	Customizable value for the delay time from end of exposure to start of AIM pattern projection. 2 Bytes: value in us	0x00B0	2	100us (0x0064)
Custom Sensor Register Value [N] (N is from 0 to 9)	Customizable default/startup value for a sensor register: 2 Bytes: register address + 2 Bytes: register value Up to 10 custom registers can be set.	0x00C[N] (N is from 0 to 9)	4	0x00000 0x00000



An additional 4us delay must be considered and summed up to the above values.

EXAMPLE: Getting a Scan Engine Serial Number

Cmd Name = GET CAMERA PAR

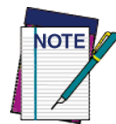
Cmd_Code = 0x40

Parameter ID Code = 0x0001

Parameter Length = 16 bytes

SEND COMMAND to the ENGINE:

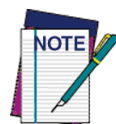
<write> 0x40 0x01 0x00 0xBF



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..



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 DE2x12-DL engine, including reading performance.

Item	Description
Physical Characteristics	
Dimensions	Nominal size: Width 0.83"/21.00 mm Height 0.45"/11.40 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 29 for more information.	
Current	Values at 23°C – VCC: 3.3 – default configuration: Max. Operating (RMS): • PARALLEL < 280mA • MIPI < 300mA Standard Operation (Typical – RMS): • PARALLEL: 220mA • MIPI: 270mA Idle (Typical – RMS): PARALLEL 20mA MIPI 27mA Low Power (RMS): PARALLEL and MIPI <0.2mA Surge Current Peak: <340mA for t<0.15ms that might occur in some conditions (see table 9)

Item	Description				
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 17 for details.				
Performance Characteristics					
Image Sensor	MP: 1280x960 pixels				
Light Source	Illumination: White LEDs Aiming: 650nm VLD				
Field of View	Standard models: 42°H x 32°V Wide angle models: 52°H x 40°V				
Print Contrast Minimum	25% minimum contrast				
Scanning Angles					
See Definition of Scanning Angles on page 29 for additional information.					
Roll Angle	Up to ± 180°				
Pitch Angle	± 60°				
Skew Angle	± 60°				
Minimum Element Width	1D Linear: 2.5 mils (DE2x12-DL, DE2x12-WA-DL) – 3 mils (DE2x12-SR) PDF: 3 mils (DE2x12-DL, DE2x12-WA-DL) – 6.6 mils (DE2x12-SR) Datamatrix: 6 mils (DE2x12-DL, DE2x12-WA-DL) – 7.5mils (DE2x12-SR)				
DE2x12-DL Depth of Field ¹					
	Typical	Guaranteed			
	Resolution [mils]	Dmin [mm]	Dmax [mm]	Dmin [mm]	Dmax [mm]
Code 39	3	65	200	75	180
Code 39	5	35	290	55	250
Datamatrix	10	75	260	90	240
EAN13	13	45	420	50	380
Datamatrix	15	55	320	75	280
Code 39	20	(–) ²	600	(–) ^b	530

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

DE2x12–SR Depth of Field ¹		Typical		Guaranteed	
	Resolution [mils]	Dmin [mm]	Dmax [mm]	Dmin [mm]	Dmax [mm]
Code 39	3	130	220	160	190
Code 39	5	85	360	100	330
Datamatrix	10	100	280	120	250
EAN13	13	45	740	50	650
Datamatrix	15	65	400	80	350
Code 39	20	(1) ²	1100	(1) ²	1000
DE2x12–WA–DL Depth of Field ¹		Typical		Guaranteed	
	Resolution [mils]	Dmin [mm]	Dmax [mm]	Dmin [mm]	Dmax [mm]
Code 39	3	50	180	65	165
Code 39	5	30	240	40	210
Datamatrix	10	40	200	50	180
EAN13	13	35	370	40	330
Datamatrix	15	30	250	40	230
Code 39	20	(1) ²	600	(1) ²	530

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

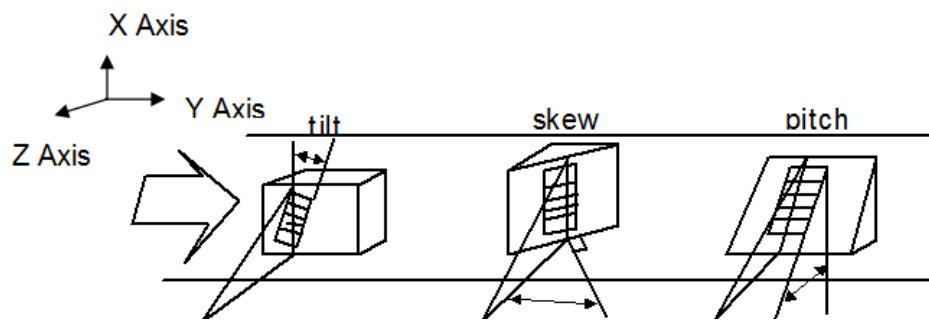
Item	Description
User Environment Refer to "Heat Dissipation" on page 17 for more information.	
Operating Temperature	Operating: –30 to 55°C / –22 to 131°F
Storage Temperature	Storage / Transport: –40 to 70°C / –40 to 158°F
Humidity (non-condensing)	95%
Mechanical Shock	2000 G ± 5% applied via any mounting 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

