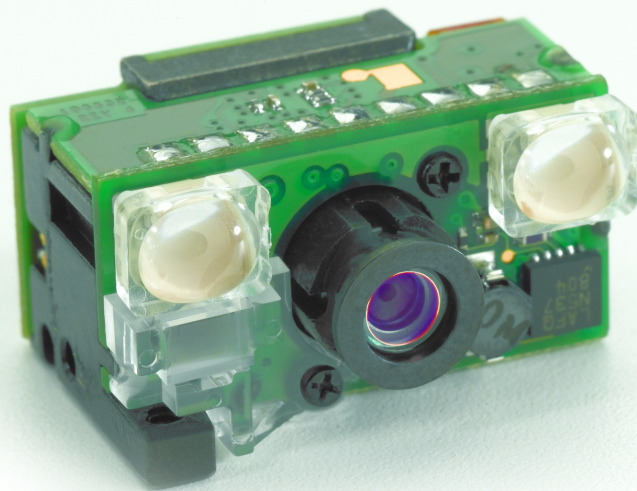




# Symbol SE4500

## Integration Guide





**Symbol SE4500**  
**Integration Guide**

72E-112996-02

Revision A

April 2010

© 2008-2010 by Motorola, Inc. All rights reserved.

No part of this publication may be reproduced or used in any form, or by any electrical or mechanical means, without permission in writing from Motorola. This includes electronic or mechanical means, such as photocopying, recording, or information storage and retrieval systems. The material in this manual is subject to change without notice.

The software is provided strictly on an “as is” basis. All software, including firmware, furnished to the user is on a licensed basis. Motorola grants to the user a non-transferable and non-exclusive license to use each software or firmware program delivered hereunder (licensed program). Except as noted below, such license may not be assigned, sublicensed, or otherwise transferred by the user without prior written consent of Motorola. No right to copy a licensed program in whole or in part is granted, except as permitted under copyright law. The user shall not modify, merge, or incorporate any form or portion of a licensed program with other program material, create a derivative work from a licensed program, or use a licensed program in a network without written permission from Motorola. The user agrees to maintain Motorola’s copyright notice on the licensed programs delivered hereunder, and to include the same on any authorized copies it makes, in whole or in part. The user agrees not to decompile, disassemble, decode, or reverse engineer any licensed program delivered to the user or any portion thereof.

Motorola reserves the right to make changes to any software or product to improve reliability, function, or design.

Motorola does not assume any product liability arising out of, or in connection with, the application or use of any product, circuit, or application described herein.

No license is granted, either expressly or by implication, estoppel, or otherwise under any Motorola, Inc., intellectual property rights. An implied license only exists for equipment, circuits, and subsystems contained in Motorola products.

MOTOROLA and the Stylized M Logo and Symbol and the Symbol logo are registered in the US Patent & Trademark Office. Bluetooth is a registered trademark of Bluetooth SIG. Microsoft, Windows and ActiveSync are either registered trademarks or trademarks of Microsoft Corporation. All other product or service names are the property of their respective owners.

Motorola, Inc.  
One Motorola Plaza  
Holtsville, New York 11742-1300  
<http://www.motorola.com/enterprisemobility>

---

## Warranty

For the complete Motorola hardware product warranty statement, go to:  
<http://www.motorola.com/enterprisemobility/warranty>.

---

## Revision History

Changes to the original manual are listed below:

| Change    | Date    | Description   |
|-----------|---------|---|
| -01 Rev A | 12/2008 | Initial Release   |
| -02 Rev A | 4/2010  | Removed patent information; updated laser compliance statement. |



# Table of Contents

## About This Guide

|                              |    |
|------------------------------|----|
| Introduction .....           | ix |
| Chapter Descriptions .....   | ix |
| Notational Conventions ..... | x  |
| Related Documents .....      | x  |
| Service Information .....    | xi |

## Chapter 1: Getting Started

|                            |     |
|----------------------------|-----|
| Introduction .....         | 1-1 |
| Symbol SE4500 .....        | 1-2 |
| Aiming System .....        | 1-3 |
| Aiming Error .....         | 1-3 |
| Aiming Control .....       | 1-3 |
| Illumination System .....  | 1-3 |
| Illumination Control ..... | 1-3 |
| Frame Rate Control .....   | 1-3 |

## Chapter 2: Installation

|  |     |
|--|-----|
| Introduction .....   | 2-1 |
| General Information .....                                      | 2-1 |
| Grounding .....  | 2-1 |
| Electrostatic Discharge (ESD) .....                            | 2-1 |
| Environment .....  | 2-1 |
| Power Supply Noise .....                                       | 2-1 |
| Thermal Considerations .....                                   | 2-2 |
| External Optics (LED Lenses and Pattern Forming Element) ..... | 2-2 |
| Image and Document Capture .....                               | 2-2 |
| Regulatory Information .....                                   | 2-2 |
| Mounting .....   | 2-3 |
| Housing Design .....   | 2-4 |
| Optical .....  | 2-4 |
| Positioning the Exit Window .....                              | 2-4 |

|   |     |
|---|-----|
| Avoiding Scratched Windows .....          | 2-4 |
| Window Material .....                     | 2-5 |
| Commercially Available Coatings .....     | 2-6 |
| A Word About Coatings .....               | 2-6 |
| Optical Path and Exit Window .....        | 2-7 |
| Recommended Exit Window Information ..... | 2-8 |
| Exit Window Notes .....                   | 2-8 |

### Chapter 3: Specifications

|                                |     |
|--------------------------------|-----|
| Introduction .....             | 3-1 |
| Technical Specifications ..... | 3-1 |
| Skew, Pitch, and Roll .....    | 3-3 |
| Decode Zones .....             | 3-4 |
| Symbol SE4500-SR .....         | 3-4 |
| Symbol SE4500-DL .....         | 3-6 |
| Symbol SE4500-HD .....         | 3-8 |

### Chapter 4: Electrical Interface

|                          |     |
|--------------------------|-----|
| Introduction .....       | 4-1 |
| Connector Drawings ..... | 4-2 |

### Chapter 5: Control Interface

|   |     |
|---|-----|
| Introduction .....                      | 5-1 |
| Command List .....                      | 5-1 |
| Transactions .....                      | 5-3 |
| I2C Command Format .....                | 5-3 |
| I2C Response Format .....               | 5-3 |
| Command Checksum .....                  | 5-4 |
| Response Status Code .....              | 5-4 |
| Command Descriptions .....              | 5-5 |
| ACQUISITION 0x58 .....                  | 5-5 |
| ACQUISITION_MODE 0x5B .....             | 5-5 |
| AIM 0x55 .....                          | 5-5 |
| AIM_BLINK_RATE 0xF4 .....               | 5-5 |
| AIM_DURING_EXPOSURE 0x56 .....          | 5-5 |
| AIM_POWER 0xF3 .....                    | 5-6 |
| AUTO_POWER_REDUCTION 0x74 .....         | 5-6 |
| EXECUTE_SCRIPT 0x77 .....               | 5-6 |
| EXTERNAL_ILLUMINATION 0x5A .....        | 5-6 |
| FRAME_RATE 0x5E .....                   | 5-6 |
| GET_EXTENDED_STATUS 0x79 .....          | 5-6 |
| GET_PARAM 0x70 .....                    | 5-7 |
| ILLUMINATION_CURRENT_LIMIT 0xF2 .....   | 5-7 |
| ILLUMINATION_DURING_EXPOSURE 0x59 ..... | 5-7 |
| ILLUMINATION_POWER_LEVEL 0xF0 .....     | 5-7 |
| IMAGE_CAPTURE_MODE 0x73 .....           | 5-7 |
| IMAGE_CROPPING 0x5D .....               | 5-7 |



|                                    |      |
|------------------------------------|------|
| IMAGE_RESOLUTION 0x5C .....        | 5-8  |
| PICKLIST_MODE 0x7B .....           | 5-8  |
| PING 0x7A .....                    | 5-8  |
| POWER_MODE 0x5F .....              | 5-8  |
| RD_OSC 0x53 .....                  | 5-9  |
| RD_SENSOR 0x51 .....               | 5-9  |
| RESET 0x57 .....                   | 5-9  |
| THERMAL_MANAGEMENT_MODE 0x80 ..... | 5-9  |
| TIME_TO_LOW_POWER 0x75 .....       | 5-9  |
| WR_OSC 0x52 .....                  | 5-9  |
| WR_SCRIPT 0x76 .....               | 5-10 |
| WR_SENSOR 0x50 .....               | 5-10 |
| Command / Response Formats .....   | 5-11 |

## Chapter 6: Application Notes

|                              |      |
|------------------------------|------|
| Introduction .....           | 6-1  |
| Image Acquisition .....      | 6-1  |
| Output Data Format .....     | 6-2  |
| Output Data Timing .....     | 6-2  |
| Recommended Procedures ..... | 6-4  |
| Normal Decode Mode .....     | 6-4  |
| Snapshot Mode .....          | 6-9  |
| Video Mode .....             | 6-10 |
| Recommendations .....        | 6-10 |
| Power Mode .....             | 6-10 |
| Scripts .....                | 6-10 |

## Appendix A: Register Settings

## Index

## Tell Us What You Think...



# About This Guide

---

## Introduction

The *Symbol SE4500 Integration Guide* discusses the theory of operation, installation, and specifications of the engine, and how to integrate the engine into data capture devices.



**NOTE** This guide provides general instructions for the installation of the engine into a customer's device. Motorola recommends that an opto-mechanical engineer perform an opto-mechanical analysis prior to integration.

---

## Chapter Descriptions

This guide includes the following topics:

- [Chapter 1, Getting Started](#) provides an overview of the engine and the theory of operation.
- [Chapter 2, Installation](#) explains how to install the engine, including information on mounting, housing design, optical, grounding, ESD, and environmental considerations.
- [Chapter 3, Specifications](#) provides technical specifications for the engine, including decode ranges.
- [Chapter 4, Electrical Interface](#) includes signal information and connector drawings.
- [Chapter 5, Control Interface](#) describes the Symbol SE4500's bi-directional control interface.
- [Chapter 6, Application Notes](#) describes Symbol SE4500 operating modes.
- [Appendix A, Register Settings](#) provides information on register settings for the engine.

---

## Notational Conventions

This document uses the following conventions:

- *Italics* are used to highlight chapters and sections in this and related documents
- bullets (•) indicate:
  - Action items
  - Lists of alternatives
  - Lists of required steps that are not necessarily sequential
- Sequential lists (e.g., those that describe step-by-step procedures) appear as numbered lists.



**NOTE** This symbol indicates something of special interest or importance to the reader. Failure to read the note will not result in physical harm to the reader, equipment or data.



**CAUTION** This symbol indicates that if this information is ignored, the possibility of data or material damage may occur.



**WARNING!** This symbol indicates that if this information is ignored the possibility that serious personal injury may occur.

---

## Related Documents

- *PL4507 Decoder Integration Guide*, p/n 72E-116649-xx
- *The I<sup>2</sup>C-Bus Specification, Version 2.1*, <http://www.semiconductors.philips.com/acrobat/literature/9398/39340011.pdf>
- *Micron MT9V022 (mono) Wide VGA CMOS Digital Image Sensor Datasheet*, <http://www.micron.com>
- *Molex connector specification, 54809 Series*, <http://www.molex.com>
- *Kyocera connector specification, 6283 Series*, <http://global.kyocera.com>

For the latest version of this guide and all guides, go to: <http://www.motorola.com/enterprisemobility/manuals>.

---

## Service Information

If you have a problem with your equipment, contact Motorola Enterprise Mobility Support for your region. Contact information is available at: <http://www.motorola.com/enterprisemobility/contactsupport>.

When contacting Enterprise Mobility Support, please have the following information available:

- Serial number of the unit
- Model number or product name
- Software type and version number.

Motorola responds to calls by E-mail, telephone or fax within the time limits set forth in support agreements.

If your problem cannot be solved by Motorola Enterprise Mobility Support, you may need to return your equipment for servicing and will be given specific directions. Motorola is not responsible for any damages incurred during shipment if the approved shipping container is not used. Shipping the units improperly can possibly void the warranty.

If you purchased your Enterprise Mobility business product from a Motorola business partner, contact that business partner for support.



# Chapter 1 Getting Started



**CAUTION** This device emits CDRH/IEC Class 2 laser and IEC Class 1M light. Do not stare into beam.

---

## Introduction

The Symbol SE4500 captures digital images for transmission to a decoder to decode a bar code of any format supported by the decoding software. The Symbol SE4500 uses laser aiming and LED illumination, and is available in the following three models to accommodate working range or more precise focusing in high-density bar code decoding or digital picture taking:

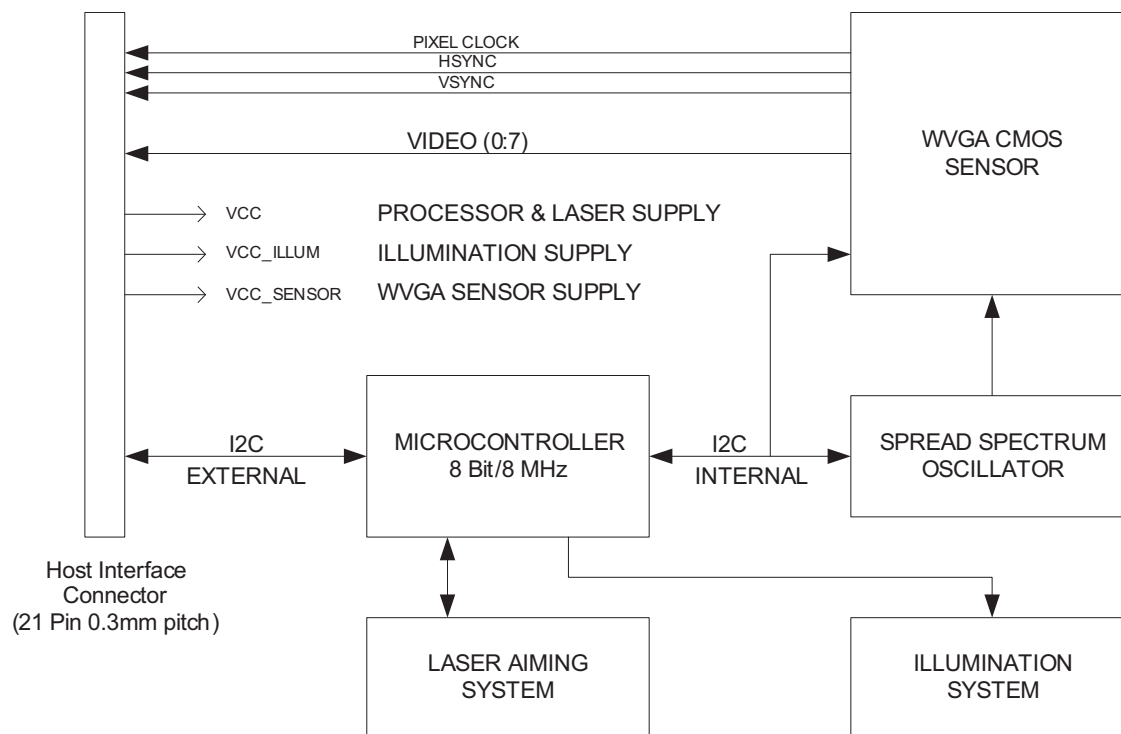
- Symbol SE4500-SR - Standard working range
- Symbol SE4500-DL - Driver's license optimized
- Symbol SE4500-HD - High density

## Symbol SE4500

The Symbol SE4500 contains:

- a monochrome CMOS image sensor
- a laser based aiming system
- an illumination system
- a standardized camera interface port and bi-directional control interface (I<sup>2</sup>C)

Figure 1-1 provides a block diagram of the imager system.



**Figure 1-1** Symbol SE4500 Block Diagram

A 21-pin ZIF connector on the Symbol SE4500 connects the engine and the host device via a 55 mm flex (available from Motorola). For information about this connector, see [Figure 4-2 on page 4-3](#) and [Figure 4-4 on page 4-5](#).

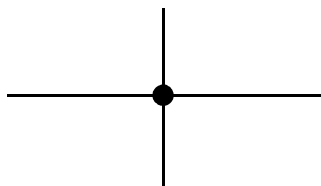
A Visible Laser Diode and associated optics (pattern forming element) generate an aiming pattern, and dual, high output LEDs provide illumination for the imager under virtually any lighting condition. The aiming subsystem, illumination system, and frame rate are under dynamic software control.

The primary component of the Symbol SE4500 imager is a 1/3" format CMOS wide VGA (752 H x 480 V) monochrome digital image sensor. The CMOS sensor converts photons to a digital representation (8 bits per pixel) of the image present on the sensor.



