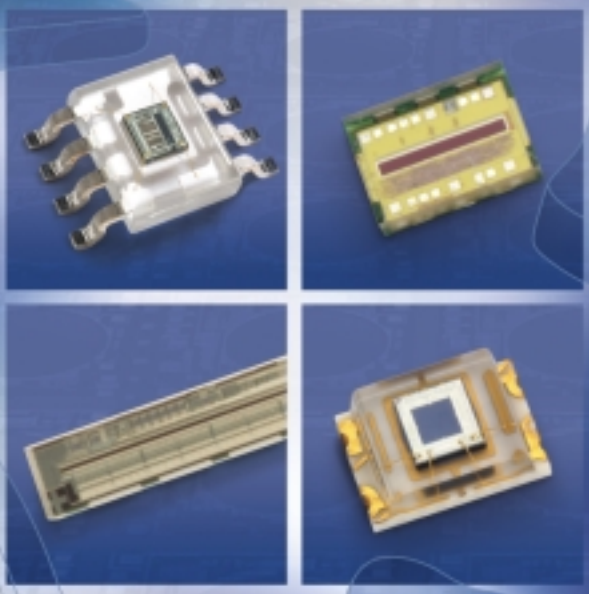
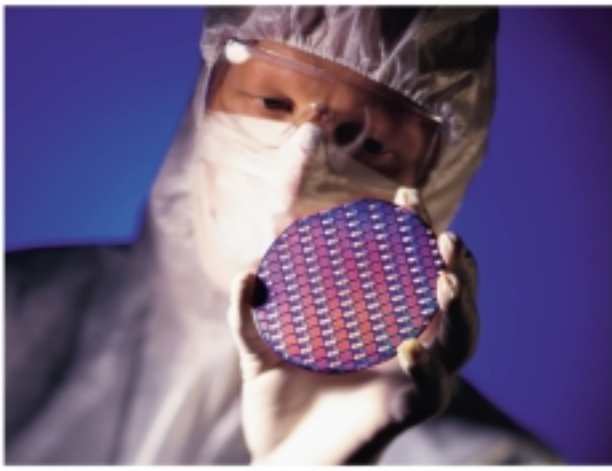
SHAPING THE FUTURE OF LIGHT SENSING SOLUTIONS



TAOS
TEXAS ADVANCED OPTOELECTRONIC SOLUTIONS®

SHAPING THE FUTURE OF LIGHT SENSING SOLUTIONS



Texas Advanced Optoelectronic Solutions (TAOS) is based in Plano, Texas. Established in 1998, the company mission is to develop, manufacture, and market leadership integrated optoelectronic products. Historically, applications requiring the sensing of light stimulus to execute a function have been implemented by either a photodiode or phototransistor – neither of which support the emerging needs for higher performance optical sensor-based applications.

Utilizing state-of-the-art technology, our semiconductor devices combine precision mixed-signal functionality with photo-detectors on the same integrated circuit to produce products with performance and cost advantages over conventional solutions. TAOS' intelligent opto sensors simplify analog-to-digital conversion of light and are designed to reduce the need for signal conditioning or preprocessing circuitry in light-centric systems. Our light sensing solutions improve system performance and reduce design cycle time giving designers the flexibility they require.

