DATALOGIC

DE2011-DL

Bar Code Scan Engine

Integration Guide

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Disclaimer

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Patents

This product is covered by one or more of the following patents:

Utility Patents: EP0996284B1; EP0999514B1; EP1128315B1; EP1172756B1; EP1396811B1; EP1413971B1; EP1804089B1; EP1828957B1; JP4435343B2; JP5192390B2; US6478224; US6512218; US6808114; US6877664; US6997385; US7053954; US7234641; US7387246; US8113430; ZL200680050007.8.

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Chapter 1
Introduction

About this Manual

This Integration Guide is provided to give instruction, opto-mechanical details, and design considerations to integrate the 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.

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

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 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

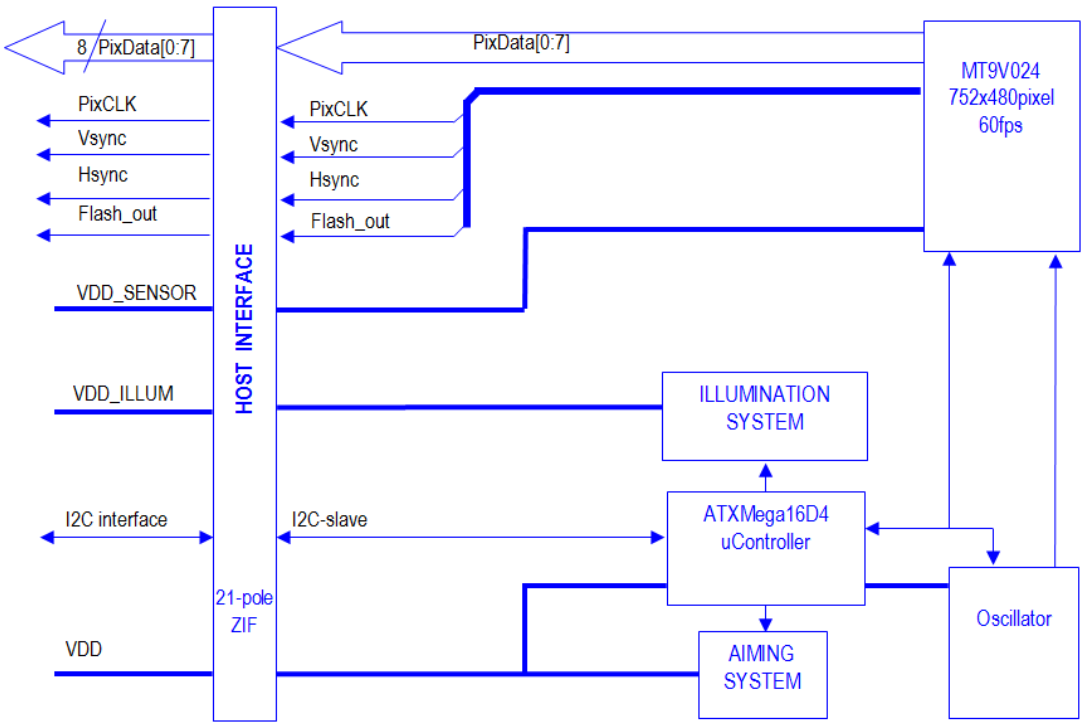
The engine has an exposed illumination system and aiming lenses on the outer surfaces. Take care of these optical components, preserving the lenses from mechanical stresses that can damage them. Avoid touching the optical surfaces to preserve the optical performance.

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. 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)

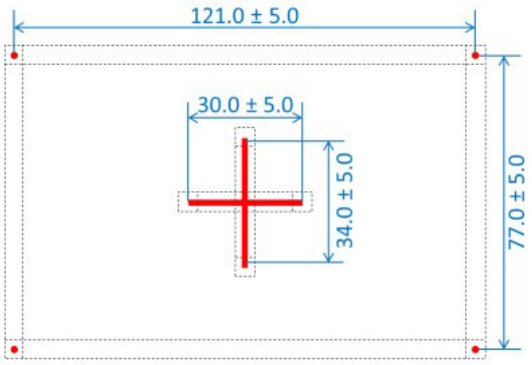
Aiming System

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

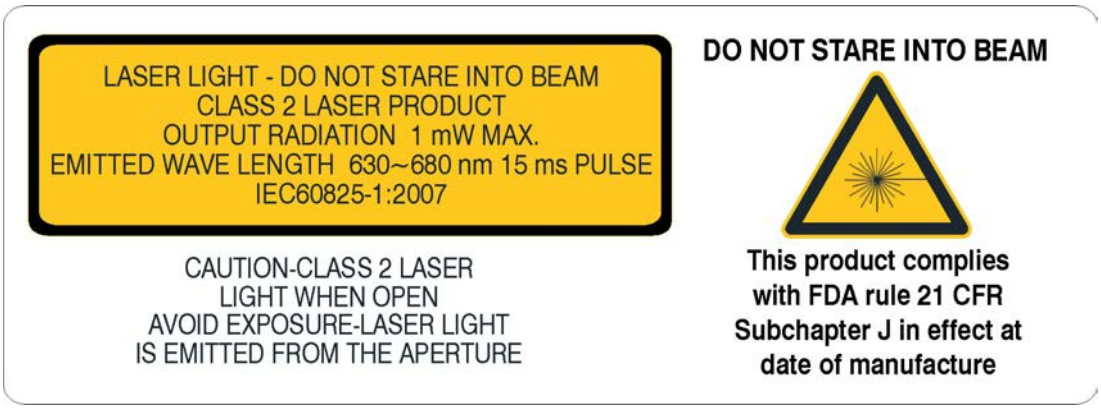
Wavelength	630-680 nm
Beam Divergence	35° (horizontal) x 25° (vertical) – see Figure 8 on page 11 and Figure 9 on page 11
Maximum pulse duration	15ms
Repetition rate	16.6ms
Maximum output power	1mW
Laser aperture	See Figure 10 on page 12

Regulatory

- EN/IEC 60825–1:2007 (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).