## Aiming System

A 655 nm laser and a pattern forming element generate a laser aiming pattern which represents the imager's field of view throughout its entire depth of field. The pattern's center dot indicates the center of the field of view.



**Figure 1-2** Aiming Pattern

The bright center spot provides visibility for aiming in sunlight and other bright light applications. The aiming pattern indicates the field of view for capturing images. The ends of the horizontal and vertical lines represent the midpoints of the sides of an imaginary box outlining the capture field.

## Aiming Error

The aiming pattern is rotated by  $2^\circ$  relative to the imaging axis in the horizontal plane to minimize parallax between the aiming axis and the imaging axis at 204 mm (8 in.) from the engine. See [Aiming Element on page 3-2](#) for Aiming Element specifications.

## Aiming Control

The Symbol SE4500 can capture images with both the aiming subsystem turned on during exposure (the image of the aiming pattern is visible in the digital image) or off. If the aiming system is turned off during exposure, brightness of the aiming pattern decreases as exposure increases.

The aiming subsystem can also be turned off completely. Motorola recommends shutting aiming off three frames prior to capturing documents to prevent the aiming pattern from appearing faintly in captured images. Note that this is not necessary for bar code decoding.

## Illumination System

The illumination system consists of two high-output, red LEDs (625 nm) and a sophisticated drive system that allows image capture and decoding throughout a full range of lighting conditions (total darkness to full sunlight).

## Illumination Control

The Symbol SE4500 can capture images with the illumination subsystem turned on or off, accommodating images that are close to the wavelength of the illumination. For example, since the engine uses red LED illumination, it may be desirable to shut off the illumination when capturing an image printed in red ink.

LED illumination can also be turned off when taking images of documents printed on semi-glossy or glossy paper or on a substrate with security marks. In this case, ensure ambient illumination provides minimum 30 fcd on the document surface. See also [Thermal Considerations on page 2-2](#).

## Frame Rate Control

The Symbol SE4500 outputs images at 60 frames per second by default. When capturing images, use lower frame rates to increase image brightness. The aiming pattern appears to blink when the frame rate is 30 fps or lower.



# Chapter 2 Installation

---

## Introduction

This chapter provides information for mounting and installing the Symbol SE4500, including physical and electrical considerations, and recommended window properties for the SE4500.

---

## General Information

### Grounding

The chassis is at ground. Isolate the Symbol SE4500 and host if installing the engine to a host that is not at ground, or has ground with the potential to inject noise.

### Electrostatic Discharge (ESD)

The Symbol SE4500 is protected from ESD events that can occur in an uncontrolled environment. Use care when handling this component and apply standard ESD handling procedures such as using grounding wrist straps and handling in a properly grounded work area.

### Environment

The engine and decoder must be sufficiently enclosed to prevent dust from gathering on the pattern forming element, optical lens, and illumination system LEDs. Dust and other external contaminants eventually degrade engine performance. Motorola does not guarantee performance of the Symbol SE4500 when used in an exposed application.

### Power Supply Noise

For reliable operation a low-noise power supply is required. Pay proper attention to power supply quality and testing to ensure the best possible performance from the SE4500. In bar code applications, up to 100 mV peak-to-peak noise is acceptable on all three power input pins (10 Hz to 100 kHz). For image capture applications, power supply noise for VCC\_SENSOR must be limited to 30 mV (peak-to-peak), across the same frequency range. To improve image quality use an additional filter on VCC\_SENSOR; to achieve optimal performance use a separate linear regulator to supply VCC\_SENSOR. Switching power supplies for VCC\_SENSOR are not recommended.

## Thermal Considerations

The Symbol SE4500 engine includes several high-power components (e.g., sensor, laser diode, LEDs) that dissipate heat during operation. The chassis can rise as much as 25° C over ambient when the engine is running at 60 frames per second with full illumination and aiming on. These extreme conditions can increase sensor noise, degrade image quality, and impact the laser diode's longevity. Use care when designing the SE4500 for integration into the target application.

As a protective measure for the laser diode, the SE4500 shuts the laser off at extreme temperatures. Other recommendations to reduce engine power consumption and heat removal include but are not limited to:

- Using reduced video frame rates (e.g., 15 fps)
- Reducing internal illumination intensity
- Mounting on a solid metallic surface that facilitates heat removal
- Selecting a housing design that allows for natural or forced convection

Note that running in continuous 60 fps video mode with both aiming and illumination enabled full time is highly uncommon. In typical decoding and image capture applications, any rise in chassis temperature is minimal.

For additional information, see [THERMAL\\_MANAGEMENT\\_MODE 0x80 on page 5-9](#).

## External Optics (LED Lenses and Pattern Forming Element)

Do not subject external optical components on the SE4500 engine to any external force. Do not hold the engine by an external optical component. This can place excessive stress in the mechanical joints that secure the components, which can cause failures such as joint cracking or breaking.

## Image and Document Capture

For specific information on image and document capture applications, contact a Motorola sales representative for a technical document on image capture using the SE4500.

## Regulatory Information

The Symbol SE4500 imager engine meets the accessible laser light limits for an CDRH/IEC Class 2 laser and IEC Class 1M LED product. Any product containing the SE4500 can meet these same regulations. Contact a Motorola sales representative for further details.

Laser products sold in North America must be reported to the U.S. Food and Drug Administration, Center for Devices and Radiological Health (CDRH) via a Laser Radiation Safety Report (Product Report). See <http://www.fda.gov/CDRH/>.

Please see the U.S. Code of Federal Regulations, 21CFR1040.10 for the specific North American requirements for laser products. For devices intended for international sale, see the IEC/EN60825-1 standard for the Safety of Laser Products.

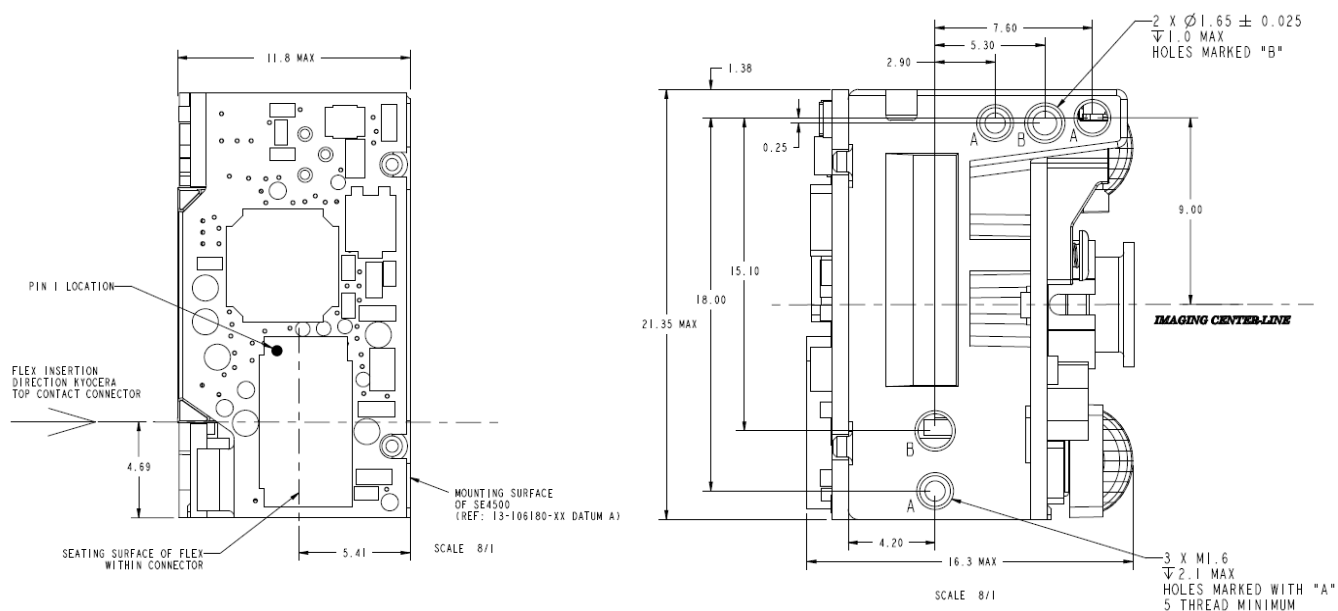
Complies with 21CFR1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007 and IEC 60825-1 (Ed. 2.0), EN60825-1:2007.

## Mounting

There are three mounting holes (M1.6x0.35) and two locator holes on the bottom of the chassis (see [Figure 2-1](#)). The Symbol SE4500 can be mounted in any orientation without degradation in performance.

- ✓ **NOTE** Mounting the Symbol SE4500 in a non-upright position results in images rotated accordingly in snapshot or video mode.

When installing the mounting screws, ensure they do not protrude past the mounting hole threads in the chassis; use 2.1 mm maximum mounting screw thread engagement. Recommended mounting screw torque is  $1.25 \pm 0.25$  in-lb.



Notes: Unless otherwise specified:

- Chassis is at ground.
- Holes marked "A" are mounting holes. Holes marked "B" are imager engine locating aides.
- This is a reference drawing and is not intended to specify or guarantee all possible integration requirements for this engine.
- All untoleranced dimensions follow a general tolerance of  $\pm 0.15$  mm.

**Figure 2-1** Symbol SE4500 Mounting Diagram

---

## Housing Design

- ✓ **NOTE** Perform an opto-mechanical analysis for the housing design to ensure optimal scanning or imaging performance.

Design the engine's housing so that internal reflections from the aiming and illumination system are not directed back toward the engine. The reflections from the window or housing can cause problems, and for particular window tilt angles, these reflections can bounce off the top or bottom of the housing and reach the engine. Also, keep all housing elements outside the engine clear aperture (see [Figure 2-2 on page 2-7](#)). Avoid any bright objects around the engine that can be reflected by a tilted window into the engine field of view and appear in a captured image.

[Recommended Exit Window Information on page 2-8](#) provides minimum exit window tilt angles. These dimensional requirements can vary. Consider using baffles or matte-finished dark internal housing colors.

---

## Optical

The Symbol SE4500 uses a sophisticated optical system that provides imaging performance that matches or exceeds the performance of much larger imagers. However, an improperly designed enclosure, or improper selection of window material, can affect the performance of the SE4500.

### Positioning the Exit Window

Position the window so that illumination system light reflected off the inside of the window is not reflected back into the engine (see [Recommended Exit Window Information on page 2-8](#)). If the designed enclosure cannot accommodate the recommended window angle, contact Motorola to discuss positioning requirements. An improperly positioned window can significantly decrease performance.

### Window Positioning Options

There are two options for window positioning:

- Parallel window - This is the preferred method for imager engines. The maximum window distance is limited. Parallel window installation requires 2-sided anti-reflection coating (see [Anti-Reflection Coatings on page 2-6](#)).
- Tilted window - This is used for either laser or imager engines. Adhere to the minimum window tilt specifications in [Table 2-4 on page 2-8](#). With tilted window installation, 2-sided anti-reflection coating is optional (see [Anti-Reflection Coatings on page 2-6](#)).

- ✓ **NOTE** For bar code reading, use either a parallel or tilted window. For document capture applications, Motorola strongly recommends the parallel window installation. For tilted windows, dust, contamination, and scratches on the window can cause visible blemishes in the images.

### Avoiding Scratched Windows

Scratches on the window can greatly reduce the performance of the imaging system. Motorola recommends recessing the window into the housing or applying a scratch resistance coating.

## Window Material

Many window materials that look clear can contain stresses and distortions that reduce performance. For this reason, use only cell-cast plastics or optical glass (with or without an anti reflection coating, depending on the application). Following are descriptions of three popular window materials: PMMA, ADC (CR-39<sup>TM</sup>), and chemically tempered float glass. [Table 2-1](#) outlines the suggested window properties.

**Table 2-1** Suggested Window Properties

| Property                            | Description  |
|-------------------------------------|--|
| Material                            | Clear cell-cast acrylic  |
| Thickness                           | 0.06 in. (1.5 mm)  |
| Wavefront Distortion (transmission) | 0.2 wavelengths peak-to-valley maximum and 0.04 $\lambda$ maximum rms over any 0.08 in. diameter within the clear aperture |
| Clear Aperture                      | To extend to within 0.04 in. of the edges all around   |
| Surface Quality                     | 60-20 scratch/dig  |

Plastic materials are not recommended for tilted windows since surface scratches cause image artifacts. Colored windows are not recommended if motion detection mode is required since it reduces engine sensitivity to the moving target.

### Cell Cast Acrylic (ASTM: PMMA)

Cell Cast Acrylic, or Poly-methyl Methacrylic (PMMA) is fabricated by casting acrylic between two precision sheets of glass. This material has very good optical quality, reasonably good impact resistance and low initial cost, but is relatively soft and susceptible to attack by chemicals, mechanical stresses, and UV light. Therefore polysiloxane coating is strongly recommended. Acrylic can be laser cut into odd shapes and ultrasonically welded.

### Cell Cast ADC (ASTM: ADC)

Also known as CR-39<sup>TM</sup>, Allyl Diglycol Carbonate (ADC) is a thermal-setting plastic produced by cell-casting. Most plastic eyeglasses sold today are uncoated, cell-cast CR-39. This material has excellent chemical and environmental resistance, and reasonably good impact resistance. It also has quite good surface hardness, and therefore does not have to be hard-coated, but may be coated for severe environments. This material cannot be ultrasonically welded.

### Chemically Tempered Float Glass

Glass is a hard material that provides excellent scratch and abrasion resistance. However, unannealed glass is brittle. Increasing flexibility strength with minimal optical distortion requires chemical tempering. Glass cannot be ultrasonically welded and is difficult to cut into odd shapes.

## Commercially Available Coatings

### Anti-Reflection Coatings

Anti-reflection coatings can be used for stray light control or to achieve maximum working range, and can be applied to the inside and/or outside of the window to reduce the amount of light reflected off the window back into the engine. However, they are expensive and have very poor abrasion and scratch resistance.

### Polysiloxane Coating

Polysiloxane type coatings are applied to plastic surfaces to improve the surface resistance to both scratch and abrasion. To apply, dip and air dry in an oven with filtered hot air.

To gauge a window's durability, use ASTM standard D1044, Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion (the Taber Test), which quantifies abrasion resistance as a percent increase in haze after a specified number of cycles and load. Lower values of the increase in haze correspond to better abrasion and scratch resistance. See [Table 2-2](#).

**Table 2-2** Taber Test Results on Common Exit Window Materials

| Sample                          | Haze 100 cycles | Haze 500 cycles | Abrasion Resistance |
|---------------------------------|-----------------|-----------------|---------------------|
| Chemically Tempered Float Glass | 1.20%           | 1.50%           | Best                |
| PMMA with Polysiloxane Hardcoat | 3%              | 10%             |                     |
| ADC                             | 5%              | 30%             |                     |
| PMMA                            | 30%             |                 | Worst               |

**\* All measurements use a 100 gram load and CS-10F Abraser.**

## A Word About Coatings

If using an anti-reflective (AR) coating, the specifications in [Table 2-3](#) apply. Polysiloxane coating is not required. Recess the exit window to minimize scratches and digs.