Item	Description
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 14. 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 sleep (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 9. DE2012 Typical RMS current consumption

DE2012 status	Current Consumption	Conditions
Low power	<0.2mA	Temperature 23°C Illumination flash duration 600us AIM laser pulse duration 8500us VCC = 3.3V VCC_IO = 3.3V VCC_ILLUM = 3.3V
Idle	20mA	
Image Acquisition (Running)	140mA	
Illumination Enabled flash duration 600us – factory default	210mA	
Illumination Enabled and AIM Enabled factory default timing	220mA	
Maximum Operating Current AIM on at factory default and flash duration 1000us (maximum value)	280mA	
Maximum surge current	Peak <340mA for less than 150us	might occur @ startup or if commands CAMERA START with param 0x01 or LED CHARGE MODE with param 0x02 are sent

Table 10. DE2112 Typical RMS current consumption

DE2112 status	Current Consumption	Conditions
Low power	<0.2mA	Temperature 23°C Illumination flash duration 600us AIM laser pulse duration 8500us VCC = 3.3V VCC_IO = 3.3V VCC_ILLUM = 3.3V
Idle	27mA	
Image Acquisition (Running)	192mA	
Illumination Enabled flash duration 600us – factory default	262mA	
Illumination Enabled and AIM Enabled factory default timing	270mA	
Maximum Operating Current AIM on at factory default and flash duration 1000us (maximum value)	300mA	
Maximum surge current	Peak <340mA for less than 150us	might occur @ startup or if commands CAMERA START with param 0x01 or LED CHARGE MODE with param 0x02 are sent



Appendix B

I²C Command Specifications

This section provides additional information about I²C Commands.

I²C COMMAND SPECIFICATIONS

- AIM BLINK (0x4F) page 32
- AIM ON IMAGE (0x36) page 32
- AIM TIME (0x4E) page 32
- AIM ENABLE (0x35) page 32
- AUTO LOW POWER (0x44) page 33
- BOOTLOADER START (0x42) page 33
- CAMERA MODE (0x3B) page 33
- CAMERA RESET (0x37) page 34
- CAMERA START (0x38) page 34
- GET CAMERA PARAM (0x40) page 34
- GET SENSOR REGISTER (0x31) page 35
- ILLUMINATION DELAY (0x34) page 35
- ILLUMINATION ENABLE (0x39) page 35
- ILLUMINATION TIME (0x48) page 35
- IMAGE ROI (0x3D) – [DE2012 models ONLY] page 35
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- SET CMD LIST (0x46) page 38
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- SET SENSOR REG (0x30) page 39

I²C Command Specifications

This section contains a complete description of the DE2x12 possible I²C supported commands in alphabetical order. For a summary list and more information, see [Command Format, starting on page 18](#).

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 whether 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 ENABLE.

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. If AIM ON IMAGE is disabled, the time in which AIM is on starts from after sensor exposure. A longer period determines a brighter aim pattern.

Accepts values from 0x00 to 0xAA; each unit corresponds to a 0.1 ms time increment (max is 0xAA=17ms, 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 8500us (factory default) – see

[Table 8 on page 25](#).



An additional 4us delay must be considered and summed up to the above values.

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 ENABLE (0x35)

Sets on or off the AIM pattern during image acquisition. With the value set to 0x01 the AIM pattern will turn on whenever the camera is in RUNNING mode. 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.

AUTO LOW POWER (0x44)

Enables system automatic power saving mode: as soon as the engine is in Idle state, the system is automatically put into Low Power state after a timeout.

For example, after issuing a camera stop (CAMERA START command with parameter = 0x00) the camera goes from RUNNING to IDLE mode and a time counter triggers: when the camera is continuously Idle for a time, previously determined using the SET AUTO POWER TIME command (default is 50ms), the system enters a power reduction state.

When an I²C command is issued the system wakes up and executes the command, then the timer is reset and starts again counting after executing the command. If the camera is Running, only a camera stop command will trigger again the timer.

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, Snapshot. 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).

SNAPSHOT (0x02): in this mode a single image is acquired each time a CAMERA START (with parameter=0x01) command is sent.

Horizontal blanking is augmented, gain control is disabled, automatic exposure control is disabled.

A first camera start should be issued for updating sensor registers new values, setting it up for best snapshot operation. If AIM pattern is enabled, after the first camera start is issued the aim will be always on until disabled (but not visible in the images).

If a camera stop is issued (CAMERA START with parameter=0x00) the scan engine returns to BARCODE DECODING default mode.

Sensor exposure and gain for each frame can be manually set using the command SET SENSOR REG for setting the

sensor registers R0x3012 (coarse_integration_time) for exposure and R0x30B0 (digital_test) bit 5 to 4 for analog gain. See sensor manual for more information.



The recommended way of exiting snapshot mode is always issuing a camera stop, sending CAMERA START with parameter=0X00 command; one last image frame will be acquired in order to reset the sensor back to BARCODE DECODING, that is its standard working mode (if LED illumination is enabled a flash will be visible).

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. If any CUSTOM SENSOR REGISTER is set using SET CAMERA PARAM command, required time increases up to about 24ms, depending on the number of customized register.

If parameter is 0x01, all system (except for the sensor) will be reset. About 7ms 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.