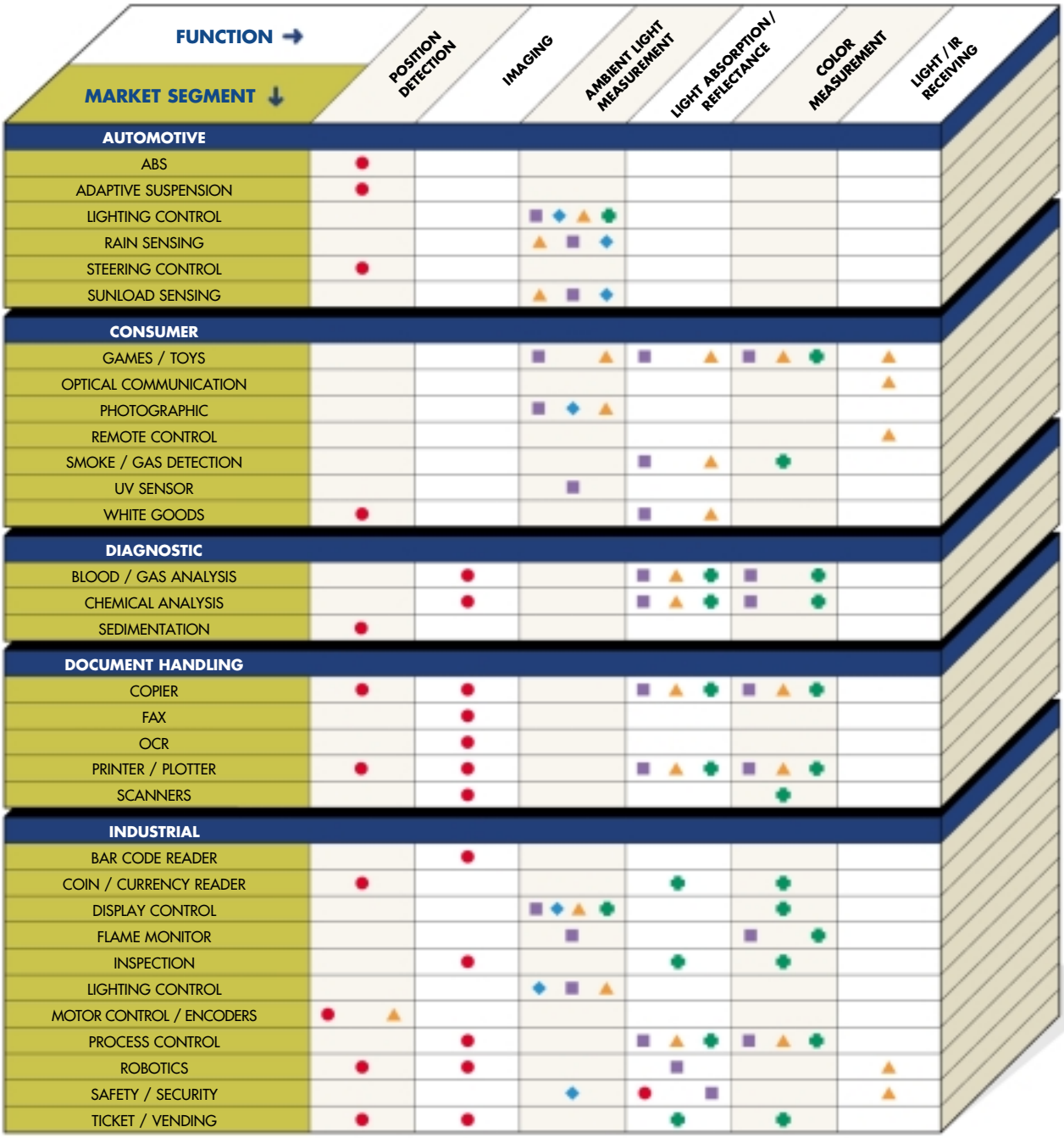
THE TAOS FAMILY OF INTELLIGENT OPTO SENSORS INCLUDES:

- **Light-to-Voltage Converters** *(page 5)*
  Low-cost, photodiode with integrated transimpedance amplifier delivering linear analog voltage output
- **Light-to-Frequency Converters** *(page 6)*
  Photodiode with integrated current-to-frequency converter, provides a direct digital interface to a microcontroller
- **Linear Sensor Arrays** *(page 7)*
  Spatial relationship optical sensor for imaging, encoding or edge detection with high linearity and uniformity
- **Light-to-Digital Converters** *(page 8)*
  Digital light level measurement in serial data output format
- **Color Sensors** *(page 9)*
  RGB filtered sensors for color discrimination, determination, and measurement

There is clearly a significant solution gap in the marketplace that TAOS is filling. Looking forward, TAOS will close this gap by migrating from a component-centric product mix to application-centric solutions and custom integrated solutions. This strategy will position TAOS as the industry leader, and enable the company to "Shape the future of light sensing solutions".

TAKING LIGHT AND APPLYING IT

We call it Lumenology.™ You'll call it amazing. Our industry-first integrated light sensors provide outstanding performance at a low cost, enabling innovative light-centric products. TAOS is committed to supporting its customers with leading-edge products and technology. Plus we are constantly working on the next generation of innovative TAOS products using our world-class mixed signal design integration and packaging skills.