**Table 2-3** AR Coatings Specifications

| Specification            | Description   |
|--------------------------|---|
| Material                 | Both tempered glass and plastic (e.g., CR-39 or hard coated acrylic) exit windows can be AR coated. AR coated glass is easier and more durable because of a better adhesion property on the glass structure. In addition, it can be more cost effective to put an AR coating on the glass substrate rather than on the plastic.           |
| AR Coating Specification | <ul style="list-style-type: none"> <li>One side tempered AR coating: 92% minimum within spectrum range from 450 nm to 700 nm.</li> <li>Double side AR coating: One side AR coating must be 97% minimum within spectrum range from 450 nm to 700 nm.</li> <li>For parallel windows, see <a href="#">Figure 2-3 on page 2-8</a>.</li> </ul> |



# Optical Path and Exit Window

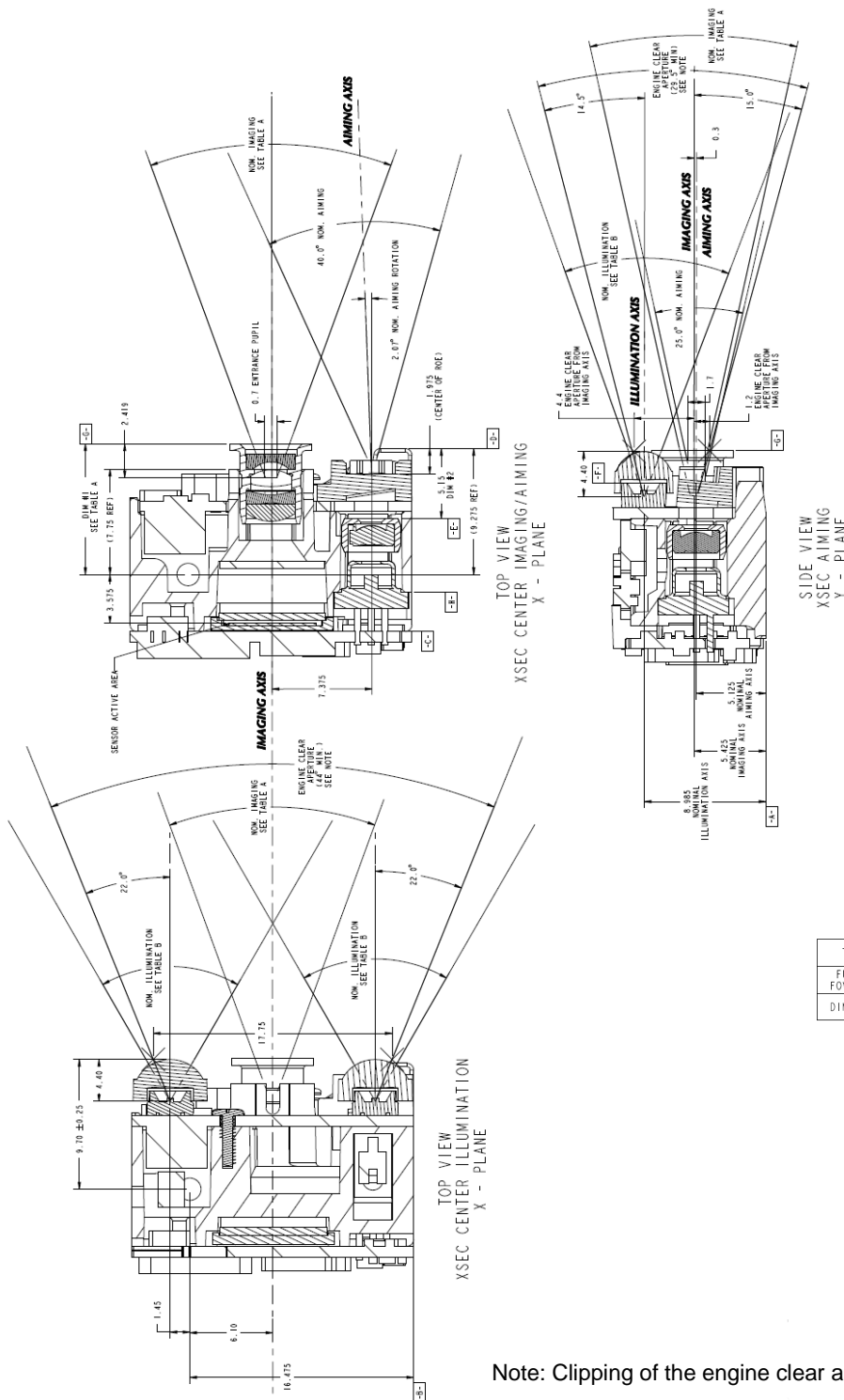


TABLE A - SE4500 IMAGING FOCUS POSITIONS

| TABLE B              | SR            | DL            | HD            |
|----------------------|---------------|---------------|---------------|
| FULL NOM FOV (X x Y) | 39.6° x 25.7° | 39.2° x 25.4° | 38.4° x 24.9° |
| DIM #1 (MM)          | 9.23±0.3      | 9.35±0.3      | 9.55±0.3      |

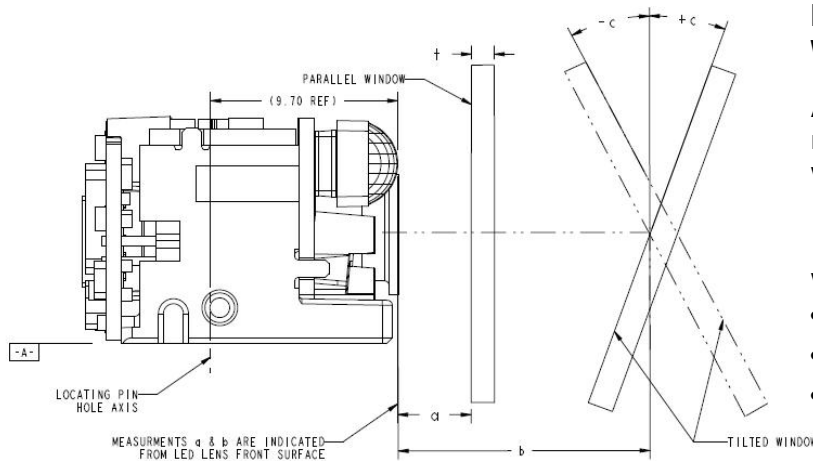
TABLE B - SE4500 ILLUMINATION PLANES

| ILLUMINATION FOV | X    | Y    |
|------------------|------|------|
| 80% INTENSITY    | 60°  | 40°  |
| 50% INTENSITY    | 66°  | 50°  |
| 20% INTENSITY    | 70°  | 54°  |
| 10% INTENSITY    | 86°  | 88°  |
| 5% INTENSITY     | 100° | 100° |

Note: Clipping of the engine clear aperture is not permitted.

Figure 2-2 Symbol SE4500 Optical Path and Exit Window

## Recommended Exit Window Information



### Maximum Distance “a” for a Parallel Window

Anti-reflection coating (2 sides), 0.4% reflections maximum per side over wavelength 620 - 640 nm.

$$a \leq 3.5 - (t / n)$$

where:

- $t$  is the window thickness
- $n$  is the index of refraction of the window
- $a$  and  $t$  are measured in millimeters.

Figure 2-3 Window Distances

Table 2-4 Recommended Exit Window Information - Tilted Window

| Distance from LED Lens Front Surface (b) in mm          | 5     | 10  | 15  | 20  | 27  |
|---|-------|-----|-----|-----|-----|
| Window Specification                                    | Angle |     |     |     |     |
| Non-coated, minimum window positive tilt (+c)           | 36°   | 31° | 32° | 29° | 28° |
| Non-coated, minimum window negative tilt (-c)           | 36°   | 30° | 29° | 29° | 28° |
| AR coated, one side, minimum window positive tilt (+c)  | 34°   | 28° | 24° | 24° | 24° |
| AR coated, one side, minimum window negative tilt (-c)  | 33°   | 28° | 26° | 25° | 24° |
| AR coated, two sides, minimum window positive tilt (+c) | 32°   | 27° | 23° | 21° | 20° |
| AR coated, two sides, minimum window negative tilt (-c) | 10°   | 15° | 15° | 15° | 15° |

### Exit Window Notes

- Do not place the exit window between the maximum distance for a parallel window (“a” in [Figure 2-3](#)) and the minimum distance for a tilted window (5 mm in [Table 2-4](#)) in respect to the front of the engine.
- Integration tolerances are not included.
- Ensure the window size is large enough to cover the engine clear aperture specified in [Figure 2-2](#) plus mounting tolerances of the window relative to the engine.

# Chapter 3 Specifications

## Introduction

This chapter provides the technical specifications of the Symbol SE4500, including decode zone and exit window characteristics.

## Technical Specifications

**Table 3-1** Symbol SE4500 Technical Specifications

| Item  | Description   |
|---|---|
| Power Requirements - Input Voltage  | 3.3 V $\pm$ 0.3 V at 23° C  |
| Operating Mode Supply Currents (conditions VCC=VCC_SENSOR=VCC_ILLUM = 3.3VDC) (at 23° C): |   |
| Low Power   | 500 $\mu$ A   |
| Idle  | 18 mA   |
| Image Acquisition   | 80 mA   |
| Illumination Enabled  | 200 mA  |
| Maximum Operating Current   | 250 mA (aiming on during exposure, illumination enabled)  |
| Maximum Sensor Power Supply Noise* (at 23° C)   | 100 mVp-p (3.3 V, 10 Hz - 100 kHz) for decoding<br>30 mVp-p (3.3 V, 10 Hz - 100 kHz) for image capture  |
| Optical Resolutions   | HD focus: 3.0 mil (Code 39), 4.0 mil (PDF417)<br>DL focus: 4.0 mil (Code 39), 5.0 mil (PDF417)<br>SR focus: 5.0 mil (Code 39), 6.7 mil (PDF417) |

\*For better image quality in image capture applications, use an additional filter on VCC\_SENSOR. For additional performance improvement, provide a separately regulated 3.3 V supply for the sensor.

**Table 3-1** Symbol SE4500 Technical Specifications (Continued)

| Item  | Description   |
|---|---|
| Specular Dead Zone<br>Illumination On<br>Illumination Off                                 | Up to 20° depending on target distance and substrate glossiness<br>None   |
| Skew Tolerance  | ± 60° (see <a href="#">Figure 3-1 on page 3-3</a> )   |
| Pitch Angle   | ± 60° (see <a href="#">Figure 3-1 on page 3-3</a> )   |
| Roll  | 360° (see <a href="#">Figure 3-1 on page 3-3</a> )  |
| Ambient Light Immunity (Sunlight)   | 9000 ft. candles (96,900 lux)   |
| Imaging Sensor<br>Image Resolution<br>Gray Scale<br>Field of View (FOV)                   | 752 H x 480 V pixels (Wide VGA)<br>256 levels (8 bits per pixel)<br>SE4500-SR: 39.6° horizontal, 25.7° vertical<br>SE4500-DL: 39.2° horizontal, 25.4° vertical<br>SE4500-HD: 38.4° horizontal, 24.9° vertical   |
| Focusing Distance from Front of Engine<br>SR<br>DL<br>HD                                  | 8 in. / 20.3 cm<br>5.3 in. / 13.5 cm<br>2.9 in. / 7.4 cm  |
| Aiming Element<br>Visible Laser Diode (VLD)<br>Central Dot Optical Power<br>Pattern Angle | 655 ± 10 nm<br>0.6 mW (typical)<br>40° horizontal, 30° vertical   |
| Illumination System<br>LEDs<br>Pattern Angle  | 625 ± 5 nm (dominant wavelength)<br>60° x 40° at 80% center intensity   |
| Shock   | 2000 G ± 5% applied via any mounting surface at -30° and 55° C for a period of 0.85 ± 0.05 msec<br>2500 G ± 5% applied via any mounting surface at 23° C for a period of 0.85 ± 0.05 msec   |
| Vibration   | Unpowered SE4500 withstands a random vibration along each of the X, Y, and Z axes for a period of one hour per axis (6 G rms), defined as follows:<br><br>20 to 80 Hz      Ramp up at 0.04 G <sup>2</sup> /Hz at 3 dB/octave<br>80 to 350 Hz      0.04 G <sup>2</sup> /Hz<br>350 Hz to 2 kHz      Ramp down at 0.04 G <sup>2</sup> /Hz at 3 dB/octave |
| ESD   | ± 2 kV @ connector  |
| Laser Safety Class  | CDRH / IEC Class 2  |
| LED Class   | IEC Class 1M  |

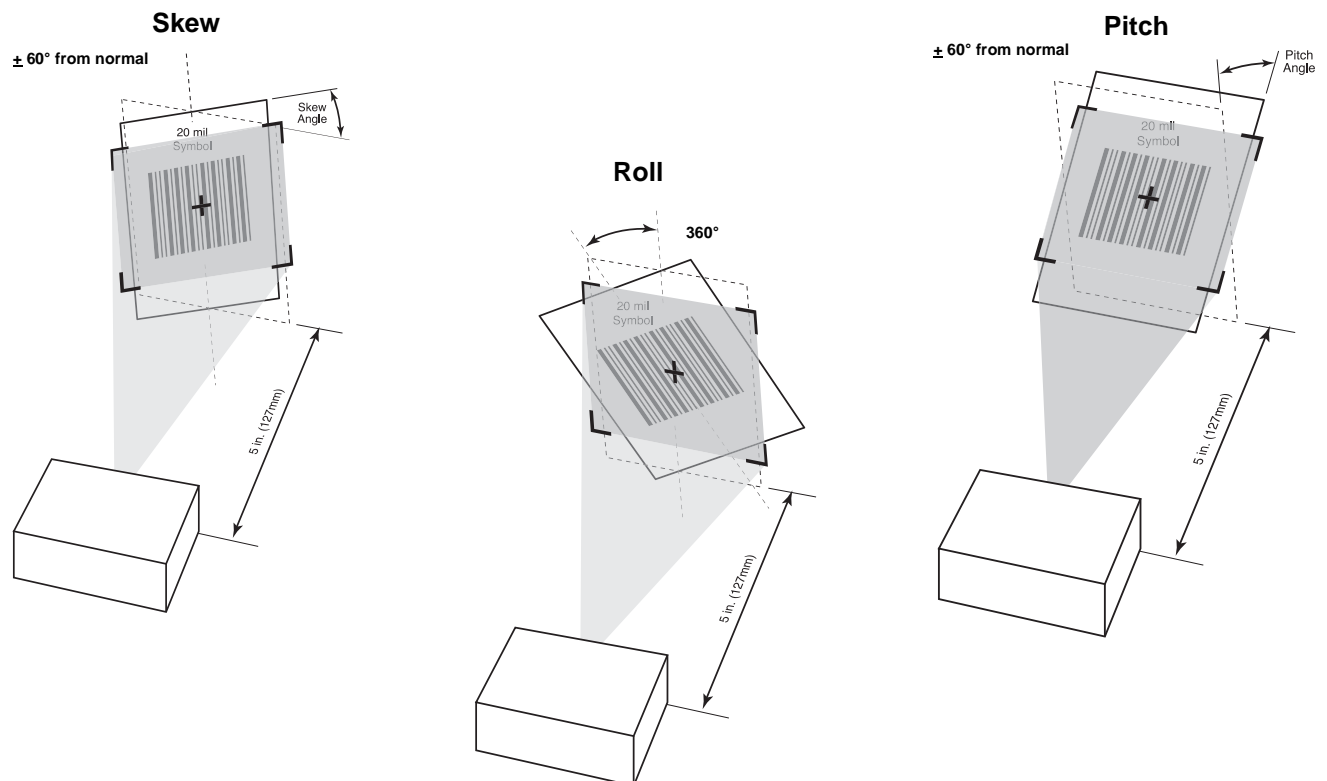
**Table 3-1** Symbol SE4500 Technical Specifications (Continued)

| Item                                | Description  |
|-------------------------------------|--|
| Temperature<br>Operating<br>Storage | -30° to 55° C (-22° to 131° F)<br>-40° to 70° C (-40° to 158° F)<br>See <a href="#">Thermal Considerations on page 2-2</a> for more information. |
| Humidity<br>Operating<br>Storage    | 95% RH, non-condensing at 55° C<br>85% RH, non-condensing at 70° C   |
| Maximum Engine Dimensions           | 11.8 mm H x 21.50 mm W x 16.3 mm D<br>0.46 in. H x 0.85 in. W x 0.64 in. D   |
| Weight                              | 8.0 grams (0.28 oz)  |
| Electrical Interface                | 21 pin 0.3 mm pitch ZIF connector<br>See <a href="#">Chapter 4, Electrical Interface</a> for more information.                                   |

✓ **NOTE** Environmental and/or tolerance parameters are not cumulative. Motorola recommends a thermal analysis if the application is subject to an extreme temperature environment.

### Skew, Pitch, and Roll

Measured on a 20 mil Code 39 symbol at a distance of 5 inches. Tolerance for skew and pitch is reduced at extreme ends of the working range.



