

bueno systems

SMART CAMERA



Bueno Systems introduces a new way of looking at inspection. In the past, some inspection jobs required cumbersome arrays of photosensors, or else \$20,000 vision systems. Now there's an inexpensive alternative: the Bueno Systems Smart Camera.

The Smart Camera combines a 64- or 128-pixel linescan sensor (the eye) with a microcontroller (the brain). Both are contained in a sealed housing the size of a soda can. The eye sees what's placed in front of it. The brain makes decisions based on what it sees.

The best part is, *you* configure the Smart Camera for your application. Need to track the edge of a moving web? The Smart Camera can do it. Need to determine bottle orientation, board width, conveyor coverage? These are just a few of the jobs the Smart Camera is doing right now.

The Smart Camera connects through its full-duplex RS422 interface to a host of real-world input/output adapters. Bueno Systems provides analog output for process control, discrete I/O for machine control, as well as RS232 for PC-based monitoring and control.

And it's this control that gives *you* control over your inspection problems.

a new dimension IN INSPECTION SYSTEMS

detect

Size
Shape
Orientation
Coverage

locate

Objects
Edges
Gaps
Holes

measure

Height
Width
Diameter
Thickness

who

uses the Smart Camera?

Motorola
Eastman Kodak
Hewlett Packard
Barr-Mullin, Inc.
Formost Packaging

Allied Signal
Texas Instruments
Deluxe Laboratories
W. L. Gore & Associates
Joseph E. Seagram & Sons

... to name just a few.



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Pricing and specifications are subject to change without notice.

specifications

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SMART CAMERAS

Image

LS64: 64-pixel x 8-bit (analog), 64-pixel x 1-bit (binary), 127-pixel x 1-bit (interpolated binary)

LS128: All LS64 modes in regular and 2x zoom fields-of-view, plus 128-pixel x 8-bit, 128-pixel x 1 bit, 255-pixel x 1-bit.

Speed

2.5 to 35ms programmable exposure time. Image acquisition ranges from 3.5ms to 13ms, depending on mode.

Memory

EEPROM: 512 bytes for user programs.

RAM: 256 bytes for temporary variables.

Programming

Compact stack-oriented language. Requires BuenoVision development software.

Communications

RS422, full duplex. 8-pin mini-DIN connector.

Lens

C-mount. Comes with 16mm standard.

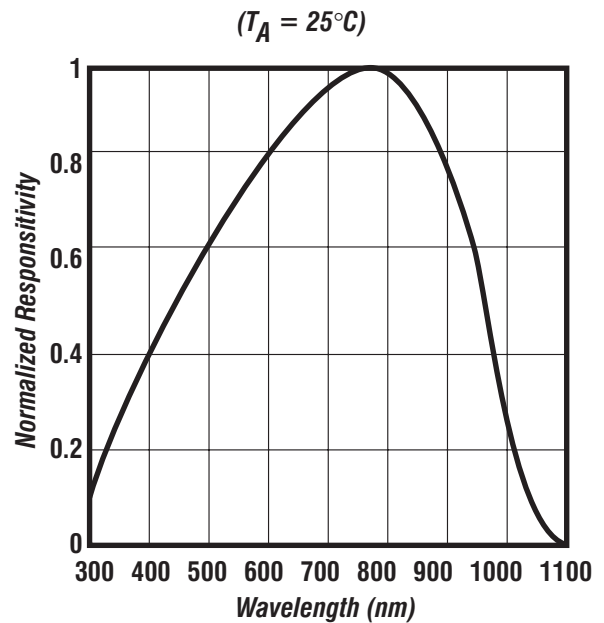
Construction

Anodized aluminum body, plastic lens cover, both O-ring sealed

Power

7-18VDC, 25ma (filtered, unregulated)

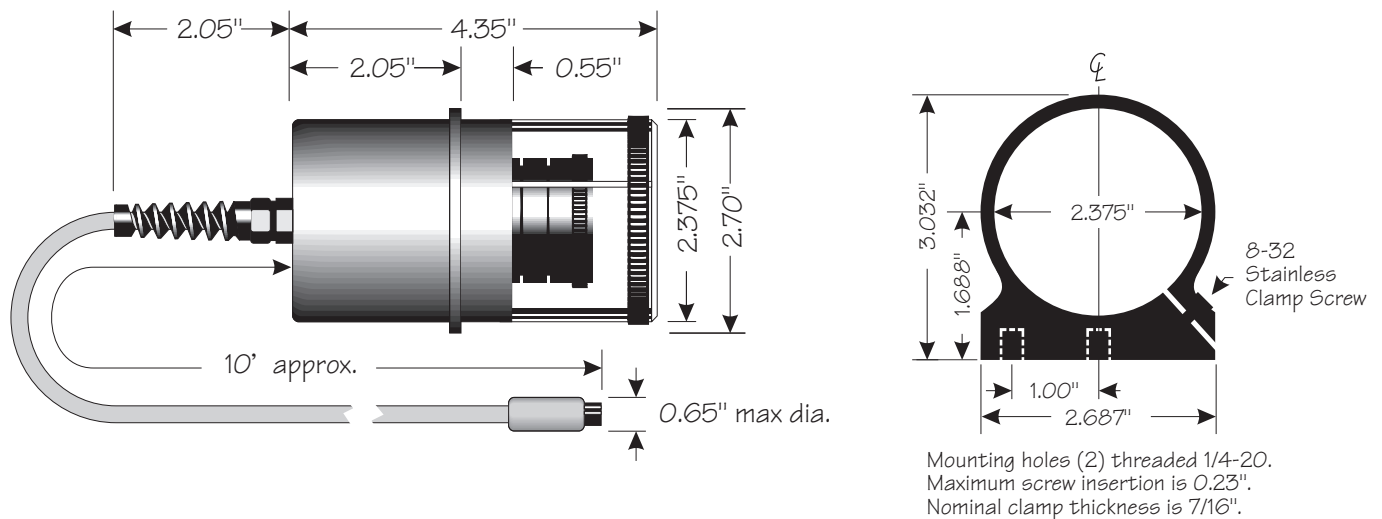
spectral response



64-Pixel Smart Camera
128-Pixel Smart Camera
Mounting Clamp & Lock
Mounting Clamp Only