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Chapter 2 Installation

This section describes how to design the mounting for optimum scan engine performance.

Mounting the Scan Engine

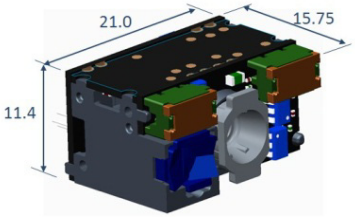
General Considerations

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 11.4mm (height) x 15.75mm (depth)

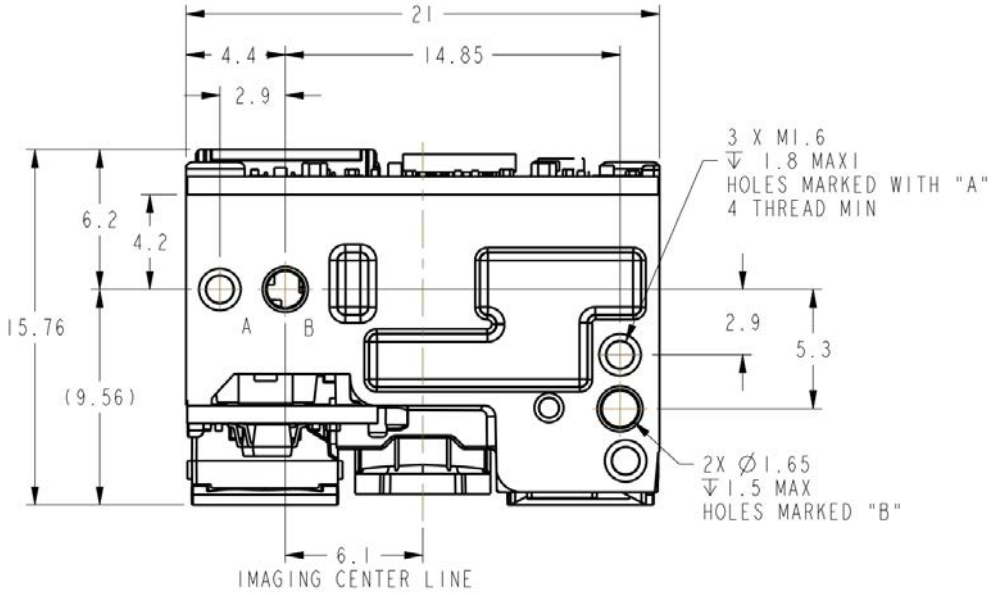
Maximum size:

21.15mm (width) x 11.55mm (height) x 15.91mm (depth)

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 5. 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

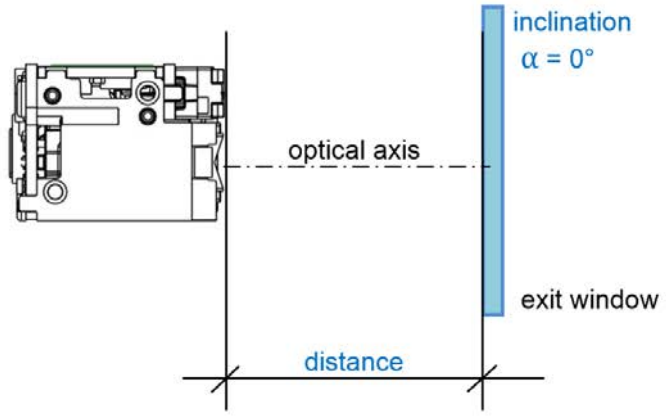
There are two options for positioning the exit window with respect to the engine optical axis:

- 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.

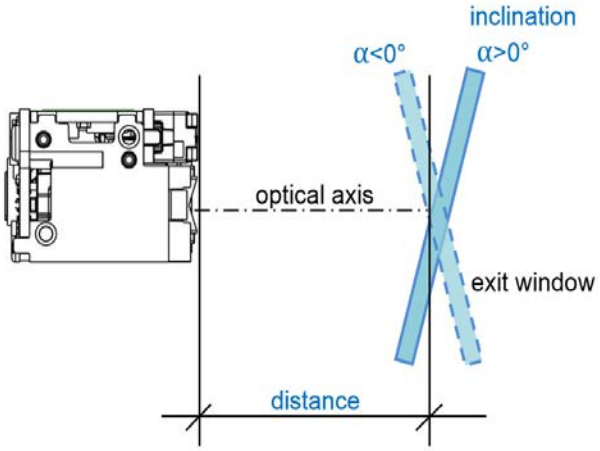
The use of a double-sided AR coated exit window is strongly recommended both for perpendicular and tilted windows.

Figure 6. Exit window positioning – perpendicular window



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

Figure 7. 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 1 on the following page.

Table 1. Exit window materials

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

Exit window properties

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

Table 2. Exit Window Properties

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

Optical paths and exit window clearance

Figure 8 and Figure 9 show the optical paths for the imaging system, the aiming system and the illumination system.