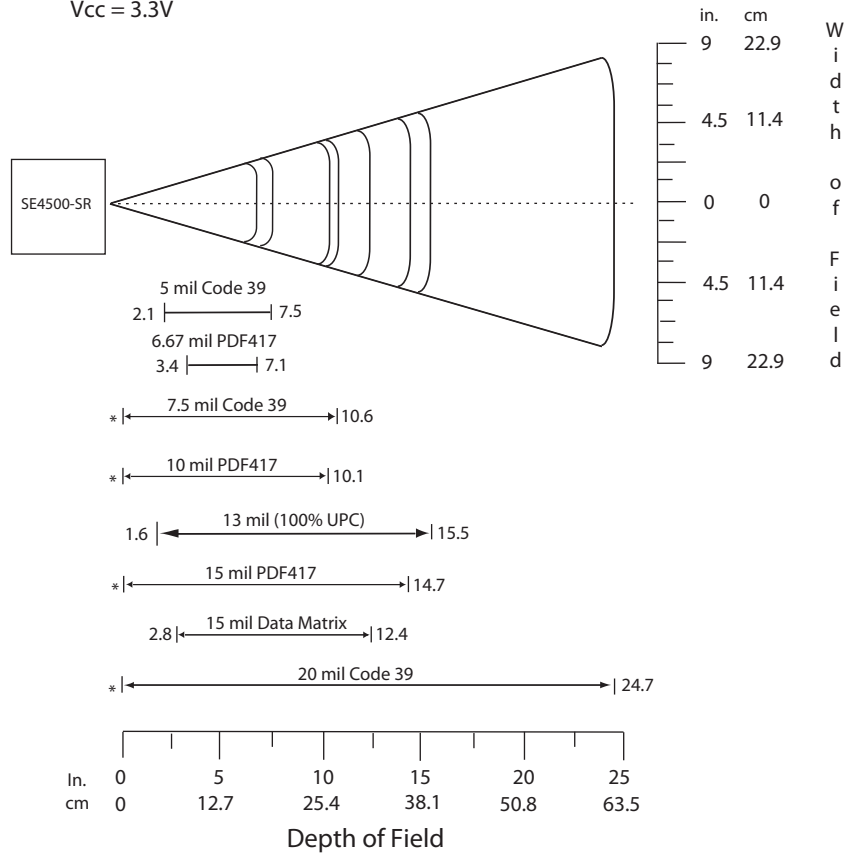
**Figure 3-1** Skew, Pitch, and Roll

## Decode Zones

### Symbol SE4500-SR

Figure 3-2 shows the decode zone for the Symbol SE4500-SR. Typical values appear. Table 3-2 lists the typical and guaranteed distances for selected bar code densities. The minimum element width (or “symbol density”) is the width in mils of the narrowest element (bar or space) in the symbol.

Note: Typical performance at 73°F (23°C)  
on high quality symbols in normal room light.  
Vcc = 3.3V



\* Minimum distance determined by symbol length and scan angle.

Figure 3-2 Symbol SE4500-SR Decode Zone

**Table 3-2** Symbol SE4500-SR Decode Distances

| Symbol Density/<br>Bar Code Type | Bar Code<br>Content/<br>Contrast <sup>Note 2</sup> | Typical Working Ranges |                     | Guaranteed Working<br>Ranges |                     |
|----------------------------------|--|------------------------|---------------------|------------------------------|---------------------|
|                                  |  | Near                   | Far                 | Near                         | Far                 |
| 5.0 mil<br>Code 39               | ABCDEFGH<br>80% MRD                                | 2.1 in<br>5.33 cm      | 7.5 in<br>19.05 cm  | 2.5 in<br>6.35 cm            | 6.8 in<br>17.27 cm  |
| 6.67 mil<br>PDF417               | 4 Col, 20 Rows<br>80% MRD                          | 3.4 in<br>8.64 cm      | 7.1 in<br>18.03 cm  | 4.1 in<br>10.41 cm           | 6.2 in<br>15.75 cm  |
| 7.5 mil<br>Code 39               | ABCDEF<br>80% MRD                                  | Note 1                 | 10.6 in<br>26.92 cm | Note 1                       | 9.6 in<br>24.38 cm  |
| 10 mil<br>PDF417                 | 3 Col, 17 Rows<br>80% MRD                          | Note 1                 | 10.1 in<br>25.65 cm | Note 1                       | 9.0 in<br>22.86 cm  |
| 13 mil<br>UPC-A                  | 012345678905<br>80% MRD                            | 1.6 in<br>5.08 cm      | 15.5 in<br>39.37 cm | 2.5 in<br>5.08 cm            | 14.2 in<br>36.07 cm |
| 15 mil<br>PDF417                 | 80% MRD  | Note 1                 | 14.7 in<br>37.34 cm | Note 1                       | 13.2 in<br>33.53 cm |
| 15 mil<br>Data Matrix            | 18 x 18 Modules<br>80% MRD                         | 2.8 in<br>7.11 cm      | 12.4 in<br>31.50 cm |                              |                     |
| 20 mil<br>Code 39                | 123<br>80% MRD                                     | Note 1                 | 24.7 in<br>62.74 cm | Note 1                       | 21.8 in<br>55.37 cm |

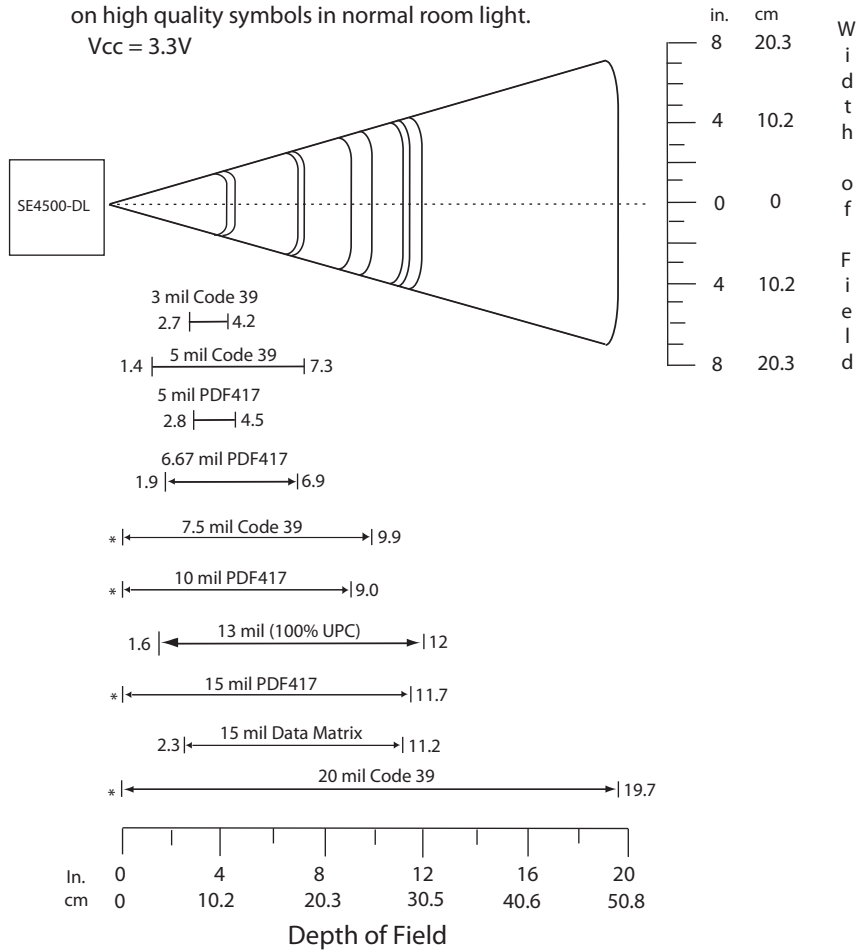
**Notes:**

1. Near distances are field-of-view (FOV) limited.
2. Contrast is measured as Mean Reflective Difference (MRD) at 670 nm.
3. Working range specifications at temperature = 23°C, pitch=18°, roll=0°, skew=0°, photographic quality, ambient light ~30 ft-c, humidity 45-70% RH.

### Symbol SE4500-DL

Figure 3-3 shows the decode zone for the Symbol SE4500-DL. Typical values appear. Table 3-3 lists the typical and guaranteed distances for selected bar code densities. The minimum element width (or “symbol density”) is the width in mils of the narrowest element (bar or space) in the symbol.

Note: Typical performance at 73°F (23°C)  
 on high quality symbols in normal room light.  
 Vcc = 3.3V



\* Minimum distance determined by symbol length and scan angle.

Figure 3-3 Symbol SE4500-DL Decode Zone



**Table 3-3** Symbol SE4500-DL Decode Distances

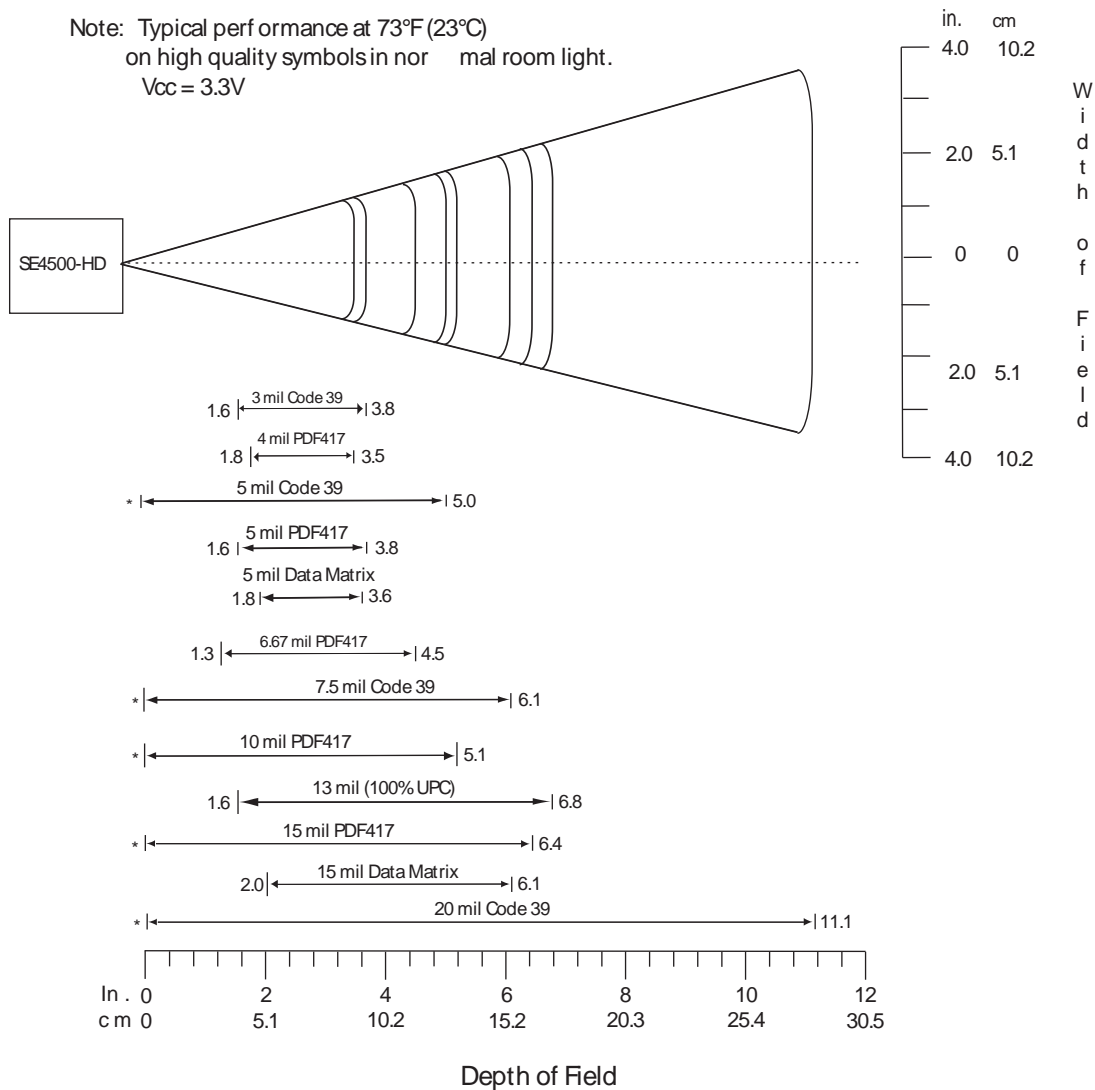
| Symbol Density/<br>Bar Code Type | Bar Code<br>Content/<br>Contrast <sup>Note 2</sup> | Typical Working Ranges |                     | Guaranteed Working<br>Ranges |                     |
|----------------------------------|--|------------------------|---------------------|------------------------------|---------------------|
|                                  |  | Near                   | Far                 | Near                         | Far                 |
| 3.0 mil<br>Code 39               | 80% MRD  | 2.7 in<br>6.86 cm      | 4.2 in<br>10.67 cm  | 3.3 in<br>8.38 cm            | 3.7 in<br>9.40 cm   |
| 5.0 mil<br>Code 39               | ABCDEFGH<br>80% MRD                                | 1.4 in<br>3.56 cm      | 7.3 in<br>18.54 cm  | 1.7 in<br>4.32 cm            | 6.7 in<br>17.02 cm  |
| 5.0 mil<br>PDF417                | 80% MRD  | 2.8 in<br>7.11 cm      | 4.5 in<br>11.43 cm  | 3.4 in<br>8.64 cm            | 3.9 in<br>9.91 cm   |
| 6.67 mil<br>PDF417               | 4 Col, 20 Rows<br>80% MRD                          | 1.9 in<br>4.83 cm      | 6.9 in<br>17.53 cm  | 2.5 in<br>6.35 cm            | 6.2 in<br>15.75 cm  |
| 7.5 mil<br>Code 39               | ABCDEF<br>80% MRD                                  | Note 1                 | 9.9 in<br>25.15 cm  | Note 1                       | 8.8 in<br>22.35 cm  |
| 10 mil<br>PDF417                 | 3 Col, 17 Rows<br>80% MRD                          | Note 1                 | 9.0 in<br>22.86 cm  | Note 1                       | 8.0 in<br>20.32 cm  |
| 13 mil<br>UPC-A                  | 012345678905<br>80% MRD                            | 1.6 in<br>5.08 cm      | 12.0 in<br>30.48 cm | 2.5 in<br>5.08 cm            | 10.7 in<br>27.18 cm |
| 15 mil<br>PDF417                 | 80% MRD  | Note 1                 | 11.7 in<br>29.72 cm | Note 1                       | 10.5 in<br>26.67 cm |
| 15 mil<br>Data Matrix            | 18 x 18 Modules<br>80% MRD                         | 2.3 in<br>5.84 cm      | 11.2 in<br>28.45 cm |                              |                     |
| 20 mil<br>Code 39                | 123<br>80% MRD                                     | Note 1                 | 19.7 in<br>50.04 cm | Note 1                       | 17.1 in<br>43.43 cm |

**Notes:****1. Near distances are FOV limited.****2. Contrast is measured as Mean Reflective Difference (MRD) at 670 nm.****3. Working range specifications at temperature = 23°C, pitch=18°, roll=0°, skew=0°, photographic quality, ambient light ~30 ft-c, humidity 45-70%RH.**

### Symbol SE4500-HD

Figure 3-4 shows the decode zone for the Symbol SE4500-HD. Typical values appear. Table 3-4 lists the typical and guaranteed distances for selected bar code densities. The minimum element width (or “symbol density”) is the width in mils of the narrowest element (bar or space) in the symbol.

Note: Typical performance at 73°F (23°C)  
on high quality symbols in normal room light.  
Vcc = 3.3V



\* Minimum distance determined by symbol length and scan angle.

Figure 3-4 Symbol SE4500-HD Decode Zone

**Table 3-4** Symbol SE4500-HD Decode Distances

| Symbol Density/<br>Bar Code Type | Bar Code<br>Content/<br>Contrast <sup>Note 2</sup> | Typical Working Ranges |                     | Guaranteed Working<br>Ranges |                    |
|----------------------------------|--|------------------------|---------------------|------------------------------|--------------------|
|                                  |  | Near                   | Far                 | Near                         | Far                |
| 3.0 mil<br>Code 39               | 80% MRD  | 1.6 in<br>4.06 cm      | 3.8 in<br>9.65 cm   | 1.8 in<br>4.57 cm            | 3.4 in<br>8.64 cm  |
| 4.0 mil<br>PDF417                | 80% MRD  | 1.8 in<br>4.57 cm      | 3.5 in<br>8.89 cm   | 2.0 in<br>5.08 cm            | 3.1 in<br>7.87 cm  |
| 5.0 mil<br>Code 39               | ABCDEFGH<br>80% MRD                                | Note 1                 | 5.0 in<br>12.70 cm  | Note 1                       | 4.5 in<br>11.43 cm |
| 5.0 mil<br>PDF417                | 80% MRD  | 1.6 in<br>4.06 cm      | 3.8 in<br>9.65 cm   | 1.9 in<br>4.83 cm            | 3.4 in<br>8.64 cm  |
| 5 mil<br>Data Matrix             | 18 x 18 Modules<br>80% MRD                         | 1.8 in<br>4.57 cm      | 3.6 in<br>9.15 cm   |                              |                    |
| 6.67 mil<br>PDF417               | 4 Col, 20 Rows<br>80% MRD                          | 1.3 in<br>3.30 cm      | 4.5 in<br>11.43 cm  | 1.4 in<br>3.30 cm            | 4.0 in<br>11.43 cm |
| 7.5 mil<br>Code 39               | ABCDEF<br>80% MRD                                  | Note 1                 | 6.1 in<br>15.49 cm  | Note 1                       | 5.5 in<br>15.49 cm |
| 10 mil<br>PDF417                 | 3 Col, 17 Rows<br>80% MRD                          | Note 1                 | 5.1 in<br>12.95 cm  | Note 1                       | 4.5 in<br>12.95 cm |
| 13 mil<br>UPC-A                  | 012345678905<br>80% MRD                            | 1.6 in<br>4.06 cm      | 6.8 in<br>17.27 cm  | 2.5 in<br>4.06 cm            | 6.1 in<br>17.27 cm |
| 15 mil<br>PDF417                 | 80% MRD  | Note 1                 | 6.4 in<br>16.26 cm  | Note 1                       | 5.7 in<br>16.26 cm |
| 15 mil<br>Data Matrix            | 18 x 18 Modules<br>80% MRD                         | 2.0 in<br>5.08 cm      | 6.1 in<br>15.49 cm  |                              |                    |
| 20.0 mil<br>Code 39              | 123<br>80% MRD                                     | Note 1                 | 11.1 in<br>28.19 cm | Note 1                       | 9.7 in<br>28.19 cm |

**Notes:****1. Near distances are FOV limited.****2. Contrast is measured as Mean Reflective Difference (MRD) at 670 nm.****3. Working range specifications at temperature = 23°C, pitch=18°, roll=0°, skew=0°, photographic quality, ambient light ~30 ft-c, humidity 45-70% RH.**



# Chapter 4 Electrical Interface

## Introduction

[Table 4-1](#) lists the pins and signals of the 21-pin connector on the Symbol SE4500. See [Figure 2-1 on page 2-3](#) for the pin 1 location on the rear of the engine, on the side opposite the aiming/illumination system.