Order No. LS64
Order No. LS128
Order No. LS-CLAMP-L
Order No. LS-CLAMP

dimensions



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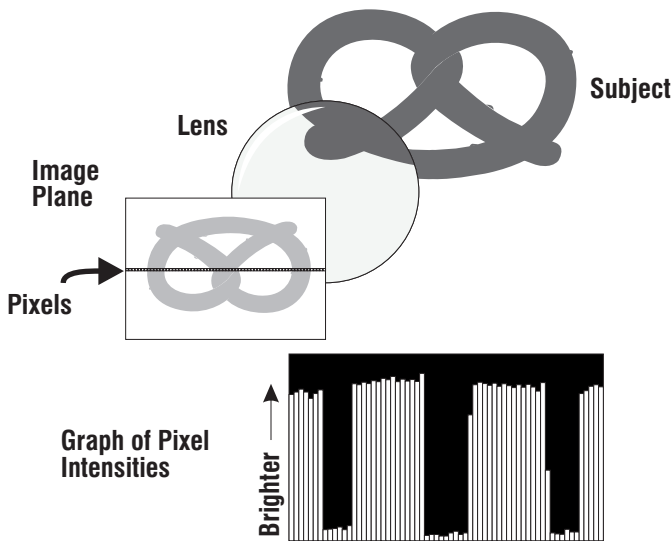
Pricing and specifications are subject to change without notice.

OPTICAL CONSIDERATIONS

The LS64 and LS128 Smart Cameras use a linear photodiode array. This array has 64 (128 for the LS128) photosensitive sites, or pixels, in a single row, as shown:



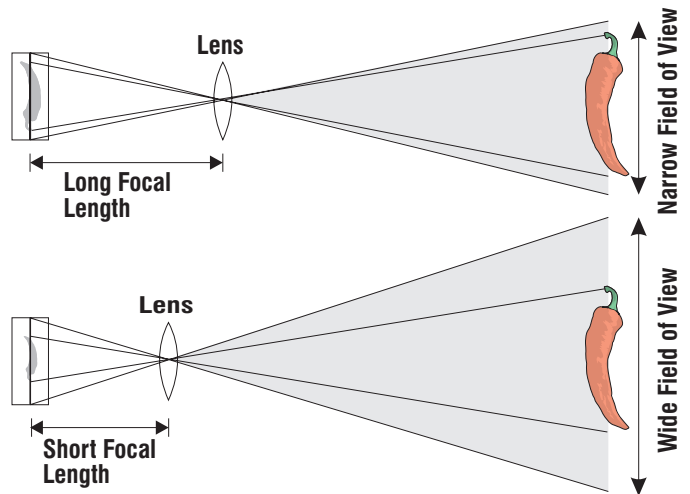
By mounting a lens in front of the array, subjects placed before the camera can be imaged onto the array. Each pixel will respond to light striking it from one small area of the subject. All the pixels taken together will therefore correspond to a narrow strip of the subject. By reading the output from the pixels into its microcontroller, the Smart Camera can obtain a light intensity profile along a line segment through the subject. See illustration:



With this intensity profile, you can configure the Smart Camera to count bright or dark pixels and locate edges over the full range of pixels, or within any subrange. In this way you can measure widths, locate objects and holes, and follow edges, among a host of other functions.

By combining several snapshots of an object as it moves by the camera, you can also determine area, perimeter, shape, orientation, etc. The calculations necessary for these measurements can be done right in the camera. The camera can then output a result over its

But how do pixels translate into actual physical dimensions, and how accurate are they? The answer is, "That depends. . ." It depends on the Smart Camera's field of view at the subject distance. You see, the Smart Camera doesn't have a fixed-width field of view. Just as in regular photography, the farther you are from your subject, the more subject you can encompass. And if you can't step back far enough, you just switch to a wide-angle lens. Or, if you need to zoom in close, you use a telephoto. The magnification of a lens is given by its focal length: the longer the focal length, the closer it brings the subject. Well, it doesn't really bring the subject closer -- it just narrows the field of view, making the subject look bigger. See illustration:



In the Smart Camera the relationships between the field of view, lens focal length, subject distance, and resolution are given below:

$$\text{Field of View} = \frac{8\text{mm}}{\text{Lens Focal Length}} \times \text{Subject Distance}$$

$$\text{Resolution per Pixel} = \frac{\text{Field of View}}{64 \text{ (or 128) Pixels}}$$

So with the standard 16mm lens, the field of view is one half the subject distance. At a distance of 16 inches, for example, the field of view will be 8 inches, and each pixel in an LS64 will resolve 1/8 inch.



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Q How fast is the Smart Camera? How many parts per minute can I inspect?