In default configuration (which is with LED CHARGE MODE set to 0x01), after a start command (CAMERA START with parameter 0x01) the engine prepares the illumination system: for about 62ms the system will not compute any I²C command; after this time the first frame will be exposed, starting camera streaming operation. If LED CHARGE MODE is set to (0x02) this preparation phase is skipped.

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 I²C 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 7 on page 24, and Table 8 on page 25.

GET SENSOR REGISTER (0x31)

Returns the desired register value of the On Semiconductors image sensor. Parameter is the 2 Bytes register address (LSB first), response is the 2 Bytes register value (LSB first).

Further details can be found on the sensor manual.

ILLUMINATION DELAY (0x34)

Sets the illumination start delay time, taking as a starting point the beginning of sensor exposure. Accepts values from 0x00 to 0xFF with a time unit of 30us, with 0x00 being the minimum value of 4us. Default value is defined in parameter “Illumination Delay Default”, that if not modified has value 0x00 = 4us delay (factory default) – see Table 8 on page 25.



An additional 4us delay must be considered and summed up to the above values.

ILLUMINATION ENABLE (0x39)

Sets on or off the illumination LEDs during image acquisition. 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 0x00 (30us) to 0x14 (1ms). Default value is defined in parameter “Illumination Time Default”, that if not modified has value 0x0C = 600us (factory default) – see Table 8 on page 25.

IMAGE ROI (0x3D) – [DE2012 models ONLY]

Sets the image region of interest, so that for each frame only the selected portion of the acquired image is output. Frame rate remains unchanged, since horizontal and vertical blanking increase so to keep row and frame time constant.

The first byte selects the desired edge to move:

0=top, 1=right, 2=bottom, 3=left

The following 2 bytes determine the new position of the selected edge (LSB first).

In default (full image =full resolution) the edges coordinates are:

- Top: 0
- Right: 1279
- Bottom: 959
- Left: 0



Use only with Halogen parallel interface version - DE2012 models.
DO NOT USE in conjunction with SENSOR BINNING command – use only with full resolution images.

LED CHARGE MODE (0x5B)

Determines the charging mode of the LED illumination circuitry:

- if set to 0x01 (default) the illumination circuitry is off, maximizing power reduction when the camera is not Running – an about 62ms pre-charge phase is present after each CAMERA START with param= 0x01 command, needed for preparing the first illumination flash; sensor starts exposing and streaming images right after this pre-charge.
- if set to 0x02 the illumination circuitry is constantly kept charged by small current pulses (one each 0.78 seconds) injecting charge (also when in Low Power state); a slightly higher current consumption (about 0.2 mA RMS) is present when camera is not Running, but there is no pre-charge phase needed, so the sensor starts exposing right after the camera start command.



WARNING

Do not send this command when the engine is in RUNNING mode.



Right after the command is sent with parameter 0x02, the above described pre-charge cycle of 62 ms is executed once.

RESTORE FACTORY DEFAULT (0x23)

Send this command with parameter = 0x00; the following User Custom Parameters values are restored to their Factory Default values:

ILLUMINATION TIME DEFAULT

ILLUMINATION DELAY DEFAULT

AIM TIME DEFAULT

AIM DELAY DEFAULT

CUSTOM SENSOR REGISTER [number 0 to 9]

See Table 8 on page 25 for Factory Default values.

RUN CMD LIST (0x47)

Executes the sequence of commands previously memorized using the SET CMD LIST command. Parameter to send is the number of the sequence to be executed (from 0 to 9).

SET AUTO POWER TIME (0x45)

Sets the timeout value after which power saving mode is activated. See AUTO LOW POWER command for more details. Parameter is the timeout value with an increasing unit scale:

0x00 is for 5ms

0x01 – 0x0A = 10–100 ms (10ms unit)

0x0B – 0x15 = 200–1200 ms (100ms unit)

0x16 – 0xFF = 2s – 235s (1s unit)

Default value is 0x05=50ms.

SENSOR BINNING (0x3C) – [DE2012 models ONLY]

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

A binning of 2 means that 2 adjacent pixels are merged (column or row wise), which means that resolution changes depending on the applied binning:

If param=0x00 no binning is applied – full resolution: 1280x960

If param=0x01 only horizontal binning is applied – res: 640x960

If param=0x02 both horizontal and vertical binning is applied – res: 640x480.



Use only with Halogen parallel interface version - DE2012 models.

DO NOT USE in conjunction with IMAGE ROI command – use only with full resolution images.

SET CAMERA PARAM (0x41)

Writes the chosen parameter to the camera's non-volatile memory area: User Custom Parameters.

The customizable parameters are (see [Table 8 on page 25](#) for details):

ILLUMINATION TIME DEFAULT

ILLUMINATION DELAY DEFAULT

AIM TIME DEFAULT

AIM DELAY DEFAULT

CUSTOM SENSOR REGISTER [number 0 to 9]

The stored values will also be used as new default values for the commands ILLUMINATION TIME, ILLUMINATION DELAY and AIM TIME, replacing the Factory Default Values.

All these user custom values will be applied after a startup, a camera reset or a power cycle.

In case of CUSTOM SENSOR REGISTER[x], the desired image sensor register (identified with its address) will be set at the desired value. If address is set to 0x0000 no register will be modified (see [Table 8 on page 25](#) for details).



Unpredictable camera behavior may occur:

Modifying registers using CUSTOM SENSOR REGISTER[x] 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.