**Table 4-1** Symbol SE4500 Signal Information

| Pin Number | SE4500 Signal Name | I/O | Note                          |
|------------|--------------------|-----|-------------------------------|
| 1          | GND                | -   | Ground                        |
| 2          | GND                | -   | Ground                        |
| 3          | I2C_CLK            | I   | I <sup>2</sup> C Clock        |
| 4          | I2C_DATA           | I/O | I <sup>2</sup> C Data         |
| 5          | VSYNC              | O   | Vertical sync                 |
| 6          | PIX_DATA_7         | O   | Sensor Pixel Data - MSB       |
| 7          | PIX_DATA_6         | O   | Sensor Pixel Data             |
| 8          | PIX_DATA_5         | O   | Sensor Pixel Data             |
| 9          | PIX_DATA_4         | O   | Sensor Pixel Data             |
| 10         | PIX_DATA_3         | O   | Sensor Pixel Data             |
| 11         | PIX_DATA_2         | O   | Sensor Pixel Data             |
| 12         | PIX_DATA_1         | O   | Sensor Pixel Data             |
| 13         | PIX_DATA_0         | O   | Sensor Pixel Data - LSB       |
| 14         | EXT_ILLUM_EN       | O   | External illumination trigger |
| 15         | VCC_SENSOR         | -   | WVGA sensor power             |
| 16         | VCC                | -   | Laser and logic power         |
| 17         | VCC_ILLUM          | -   | Illumination power            |
| 18         | HSYNC              | O   | Horizontal sync               |
| 19         | GND                | -   | Ground                        |
| 20         | PIXCLK             | O   | Sensor pixel clock            |
| 21         | GND                | -   | Ground                        |

## Connector Drawings

For detailed connector information, refer to the manufacturer's specifications.

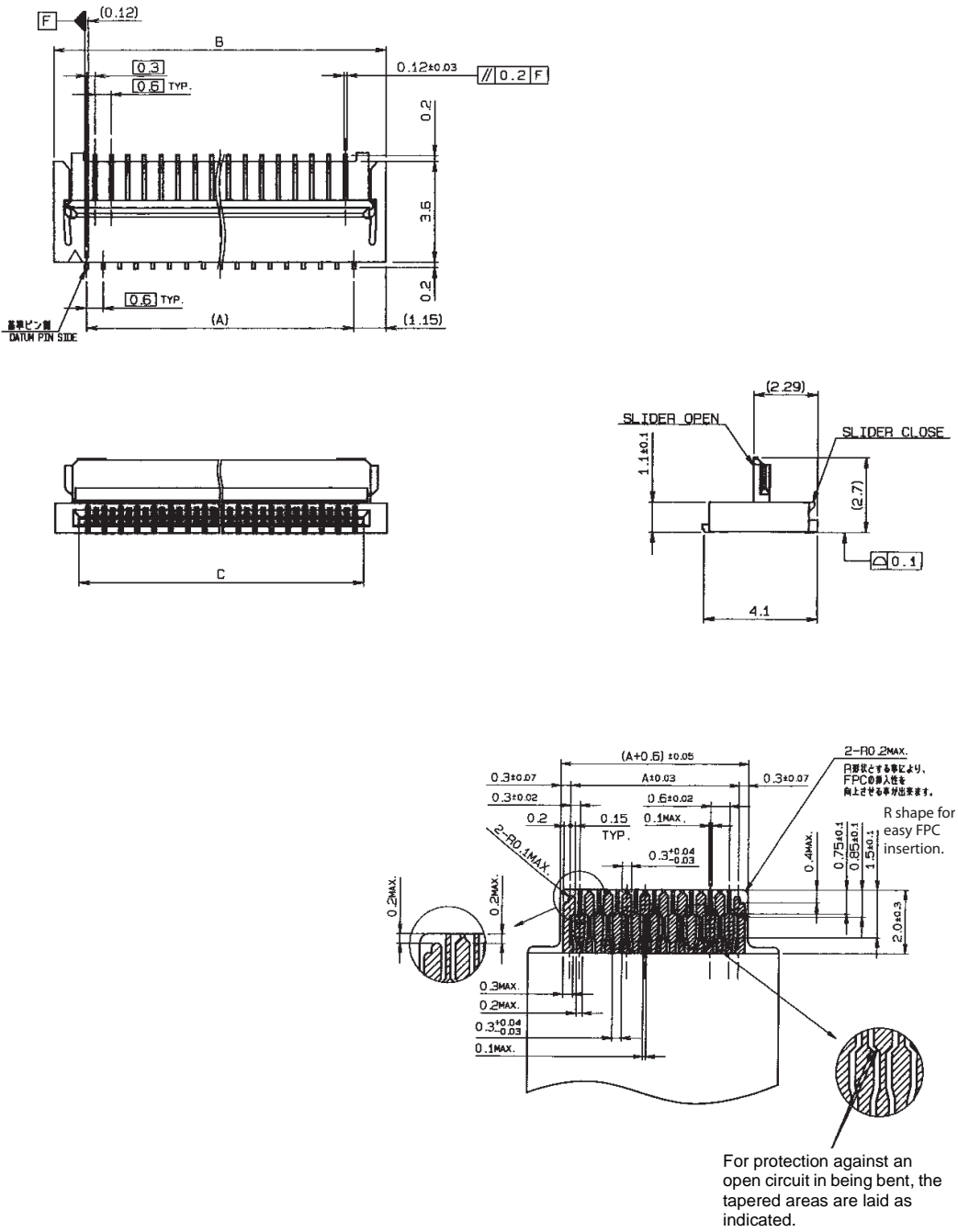


Figure 4-1 21-Pin ZIF Connector (SE4500 Imager to Flex), Motorola p/n 50-12100-2193 (Kyocera 6283 Series)

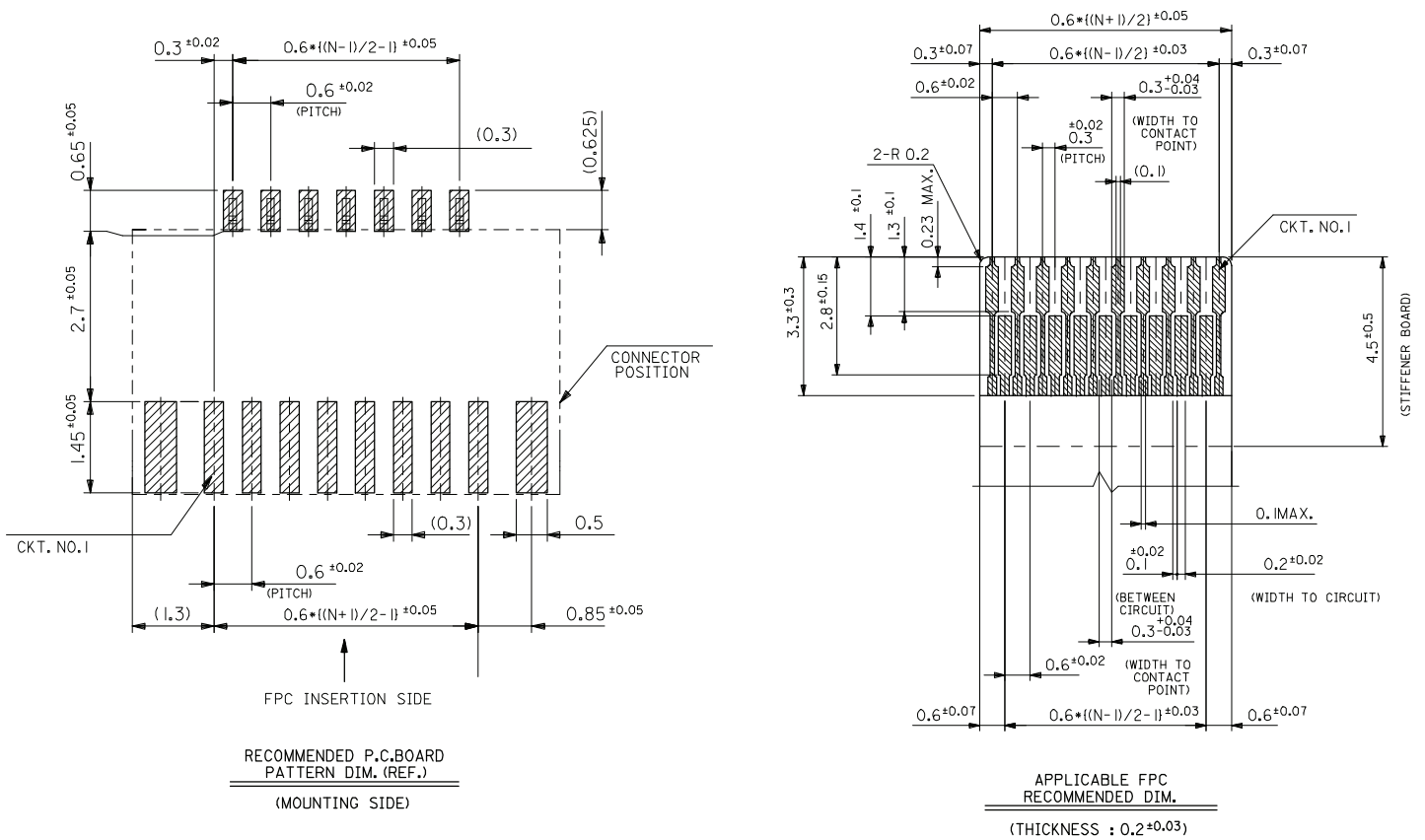
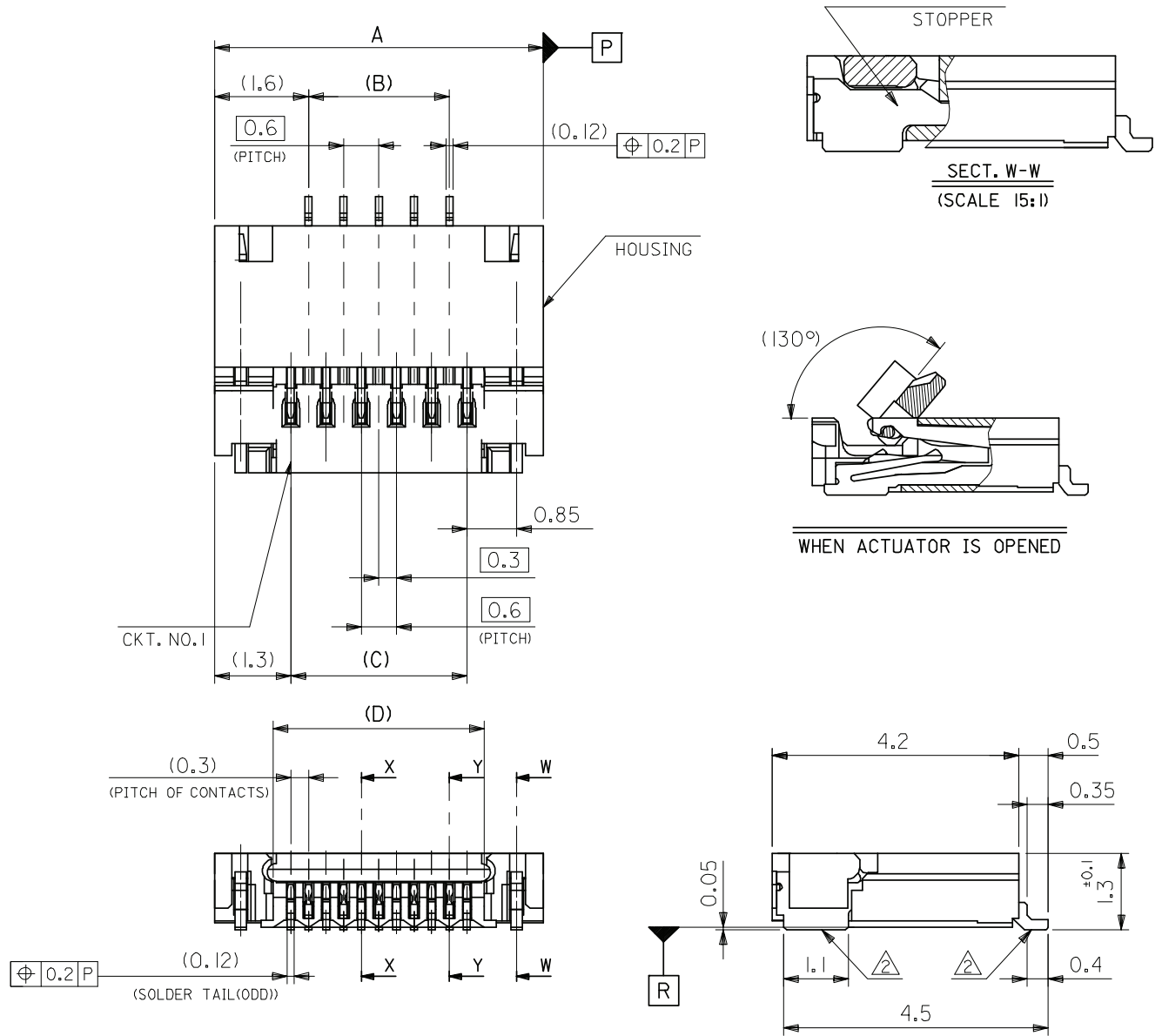


Figure 4-2 21-Pin ZIF Connector (Flex to PL4507 Decoder/CL4500), Motorola p/n 50-12100-2154 (Molex 54809 Series)



**Figure 4-3** 21-Pin ZIF Connector (Flex to PL4507 Decoder/CL4500), Motorola p/n 50-12100-2154 (Molex 54809 Series) (continued)