A It depends on the application. Some applications require continuous monitoring, such as tracking the edge of a web for example, while others are looking at discrete objects. Of the latter, some features, such as presence or absence of a part can be seen in a single snapshot. Others, such as shape or orientation, require several snapshots while the part is moving by. Also factored into the equation is the processing time required before outputting a result. So, although there is no single answer to this question, we *can* provide some examples from past applications using the LS64, as follows:

Web processes, simple measurements: 120 measurements/sec.

Discrete objects, single snapshot per item, items spaced on 10-inch centers, moderately complex decision: 250 parts/min.

Discrete objects six inches long, one inch separation, snapshot every 1/4 inch, moderately complex decision: 65fpm conveyor speed.

Inspections using the LS128 will be slightly slower due to the increased resolution.

Q Can the Smart Camera distinguish color?

A The Smart Camera is a black-and-white sensor. However, it is possible to distinguish between two contrasting colors by using a color filter. For example, if it is necessary to distinguish between green and red, putting a red filter on the camera will cause green objects to look dark and red objects to look bright.

Q The features I'm looking for are plain as day to the eye with the light that's available. Can I use ambient lighting with the Smart Camera?

A No. Ambient lighting by its very nature is too variable and non-uniform. Although the human eye is capable of distinguishing features in variable lighting conditions, it's had millions of years to evolve this capability. Electronic inspection systems need a little more help. By using controlled illumination, you give your inspection project the best chance for success. We can help you with lighting, from suggesting the best method to providing the fixtures.

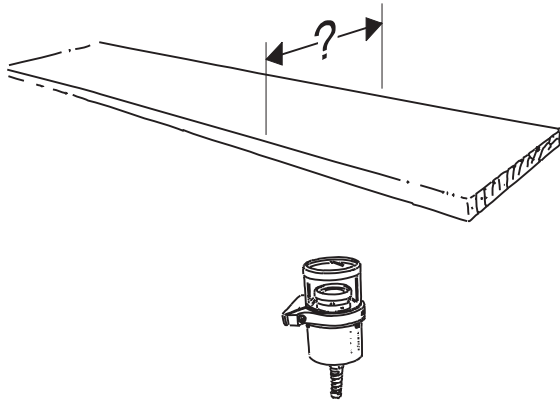
Q I want to measure the width (length, height, etc.) of a board (pipe, bar, etc.). But the board is 10 inches wide, and I need to measure ± 0.01 inches, or one part in a thousand. If the Smart Camera's resolution is only one in 64 or 128, how can I do it?

A If the width of the boards you're looking at vary by only a half inch, say, and one edge can be pressed against a stop, you only need to look at 3/4 inch of the other edge to get an accurate measurement (1/128th of 3/4 inch is 0.006 inch). The fixed distance of the camera from the stop can be calibrated out. If using a stop is impractical, two cameras can be mounted a fixed distance apart, each focussed on one edge, and the fixed distance between the cameras calibrated out.



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Measuring Board Width



Problem

A manufacturer of lumber sawing equipment wants to sort boards coming out of a high-speed chop saw by width.

Solution

By mounting an LS64 Smart Camera under the board, it is possible to get an accurate measurement of the board width, without parallax errors due to variations in board thickness.

Our analog output module (AOUT1-5) feeds width information from the camera to the sorter through a spare analog input on the saw's motion control electronics.

Determining Conveyor Coverage

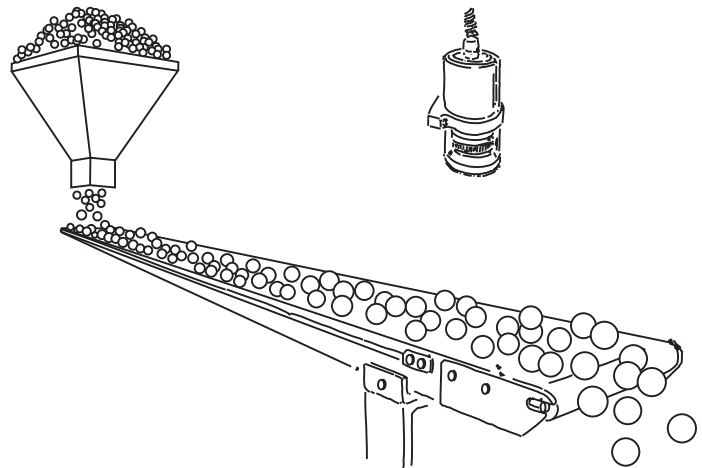
Problem

A fruit packer needs to control the flow of oranges on a conveyor.

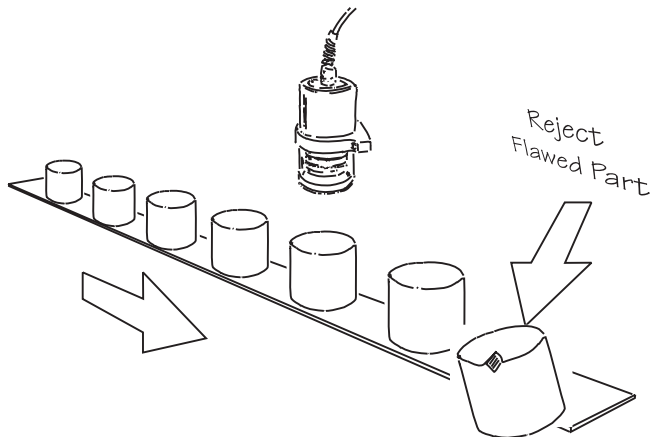
Solution

By mounting an LS64 Smart Camera over the conveyor it is possible to determine the percent of conveyor coverage by the oranges. The camera controls the hopper, dumping oranges on the belt, thereby keeping the flow of oranges even. The flow can be changed by using a dial input to fine tune the amount of product.