TAOS OPTICAL SENSOR PRODUCTS

- **LIGHT-TO-VOLTAGE** (TSL250R, TSL251R, TSL252R, TSL253R, TSL254R, TSL257, TSL260R, TSL261R, TSL262R, TSL267, TSL12, TSL13, TSL14, CUSTOM)
- **LIGHT-TO-FREQUENCY** (TSL230R/A/B, TSL235R, TSL237, TSL245R)
- **LINEAR SENSOR ARRAYS** (TSL201R, TSLW201R, TSL202R, TSL208R, TSL210, TSL2014, TSL1401R, TSL1401CS, TSLW1401R, TSL1402R, TSL1406R, TSL1410R, TSL1412S, TSL3301)
- **LIGHT-TO-DIGITAL** (TSL2550, TSL2560, TSL2561)
- **COLOR SENSORS** (TCS230)

PUTTING TAOS LIGHT SENSING SOLUTIONS TO WORK

PULSE OXIMETER
A non-invasive means of determining arterial blood oxygen level by utilizing selected wavelengths of light.
TSL237 and TSL235R

LAPTOP COMPUTER
Display backlight control for portable equipment.
TSL2550 or TSL2560

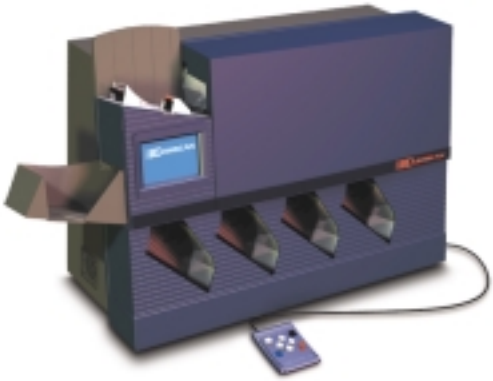
BRIX METER
Measures the sugar content concentration of fruit juices, foods, drinks, and condiments.
TSL1401CS

SMOKE DETECTOR
Simplified smoke detector design with improved performance. **TSL267**

COLOR SENSING
Calibrates computer displays for accurate color rendition.
TSL237 and TSL235R

BARCODE READER
Provides aperture control for CCD camera. **TSL230RD**

MONEY CHECKER
Verifies that currency is valid by distinguishing characteristics in the ink or paper.
TSL250R and TSL210



ROBOT VACUUM CLEANER
Cleans carpet and floors and docks to empty dirt container and recharge itself automatically. **TSL262R**

HAND DRYER
Infrared sensor detects presence of a user to signal the blower fan to turn on. **TSL261R**

FLAT PANEL DISPLAYS
Optimum viewing is maintained in diverse lighting conditions by controlling the display panel backlighting.
TSL2561

DISHWASHER
Turbidity sensor for dishwashers. Answers the question, are your dishes clean? **TSL230R**

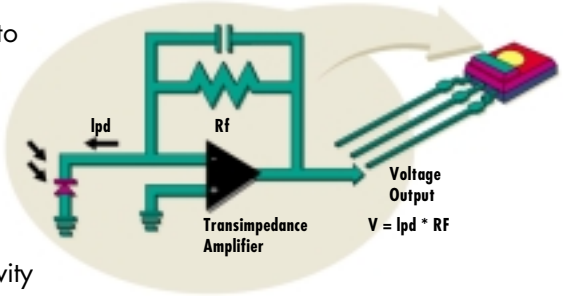
COLOR PALETTE
Pocket-sized electronic instrument takes the guesswork out of matching colors to paint store swatches.
TCS230

PORTABLE SCANNER
Hand held scanner that captures, translates and or defines words.
TSL1401R

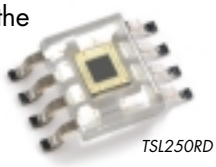
STEERING ANGLE SENSOR
Monitors steering wheel angular rotation and velocity for control of automobile stability and braking.
TSLW1401R

THE FIRST STEP

The Light-to-Voltage Converter family converts light intensity to a voltage. These devices simplify the design by integrating a photodiode and a transimpedance amplifier on a single monolithic IC. This family provides a linear output voltage that is proportional to the light intensity. The members of the family are shown in the table below. The devices cover a wide range of speed and responsivity options to span a variety of applications.



Members of the Light-to-Voltage Converter family are available in both clear and near-infrared (NIR) transmissive black plastic packages. Devices (TSL1X and TSL25X) packaged in clear plastic are responsive to all wavelengths from 350 nm to 1000 nm. Devices (TSL26X) packaged in the visible-light-blocking black plastic package respond to near-IR radiation in the 850 nm to 1000 nm range. The Light-to-Voltage Converters can be used to measure ambient light in lighting controls and electronic dimming ballasts, contrast and brightness controls in signs, media detection in printers, measuring light absorption and reflection in a variety of applications, and medical applications such as reagent strip readers and pulse oximetry.