To roll back the memory to factory default values (losing all 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 150 bytes (command codes + command parameters). NAK response is issued by the camera if limits are not respected. LSB first standard is used.

The commands that can be inserted in a list are:

AIM ENABLE
CAMERA START
ILLUMINATION ENABLE
SET SENSOR REG
CAMERA MODE

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.

“**Command<x>**” is the normal byte sequence of the desired command;

Example: (0x46)(0x02)(0x09) (0x02)(0x39)(0x01)
(0x05)(0x30)(0x12)(0x30)(0x54)(0x01)(<CRC BYTE>)

Will store in list number 2 the sequence: “enable illumination” and “set sensor register address R0x3012 with value 0x0154”.



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.

SET LOW POWER (0x3F)

Instantly activates/deactivates system power saving mode, toggling the scan engine between Idle and Low Power mode. This command can only be used when the camera is NOT in Running mode, since it puts both the microcontroller 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 unless AUTO LOW POWER is enabled.

SET SENSOR REG (0x30)

Stores the newly chosen value for the desired register of the On Semiconductors image sensor. Further details can be found on the sensor manual. Parameters are: 2bytes register address followed by 2bytes register value; LSB first standard is used, both for address and value.



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 DE2x12 engine is based on the AR0134 monochrome image sensor.

Figure 15 and Figure 16 below show the pixel array description and the spatial illustration of image readout.

Figure 15. Pixel array description

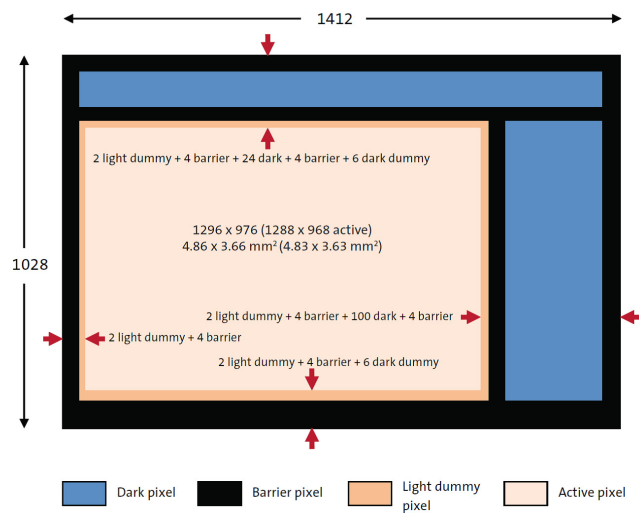
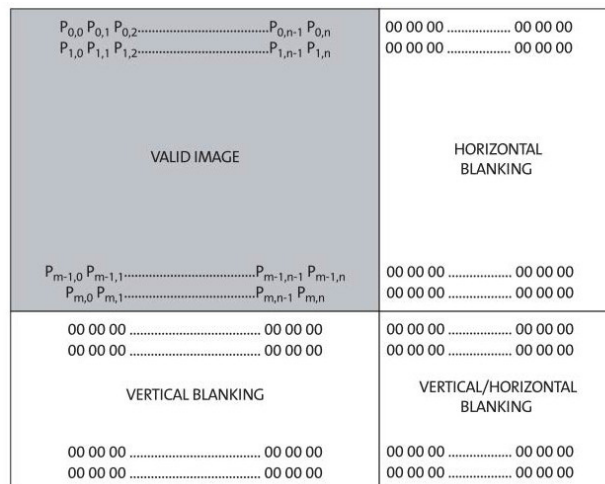


Figure 16. Spatial illustration of image readout characterizing the progressive scan mode



Parallel Output Data Timing

In the parallel version, the data output of the sensor is synchronized with the PIXCLK output. When LINE_VALID (LV) is HIGH, one 8-bit pixel datum is output every PIX- CLK period. Figure 17 shows an example of pixel data timing, and Figure 18 shows basic timing for a complete frame readout.

Pixel 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=60°C.

Figure 17. Timing example of pixel data

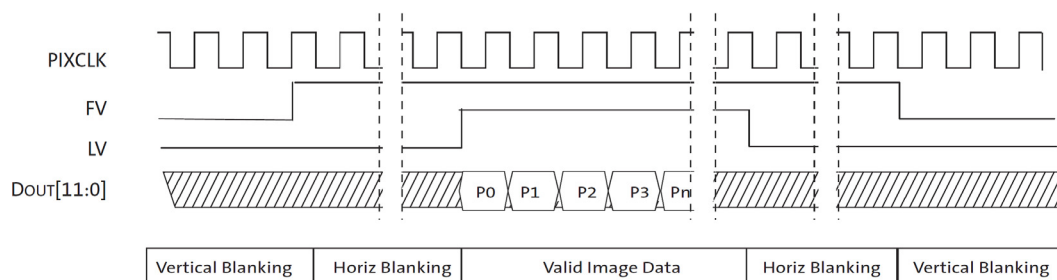


Figure 18. Row Timing and FRAME_VALID/LINE_VALID Signals

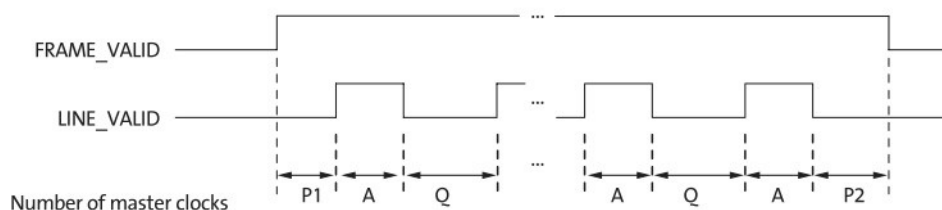


Table 11. Description of the parameters determining the frame time.