Figure 8. Top view - Aiming, imaging and illumination optical paths

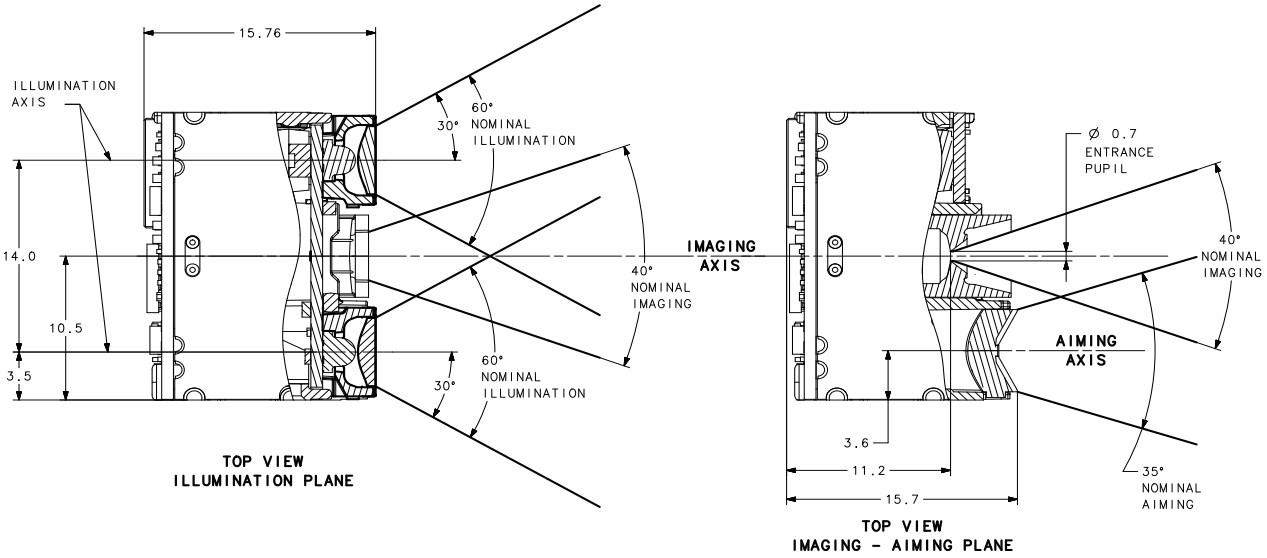


Figure 9. Side View - Aiming, imaging and illumination optical paths

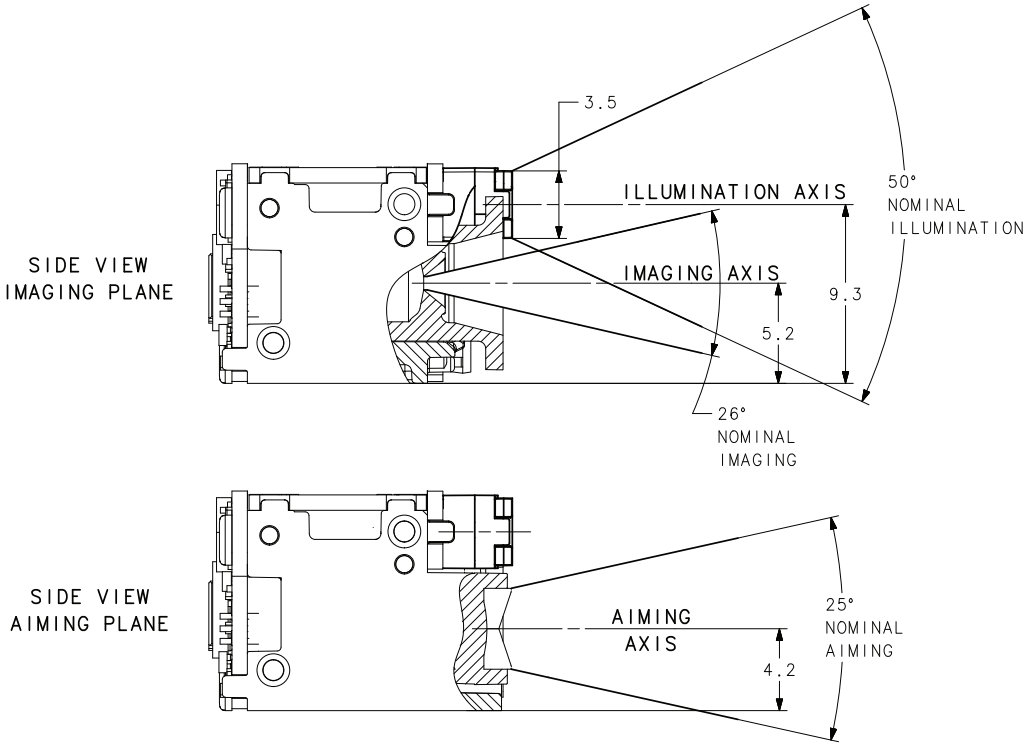
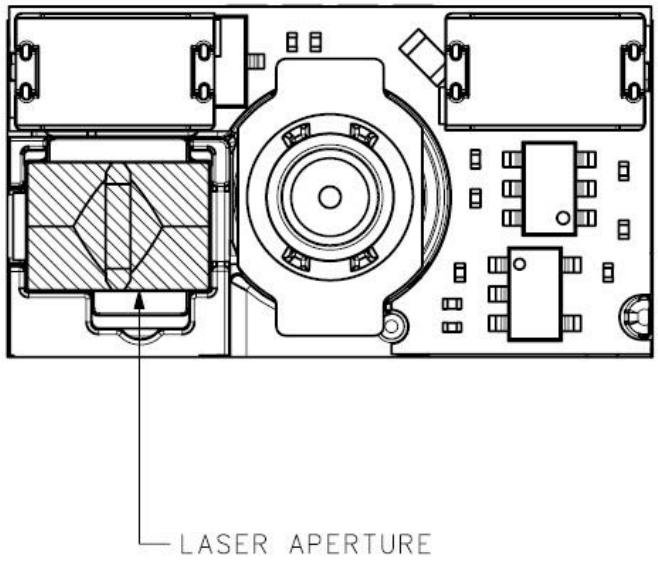


Figure 10. Front View - Laser aperture



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
1	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

The DE2011-DL scan engine is equipped with a Kyocera 21-pole ZIF 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, available at http://www.kyocera-connector.com/prdct/type/fpc/index.html#2

Powerup sequence

In order 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.