In a similar application a packer wants to keep the flow of oranges equal between *two* belts. This was achieved by using two cameras communicating with a PLC.



Detecting Surface Flaws



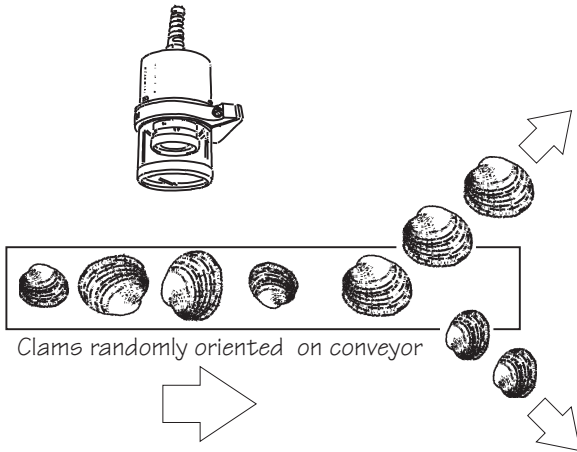
Problem

A manufacturer of cylindrical magnets wants to find surface flaws on the face of the magnets.

Solution

By using the math capabilities of the LS128 Smart Camera, the manufacturer is able to calculate the surface area of each magnet's face as it is conveyed past. Flawed magnets appear to the camera to have a smaller total surface area. When the inspection unit encounters a flawed magnet it sends a signal to an MPX2A discrete I/O module to operate a reject solenoid directly.

Sorting by Size



Problem

A seafood processor needs to grade clams by size, specifically by the major (widest) diameter of the clam.

Solution

Because the clams are randomly oriented, measuring their major diameters directly can be difficult. But by relating diameter to area and perimeter, two easily measured features, the diameter can be inferred from those features. By taking advantage of the complete math capabilities internal to the smart camera, it is possible to scan each clam as it passes and calculate its major diameter.

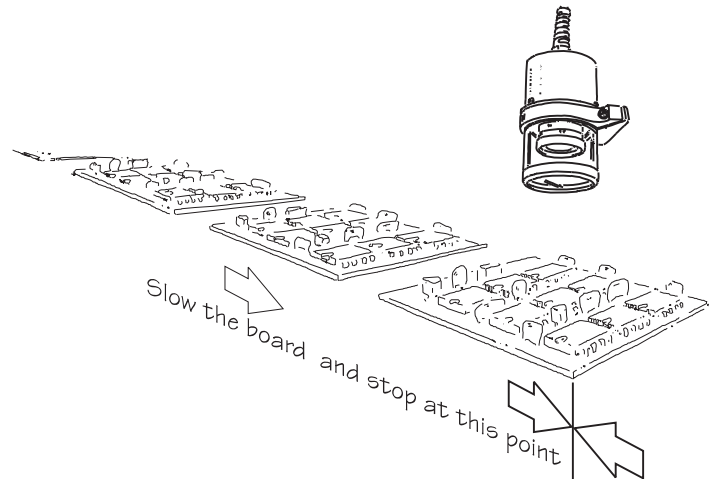
Problem

An electronic equipment manufacturer has problems controlling the position of circuit boards ahead of a robotic soldering station. They need to precisely decelerate and stop each circuit board without jarring it and misaligning loose parts.

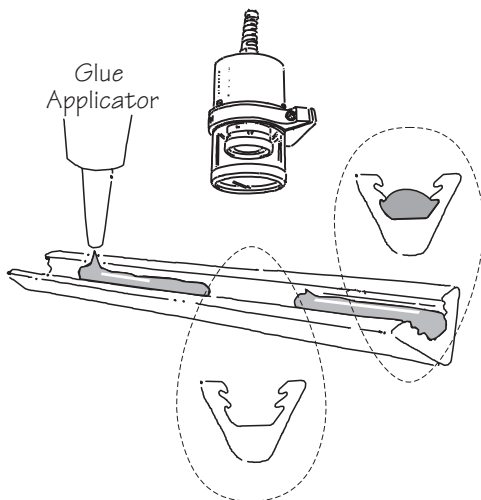
Solution

The LS64 Smart Camera looks at the edge of each approaching board to calculate and anticipate the rate of deceleration. By feeding this information to a motion controller, it is possible to gradually decelerate the board and precisely stop it at the target point without jarring components from their original locations.

Position Feedback for Motion Control



Detecting Glue in Automotive Molding



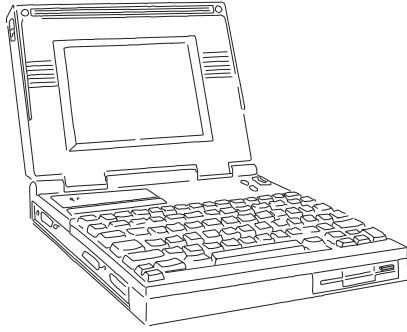
Problem

An automotive manufacturer has problems determining the consistency of glue application on extruded rubber door moldings. They need to know if the glue line is interrupted or has run out during application and to stop the line if so.

Solution

A Smart Camera, mounted immediately after the glue applicator, is used to detect the presence and absence of glue. Upon detection of a void in the glue line, the camera sends a signal to stop the machine and alert an operator.

product brief



ENO VISION

Development Software for the
LS64 & LS128 Smart Cameras

BuenoVision is an integrated Windows-oriented development tool that brings control of Bueno Systems' Smart Cameras to your fingertips. With it you can:

- Create programs for the LS64 or LS128 Smart Camera.
- Monitor the I/O functions of the camera.
- Set up the camera and hardware using a monitor program that lets you see what the camera sees in real time.
- Load programs into the Smart Camera without disconnecting any installation cabling or removing the camera from its mount.