Example Based on a 1280x960 frame, 74 MHz pixel clock, 54 frames per second.

Parameter	Name	Equation	Pixel Clock Number	Timing at 74 MHz
A	Active data time	Sensor register defined	1,280	17.28us
P1	Frame start blanking	2782 (fixed)	2,782	37.59us
P2	Frame end blanking	2782 (fixed)	2,782	37.59us
Q	Horizontal blanking	Sensor register defined	108 pixel clocks	1.46us
A+Q	Row time	A+Q	1,388	18.76us
V	Vertical blanking	Sensor register defined	37,572	507.73us
FV	Frame valid time	Sensor register defined	1,332,480	18.01ms
F	Total frame time	V+FV	1,370,052	18.52 ms

MIPI-CSI2 Timing Parameters

In the MIPI-CSI2 interface version, the data output of the sensor is serialized and sent via 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 296 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=60°C.

Table 12. MIPI CSI2 Timing

MIPI Parameter	Description	Typical Value
HS-CLK	High Speed transmission Clock frequency.	296 MHz
TCLK-POST	Time that High Speed Clock continues after all Data Lanes are in Low Power.	174 ns
TCLK-PRE	Time that High Speed Clock is driven before any Data Lane switch from Low Power to High Speed.	16 ns
TCLK-PREPARE	Time for data Lane signals both driven to Low Power 0 (LP-00) before entering HS mode (HS-0).	53 ns
TCLK-TRAIL	Time that Clock HS-0 state is driven after the last Clock transition of a High Speed burst.	73 ns
TCLK-PREPARE + TCLK-ZERO	TCLK-PREPARE + time that the transmitter drives the HS-0 state prior to starting the High Speed Clock.	335 ns
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.	53 ns
THS-PREPARE+THS-ZERO	THS-PREPARE + time that the transmitter drives the HS-0 state prior to transmitting the High Speed Data packet.	175 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.	82 ns
TLP-01	Transmitted length of any Low-Power LP-01 state period.	68 ns
THS-EXIT (Clock)	Time that of the Clock LP-11 state following a HS burst (varies if sensor Horizontal Blanking is modified).	377 ns

Sensor Registers Settings

For information on register settings, refer to the On Semiconductor AR0134 mono-chrome 1.2Mp Image Sensor documentation, 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 19 and Figure 20).

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

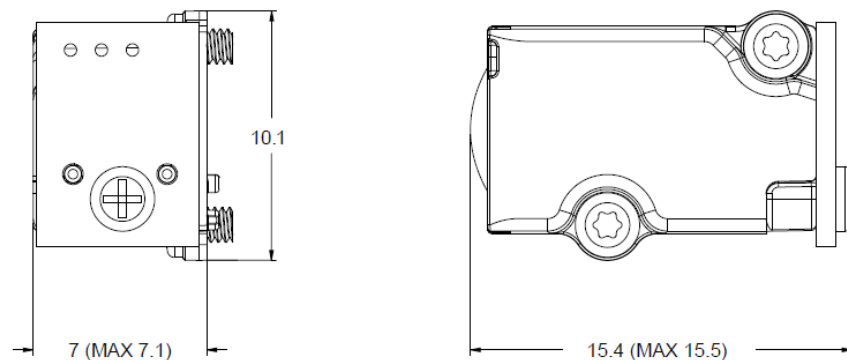
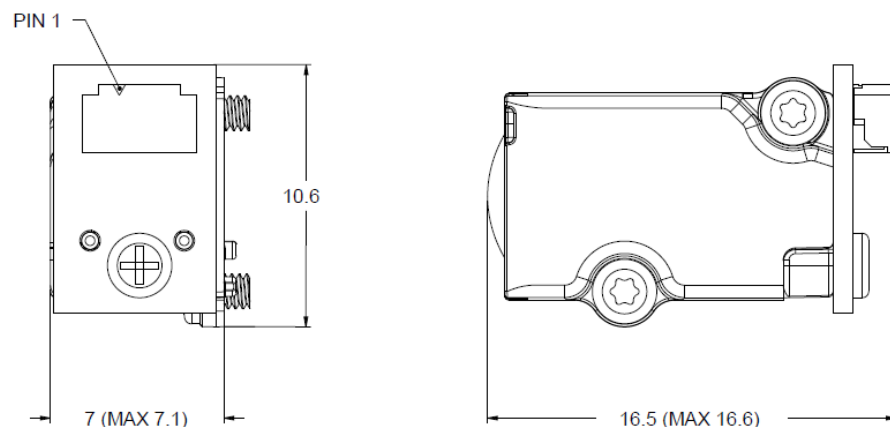


Figure 20. Green spot with connector (back and side view)



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 21 and Figure 22).