TSL250RD


TSL12T

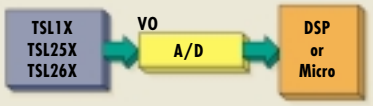
DEVICE	RISE TIME (µs)	RESPONSIVITY (mV/(µW/cm²))	SPECTRAL RESPONSE (nm)
TSL12S	20	248 @ 640 nm	320 - 1050
TSL13S	8	64 @ 640 nm	320 - 1050
TSL14S	3	16 @ 640 nm	320 - 1050
TSL12T	20	96 @ 640 nm	320 - 1050
TSL13T	8	24 @ 640 nm	320 - 1050
TSL250R	260	137 @ 635 nm	350 - 1000
TSL250RD	260	69 @ 640 nm	350 - 1000
TSL251R	70	52 @ 635 nm	350 - 1000
TSL251RD	70	17 @ 640 nm	350 - 1000
TSL252R	7	10.2 @ 635 nm	350 - 1000
TSL253R	7.5	137 @ 635 nm	350 - 1000
TSL254	2	3.5 @ 880 nm	350 - 1000
TSL257	160	1300 @ 470 nm	350 - 1000
TSLB257	160	1180 @ 470 nm	350 - 1000
TSLG257	160	1250 @ 524 nm	350 - 1000
TSLR257	160	1820 @ 635 nm	350 - 1000
TSL260R	260	111 @ 940 nm	850 - 1000
TSL260RD	260	62 @ 940 nm	850 - 1000
TSL261R	70	43.5 @ 940 nm	850 - 1000
TSL261RD	70	16 @ 940 nm	850 - 1000
TSL262R	7	9.1 @ 940 nm	850 - 1000
TSL267	160	450 @ 940 nm	850 - 1000

Interfacing

Comparator

Light-Activated Switching

A/D Converter



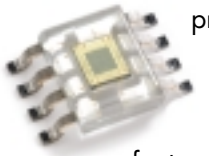
Linear Light Measurement

ADVANTAGES OF USING TAOS' LIGHT-TO-VOLTAGE CONVERTERS:

- *Lower noise than a discrete photodiode solution*
- *Increased reliability*
- *Reduced board space and part count*
- *Reduction complexity and design time*

THE NEXT STEP

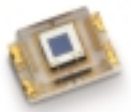
An exciting development in Intelligent Opto Sensors is the Light-to-Frequency Converter. These devices convert light intensity to a digital format for a direct interface to a microcontroller or digital signal processor. This compact device performs the functions of light sensing, signal conditioning and analog-to-digital conversion all in a single package! The output of this device is a constant-amplitude waveform with frequency linearly proportional to light intensity and features a dynamic range of up to 160 dB.


TSL230RD


TSL235R

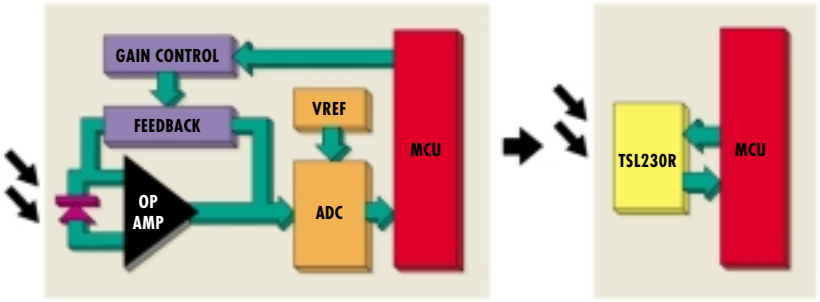
TSL245R

The TSL230R programmable Light-to-Frequency Converter is a prime example of an Intelligent Opto Sensor because it not only outputs light intensity information but also provides programming capability for adjustment of the input sensitivity and output frequency scaling. The TSL235R provides a scaled down economical version of this device without the programmability. The TSL245R offers the same functionality in a visible-light-blocking package for use in near-infrared sensing applications. The TSL237 combines enhanced sensitivity with ultra-low dark signal giving the ability to sense a wide range of light down to ultra-low light levels (0.00002 Lux) undetectable by most silicon-based sensors.