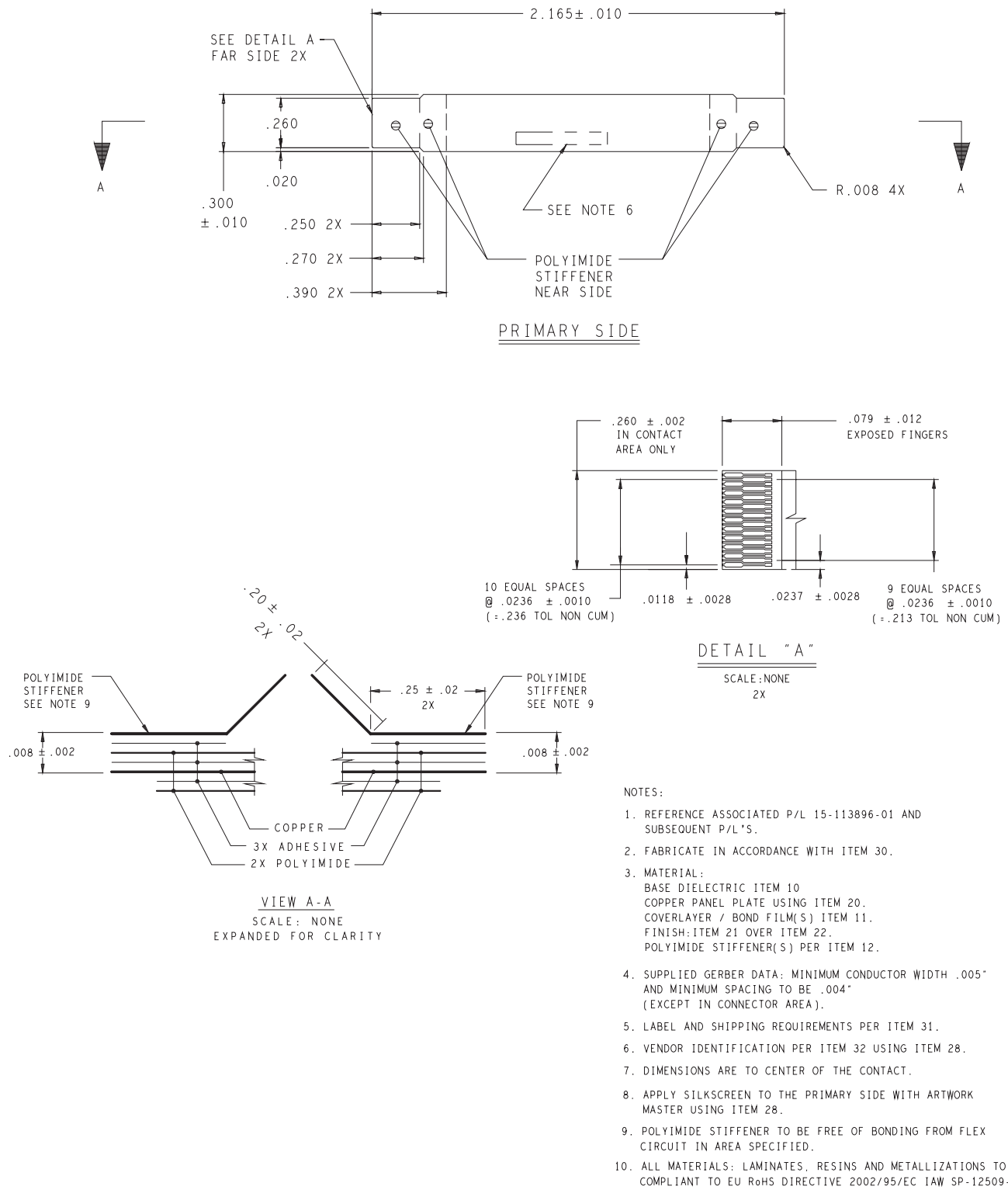


Figure 4-4 Symbol SE4500 to PL4507 Decoder/CL4500 21-Pin Flex, Motorola p/n 15-113896-01



# Chapter 5 Control Interface

## Introduction

The Symbol SE4500 bi-directional control interface uses the industry-standard I<sup>2</sup>C protocol. The SE4500 protocol is a host-initiated command/response type protocol, and does not support unsolicited responses.

## Command List

The Symbol SE4500 protocol supports the commands listed in [Table 5-1](#). For detail on each command, see [Command Descriptions on page 5-5](#).

**Table 5-1** Symbol SE4500 Command List

| I <sup>2</sup> C Command Set | Opcode | Description   |
|------------------------------|--------|---|
| ACQUISITION                  | 0x58   | Starts and stops image data output.                   |
| ACQUISITION_MODE             | 0x5B   | Optimizes the Symbol SE4500 for a specific operation. |
| AIM                          | 0x55   | Turns the aim pattern on and off.                     |
| AIM_BLINK_RATE               | 0xF4   | Controls the blink rate of the aim pattern.           |
| AIM_DURING_EXPOSURE          | 0x56   | Captures the aim pattern in the image.                |
| AIM_POWER                    | 0xF3   | Controls the brightness of the aim pattern.           |
| AUTO_POWER_REDUCTION         | 0x74   | Places the SE4500 in a low power state when idle.     |
| ENTER_BOOTLOADER             | 0x91   | Enters bootloader mode.                               |
| EXECUTE_SCRIPT               | 0x77   | Executes a programmed script.                         |
| EXTERNAL_ILLUMINATION        | 0x5A   | Controls the operation of the EXT_ILLUM_EN signal.    |
| FRAME_RATE                   | 0x5E   | Sets the SE4500 frame rate.                           |
| GET_EXTENDED_STATUS          | 0x79   | Gets the SE4500 operating states.                     |
| GET_PARAM                    | 0x70   | Gets SE4500 parameters.                               |

**Table 5-1** Symbol SE4500 Command List (Continued)

| I <sup>2</sup> C Command Set | Opcode | Description   |
|------------------------------|--------|---|
| ILLUMINATION_CURRENT_LIMIT   | 0xF2   | Reduces the illumination system current drawn from the host.                    |
| ILLUMINATION_DURING_EXPOSURE | 0x59   | Turns illumination on and off.  |
| ILLUMINATION_POWER_LEVEL     | 0xF0   | Sets the illumination brightness level.   |
| IMAGE_CAPTURE_MODE           | 0x73   | Sets the image capture mode.  |
| IMAGE_CROPPING               | 0x5D   | Crops the output image.   |
| IMAGE_RESOLUTION             | 0x5C   | Sets the resolution of the output image.  |
| PICKLIST_MODE                | 0x7B   | Sets the rate of picklist frames.   |
| PING                         | 0x7A   | Used for test purposes.   |
| POWER_MODE                   | 0x5F   | Places the SE4500 in low power mode.  |
| RD_OSC                       | 0x53   | Reads the oscillator registers.   |
| RD_SENSOR                    | 0x51   | Reads the Micron MT9V022 registers.   |
| RESET                        | 0x57   | Returns engine components to a default state.                                   |
| THERMAL_MANAGEMENT_MODE      | 0x80   | Dynamically adjusts the SE4500's frame rate to reduce its internal temperature. |
| TIME_TO_LOW_POWER            | 0x75   | Sets the length of time the SE4500 is idle before entering low power mode.      |
| WR_OSC                       | 0x52   | Writes to the oscillator registers.   |
| WR_SCRIPT                    | 0x76   | Programs more than one SE4500 command into one script.                          |
| WR_SENSOR                    | 0x50   | Writes to the Micron MT9V022 registers.   |

## Transactions

I<sup>2</sup>C transactions control the Symbol SE4500, where a transaction consists of a command followed by a response. I<sup>2</sup>C is a master/slave protocol, meaning the host initiates both transmissions.

The Symbol SE4500 typically processes a command in less than 1 ms, but some commands take up to 100 ms. For this reason, after sending a command, the host (I<sup>2</sup>C master) should request a response, and if the Symbol SE4500 does not respond the host should retry the response request for up to 100 ms. If the Symbol SE4500 does not respond within this time, a hard failure occurred.

The I<sup>2</sup>C format of these commands and responses is as follows.

### I<sup>2</sup>C Command Format

<I2C-Start Bit> <SLA-W> <Cmd-Opcode> <[SE4500-Cmd-Data]> <Checksum> <I2C-Stop-Bit>

where:

- *I2C-Start-Bit* and *I2C-Stop-Bit* are as defined by the I<sup>2</sup>C specification
- *SLA-W* is 0xB8 (Slave-Addr + Write-Op) or
  - Slave Address is 0x5C (or 0xB8 after shifting into 7 MSBs)
  - Write-Op is 0x00
- *Opcode* is 1 byte from the *SE4500 Command Op* column in [Table 5-3 on page 5-11](#).
- *[SE4500-Cmd-Data]* is from the *SE4500 Command Data* column in [Table 5-3 on page 5-11](#). This can be NULL.
- *Checksum* is a 1 byte checksum of the *SE4500 Cmd Data* bytes. See [Command Checksum on page 5-4](#).

### I<sup>2</sup>C Response Format

<I2C-Start Bit> <SLA-R> <Rsp-Opcode> <Status> <[SE4500-Rsp-Data]> <I2C-Stop-Bit>

Where:

- *I2C-Start-Bit* and *I2C-Stop-Bit* are as defined by the I<sup>2</sup>C specification
- *SLA-R* is 0xB9 (Slave-Addr + Read-Op) or
  - Slave Address is 0x5C (or 0xB8 after shifting into 7 msb's)
  - Read-Op is 0x01
- *Opcode* is 1 byte from the *SE4500 Response Op* column in [Table 5-3 on page 5-11](#).
- *Status* indicates whether the SE4500 successfully processed the command. See [Response Status Code on page 5-4](#).
- *[SE4500-Rsp-Data]* is from the *SE4500 Response Data* column in [Table 5-3 on page 5-11](#). This can be NULL.

## Command Checksum

Every command must include a checksum, calculated as follows:

1. Sum the bytes in the command, starting from the opcode through the last command data byte.
2. Use only the low byte of this result.
3. Perform a 2's complement of this result.

This value is the checksum and is added to the checksum field of the command.

## Response Status Code

Every response includes a status code that indicates the success of the command. A successful command returns an ACK or 0x80.

[Table 5-2](#) lists status codes for single errors. Note that these error codes are bit positions within the status byte, and two errors can occur (e.g., NAK and AIM\_POWER\_FAIL), resulting in values not listed in this table.

**Table 5-2** *Response Status Codes*

| Status               | Value            | Cause / Meaning  |
|----------------------|------------------|--|
| ACK                  | 0x80             | Command was successful.  |
| NAK                  | 0x82 (Bit 1 set) | Command failed. Possible causes are: <ul style="list-style-type: none"> <li>• Invalid opcode</li> <li>• Invalid command format</li> <li>• Invalid parameter value</li> </ul> |
| CKSM_ERR             | 0x84 (Bit 2 set) | The transmitted checksum did not match the checksum of the data.   |
| AIM_POWER_FAILURE    | 0x88 (Bit 3 set) | The aiming power exceeded its limit.   |
| THERMAL_FAILURE      | 0x90 (Bit 4 set) | The internal temperature exceeded its limit.   |
| INTERNAL_I2C_FAILURE | 0xA0 (Bit 5 set) | The internal I <sup>2</sup> C interface failed.  |

---

## Command Descriptions

See [Table 5-3 on page 5-11](#) for command and response formats for all Symbol SE4500 commands.

### ACQUISITION 0x58

ACQUISITION Start causes the Symbol SE4500 to output image data on the camera interface. ACQUISITION Stop stops the image data output.

After receiving the Stop command, the Symbol SE4500 may not respond to subsequent commands for up to one frame time (16.6 ms at 60 fps) because the system requires the current frame to complete before the engine processes new commands. Issuing commands during this time results in unacknowledged I<sup>2</sup>C commands, requiring command retries.

### ACQUISITION\_MODE 0x5B

Optimizes the engine's behavior for bar code decoding, image capture, motion detection, or aiming pattern capture.

### AIM 0x55

Turns the aiming pattern on and off. AIM only turns aiming on if acquisition is started. Setting AIM On while acquisition is stopped does not turn aiming on, although it turns aiming on upon the next ACQUISITION Start command.

### AIM\_BLINK\_RATE 0xF4

Controls the blink rate of the aiming pattern. The aiming pattern only blinks when AIM is enabled. The default is Always On.

This command takes two parameters as follows:

- Byte 1 = Number of frames the aiming pattern remains on; 0 = Always On
- Byte 2 = Number of frames the aiming pattern is off.

Blink rate/times depend on the frame rate, for example:

- At 60 fps, to blink at 1/3 seconds on and 2/3 seconds off, set Byte 1 to 20 and Byte 2 to 40.
- At 30 fps, to blink at 1/3 seconds on and 2/3 seconds off, set Byte 1 to 10 and Byte 2 to 20.

✓ **NOTE** When using Picklist Mode, AIM\_BLINK\_RATE must remain at its default.

### AIM\_DURING\_EXPOSURE 0x56

When enabled, this keeps the aiming pattern on when capturing an image, meaning the pattern is visible in the image. When disabled, the aiming pattern is not visible in acquired images. The default is disabled.

Enabling AIM\_DURING\_EXPOSURE has no effect unless AIM is also on. Enabling AIM\_DURING\_EXPOSURE while acquisition is stopped does not turn aiming on, although it turns aiming on upon the next ACQUISITION Start command.

### **AIM\_POWER 0xF3**

Controls the brightness of the aiming pattern. The default is 0x0 or Always On.

A value of 0x0 indicates that exposure and readout times control the aim's duration (and power or brightness).

Values of 0x1 - 0xFF indicate the aiming duration increments from 0.5 ms upward in 0.5 ms intervals; however, exposure and readout times clip its maximum value.

### **AUTO\_POWER\_REDUCTION 0x74**

Places the Symbol SE4500 in a low power state when idle for the duration of time specified by the TIME\_TO\_LOW\_POWER command. Any I<sup>2</sup>C command wakes the Symbol SE4500 from low power mode.

The Symbol SE4500 is considered idle only if acquisition is stopped. While acquisition is started, the Symbol SE4500 does not automatically enter low power mode.

### **EXECUTE\_SCRIPT 0x77**

After programming a script (via the WR\_SCRIPT command), use this command to execute it.

### **EXTERNAL\_ILLUMINATION 0x5A**

Controls operation of the EXT\_ILLUM\_EN signal on the Symbol SE4500 host connector.

### **FRAME\_RATE 0x5E**

Sets the Symbol SE4500 frame rate.

### **GET\_EXTENDED\_STATUS 0x79**

The Symbol SE4500 internally tracks various operating states and stores these states in the extended status structure. This command gets these states from the SE4500. The following are the operating conditions and descriptions.

Each operating condition has 2 bits in the extended status:

- Instantaneous bit - set if the condition exists when the GET\_EXTENDED\_STATUS command is issued. If the condition occurred in the past and no longer exists, the bit is cleared. These bits are reported in the first byte of the extended status data.
- Latched bit - set when the condition is first detected and remains set (even if the condition no longer exists) until the GET\_EXTENDED\_STATUS command is issued, which clears the bit. If a latched bit is set when the GET\_EXTENDED\_STATUS command is issued, this indicates the condition occurred at some point since the last GET\_EXTENDED\_STATUS command. These bits are reported in the second byte of the extended status data.
- Note that these conditions are bit positions within the extended status bytes; these conditions can occur simultaneously resulting in values not shown below.



**Operating States (Individual Bytes)**

- 0x01: The internal temperature is approaching the threshold at which it can affect laser operation.
- 0x08: The internal temperature has reached the threshold at which it affects laser operation.
- 0x02, 0x04, 0x20, 0x40: Internal warning.

**GET\_PARAM 0x70**

Allows a host to read out parameters stored in the Symbol SE4500 (non-volatile memory). See [Table 5-4 on page 5-14](#) for a list of these parameters.

**ILLUMINATION\_CURRENT\_LIMIT 0xF2**

Use this to reduce the maximum current draw on VCC\_ILLUM. Higher values (lower currents) reduce illumination brightness.

**ILLUMINATION\_DURING\_EXPOSURE 0x59**

Turns Illumination on and off. Illumination only turns on if acquisition is started. Enabling illumination while acquisition is stopped does not turn illumination on, although it turns on illumination upon the next ACQUISITION Start command.

**ILLUMINATION\_POWER\_LEVEL 0xF0**

Sets the Symbol SE4500's illumination power (brightness) level. Settings are:

- 0x00 = Lowest power level
- 0xFF = Highest power level

**IMAGE\_CAPTURE\_MODE 0x73**

Sets image capture mode to one of the following:

- Continuous (0x00) - an ACQUISITION Start command results in continuous image frames (one right after another) until you issue the ACQUISITION Stop command.
- Snapshot (0x01) - an ACQUISITION Start command results in only one image frame. Issue another ACQUISITION Start command to acquire another image/frame.

The default is Continuous.

**IMAGE\_CROPPING 0x5D**

Crops the output image to the specified pixel edge.

## IMAGE\_RESOLUTION 0x5C

Sets the resolution of the output image. Row Bin 2 and Column Bin 2 halve the number of rows and columns, respectively, in the image. Row Bin 4 and Column Bin 4 cut the number of rows and columns by a factor of 4.

This command is cumulative, i.e., to set Row Bin 2 and Column Bin 2, use the two-command sequence:

```
<0x5C> <0x01> <Checksum> <0x5C> <0x03> <Checksum>
```

To return to Normal, use the single command:

```
<0x5C> <0x00> <Checksum>
```

## PICKLIST\_MODE 0x7B

Specifies the rate of picklist frames. For picklist frames, illumination is off and the aiming pattern is captured in the image, enabling you to locate (through software image processing) the aiming pattern in the image.

This command has two parameters:

- Number of Picklist Frames (referred to as **M**): how many consecutive Picklist frames are output.
- Number of Frames (referred to as **N**): how many frames before Picklist frames start again.

The default is 0,60, or 0 Picklist frames every 60 frames.

### Example

Two picklist frames - every 60 frames use the arguments [`<0x02> <0x3C>`]

One picklist frame - every 30 frames use the arguments [`<0x01> <0x1E>`]

Configure PICKLIST\_MODE before starting acquisition. When acquisition starts, the picklist sequence begins. The first **M** frames are picklist frames, and the next **N-M** frames are non-picklist frames. This sequence cycles every **N** frames. The host system must track/count every frame to determine when picklist frames and non-picklist frames occur.