Figure 21. Maximum depth including green spot with soldering holes

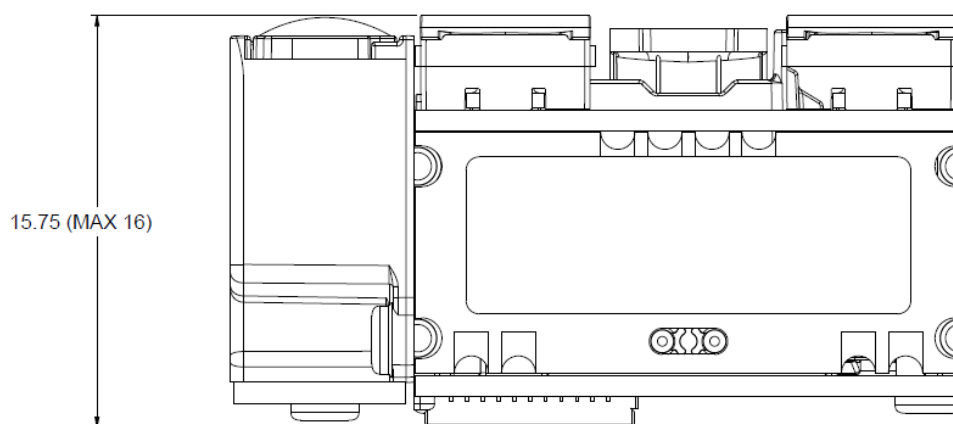
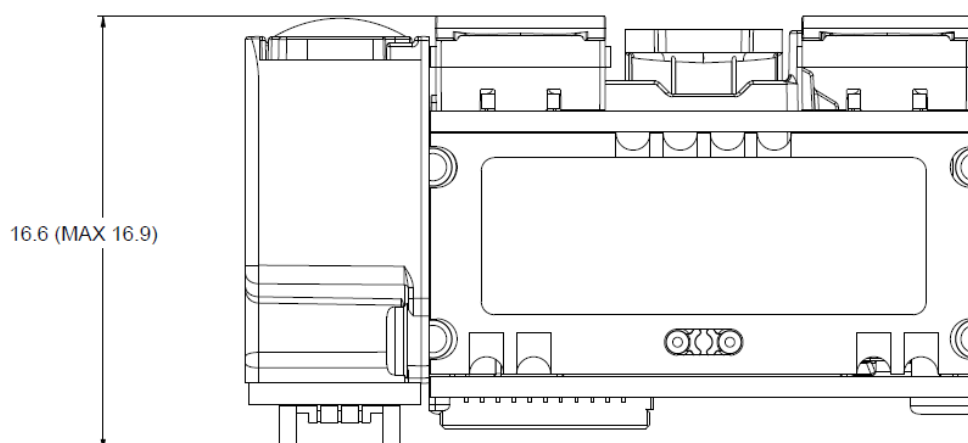