BuenoVision is a seamless toolkit of software utilities that help you to solve your toughest machine vision problems at a fraction of the cost of other systems.

The Project Window

Features and utilities of the development system are accessed from the project window using menu or tool bar commands. The window is laid out in an intuitive way that makes it easy to learn and use.

The Program Editor

Programs are written with the program editor (the main screen of the project window), using the standard Windows drag and drop techniques and editing features. Our BSL language is an easy to learn but flexible programming language with math and logic functions to help you solve the trickiest of inspection problems. With it you can create programs that are robust, quick, and specific to your application.

Setup

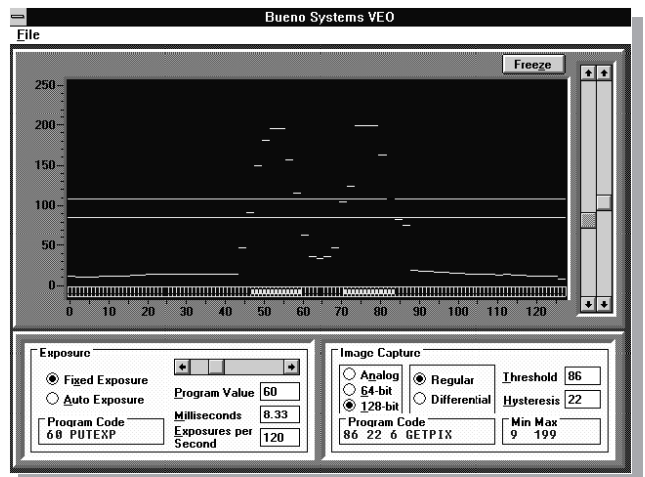
To fine tune the installation of your Smart Camera use VEO, the viewfinder of BuenoVision. It lets you see what the camera sees in real time. Use it to align, focus and set the aperture of the camera. Use it to adjust the lighting and determine operating parameters and settings for your LS64 or LS128 programs. VEO is a hands-on utility that lets you experiment with your setup to get the most out of your installation.

```
----- Eggsample #2, Measuring Eggs -----
(* This example uses encoder pulses to time the *)
(* measurement of moving objects, giving consistent *)
(* results regardless of the speed at which they travel *)
(* across the field of view. *)

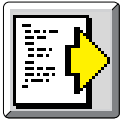
-----Declaration Section-----
REG
PulsePix: R1      (* Assign names to the registers*)
NewPulse: R2
NewEgg: R3
EggArea: R5R4
EggPix: R6
VAR
ScanData: 16     (* Set aside 16 bytes of RAM *)
                (* to store the image from *)
                (* scan initiated by GETPIX. *)

-----Program Starts Here-----
PROG
Start:
00 PUTEXP      (* Set exposure to AutoExposure. *)

00H PUT NewPulse (* This section clears all the *)
```

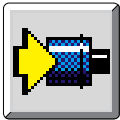


Compiler



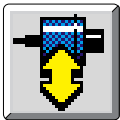
Once you have entered your program into the program editor, press the compile button to generate an object file from your source program. This is the machine code that is loaded into the LS64's EEPROM. This step will also check for programming errors. If it finds any it will highlight them in the programming window and let you know what it expected from you in the message window.

Loader



To load your program into the camera just press the load button. In a matter of seconds the program is written into the LS64's memory where it will remain until you change it (even if you lose power, disconnect it or shut it down). The program in the camera runs anytime there is power to it. No switches or extra control devices are necessary.

Communications



Press the communications button to switch to the communications utility. It lets you set up serial communications protocols to monitor the output of the camera in several different modes, including character and graphics modes. This is a great tool for proofing your programs and performing trial runs of prototype control systems.



Reference Manual

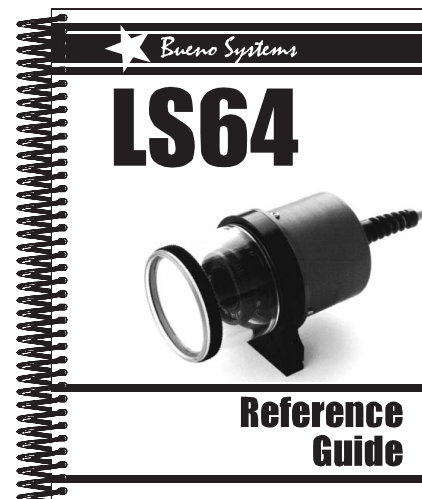
The comprehensive 148-page reference manual that comes with BuenoVision covers everything from camera operation and lighting to programming. It even has an "Out of the Box" chapter to help you get your system up and running in the shortest amount of time. And its tutorial section is designed to get you up to speed on programming fast.

Requirements

CPU: 486-33 or higher

Operating System: Windows 3.1 or higher

Installation: 3½" disk drive.



**BuenoVision Software
Manual Only**

**Order No. LS-SFTWR
Order No. LS-MANUAL**



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product brief

ISCRETE I/O

for the LS64 & LS128 SMART CAMERAS



specifications

Outputs (2), each having:

Phototransistor: 0-30VDC, 0-20ma, .1ms switch time.

MOSFET: 0-40VDC, 0-1A, 1ms turnon, 8ms turnoff.

Inputs (2):

12-32VDC, 5-12ma, 5.5ms switch time.

