

## SBIG CCD IMAGING CAMERAS

The SBIG product line consists of a series of thermoelectrically cooled CCD imaging cameras designed for a wide range of applications ranging from astronomy, tricolor imaging, color photometry, spectroscopy, medical imaging, densitometry, to chemiluminescence and epifluorescence imaging, etc. This catalog includes information on astronomical imaging cameras, scientific imaging cameras, autoguiding, and accessories. We have tried to arrange the catalog so that it is easy to compare products by specifications and performance. The tables shown below compare some of the basic characteristics on each CCD imaging camera in our product line. You will find a more detailed set of specifications with each individual imaging camera description.



ST-2000XM with 35mm camera lens attached

## HOW TO GET STARTED USING YOUR CCD IMAGING CAMERA

It all starts with the software. If there's any company well known for its outstanding imaging camera software it's SBIG. Our CCDOPS Operating Software is well known for its user oriented camera control features and stability. For parallel cameras, our CCDOPS software is available for MS-DOS, Macintosh and Windows applications. For USB cameras we offer CCDOPS for Windows as well as CCDSoftV5 for Windows. CCDOPS is also available for free download from our web site along with sample images that you can display and analyze using the image processing and analysis functions of the CCDOPS software. You can become thoroughly familiar with how our imaging cameras work and the capabilities of the software before you purchase an imaging camera.

New customers receiving their CCD imaging camera should first read the installation section in their CCDOPS Operating Manual. Once you have read that section you should have no difficulty installing CCDOPS software on your hard drive, connecting the parallel or USB cable from the imaging camera to your computer, initiating the imaging camera and within minutes start taking your first CCD images. Many of our customers are amazed at how easy it is to start taking images. Additional information can be found by reading the image processing sections of the CCDOPS and CCDSoftV5 Manuals. This information allows you to progress to more advanced features such as automatic dark frame subtraction of images, focusing the imaging camera, viewing, analyzing and processing the images on the monitor, co-adding images, taking automatic sequences of images, photometric and astrometric measurements, etc.

## A PERSONAL TOUCH FROM SBIG

At SBIG we have had much success with a program in which we continually review customer's images sent to us on disk or via e-mail. We can often determine the cause of a problem from actual images sent in by a user. We review the images and contact each customer personally. Images displaying poor telescope tracking, improper imaging camera focus, oversaturated images, etc., are typical initial problems. We will help you quickly learn how to improve your images. You can be assured of personal technical support when you need it. The customer support program has furnished SBIG with a large collection of remarkable images. Many customers have had their images published in SBIG catalogs, ads, and various astronomy magazines. We welcome the chance to review your images and hope you will take advantage of our trained staff to help you improve your images.

## Typical Specifications

Camera Model	CCD	CCD Size (mm)	Pixel Size (microns)	Pixel Array	# Pixels	Full Well Capacity	ABG	A/D	Read Noise	Dark Current (I)	TE Cooling Stages	Cooling Delta Deg. C
<b>ST-5C</b>	TC-255	3.2 x 2.4	10 x 10	320 x 240	76,800	50,000 e-	Yes	16 bits	25 e-	5 e-	1	-25
<b>ST-237A</b>	TC-237	4.9 x 3.7	7.4 x 7.4	657 x 495	325,215	20,000 e-	Yes	16 bits	14 e-	5 e-	1	-25
<b>STV<sup>(2)</sup></b>	TC-237	4.9 x 3.7	7.4 x 7.4	656 x 480 <sup>(3)</sup>	314,800	20,000 e-	Yes	10 to 16 bits	17 e-	5 e-	1	up to -25
<b>ST-7XE</b>	KAF-0401E (+TC-211)	6.9 x 4.6	9 x 9	765 x 510	390,150	100,000 e- (NABG)	Yes/No	16 bits	15 e-	1 e-	1 or 2	-45 <sup>(4)</sup>
<b>ST-8XE</b>	KAF-1602E (+TC-237)	13.8 x 9.2	9 x 9	1530 x 1020	1.5 million	100,000 e- (NABG)	Yes/No	16 bits	15 e-	1 e-	1 or 2	-45 <sup>(4)</sup>
<b>ST-9XE</b>	KAF-0261E (+TC-237)	10.2 x 10.2	20 x 20	512 x 512	262,000	150,000 e-	No	16 bits	15 e-	10 e-	1 or 2	-45 <sup>(4)</sup>
<b>ST-10XE</b>	KAF-3200E (+TC-237)	14.9 x 10	6.8 x 6.8	2184 x 1472	3.2 million	77,000 e-	No	16 bits	9 e-	0.5 e-	1 or 2	-45 <sup>(4)</sup>
<b>ST10XME</b>	KAF-320ME (+TC-237)	14.9 x 10	6.8 x 6.8	2184 x 1472	3.2 million	77,000 e-	No	16 bits	9 e-	0.5 e-	1 or 2	-45 <sup>(4)</sup>
<b>ST-1001E</b>	KAF-1001E	24.6 x 24.6	24 x 24	1024 x 1024	1 million	180,000 e-	No	16 bits	15 e-	~1 e- <sup>(1)</sup>	2	-45 <sup>(4)</sup>
<b>ST-2000XM</b>	KAI-2001M (+TC-211)	11.8 x 8.9	7.4 x 7.4	1600 x 1200	1.92 million	45,000 e-	Yes	16 bits	12 e-	0.35 e-	1 or 2	-45 <sup>(4)</sup>
<b>237 Tracking ST-8/9/10</b>	TC-237	4.9 x 3.7	7.4 x 7.4	657 x 495	325,215	20,000 e-	Yes	16 bits	12 e-	5 e-	1 or 2	-45 <sup>(4)</sup>
<b>211 Tracking ST-7/2000</b>	TC-211	2.6 x 2.6	13.75 x 16	192 x 164	31,000	95,000	Yes	16 bits	12 e-	5 e-	1 or 2	-45 <sup>(4)</sup>