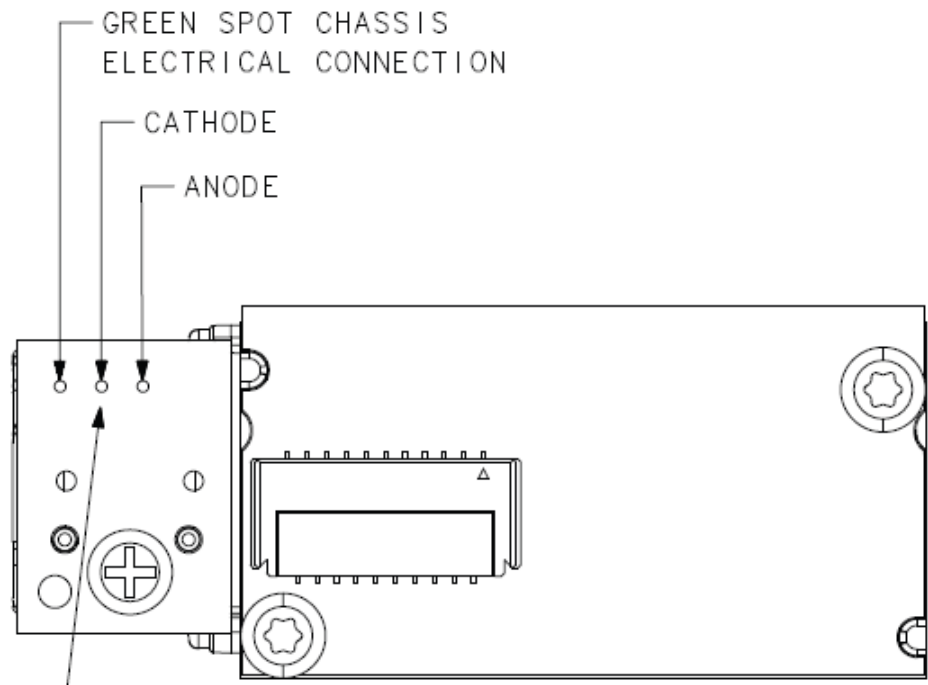
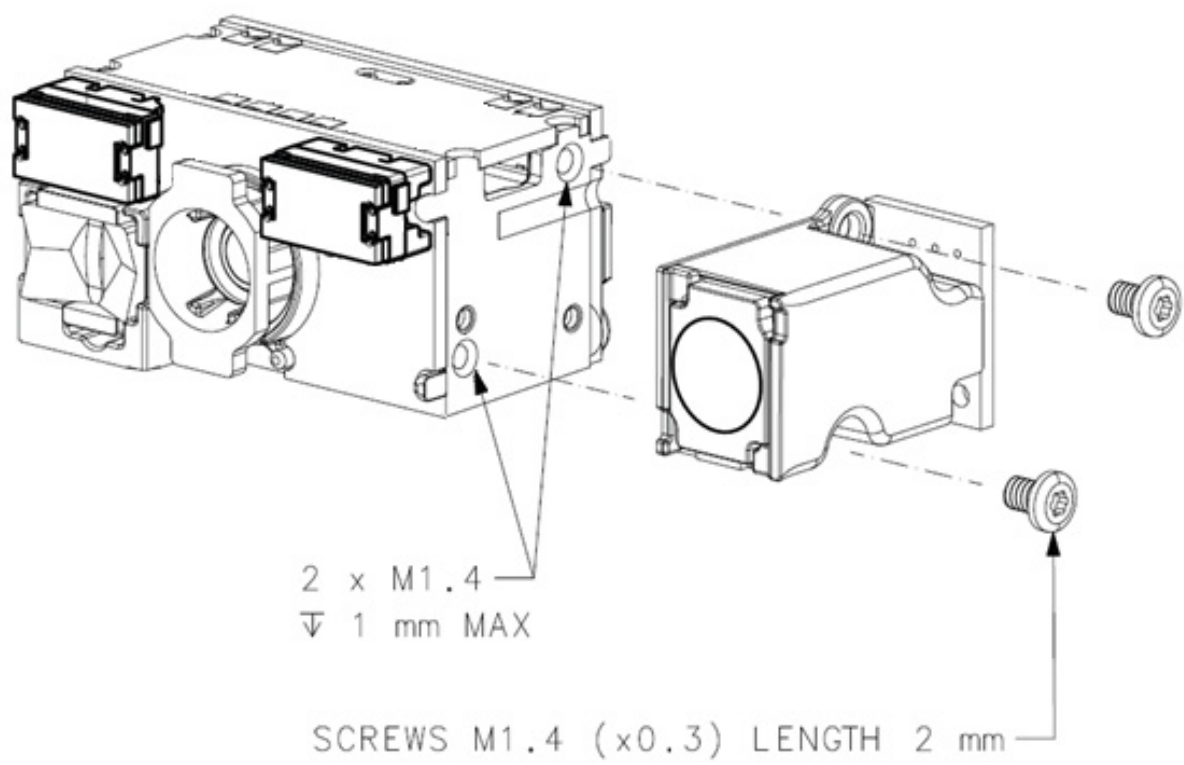
Figure 22. Maximum depth including green spot with connector



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.

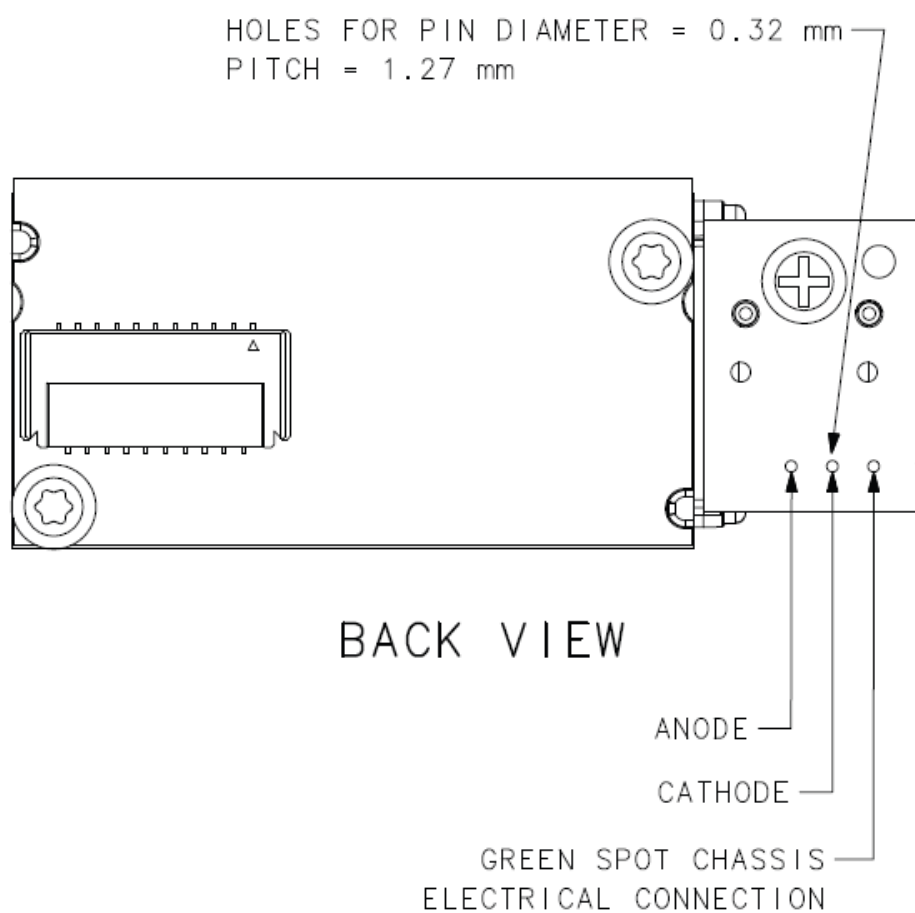
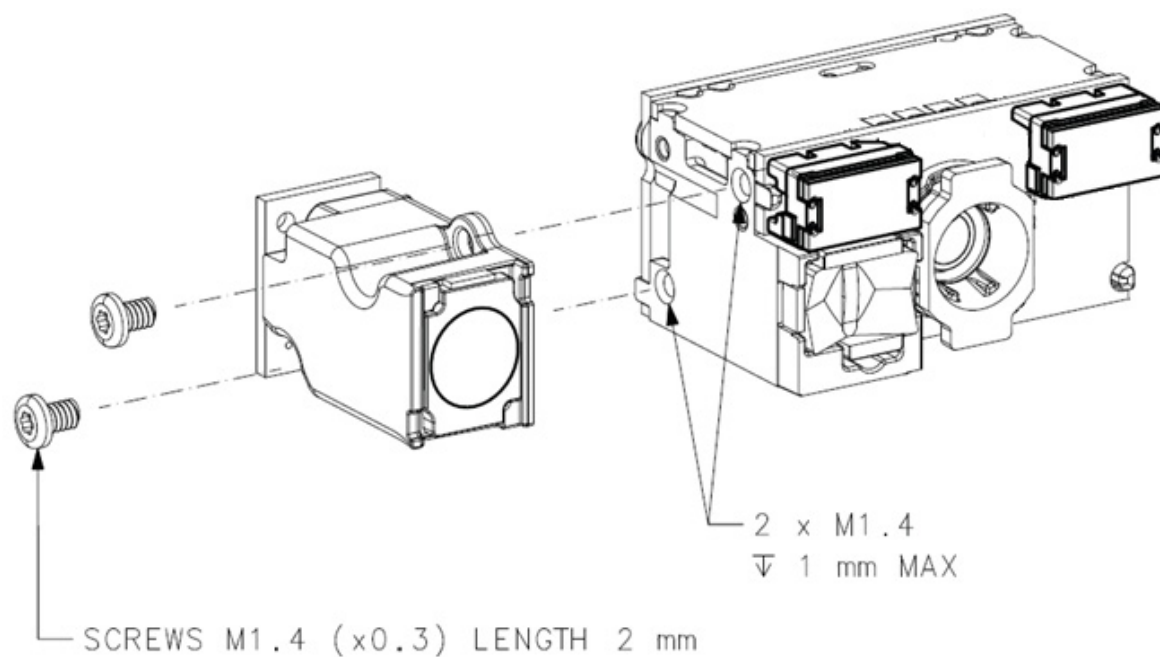
In the following all the drawings refer to the model with soldering holes, but mechanical interface is the same also for connector version.