TSL237T


TSL230R

TSL230R Simplifies Your System



From This *To This*

ADVANTAGES OF USING TAOS' LIGHT-TO-FREQUENCY CONVERTERS:

- *High noise immunity*
- *Wide dynamic range*
- *High resolution*
- *Reduction of components*
- *Simplicity of interface to processors*

DEVICE	DARK SIGNAL FREQUENCY	MINIMUM FULL-SCALE FREQUENCY	SPECTRAL RESPONSE	PACKAGE
TSL230R	0.4 Hz	1.1 MHz	350 - 1000 nm	8-pin clear dip
TSL230RD	0.4 Hz	1.1 MHz	350 - 1000 nm	8-pin SOIC
TSL235R	0.4 Hz	500 KHz	350 - 1000 nm	3-pin side looker
TSL237	0.1 Hz	500 KHz	350 - 1000 nm	3-pin side looker
TSL237T	0.1 Hz	500 KHz	350 - 1000 nm	4-pin TMB
TSL245R	0.4 Hz	500 KHz	850 - 1000 nm	3-pin side looker

AN ADDED DIMENSION

TAOS' family of CMOS Linear Sensor Arrays provides the capability of measuring spatial relationships in addition to light intensity. These devices consist of a linear array of integrating photosensing elements (pixels) which measure incident light over some exposure time and generate an output that can be either a voltage or a digital word which represents the light exposure at each pixel.

The family is made up of a number of devices that differ by their spatial resolution (dots per inch) and/or the number of pixels. Devices are available in 200, 300 and 400 dots per inch (DPI) and array lengths from 64 to 1536 pixels. Applications include edge detection, liquid level detection, contact image sensing, optical character recognition, object measurement, and spectroscopy in applications such as copiers, document scanners, automobiles, optical rotary encoders, and medical equipment.

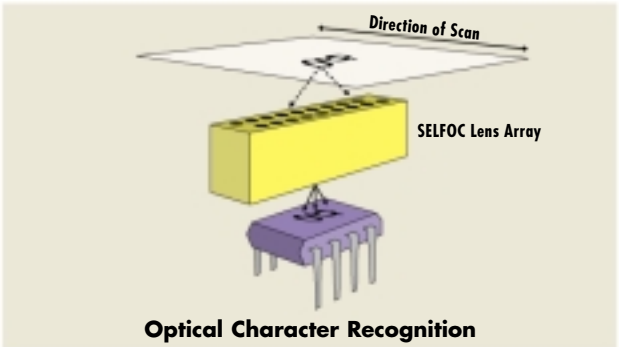
ADVANTAGES OF USING TAOS' LINEAR SENSOR ARRAYS:

- *Wide range of array lengths and pixel densities*
- *Allows precise measurement of distances*
- *High linearity and uniformity*
- *Wide dynamic range*
- *Requires only a serial input signal and a clock*

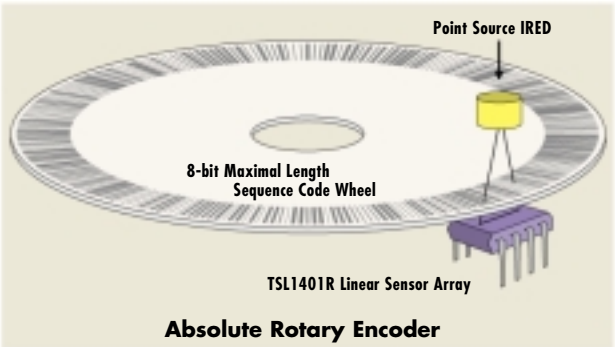
	200 DPI					300 DPI	400 DPI					
	TSL201R	TSL202R	TSL208R	TSL210	TSL2014	TSL3301	TSL1401CS	TSL1401R	TSL1402R	TSL1406R	TSL1410R	TSL1412
RESOLUTION (DPI)	200	200	200	200	200	300	400	400	400	400	400	400
#PIXELS	64	128	512	640	896	102	128	128	256	768	1280	1536
ACTIVE LENGTH (mm)	8.26	16.52	66.06	82.58	115.61	8.64	8.12	8.12	16.23	48.69	81.15	97.38
OUTPUTS	One Analog	Two Analog	One Analog	Five Analog	Two Analog	One 8-bit Digital	One Analog	One Analog	Two Analog	Two Analog	Two Analog	Two Analog

Note: Each analog output bank corresponds to 64 pixels for the 200 DPI and 128 pixels for the 400 DPI linear arrays. The TSL1401R and TSL201R are available in extended temperature package (-40°C to 85°C). The devices are given a TSLW prefix (i.e. TSLW1401R).