In a typical triggering environment where acquisition starts with a trigger and stops with a decode (or trigger release), each trigger pull (ACQUISITION Start) restarts the picklist sequence.

Do not change PICKLIST\_MODE when acquisition is started because this can result in an indeterminate number of picklist frames.

## PING 0x7A

Use this command for test purposes to verify that the engine is in a powered state.

## POWER\_MODE 0x5F

Changes the SE4500's power mode. Although this command offers a Full Power mode option, any command returns the Symbol SE4500 to full power mode.



**NOTE** This command is rejected (a NAK is sent) if acquisition is running (ACQUISITION = Start). If low power is required during acquisition, first send ACQUISITION = Stop, then POWER\_MODE = Low Power.

**RD\_OSC 0x53**

Reads oscillator registers. Refer to the DS1086L oscillator specification from Maxim (<http://www.maxim-ic.com>) for register descriptions.

**RD\_SENSOR 0x51**

Reads Micron MT9V022 sensor registers. Refer to the MT9V022 specification from Micron for register descriptions.

**RESET 0x57**

Returns the SE4500 to a default state.

**THERMAL\_MANAGEMENT\_MODE 0x80**

When enabled, the Symbol SE4500 dynamically adjusts its frame rate (from 60 fps to 30 fps) in an attempt to reduce its internal temperature. When the internal temperature reaches a threshold, the Symbol SE4500 enters Thermal Warning state and reduces its frame rate to 30 fps. If the Symbol SE4500 returns to normal operating temperature it exits Thermal Warning and returns to 60 fps. Use the GET\_EXTENDED\_STATUS command to determine if the Symbol SE4500 is in Thermal Warning mode.

When disabled, the Symbol SE4500 does not dynamically change its frame rate due to temperature changes. The default is disabled.

Only use this mode when FRAME\_RATE is set to 60 fps.

**TIME\_TO\_LOW\_POWER 0x75**

Sets the length of time the Symbol SE4500 must be idle before it enters low power mode. This only applies if AUTO\_POWER\_REDUCTION is enabled.

**WR\_OSC 0x52**

Writes directly to the oscillator IC registers. Refer to the DS1086L oscillator specification from Maxim (<http://www.maxim-ic.com>) for register descriptions.

Note that the Symbol SE4500 controls many oscillator registers. Using this command to write registers may conflict with Symbol SE4500 requirements, causing unpredictable behavior.

## WR\_SCRIPT 0x76

Programs more than one SE4500 command into a script, which can be executed using a single command (EXECUTE\_SCRIPT). Use this method whenever possible to increase performance and timing synchronization.

There are ten scripts (Script-0 through Script-9) and a total of 150 bytes for all scripts. Exceeding these limits results in a NAK status code. The general format for this command is:

```
<0x76><Script#><Len> [ <C1Len><C1Op><C1Data> ] [ <C2Len><C2Op><C2Data> ]
[ <C3Len><C3Op><C3Data> ] <Checksum>
```

✓ **NOTE** Brackets ( [ ] ) appear in this example for clarity only, and are not part of the commands.

### Example

To program script 2 with AIM\_ON, ILLUM\_ON, and ACQUISITION\_ON, format the WR\_SCRIPT command as follows:

```
<0x76><0x02><0x09> [ <0x02><0x55><0x01> ] [ <0x02><0x59><0x01> ] [ <0x02><0x58><0x01> ] <0x70>
```

## WR\_SENSOR 0x50

Writes directly to the Micron MT9V022 sensor registers. Refer to the MT9V022 specification from Micron for register descriptions.

Note that the Symbol SE4500 controls many sensor registers. Using this command to write sensor registers may conflict with Symbol SE4500 requirements, causing unpredictable behavior.

## Command / Response Formats

Table 5-3 depicts the command and response formats for all Symbol SE4500 commands.

In the columns *SE4500 Command Data* and *SE4500 Response Data*, the following letters identify the size of the data: (B) = Byte, (W) = Word, or (A) = Array. Words are in Little-Endian format (low byte first).

\* indicates the default.

**Table 5-3** Symbol SE4500 Command and Response Formats

| Function                     | SE4500 Command |   | SE4500 Response |                                       |
|------------------------------|----------------|---|-----------------|---------------------------------------|
|                              | Op             | SE4500 Command Data <sup>Note1</sup>  | Op              | SE4500 Response Data <sup>Note2</sup> |
| WR_SENSOR                    | 0x50           | (B) Register (W) Value  | 0x50            | -                                     |
| RD_SENSOR                    | 0x51           | (B) Register  | 0x51            | (W) Value                             |
| WR_OSC                       | 0x52           | (B) Register (W) Value  | 0x52            | -                                     |
| RD_OSC                       | 0x53           | (B) Register  | 0x53            | (W) Value                             |
| AIM                          | 0x55           | (B)<br>0x00=Off*<br>0x01=On   | 0x55            | -                                     |
| AIM_DURING_EXPOSURE          | 0x56           | (B)<br>0x00=Off*<br>0x01=On   | 0x56            | -                                     |
| RESET                        | 0x57           | (B)<br>0x00=Sensor<br>0x01=SE4500   | 0x57            | -                                     |
| ACQUISITION                  | 0x58           | (B)<br>0x00=Stop<br>0x01=Start  | 0x58            | -                                     |
| ILLUMINATION_DURING_EXPOSURE | 0x59           | (B)<br>0x00=Off*<br>0x01=On   | 0x59            | -                                     |
| EXTERNAL_ILLUMINATION        | 0x5A           | (B)<br>0x00=Floating Input*<br>0x01=On<br>0x02=Off<br>0x03=Follow Internal Illumination<br>0x04=Follow Trigger<br>0x05=Alternate with Internal Illumination | 0x5A            | -                                     |
| ACQUISITION_MODE             | 0x5B           | (B)<br>0x00=Barcode Decode*<br>0x01=Document Capture<br>0x02=Motion Detect<br>0x03=Aim Capture  | 0x5B            | -                                     |

### Notes:

1. Every command has a 1 byte checksum (last byte of command). See *Command Checksum* on page 5-4.
2. Every response has a 1 byte status code immediately following the Opcode. See *Response Status Code* on page 5-4.
3. These commands/responses have a variable length data field indicated by (A):Array. See *Table 5-4* on page 5-14 for the length of the field based on the param number.

**Table 5-3** Symbol SE4500 Command and Response Formats (Continued)

| Function   | SE4500 Command |  | SE4500 Response                        |      |                                       |                            |
|--|----------------|--|--|------|---------------------------------------|----------------------------|
|  | Op             | SE4500 Command Data <sup>Note1</sup>   |  | Op   | SE4500 Response Data <sup>Note2</sup> |                            |
| IMAGE_RESOLUTION   | 0x5C           | (B)<br>0x00=Normal*<br>0x01=Row Bin 2<br>0x02=Row Bin 4<br>0x03=Column Bin 2<br>0x04=Column Bin 4  |  | 0x5C | -                                     |                            |
| IMAGE_CROPPING   | 0x5D           | (B) Edge<br>0x00=Top<br>0x01=Right<br>0x02=Bottom<br>0x03=Left   | (W) Value<br>(No. of pixels to crop)   | 0x5D | -                                     |                            |
| FRAME_RATE   | 0x5E           | (B)<br>0x00=60fps*<br>0x01=30fps<br>0x02=15fps<br>0x03=10fps   |  | 0x5E | -                                     |                            |
| POWER_MODE   | 0x5F           | (B)<br>0x00=Full*<br>0x01=Low  |  | 0x5F | -                                     |                            |
| ILLUMINATION_POWER_LEVEL                                 | 0xF0           | (B)<br>0x00=Lowest<br>0xFF=Highest Power Level<br>0x9E=Default   |  | 0xF0 | -                                     |                            |
| ILLUMINATION_CURRENT_LIMIT                               | 0xF2           | (B)<br>0x00=Highest current<br>0xFF=Lowest current   |  | 0xF2 | -                                     |                            |
| AIM_POWER  | 0xF3           | (B)<br>0x00* = Aim's duration is controlled by Exposure and Readout times.<br>0x01-0xFF = Aim's duration increments from 0.5 ms in 0.5 ms duration, its maximum value controlled by Exposure and Readout time. |  | 0xF3 | -                                     |                            |
| AIM_BLINK_RATE   | 0xF4           | (B) On Time<br>in ~17ms increments   | (B) Off Time<br>in ~17ms<br>increments | 0xF4 | -                                     |                            |
| ENTER_BOOTLOADER   | 0x91           | (A) Signature (3 bytes:<br>0xAA, 0x50, 0x5F)   |  | 0x91 |                                       |                            |
| GET_PARAM<br>(see Note 3 and <a href="#">Table 5-4</a> ) | 0x70           | (W) Param#   |  | 0x70 | (W) Param#                            | (A) Param Data<br>(Note 3) |

**Notes:**

1. Every command has a 1 byte checksum (last byte of command). See *Command Checksum* on page 5-4.
2. Every response has a 1 byte status code immediately following the Opcode. See *Response Status Code* on page 5-4.
3. These commands/responses have a variable length data field indicated by (A):Array. See *Table 5-4* on page 5-14 for the length of the field based on the param number.

**Table 5-3** Symbol SE4500 Command and Response Formats (Continued)

| Function                | SE4500 Command |   | SE4500 Response |  |
|-------------------------|----------------|---|-----------------|--|
|                         | Op             | SE4500 Command Data <sup>Note1</sup>  | Op              | SE4500 Response Data <sup>Note2</sup>  |
| IMAGE_CAPTURE_MODE      | 0x73           | (B)<br>0x00 = Continuous<br>0x01 = Snapshot   | 0x73            | -  |
| AUTO_POWER_REDUCTION    | 0x74           | (B)<br>0x00=Disabled<br>0x01=Enabled  | 0x74            | -  |
| TIME_TO_LOW_POWER       | 0x75           | (B)<br>0x01* - 0x0A = 10-100 ms, 10 ms increments<br>0x0B - 0x14 = 100-900 ms, 100 ms increments<br>0x15 - 0xFF = 1s - 235 s, 1 s increments<br>0x00 = 5 ms | 0x75            | -  |
| WR_SCRIPT (Note 3)      | 0x76           | (B) Script#      (A) Script Data  | 0x76            | -  |
| EXECUTE_SCRIPT          | 0x77           | (B) Script#   | 0x77            | -  |
| GET_EXTENDED_STATUS     | 0x79           | -   | 0x79            | Returns 4 bytes as follows:<br>(B) Aim Power and Thermal Critical status<br>(B) Thermal Warning Status<br>(B) Spare1<br>(B) Spare2 |
| THERMAL_MANAGEMENT_MODE | 0x80           | (B)<br>0x00=Disabled<br>0x01=Enabled  | 0x80            |  |
| PING                    | 0x7A           | -   | 0x7A            |  |
| PICKLIST_MODE           | 0x7B           | (B) #Picklist-Frames      (B) #Frames   | 0x7B            |  |

**Notes:**

1. Every command has a 1 byte checksum (last byte of command). See *Command Checksum* on page 5-4.
2. Every response has a 1 byte status code immediately following the Opcode. See *Response Status Code* on page 5-4.
3. These commands/responses have a variable length data field indicated by (A):Array. See *Table 5-4* on page 5-14 for the length of the field based on the param number.

**Table 5-4** *Symbol SE4500 Parameter Numbers and Data Formats*

| Parameter                            | Description               | Number | Length (bytes) |
|--------------------------------------|---------------------------|--------|----------------|
| MODEL_NUMBER                         | Engine model number       | 0      | 18             |
| SERIAL_NUMBER                        | Engine serial number      | 1      | 16             |
| DATE_MANUFACTURE                     | Engine manufacturing date | 2      | 7              |
| DATE_SERVICE                         | Engine service date       | 3      | 7              |
| SCANNER_BOOTLOADER_FIRMWARE_VERSION  | Engine bootloader version | 10     | 8              |
| SCANNER_PRODUCTCODE_FIRMWARE_VERSION | Engine firmware version   | 20004  | 8              |
| ENGINE_ID                            | Engine ID number          | 20005  | 1              |
| HARDWARE_VERSION                     | Engine hardware version   | 20006  | 1              |
| DEVICE_CLASS                         | Engine device class.      | 20007  | 18             |
| GUID                                 | Generally Unique ID       | 14     | 32             |



# Chapter 6 Application Notes

---

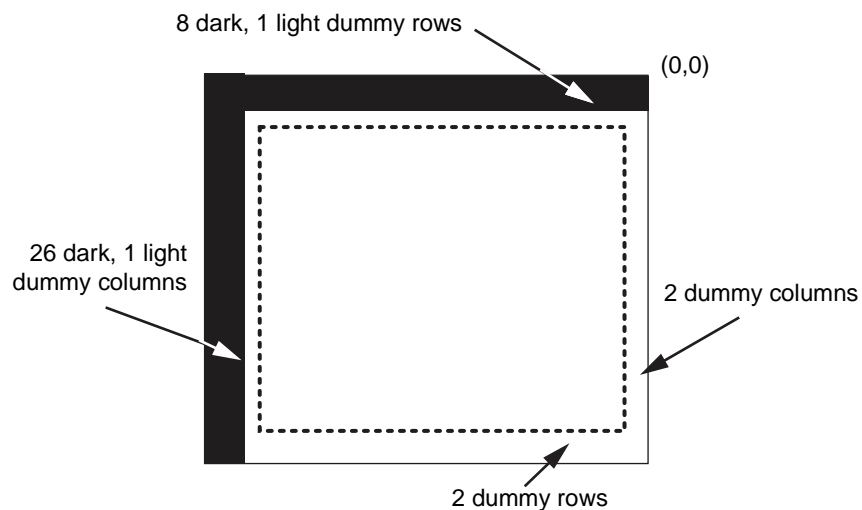
## Introduction

This chapter includes image acquisition and power consumption information. LED illumination is required for decoding.

---

## Image Acquisition

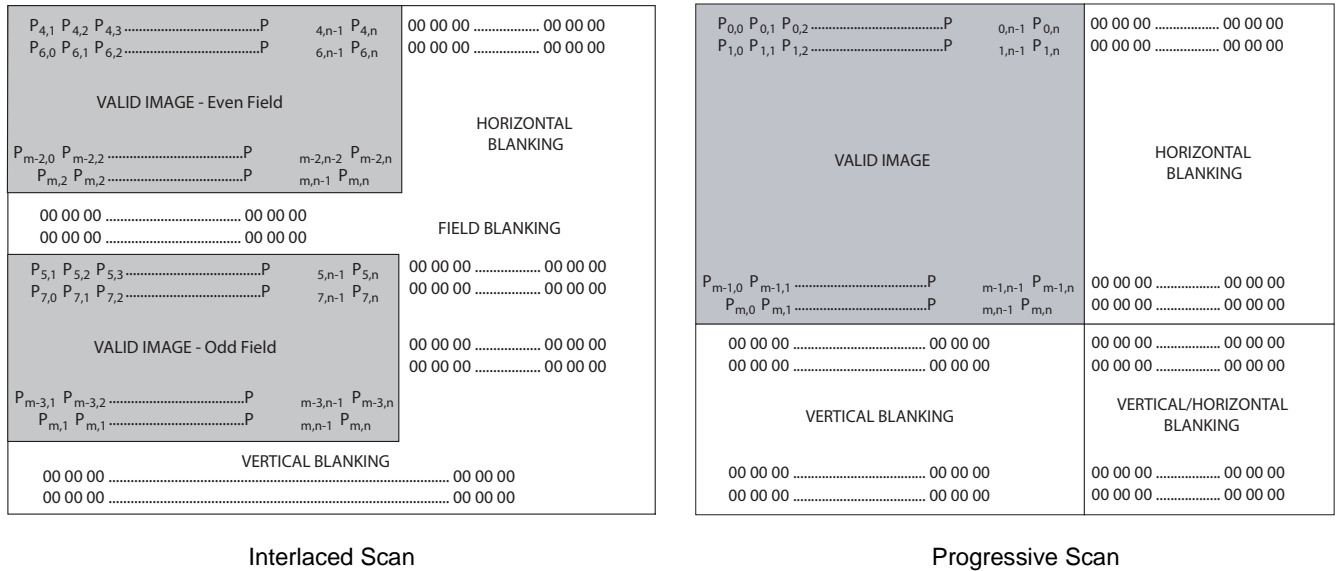
The Symbol SE4500 contains a wide VGA CMOS sensor. [Figure 6-1](#) and [Figure 6-2](#) illustrate pixel output format, and [Figure 6-3](#) and [Figure 6-4](#) show basic timing information.