Camera Ports (2):

8-pin mini-DIN female, LS64- and LS128-compatible.

Programming Port:

Full-duplex RS422, RJ11 connector. Requires CV232 adapter cable for RS232 use with a PC.

Power Requirements:

24VDC \pm 10%, 100ma (with two cameras plugged in).

Galvanic Isolation:

All discrete I/O and the power input are isolated from the logic and from each other.

The Bueno Systems MPX2A Discrete I/O Module interfaces up to two LS-series Smart Cameras to two optically-isolated input and two optically-isolated output channels. Each of the two output channels has both a high-speed phototransistor output suitable for interfacing to PLCs and a high-current MOSFET output capable of driving relays and solenoids directly.

All the I/Os are isolated from each other and can work with both current-sourcing (PNP) and current-sinking (NPN) logic. Indicator LEDs let you see what's happening at all times. Furthermore, any edge of any input can be programmed to trigger the cameras connected to it.

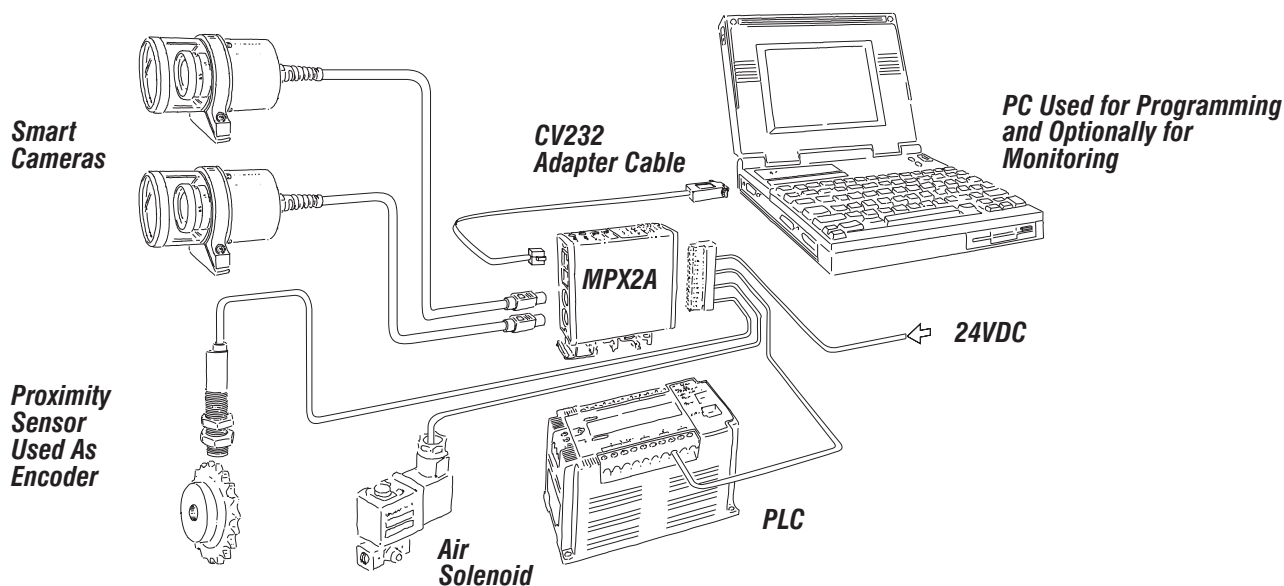
And programming couldn't be simpler. A few characters sent from the camera's serial output are all it takes to set up the MPX2A, read its inputs and change its outputs. What's more, a computer plugged into the programming port can program or monitor either camera without having to do any plugging or unplugging.

With a Bueno Systems Smart Camera and the MPX2A, you have everything you need for a self-contained inspection system. No computer need be attached except to program, and no PLC is required for control.

typical installation

Discrete I/O Module

Order No. MPX2A



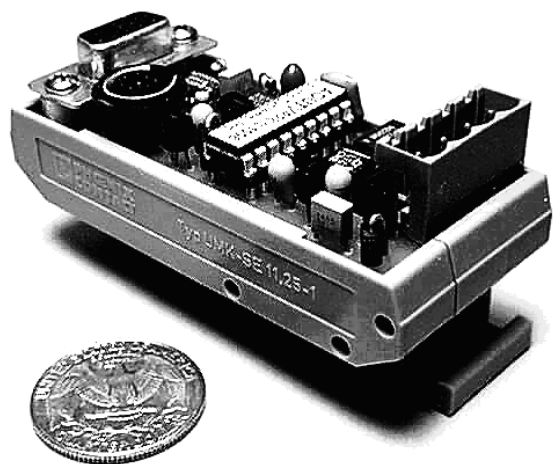
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product brief

ANA 0 0 TP T

for the LS64 & LS128 SMART CAMERAS



specifications

Output Voltage:

AOUT1-5: 0-5V, 19.5mv resolution (8-bit).

AOUT1-10: 0-10V, 39mv resolution (8-bit).

Input Signal:

With camera plugged in: RS422, 2400 baud.

Without camera: RS232, 2400 baud.

Each 8-bit character received is converted to a voltage.

Power Requirements:

15-24VDC, 50ma (with camera plugged in).

Galvanic Isolation:

None. Power common, voltage out common, camera ground, and RS232 ground are connected together.

The Bueno Systems Analog Output Module provides an easy way to interface the LS-series Smart Cameras to PLCs, recorders, and process control equipment requiring analog input. It works by converting any characters received from the Smart Camera's RS422 port to a proportional analog voltage. This voltage can represent width, height, position error – or whatever the user wants it to.