**Notes:**

(1) Electrons / pixel / second at 0 degrees C except for ST-1001E at -25 C and Tracking CCDs at -5 C.

(2) The STV is a video camera and autoguider utilizing the TC-237 CCD.

(3) STV full frame digital images are binned to 320 x 200.

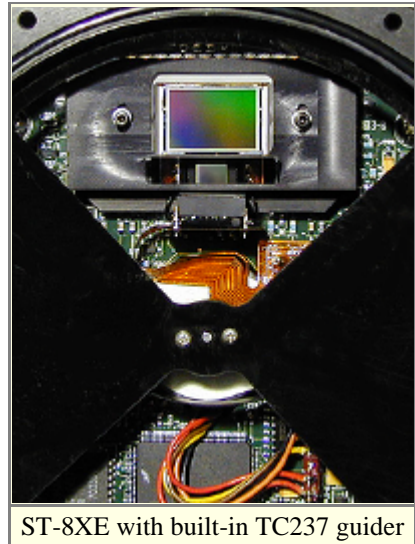
(4) Maximum delta-T with single stage cooling and water assist

### TRACK AND ACCUMULATE (U.S. Patent # 5,365,269)

Using an innovative engineering approach SBIG developed an imaging camera function called Track & Accumulate (TRACCUM) in which multiple images are automatically registered to create a single long exposure. Since the long exposure consists of short images the total combined exposure significantly improves resolution by reducing the cumulative telescope periodic error. In the TRACCUM mode each image is shifted to correct guiding errors and added to the image buffer. In this mode the telescope does not need to be adjusted. The great sensitivity of the CCD virtually guarantees that there will be a usable guide star within the field of view. This feature provides dramatic improvement in resolution by reducing the effect of periodic error and allowing unattended hour long exposures. SBIG has been granted U.S. Patent # 5,365,269 for Track & Accumulate.

### DUAL CCD SELF-GUIDING (U.S. Patent # 5,525,793)

With the introduction of Models ST-7 and ST-8 CCD Imaging Cameras, which incorporate two separate CCD detectors, SBIG was able to accomplish the goal of introducing a truly self-guided CCD imaging camera. The ability to select guide stars with a separate CCD through the full telescope aperture is equivalent to having a thermoelectrically cooled CCD autoguider in your imaging camera. This feature has been expanded to the ST-7XE, ST-8XE, ST-9XE, ST-10XE/XME and ST-2000XM cameras. One CCD is used for guiding and the other for collecting the image. They are mounted in close proximity, both focused at the same plane, allowing the imaging CCD to integrate while the PC uses the guiding CCD to correct the telescope. Using a separate CCD for guiding allows