**Figure 6-1** Pixel Output Format

### Output Data Format

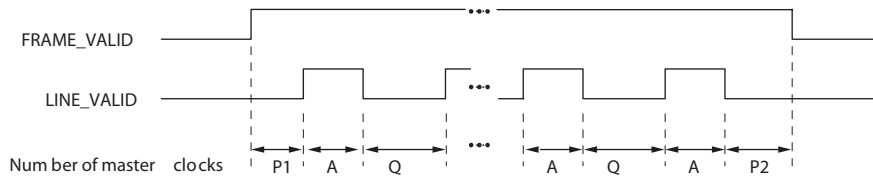
Image data can be read out in a progressive scan or in interlaced scan mode. Vertical and horizontal blanking surrounds valid image data, as shown in *Figure 6-2*.



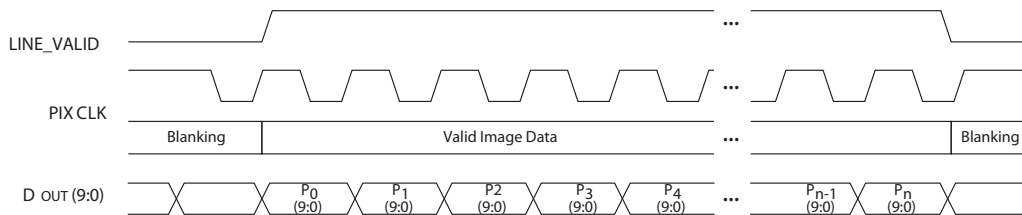
**Figure 6-2** Image Readout

### Output Data Timing

Data output is synchronized with the PIXCLK output. When LINE\_VALID is high, one 10-bit pixel datum is output every PIXCLK period.



**Figure 6-3** Row Timing and FRAME\_VALID / LINE\_VALID Signals



**Figure 6-4** Pixel Data Timing Example

**Table 6-1** *Frame Time*

| Parameter | Description          | Pixel Clock | Master Clocks | Time  | Units |
|-----------|----------------------|-------------|---------------|-------|-------|
| A         | Active data time     | 752         | 752           | 28.02 | μs    |
| P1        | Frame start blanking | 71          | 71            | 2.66  | μs    |
| P2        | Frame end blanking   | 23          | 23            | 0.86  | μs    |
| Q         | Horizontal blanking  | 94          | 94            | 3.52  | μs    |
| A + Q     | Row time             | 846         | 846           | 31.72 | μs    |
| V         | Vertical blanking    | 38,074      | 38,074        | 1.43  | ms    |
| Nrows     | Frame valid time     | 406,080     | 406,080       | 15.23 | ms    |
| F         | Total frame time     | 444,154     | 444,154       | 16.66 | ms    |

---

## Recommended Procedures

The following trigger mode procedures describe the recommended transaction sequence between a host and the Symbol SE4500. These transaction sequences use discrete commands for clarity. Replace any set of discrete commands with a multi-command EXECUTE\_SCRIPT to improve throughput.

### Normal Decode Mode

#### Level Trigger Mode Procedure

The system is initialized as follows:

- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The host sends the Acquisition Stop command.
- The host sends the Barcode Decode mode command.
- The SE4500 optimizes the image output for bar code decoding.
- The SE4500 enters standby mode (or low power mode if enabled).

Upon a trigger pull:

- The host sends the Illumination On command.
- The SE4500 exits standby mode (or low power mode if enabled).
- The host sends the Aim On command.
- The host sends the Acquisition Start command.
- The SE4500 begins outputting images.
- The host attempts to decode the images.

Upon a good decode or trigger release:

- The host sends the Acquisition Stop command.
- The SE4500 stops outputting images.
- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The SE4500 enters standby mode (or low power mode if enabled).

### **Picklist in Level Trigger Mode Procedure**

The system is initialized as follows:

- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The host sends the Acquisition Stop command.
- The host sends the Barcode Decode mode command.
- The host sends the Picklist Mode(1,60) command
- The SE4500 optimizes the image output for bar code decoding.
- The SE4500 enters standby mode (or low power mode if enabled).

Upon a trigger pull:

- The host sends the Illumination On command.
- The SE4500 exits standby mode (or low power mode if enabled).
- The host sends the Aim On command.
- The host sends the Acquisition Start command.
- The SE4500 begins outputting images. Starting with the first frame, every 60th frame is a picklist frame (1,61,121,181 ...).
- The host attempts to decode the images.

Upon a good decode or trigger release:

- The host sends the Acquisition Stop command.
- The SE4500 stops outputting images.
- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The SE4500 enters standby mode (or low power mode if enabled).

## Presentation Mode Procedure

The system is initialized as follows:

- The host sends the Aim Off command.
- The host sends the Illumination On command.
- The host sends the Illumination Power Off command (Off is the default, but power can be set low to allow motion detection in darkness).
- The host sends the Acquisition Start command (and never sends the Stop command).
- The host sends the Motion Detect mode command.
- The SE4500 optimizes the image output for motion detection.
- The SE4500 continuously outputs images.
- In this mode, the SE4500 does not enter standby or low power mode.

Upon the host detecting motion:

- The host sends the Aim On command.
- The host sends the Illumination Power Full command.
- The host sends the Barcode Decode mode command.
- The SE4500 optimizes the image output for bar code decoding.
- The host attempts to decode the images.

Upon a good decode:

- The host sends the Aim Off command.
- The host sends the Illumination Power Off command (Off is the default, but power can be set low to allow motion detection in darkness).
- The host sends the Motion Detect mode command.
- The SE4500 optimizes the image output for motion detection.

During this mode:

- The SE4500 does not automatically enter standby or low power mode.
- The host uses the Power Mode command to put the SE4500 into a low power mode (for support of Bus Powered USB).

### **Auto-AIM Mode Procedure**

The system is initialized as follows:

- The host sends the Illumination Off command.
- The host sends the Aim On command.
- The host sends the Motion Detect mode command.
- The host sends the Acquisition Start command (and never sends the Stop command).
- The host sends the Aim Off command.
- The SE4500 optimizes the image output for motion detection.
- The SE4500 continuously outputs images

Upon the host detecting motion:

- The host sends the Barcode Decode mode command.
- The host sends the Aim On command.

Upon a trigger pull:

- The host sends the Illumination On command.
- The SE4500 optimizes the image output for bar code decoding.
- The host attempts to decode the images.

Upon a good decode or trigger release:

- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The host sends the Motion Detect mode command.
- The SE4500 optimizes the image output for motion detection.

During this mode:

- The SE4500 does not automatically enter low power mode.
- The host uses the Power Mode command to put the SE4500 into a low power mode (for support of Bus Powered USB).

### **Picklist in Auto-AIM Mode Procedure**

The system is initialized as follows:

- The host sends the Illumination Off command.
- The host sends the Aim On command.
- The host sends the Motion Detect mode command.
- The host sends the Picklist Mode(1,60) command
- The host sends the Acquisition Start command (and never sends the Stop command).
- The host sends the Aim Off command.
- The SE4500 optimizes the image output for motion detection.
- The SE4500 continuously outputs images. Starting with the first frame, every 60th frame is a picklist frame (1,61,121,181 ...).

Upon the host detecting motion:

- The host sends the Barcode Decode mode command.
- The host sends the Aim On command.

Upon a trigger pull:

- The host sends the Illumination On command.
- The SE4500 optimizes the image output for bar code decoding.
- The host attempts to decode the images.

Upon a good decode or trigger release:

- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The host sends the Motion Detect mode command.
- The SE4500 optimizes the image output for motion detection.

During this mode:

- The SE4500 does not automatically enter low power mode.
- The host uses the Power Mode command to put the SE4500 into a low power mode (for support of Bus Powered USB).



## Snapshot Mode

### Level/Presentation/Auto-Aim Trigger Mode Procedure

The system is initialized as follows:

- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The host sends the Acquisition Stop command.
- The host sends the Imaging mode command.
- The SE4500 optimizes the image output for image capture.
- The SE4500 (typically) enters low power mode.

Upon a trigger pull:

- The host sends the Illumination On command.
- The SE4500, if in low power mode, exits low power mode (either Reduced or Sleep).
- The host sends the Aim On command.
- The host sends the Acquisition Start command.
- The SE4500 captures an image.

Upon completion of an image capture:

- The SE4500 stops outputting image.
- The host sends the Acquisition Stop command.
- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The host goes back to Normal Decode Mode.
- The SE4500 (when all conditions are met) enters Reduced Power mode.

## Video Mode

### Level/Auto-Aim Trigger Mode

The system is initialized as follows:

- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The host sends the Acquisition Stop command.
- The host sends the Imaging mode command.
- The SE4500 optimizes the image output for video.
- The SE4500 (typically) enters low power mode.

Upon a trigger pull:

- The host sends the Illumination On command.
- The SE4500, if in low power mode, exits low power mode (either Reduced or Sleep).
- The host sends the Aim On command.
- The host sends the Acquisition Start command.
- The SE4500 begins outputting video stream.

Upon a trigger release:

- The host sends the Acquisition Stop command.
- The SE4500 stops outputting the video stream.
- The host sends the Aim Off command.
- The host sends the Illumination Off command.
- The SE4500 (when all conditions are met) enters Reduced Power mode.

---

## Recommendations

### Power Mode

The Symbol SE4500 powers up into full power mode. To save power, enable `AUTO_POWER_REDUCTION`.

### Scripts

For improved performance and timing synchronization, replace a set of discrete commands with a multi-command `EXECUTE-SCRIPT`.



# Appendix A Register Settings

For information on register settings for the engine, refer to the *Micron MT9V022 (mono) Wide VGA CMOS Digital Image Sensor Datasheet*, available at <http://www.micron.com>.



# Index

## A

|                          |     |
|--------------------------|-----|
| aiming                   | 1-3 |
| control                  | 1-3 |
| element                  | 3-2 |
| ambient light immunity   | 3-2 |
| anti-reflection coatings | 2-6 |

## B

|               |     |
|---------------|-----|
| block diagram | 1-2 |
|---------------|-----|

## C

|                            |           |
|----------------------------|-----------|
| cable                      |           |
| drawings                   | 4-2       |
| CMOS                       | 1-2       |
| coatings                   | 2-6       |
| command checksum           | 5-4       |
| command descriptions       | 5-5       |
| command format             | 5-3, 5-11 |
| command list               | 5-1       |
| connector                  |           |
| drawings                   | 4-2       |
| flex                       | 4-5       |
| considerations             |           |
| optical                    | 2-4       |
| avoiding scratched windows | 2-4       |
| positioning exit window    | 2-4       |
| control interface          | 5-1       |
| command checksum           | 5-4       |
| command descriptions       | 5-5       |
| command format             | 5-3, 5-11 |
| command list               | 5-1       |
| data formats               | 5-14      |
| parameter numbers          | 5-14      |
| recommendations            | 6-4, 6-10 |

|                                |           |
|--------------------------------|-----------|
| auto-aim mode                  | 6-7       |
| level trigger mode             | 6-4       |
| picklist in auto-aim mode      | 6-8       |
| picklist in level trigger mode | 6-5       |
| presentation mode              | 6-6       |
| snapshot mode                  | 6-9       |
| video mode                     | 6-10      |
| response format                | 5-3, 5-11 |
| status codes                   | 5-4       |
| transactions                   | 5-3       |
| conventions                    |           |
| notational                     | x         |

## D

|                                |      |
|--------------------------------|------|
| data formats                   | 5-14 |
| decode distances               |      |
| DL focus                       | 3-7  |
| HD focus                       | 3-9  |
| SR focus                       | 3-5  |
| decode mode                    |      |
| auto-aim mode                  | 6-7  |
| level trigger mode             | 6-4  |
| picklist in auto-aim mode      | 6-8  |
| picklist in level trigger mode | 6-5  |
| presentation mode              | 6-6  |
| recommendations                | 6-4  |
| decode zones                   | 3-4  |
| DL focus                       | 3-6  |
| HD focus                       | 3-8  |
| SR focus                       | 3-4  |
| dimensions                     | 3-3  |
| document capture               | 2-2  |

**E**

electrical interface ..... 3-3  
     signal information ..... 4-1  
 environment ..... 2-1  
 ESD ..... 2-1, 3-2  
 exit window  
     avoiding scratches ..... 2-4  
     coatings ..... 2-6  
     diagram ..... 2-7  
     material ..... 2-5  
     positioning ..... 2-4  
     properties ..... 2-5, 2-8  
 external optics ..... 2-2

**F**

flex ..... 4-5  
 flex connector ..... 1-2  
 focus positions  
     distance from engine ..... 3-2

**G**

grounding ..... 2-1

**H**

HD focus decode distances ..... 3-9  
 housing design ..... 2-4  
 humidity specification ..... 3-3

**I**

I2C  
     command format ..... 5-3, 5-11  
     response format ..... 5-3, 5-11  
     transactions ..... 5-3  
 illumination system ..... 1-3  
 image acquisition ..... 6-1  
 image capture ..... 2-2  
 information, service ..... xi  
 installation  
     environment ..... 2-1  
     ESD ..... 2-1  
     external optics ..... 2-2  
     grounding ..... 2-1  
     housing ..... 2-4  
     mounting ..... 2-3  
     mounting diagram ..... 2-3  
     optical considerations ..... 2-4  
     positioning exit window ..... 2-4  
     thermal considerations ..... 2-2

**L**

laser ..... 1-3  
 LED ..... 1-3, 3-2

**M**

mounting ..... 2-3  
     diagram ..... 2-3

**N**

notational conventions ..... x

**O**

optical ..... 2-4  
     avoiding scratched windows ..... 2-4  
     exit window material ..... 2-5  
     path and exit window diagram ..... 2-7  
     positioning exit window ..... 2-4  
     resolution ..... 3-1  
 optics ..... 2-2  
 output data format ..... 6-2  
 output data timing ..... 6-2

**P**

parameter numbers ..... 5-14  
 pinouts ..... 4-1  
 pixel output ..... 6-1  
 polysiloxane coating ..... 2-6  
 power mode recommendations ..... 6-10  
 power supply noise ..... 2-1

**R**

register settings ..... A-1  
 regulatory ..... 1-1, 2-2  
 response format ..... 5-3, 5-11

**S**

script recommendations ..... 6-10  
 service information ..... xi  
 shock specification ..... 3-2  
 signal information ..... 4-1  
 skew, pitch and roll ..... 3-2, 3-3  
 snapshot mode ..... 6-9  
 specular dead zone ..... 3-2  
 SR focus decode distances ..... 3-5  
 status codes ..... 5-4

**T**

|                                 |     |
|---------------------------------|-----|
| technical specifications .....  | 3-1 |
| temperature specification ..... | 3-3 |
| thermal considerations .....    | 2-2 |
| timing diagrams .....           | 6-2 |

**V**

|                               |          |
|-------------------------------|----------|
| vibration specification ..... | 3-2      |
| video mode .....              | 6-10     |
| visible laser diode .....     | 1-2, 3-2 |

**W**

|              |     |
|--------------|-----|
| weight ..... | 3-3 |
| WVGA .....   | 1-2 |

**Z**

|                     |     |
|---------------------|-----|
| ZIF connector ..... | 1-2 |
|---------------------|-----|





# *Tell Us What You Think...*

We'd like to know what you think about this Manual. Please take a moment to fill out this questionnaire and fax this form to: (631) 738-4618, or mail to:

Motorola, Inc.  
One Motorola Plaza M/S B-10  
Holtsville, NY 11742-1300  
Attention: Technical Publications Manager  
Advanced Data Capture Division

**IMPORTANT:** If you need product support, please call the appropriate customer support number provided. Unfortunately, we cannot provide customer support at the fax number above.

Manual Title: \_\_\_\_\_  
(please include revision level)

How familiar were you with this product before using this manual?

- Very familiar     Slightly familiar     Not at all familiar

Did this manual meet your needs? If not, please explain.

---

---

---

What topics need to be added to the index, if applicable?

---

---

---

What topics do you feel need to be better discussed? Please be specific.

---

---

---

What can we do to further improve our manuals?

---

---

---

Thank you for your input—We value your comments.







**MOTOROLA**

Motorola, Inc.  
One Motorola Plaza  
Holtsville, New York 11742, USA  
1-800-927-9626  
<http://www.motorola.com/enterprisemobility>

MOTOROLA and the Stylized M Logo and Symbol and the Symbol logo are registered in the U.S. Patent and Trademark Office.  
All other product or service names are the property of their respective owners.

© Motorola, Inc. 2010



72E-112996-02 Revision A - April 2010