This handy module also provides an RS232-to-RS422 converter. Simply plug the camera into its 8-pin mini-DIN connector and your computer's RS232 cable into its standard DB-9 connector, and you can upload and run programs and see what the camera's looking at – all without unplugging anything. Plus, without a camera plugged in, the Analog Output Module acts as an RS232-to-analog converter. Commands sent from your computer are converted directly to analog.

The Analog Output Module is compact, snaps onto a 35mm DIN rail, runs off of 15-24VDC., and powers the camera plugged into it. It comes in two flavors: 0-5 volts out and 0-10 volts out.

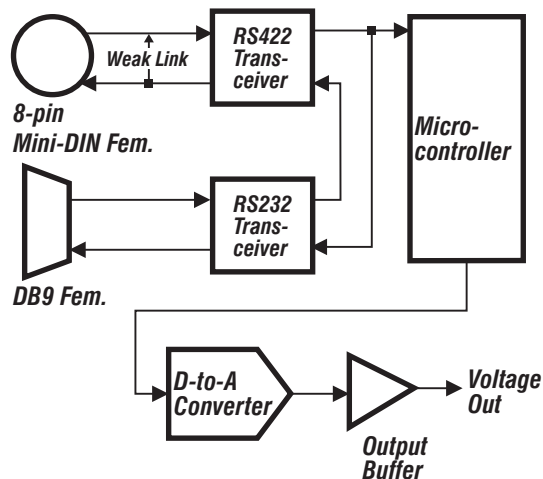
Analog Output Module, 0-5V

Order No. AOUT1-5

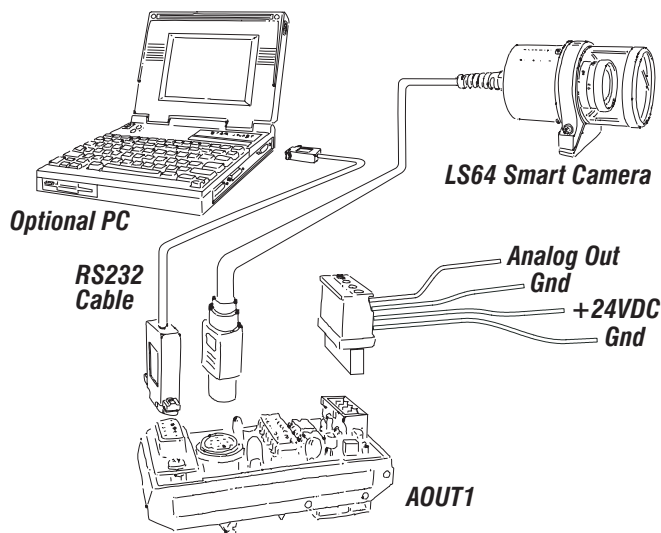
Analog Output Module, 0-10V

Order No. AOUT1-10

block diagram



typical installation



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product brief

POWER SUPPLY

for the LS64 & LS128 SMART CAMERAS



Power Supply

Order No. PS422

The Bueno Systems PS422 supplies power to one LS-series Smart Camera from any 120VAC or 240VAC source. It also provides an interface transition from the camera's 8-pin mini-DIN connector to the RJ11 connector used by the CV232 converter (below) and supplies power to the CV232.

specifications

Input Voltage:

120/240VAC, switch-selectable

Output Voltage:

7.3VDC, 50ma, unregulated.

Interface (RS422):

8-pin mini-DIN for camera; RJ11 for CV232.

RS CONVERTER

for the LS64 & LS128 SMART CAMERAS



RS232 Converter

Order No. CV232

The Bueno Systems CV232 provides an RS232-to-RS422 conversion for connecting PCs and other RS232 serial devices to the LS-series Smart Cameras. Power is taken from the RS422 side, as provided by Bueno Systems RS422 devices.

specifications

RS232 Interface:

Female DB9 connector, compatible with most PC serial ports.

RS422 Interface:

RJ11 plug, compatible with the PS422 (above) and the MPX2A programming port.

Power:



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product brief

E I MINATORS



Good lighting is one of the most important requirements for a successful machine vision application. Bueno Systems' LED illuminators provide a very uniform, flicker-free source of light for backlighting or frontlighting subjects of the Smart Camera. These light sources run cooler, last longer (100,000 hours is possible), and use lower voltage and less power than more traditional lamps such as incandescent and fluorescent. What's more, their unique reflective/refractive optical design results in a thin profile that fits where other lamps won't.

They are readily available in 3-, 6-, 9-, and 12-inch lengths, but can be ordered in any multiple of 3 inches up to several feet long. Each lamp is ruggedly constructed of anodized aluminum and comes equipped with a standard 4-prong Eurostyle sensor connector. Air purge fittings are available for use in dirty environments.

The result is a high-performance, money- and downtime-saving light source that brings out the best performance in your inspection system.

specifications

Power Requirements

18-30VDC, 20ma per inch of length.

Regulation

LEDs are current-regulated for even illumination over varying voltage conditions.

Dimensions

Lighted Area: 1.25" x (Nominal length - 0.25")

Overall: 2.75" x 1.125" x (Nominal length + 1")

Environmental Seal

None. Airpurge fittings available.