Engine latency at powerup

At powerup the engine begins executing the code when the 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).

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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 19 or Table 5 on page 19.

I²C Element	Description
Command Parameters:	Data bytes required by the command, shown in Table 5 on page 19.
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 I²C 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:	
Response Data:	Data returned by the issued command (can be one or multiple bytes or none), LSB first. See Table 5 on page 19.

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 17.

For more information on the commands, see "I2C Command Specifications" on page 30.

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=Full System Reset	
[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 run (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 TOGGLE	Switches the aiming system ON/OFF.	**1 Byte:** 00=Off 01=On	

‡ **See Table 6 on page 23 and Table 7 on page 24 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 can 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.	
[0x39]	ILLUMINATION ENABLE	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 0x01-0x0C = illumination time set to *value**50us. (per Frame)	
IMAGE SENSOR				
[0x30]	SET SENSOR REG	Writes new value to the Aptina MT9V024 desired register.	**1 Byte:** Register address + **2 Bytes:** Register new value	
[0x31]	GET SENSOR REG	Gets Aptina 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 23 and Table 7 on page 24 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 24 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	0x07D4	8
Camera ID	Camera ID number	0x07D5	1
Hardware Version	Camera hardware version	0x07D6	1
Device Class	Camera device class	0x07D7	18
GUID	Generally Unique ID	0x000E	32
Family ID	Halogen1 Family ID	0x03F7	8
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	Length (Bytes)	FACTORY VALUE
Illumination Duration	Customizable default/startup value for the illumination pulse time (per frame) **1 Byte**: 0x00–0x0C = illumination time set to value*50us.	0x00B7	1	600us (0x0C)
Illumination Delay	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 Duration	Customizable default/startup value for the AIM pattern "on" time (per frame) **2 Bytes:** value in us	0x00B9	2	8500us (0x2134)
Aim Delay	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 Aptina 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..

Tthe 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 0.83”/21.15 mm Height 0.45”/11.55 mm Depth 0.63”/15.91 mm
Weight	9 g / 0.32 ounces
Interface	Camera port on a 21 pin ZIF Connector
Electrical Characteristics See "Power Consumption Details" on page 28 for more information.	
Current	Max. Operating: < 200mA Standard Operation: 160mA Idle (Typical): 21mA Low power: <0.2mA
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
Light Source	Illumination: White LEDs Aiming: 650nm VLD

Item	Description
Field of View	40° Hx26° V
Print Contrast Minimum	25% minimum contrast
Scanning Angles See Definition of Scanning Angles on page 27 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	(1)[b]	200	(1)[b]	180
EAN13	13	45	420	50	380
Datamatrix	15	35	265	45	245
Code 39	20	(1)[b]	590	(1)[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

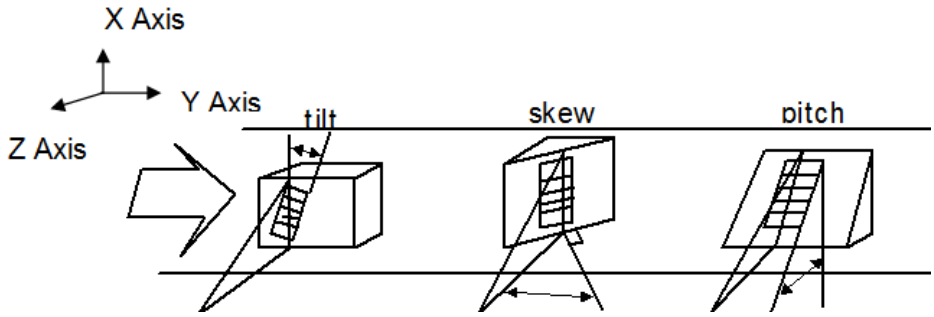
Item	Description
User Environment	
Operating Temperature	Operating : -30 to 50°C / -22 to 131°F
Storage Temperature	Storage / Transport : -40 to 70°C / -40 to 158°F
Humidity (non-condensing)	95%
Mechanical Shock	2000 G ± 5% applied via any mounting surface at -30° and 70° C for a period of 0.85 ± 0.05 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	±2.0kV @ connector

Item	Description
Regulatory	
Aiming System (laser)	EN/IEC 60825-1:2007 (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 11. ISO15423 angle definition



Reading distances are measured along Z-axis.

Power Consumption Details

While operating, the engine switches between different status conditions. Each status 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 8. Mean power consumption upper limits

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

Appendix B
I²C Command Specifications

This section provides additional information about I²C Commands.

I2C COMMAND SPECIFICATIONS

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 17.

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 also determined by the user modifying the parameter AIM DURATION (see Table 7 on page 24)

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

AIM TOGGLE (0x35)

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 (0x41)

Stops executing the engine camera application and runs the engine bootloader. Takes as input the following signature code: 0xAA, 0x50, 0x5.

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 ON 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.

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 23, and Table 7 on page 24.