ST-8XE with built-in TC237 guider

100% of the primary CCD's active area to be used to collect the image. The telescope correction rate and limiting guide star magnitude can be independently selected. First tests at SBIG indicated that 95% of the time a star bright enough for guiding will be found on a TC211 tracking CCD without moving the telescope, using an f/6.3 telescope. The TC211 tracking CCD is used on the ST-7XE and ST-2000XM. However, with the recent release of USB electronics and new camera models, the tracking CCD used in the ST-8XE, ST-9XE and ST-10XE/XME cameras has been upgraded to a larger TC237 CCD with twice the area of the TC211 so the chances of finding a guide star without searching are even higher. The self-guiding function quickly established itself as the easiest and most accurate method for guiding CCD images. Placing both detectors in close proximity at the same focal plane insures the best possible guiding. Many of the long integrated exposures now being published are taken with this self-guiding method, producing very high resolution images of deep space objects. SBIG has been granted U.S. Patent # 5,525,793 for the dual CCD Self-Guiding function.

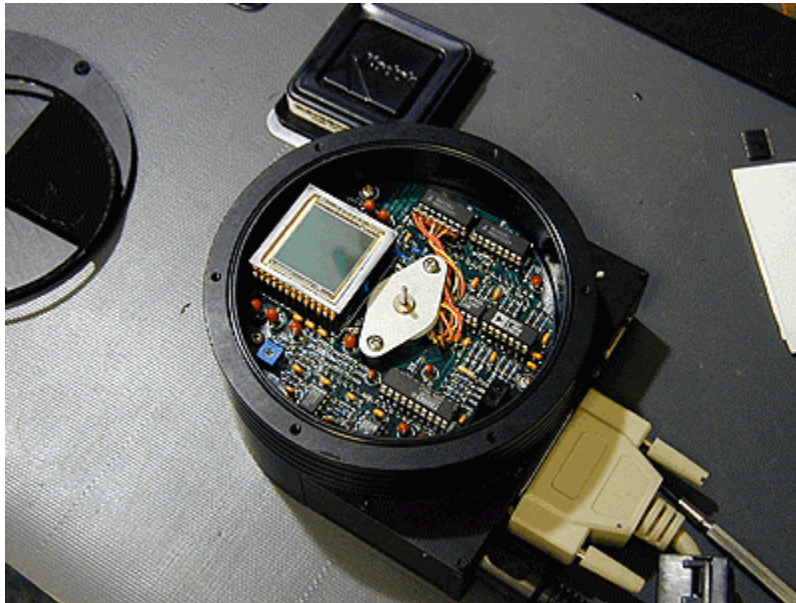
## CAMERA FEATURES

Camera Model	Remote Control Autoguide	Stand Alone Autoguide (no computer)	Self-guide (dual CCD)	Electronic Shutter	Mechanical Shutter	Integrated Filter Wheel	AO-7 Compatible	Video Output	Track & Accumulate
<b>ST-5C</b>	Yes	No	No	Yes	Yes	Yes	No	No	Yes
<b>ST-237A</b>	Yes	No	No	Yes	Yes	Yes	No	No	Yes
<b>STV</b>	Yes <sup>(1)</sup>	Yes	No	Yes	Yes	Yes	No	Yes	Yes
<b>ST-7XE</b>	Yes <sup>(2)</sup>	No	Yes	No	Yes	Yes	Yes	No	Yes
<b>ST-8XE</b>	Yes <sup>(2)</sup>	No	Yes	No	Yes	Yes	Yes	No	Yes
<b>ST-9XE</b>	Yes <sup>(2)</sup>	No	Yes	No	Yes	Yes	Yes	No	Yes
<b>ST-10X(M)E</b>	Yes <sup>(2)</sup>	No	Yes	No	Yes	Yes	Yes	No	Yes
<b>ST-1001E</b>	Yes	No	Yes	No	Yes	No	No	No	Yes
<b>ST-2000XM</b>	Yes <sup>(2)</sup>	No	Yes	Yes	Yes	Yes	Yes	No	Yes

**Notes:**

**(1) The STV does not require a computer to autoguide or to take video or digital images.**

**(2) The ST-7XE, ST-8XE, ST-9XE, ST-10X(M)E and ST-2000XM can autoguide and self-guide.**



## COMPUTER PLATFORMS

SBIG is unique in its support of both PC and Macintosh platforms for our parallel cameras. The imaging cameras in this catalog communicate with the host computer through standard serial, parallel or USB ports depending on the specific models. Since there are no external plug-in boards required with our imaging camera systems we encourage users to operate with the new family of high resolution graphics laptop computers. We furnish Operating Software for you to install on your host computer. Once the software is installed and communication with the imaging camera is set up complete control of all of the imaging camera functions is through the host computer keyboard. The recommended minimum requirements for memory and video graphics are as shown below.