Compatible Cable

Turck EuroFast, 4-pin female (e.g. WK 4.4T-6, WKC 4.4T-6)

3" LED Illuminator

Order No. LEDS03

6" LED Illuminator

Order No. LEDS06

9" LED Illuminator

Order No. LEDS09

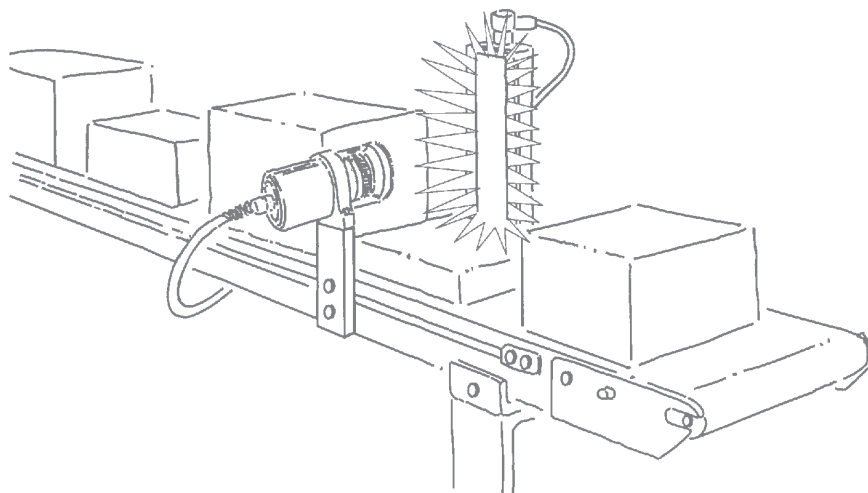
12" LED Illuminator

Order No. LEDS12

15-foot connecting cable

Order No. LED-CABLE

typical application



An LS64 Smart Camera measures the heights of boxes moving by on a conveyor. An LED illuminator backlights the boxes for maximum contrast.



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terms & prices

Effective 1 November 1996

Terms

Net 30 days on approval of credit, or COD.
Washington residents add 7.9% sales tax.
Taxes may also apply in other jurisdictions.

Shipping Charges

Prices are F.O.B. Port Townsend, WA.
Customer is invoiced for shipping charges
and full insurance on all shipments.

Satisfaction Guarantee

Within 30 days of purchase, customer may
return any stock Bueno Systems product in
new condition for any reason for full refund
or credit.

Quantity Discounts

Quantity discounts based on annual
purchase volume are available. Please
consult the factory or your local
representative.

Project Evaluation

Bueno Systems provides free preliminary
project evaluation. Just send us the part you
want to inspect, and we can usually
determine the project's feasibility in short
order at no charge.

More extensive evaluation is available for up
to a \$2000 maximum charge. This will
include a documented Smart Camera
program which makes the necessary
distinctions in our lab. (This program may
require some minor modification by the
customer to get it working in the field.) If,
after this process, the project proves
infeasible, there is no charge.

Software License

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or custom, remains the property of Bueno
Systems, Inc. Customer is granted an end-
user license to use the software at the site
and on the equipment covered by the
license. Customer may freely copy, modify,
and distribute any application software
obtained, but cannot prevent others from
doing the same.

list price schedule

Smart Cameras & Accessories

LS64	64-Pixel Smart Camera w/16mm Lens	\$1260
LS128	128-Pixel Smart Camera w/16mm Lens	\$1575
LS-CLAMP-L	Mounting Clamp with Lock	\$ 141
LS-CLAMP	Mounting Clamp only	\$ 98
LS-COVER	Spare Plastic Lens Cover	\$ 98

Lenses

LENS-16U	16mm Lens	\$ CALL
LENS-25U	25mm Lens	\$ CALL
LENS-SPACE-5	5mm Macro Spacer	\$ 10

Interfacing

PS422	Power Supply	\$ 39
CV232	RS232 Converter	\$ 149
MPX2A	Discrete I/O Module	\$ 675
MPX4PD (1st Qtr 97)	PLC Direct 105 Interface	\$ 625
AOUT1-5	0-5V Analog Output	\$ 345
AOUT1-10	0-10V Analog Output	\$ 345

Lighting

LEDS03	3-inch LED Backlight	\$ 289
LEDS06	6-inch LED Backlight	\$ 382
LEDS09	9-inch LED Backlight	\$ 476
LEDS12	12-inch LED Backlight	\$ 570
LEDE1	LED Endfire Floodlight	\$ 349
LED-CABLE	Cable for LED lights (15ft.)	\$ 39

Development Tools

LS-SFTWR	BuenoVision Software & Manual	\$ 398
LS-MANUAL	Manual Only	\$ 39

Package Deals (Limit One per Customer)

LS64-KIT	LS64, LS-CLAMP, PS422, CV232, LS-SFTWR	\$1589
LS128-KIT	LS128, LS-CLAMP, PS422, CV232, LS-SFTWR	\$1899

limited warranty

Bueno Systems, Inc., warrants its equipment to be free of defects in materials and workmanship for a period of one year from the date of purchase. During this warranty period, Bueno Systems will repair or replace, at its option, any warranted defects in its equipment at no charge. This warranty does not apply to equipment which has been damaged as a result of accident, misuse, abuse, or unauthorized modification or service by parties other than Bueno Systems. Software is sold "as is" without any express warranty.

The foregoing is the complete warranty for Bueno Systems' products. All other warranties including, but not limited to, merchantability and fitness for a particular use are disclaimed. **In no event shall Bueno Systems be liable for any incidental or consequential damages arising from the use of, or inability to use, its products, beyond a refund of the purchase price. Bueno Systems specifically does not authorize the use of its products in situations where failure or malfunction could result in loss of life, personal injury, or property damage.**



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Pricing and specifications are subject to change without notice.