GET SENSOR REGISTER (0x31)

Returns the desired register value of the Aptina 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 PULSE DURATION

ILLUMINATION DELAY

AIM PULSE DURATION

AIM DELAY

SENSOR AEC MAX EXPOSURE

See Table 7 on page 24 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 PULSE DURATION

ILLUMINATION DELAY

AIM PULSE DURATION

AIM DELAY

SENSOR AEC MAX EXPOSURE

See Table 7 on page 24 for details.

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

SET COMMAND 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.

Possible commands for the list are:

AIM TOGGLE

CAMERA START

ILLUMINATION ENABLE

SET SENSOR REG

Command format:

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

Where "command x" is the normal byte sequence of the desired command.

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 Aptina 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 12 and Figure 13 below show the pixel array description and the spatial illustration of image readout.

Figure 12. Pixel array description

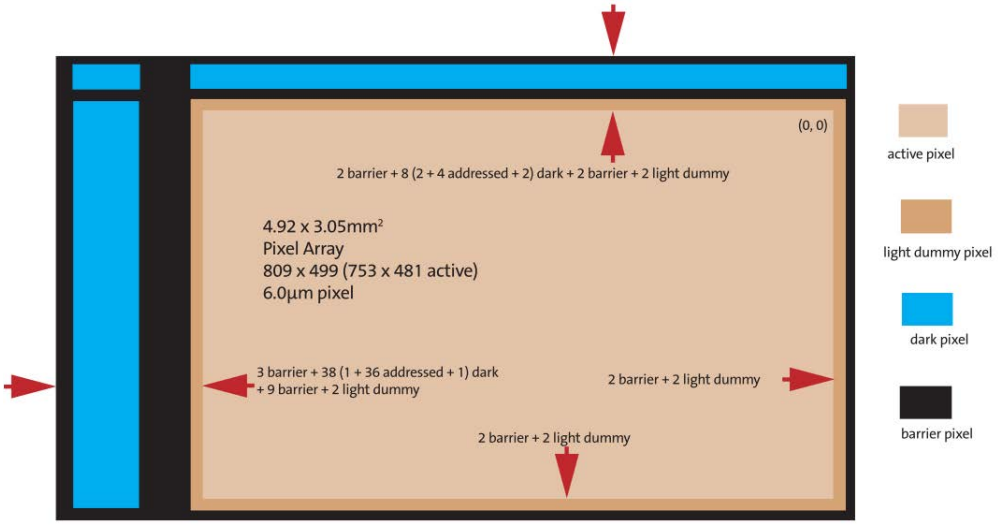
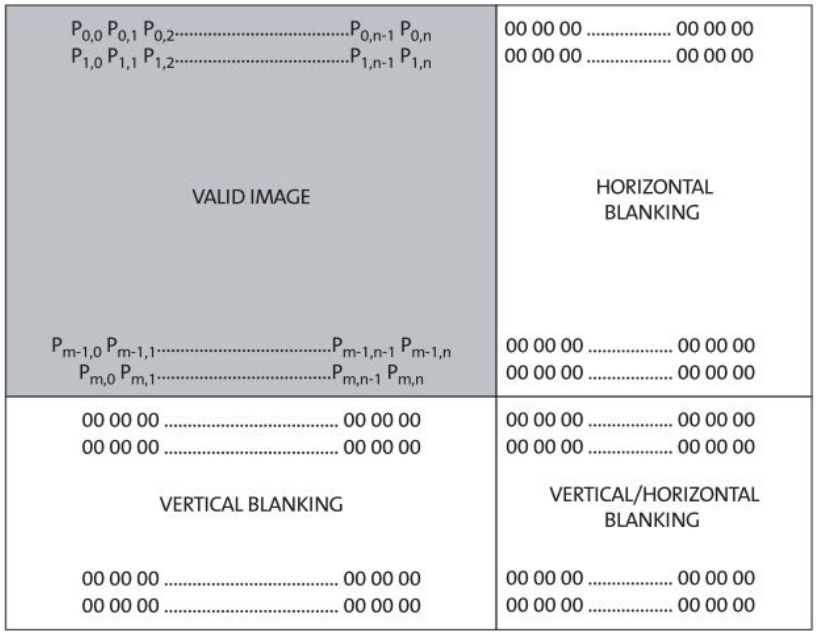


Figure 13. Spatial illustration of image readout characterizing the progressive scan mode



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 PIX-CLK period. Figure 14 shows an example of pixel data timing, and Figure 15 shows basic timing for a complete frame readout.

Figure 14. Timing example of pixel data

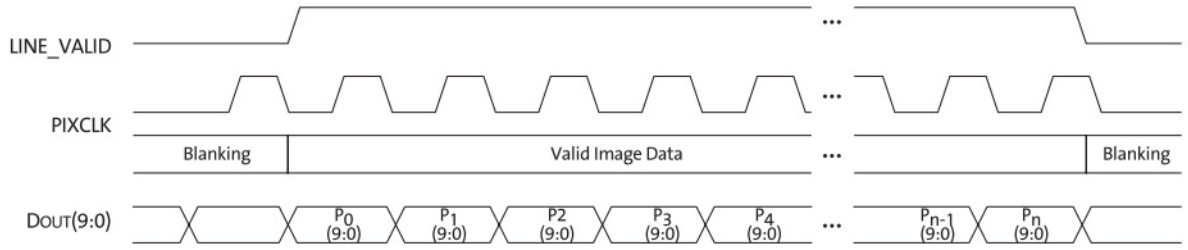
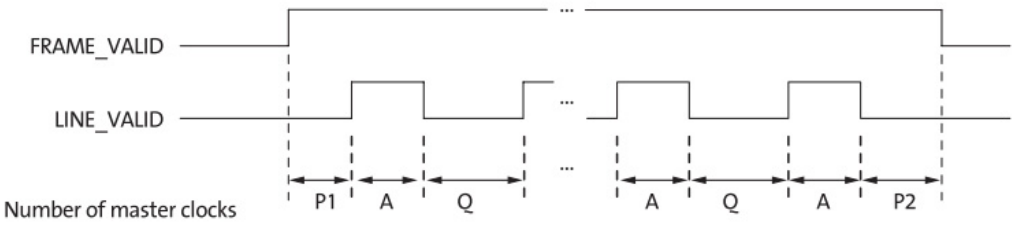