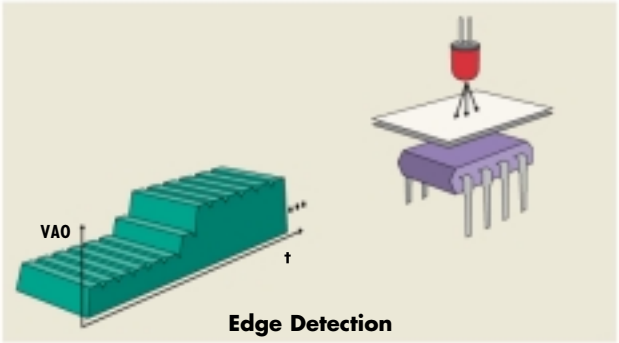
Typical Linear Sensor Array Applications



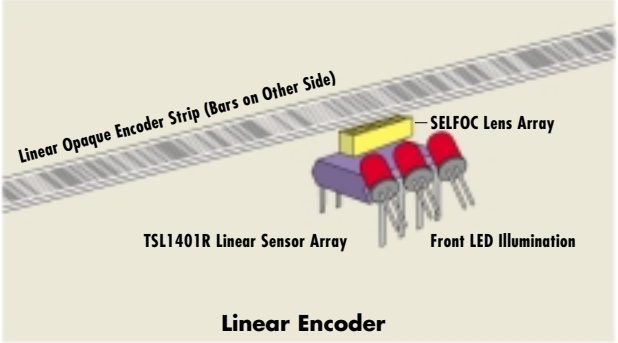
Optical Character Recognition



Absolute Rotary Encoder



Edge Detection



Linear Encoder

A NEW GENERATION IN LIGHT SENSING

Ambient Light Sensing Applications

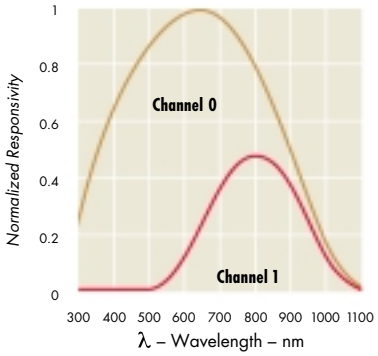
TAOS' Light-to-Digital Converters combine a broadband photodiode (350 nm to 1100 nm) with a visible light blocking photodiode in a single CMOS integrated circuit. With integrated analog-to-digital conversion circuitry, data is output via a serial interface using two standard protocols: SMBus and I²C. One common application is to use the Light-to-Digital Converter in an ambient light sensing application. Light intensity in Lux (i.e. illuminance) can be easily calculated using the output from both photodiodes without the need of using an expensive optical filter. In addition, TAOS' Light-to-Digital Converters can be used in any general application where a high-resolution light sensor is required using a two-wire digital interface.

This family of devices is ideal for use with notebooks, tablets, flat-panel televisions, cell phones, and digital cameras. Other applications include street light control, security lighting, sunlight harvesting, machine vision, and automotive instrumentation clusters.

ADVANTAGES OF USING TAOS' LIGHT-TO-DIGITAL CONVERTERS:

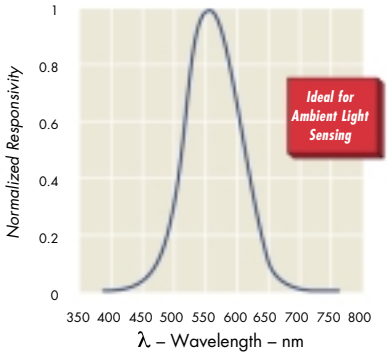
- *Extends battery life in mobile applications (up to 25%)*
- *Reduces eyestrain and optimizes display aesthetics*
- *Extends lamp life*
- *Shortens design-in cycle*
- *Eliminates 2-4 parts and reduces overall cost*
- *Minimizes firmware overhead with built-in interrupt and definable Hi/Lo thresholds*
- *Automatically filters out AC lighting flicker*
- *Virtually immune to noise with two-wire digital interface*
- *Measures light intensity at low-light levels (e.g. keyboard illumination) and bright light to support full dynamic range of display panel (e.g. 180 nits and above)*
- *Supports User Presence Detection (TSL2560/61)*