Green Spot Projector - Left side mounting



BACK VIEW

Green Spot Projector - Right side mounting



Green Spot Projector – Electrical Interface

Anode Pin (connector PIN 1):

Provide power supply of 5V; a minimum of 2,2 μ F (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).

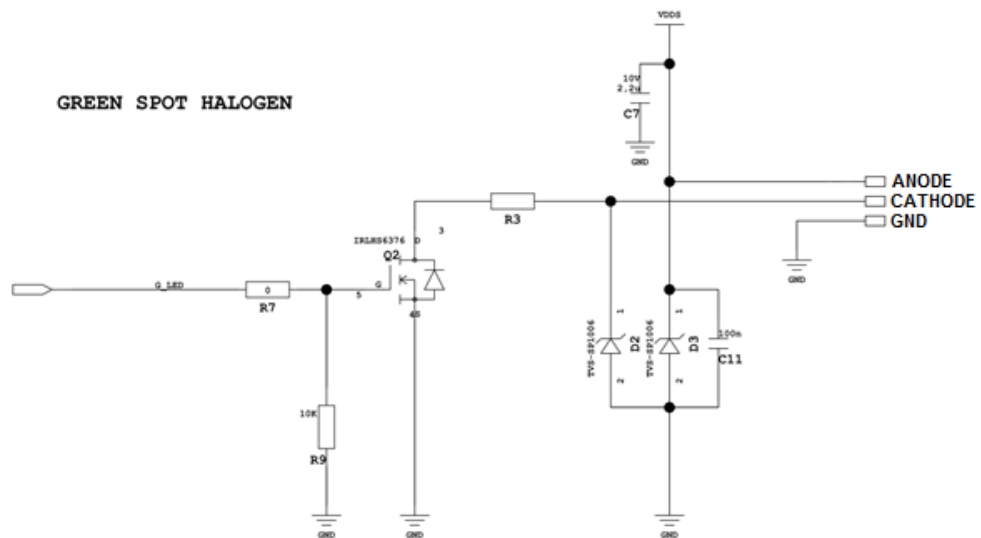
Electrical Characteristics

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 μ s, D = 0.1, TA=25°C	IFM	100	mA
Reverse voltage (TS = 25 °C)	VR	5	V
Wavelength at peak emission IF = 20 mA	λ_{peak}	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	μ A

Typical electrical driver

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.





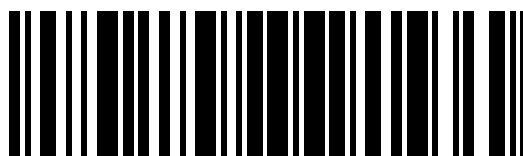
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