Figure 15. Row Timing and FRAME_VALID/LINE_VALID Signals



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 Aptina MT9V024 mono-chrome WVGA Image Sensor Datasheet, available at http://www.aptina.com.

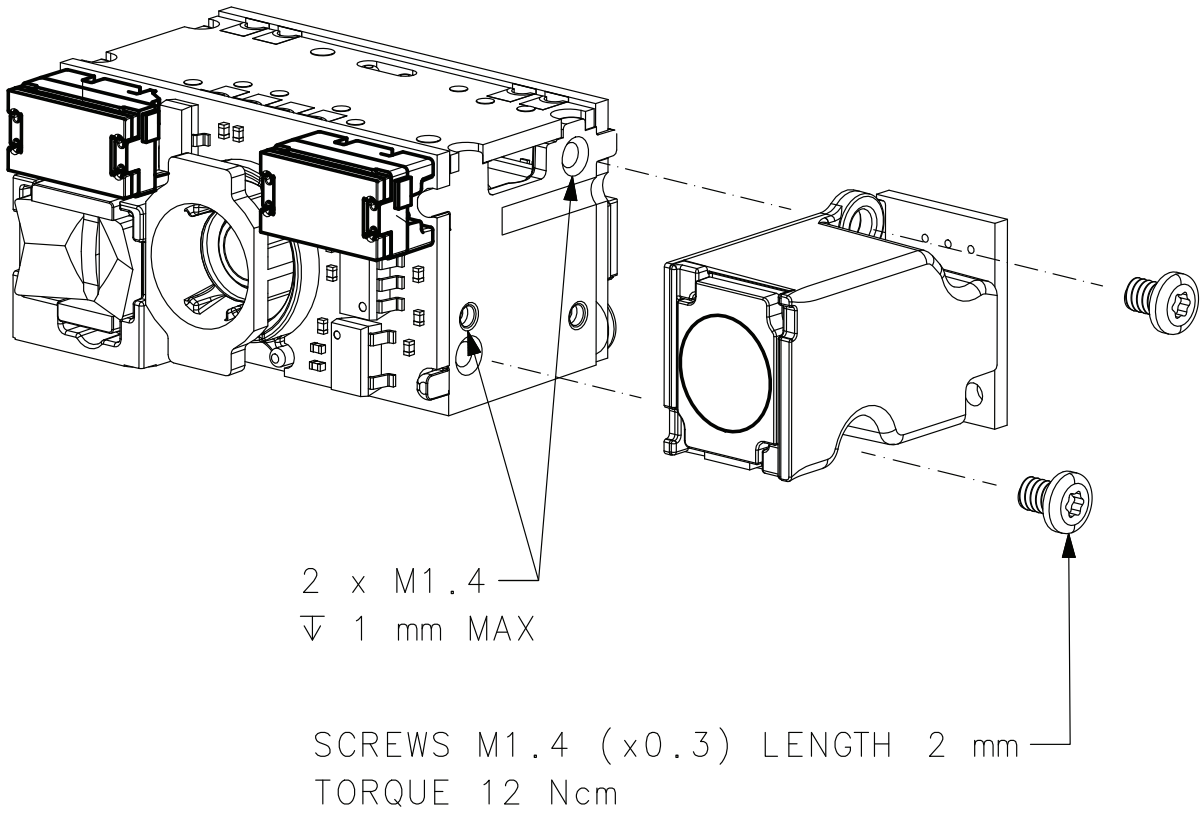
Appendix D
Accessories

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

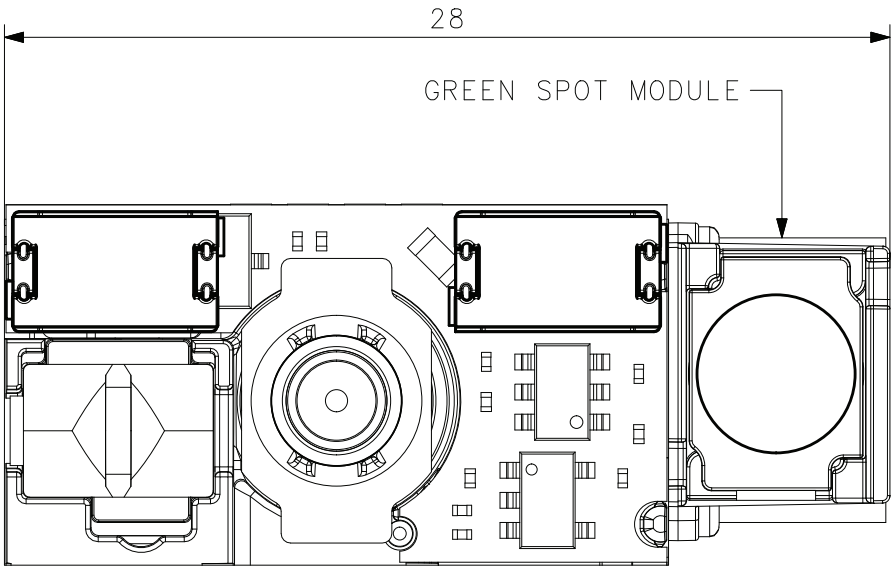
Green Spot Projector

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.