Spectral Responsivity



*TAOS' patented silicon design uses the digital output of Channel 1 to compensate for the effect of the infrared component on Channel 0. Thereby, the **human eye response** (Lux) is derived without the use of an expensive photopic filter.*

Photopic Responsivity



FEATURE	TSL2550	TSL2560	TSL2561
Packaging	*SO-8 (8-pin) TMB (4-pin)*	*TMB (6-pin) Chipscale (6-pin)*	*TMB (6-pin) Chipscale (6-pin)*
Digital Output Format	SMBus & I²C (up to 100 KHz)	SMBus	I²C (Fast Mode up to 400 KHz)
ADC Digital Output	7-bit companded	16-bit linear	16-bit linear
Dynamic Range (Lux)	0-10,000	0.1-40,000	0.1-40,000
Selectable Integration Time	160 & 800 msec	12, 100, & 400 msec	12, 100, & 400 msec
Manual Start/Stop Integration	No	Yes	Yes
Interrupt	No	Yes	Yes
No. of Addresses	1	3	3
Programmable Gain	N/A	1x & 16x	1x & 16x
Operating Voltage	5V	3V	3V

THE WORLD IS NOT JUST BLACK OR WHITE

We live in a world full of colors and it is becoming increasingly important to have an economical means to accurately determine the color and color quality of objects. TAOS' color sensors enable the design engineer to implement cost effective color sensing using the TCS230 Programmable Color Light-to-Frequency Converter.

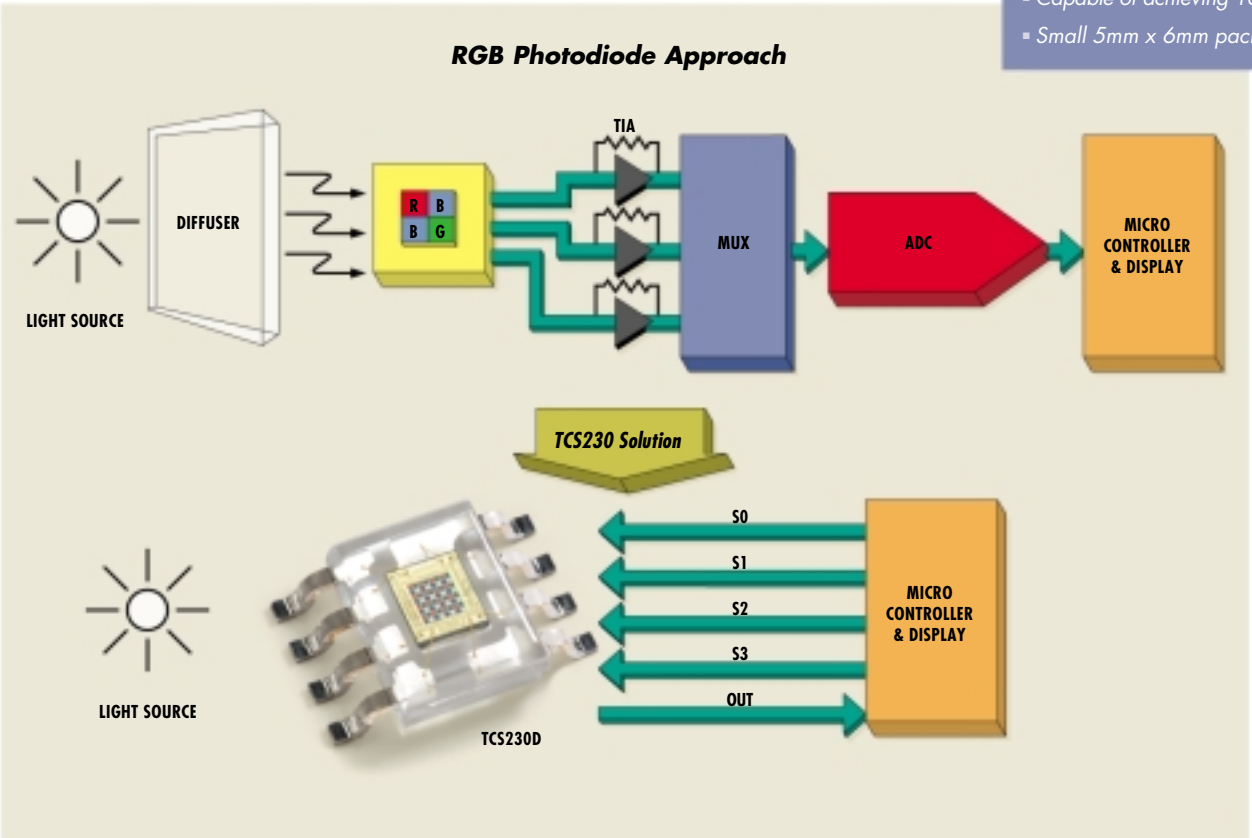
The TCS230 Programmable Color Light-to-Frequency Converter combines configurable color filtered silicon photodiodes and a current-to-frequency converter on a single monolithic CMOS integrated circuit. The TCS230 reads an 8x8 array of photodiodes, 16 of which have red filters, 16 have blue filters, 16 have green filters, and 16 are unfiltered. The color-filtered sensors are uniformly distributed across the sensing area creating four separate channels and eliminating the need for a diffuser.