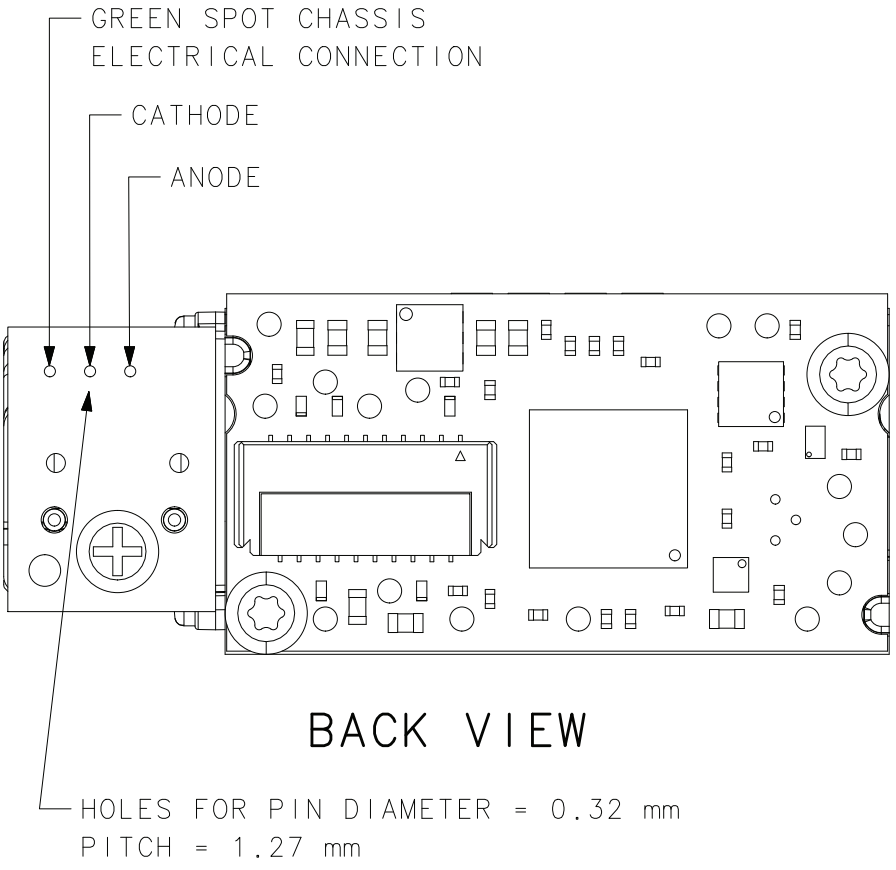
Green Spot Projector - Left side mounting



Left side mounting (continued)

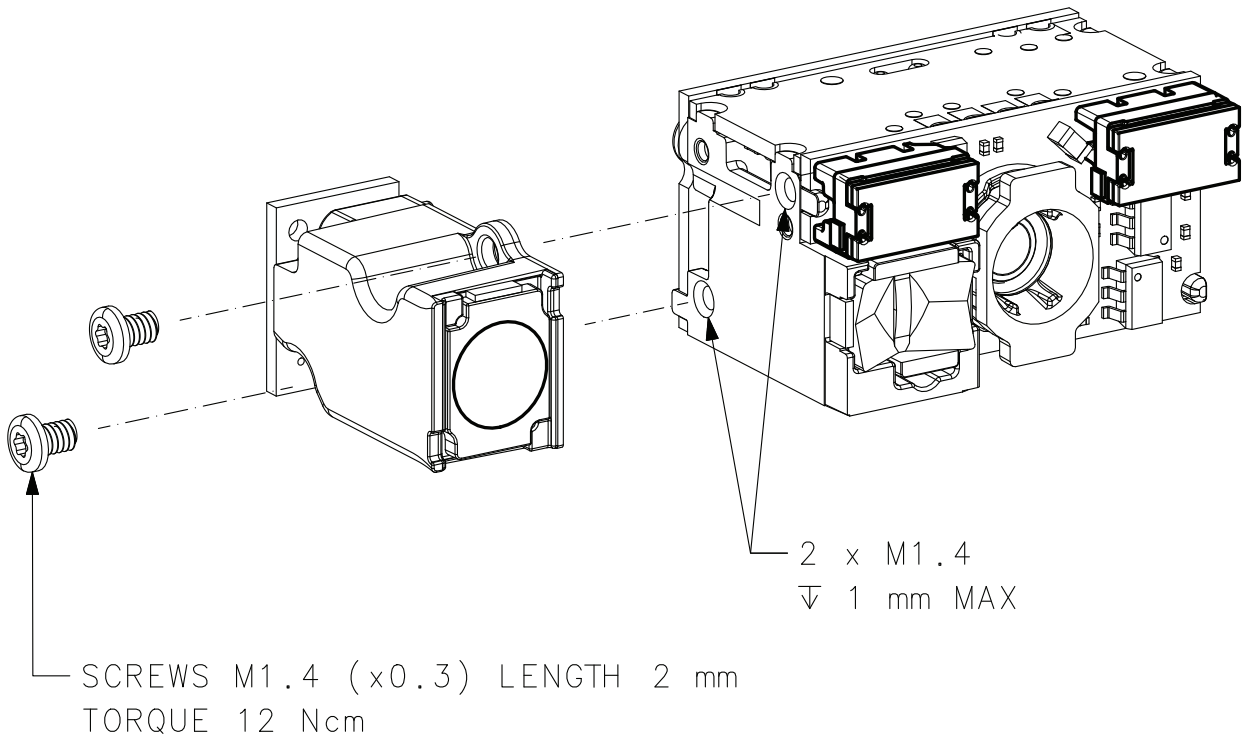


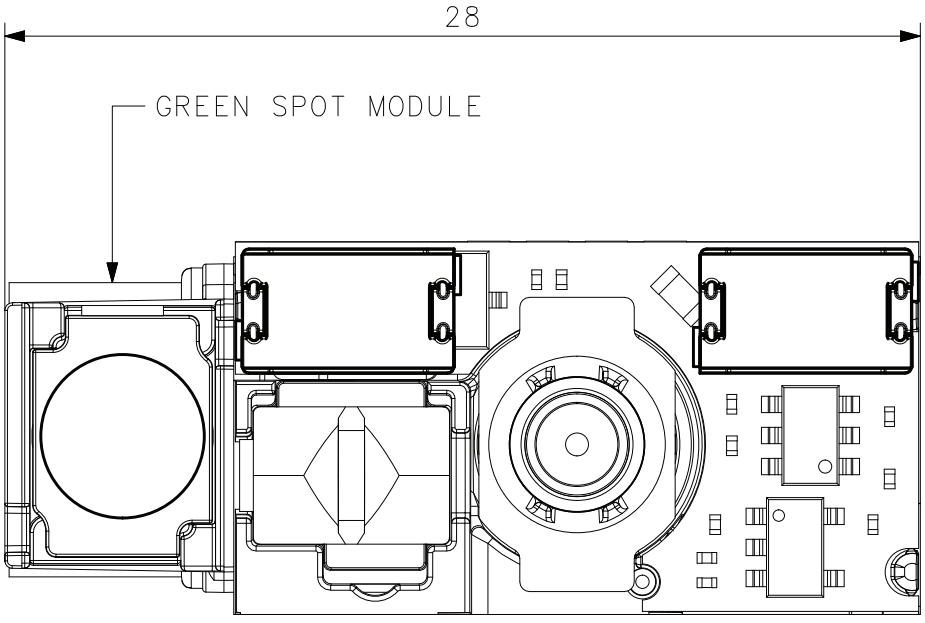
FRONT VIEW



BACK VIEW

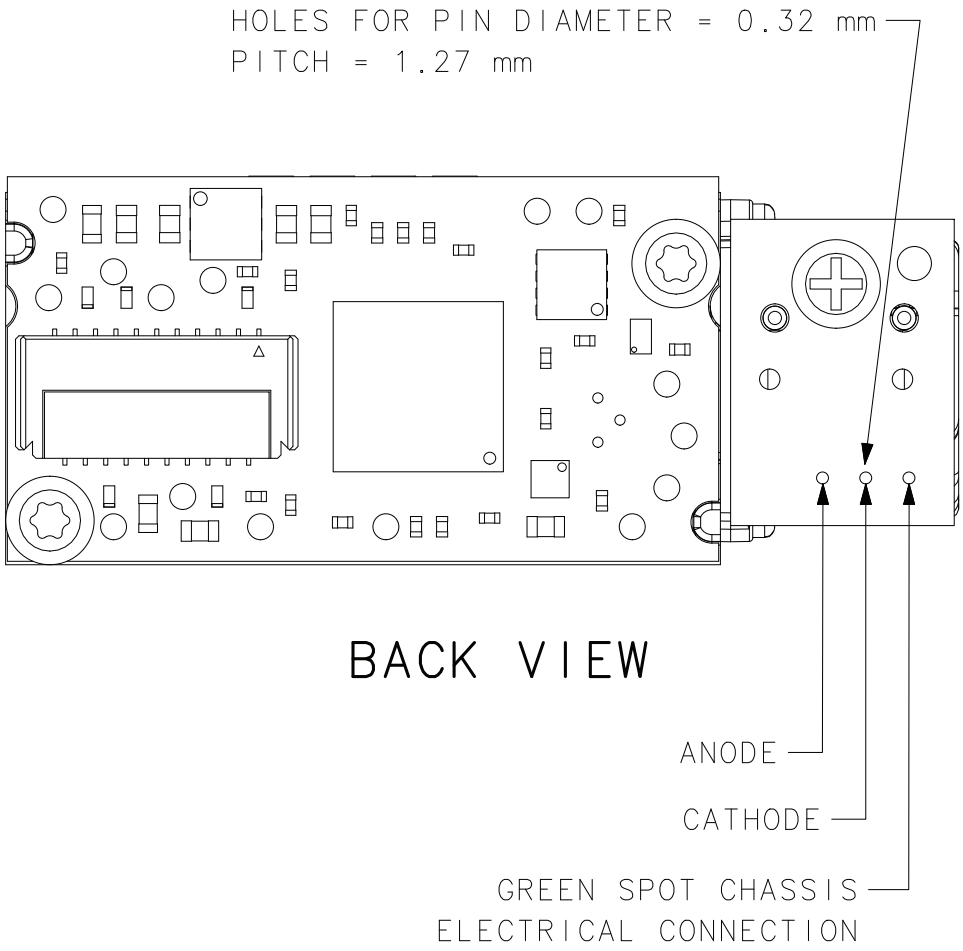
Green Spot Projector - Right side mounting





FRONT VIEW

Right side mounting (continued)



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