TCS230D

The device output is a square wave (50% duty cycle) whose frequency is directly proportional to the light intensity incident on the red, green, blue, or unfiltered channel. An internal multiplexer allows selection of any of the four channels to be sent to the output pin. The TCS230 interfaces directly to a microcontroller or DSP and is available in a 8-pin SOIC package.

ADVANTAGES OF USING TAOS' COLOR SENSORS:

- *Red, green, blue, and clear color sensors in one package*
- *Integrated color sensing and conversion to digital format*
- *Direct single wire interface to microcontroller*
- *Capable of achieving 16-bit resolution*
- *Small 5mm x 6mm package footprint*



HANDS-ON TOOLS DESIGNED TO AID THE DESIGNER

To assist designers, TAOS offers Evaluation Modules (EVM) to demonstrate our products to you in a 'hands on' environment. The tools are divided into their respective families and details their particular features.

LIGHT-TO-FREQUENCY CONVERTERS - NEW EVM COMING SPRING, 2005

With a USB PC interface, this evaluation module illustrates simple hardware and software techniques for interfacing the Light-to-Frequency converters to a micro-controller and processing the information. A number of applications can be demonstrated including ambient light measurement, transmissive light measurements, and reflective light measurements. The new Light-to-Frequency EVM can be used to demonstrate the TSL230R, TSL235R, TSL237, and TSL245R.

LIGHT-TO-DIGITAL CONVERTERS - TSL2550 & TSL2560 EVMS

TSL2560 EVM

Test drive the most complete evaluation module for Ambient Light Sensing today!

TSL2550 EVM

The TSL2560/61 EVM is no ordinary utility. It simulates automatic brightness control using the computer display panel where it is installed. The EVM connects to any notebook or desktop computer via a USB port in which the software interface provides control over the device feature set and demonstrates a "full-blown" ALS implementation. The TSL2550 EVM supports either a RS232 or PCMCIA interface and includes a Windows-based user interface to command the device features.

LINEAR SENSOR ARRAYS - PC404A & TSL3301 EVMS

PC404A EVM

The PC404A EVM provides the necessary timing and clock signals on-board to support the evaluation of the TSL201R, TSL202R, TSL208R, TSL1401R, TSL1402R, TSL1406R, TSL1410R, and TSL1412S. The user only needs a 5V regulated power supply and an oscilloscope to observe the analog output signals. The TSL3301 EVM can demonstrate optical edge detection, linear spatial measurement, document scanning, imaging functions, and provides full control of the TSL3301 internal registers and integration time. Included is a Windows-based host PC application CD with RS232 interface to an on-board microcontroller as well as two different optical lens options: a SELFOC lens array for document scanning and a camera lens for line-scan camera imaging.

TSL3301 EVM

COLOR SENSORS - TCS230 EVM

TCS230 EVM

The TCS230 EVM is a versatile evaluation system that allows you to quickly and easily evaluate the TCS230 RGB color sensor in color measurement applications. TAOS has made it easy for the design engineer to become familiar with the TCS230 color sensor by making available the TCS230 EVM. This unique EVM consists of a lens module with white LED illuminator, a Parallax Board of Education (BOE) module and programmed BASIC Stamp, and PC host software that displays the RGB output values from the TCS230.

Sensing Light Across the World

FOR YOUR NEAREST TAOS REPRESENTATIVE VISIT OUR WEBSITE AT WWW.TAOSINC.COM

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