## COMPUTER SYSTEM REQUIREMENTS

MODEL	COMPUTER MEMORY	VIDEO GRAPHICS
ST-5C	4 MEG	640 x 480, 256 Color or higher
ST-237A	4 MEG	640 x 480, 256 Color or higher
STV	4 MEG	640 x 480, 256 Color or higher
ST-7XE	4 MEG	800 x 600, 256 Color or higher
ST-8XE	8 MEG	800 x 600, 1280 x 1024 preferred, 256 Color or higher
ST-9XE	4 MEG	800 x 600, 256 Color or higher
ST-10XE/XME	16 MEG	800 x 600, 1280 x 1024 or greater preferred, 256 Color or higher
ST-1001E	8 MEG	800 x 600, 1280 x 1024 preferred, 256 Color or higher
ST-2000XM	16 MEG	800 x 600, 1280 x 1024 preferred, 256 Color or higher

## COMPUTER INTERFACE AND MECHANICAL SPECS

Camera Model	Computer Interface	(1) Remote Operating Distance	Control Software	Optical Head Size	Optical Head Weight	CPU Size	CPU Weight	Power Supply	Custom Case
ST-5C	Parallel	>150'	DOS / MAC / WIN	3 x 1.8"	1 lb..	8x10x2"	2.4 lb.	Yes	Optional
ST-237A	Parallel	>150'	DOS / MAC / WIN	3 x 1.8"	1 lb.	8x10x2"	2.4 lb.	Yes	Optional
STV	Video/Serial	>150'	WIN	3 x 1.8"	1 lb.	12x9x3"	4 lb.	Yes	Optional
ST-7XE	USB	>300'	WIN	5 x 3"	2 lb.	None	n/a	Yes	Yes
ST-8XE	USB	>300'	WIN	5 x 3"	2 lb.	None	n/a	Yes	Yes
ST-9XE	USB	>300'	WIN	5 x 3"	2 lb.	None	n/a	Yes	Yes
ST-10XE	USB	>300'	WIN	5 x 3"	2lb.	None	n/a	Yes	Yes
ST-1001E	Parallel	>150'	WIN	5 x 3"	2lb.	None	n/a	Yes	Yes
ST-2000XM	USB	>300'	WIN	5 x 3"	2lb.	None	n/a	Yes	Yes

**Notes:**

(1) Estimated operational distance between computer and camera/CPU with appropriate cable. The limit is determined by the user's computer and the quality of the cable. The 300' distance for USB cameras requires a USB extender with CAT5 cable.

**COMMON FEATURES OF THE NEW USB  
ST-7XE, ST-8XE, ST-9XE, ST-10XE/XME  
AND ST-2000XM SELF-GUIDING CAMERAS:**

**FASTER DOWNLOADS**

High speed electronics and high speed USB interface are now standard with data transfer rates up to 426,000 pixels per second!

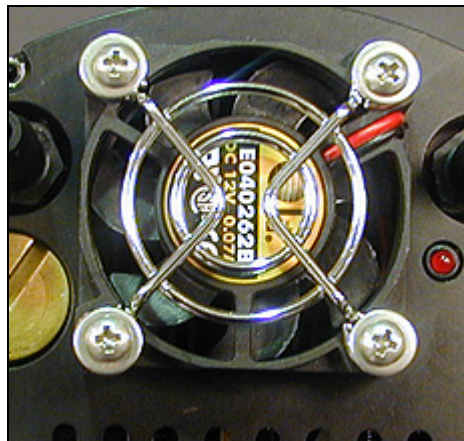


High Speed USB Download Rates	ST-2000XM	ST-7XE	ST-8XE	ST-9XE	ST-10XE
Full Frame	4.5 sec.	1 sec.	3.7 sec.	0.7 sec.	8.7 sec.
Focus Mode	~0.5 sec	~0.5 sec	~0.5 sec	~0.5 sec	~0.5 sec

Note: USB download times are processor dependent and will vary from computer to computer. These download times were measured on a 933 MHz Pentium III. Focus Mode rates were the fastest achieved using a 20 x 20 pixel subframe in Focus / Planet mode.

**BETTER COOLING**

The standard single stage cooling design has been improved to provide cooling performance previously available only with an optional second stage cooling booster.



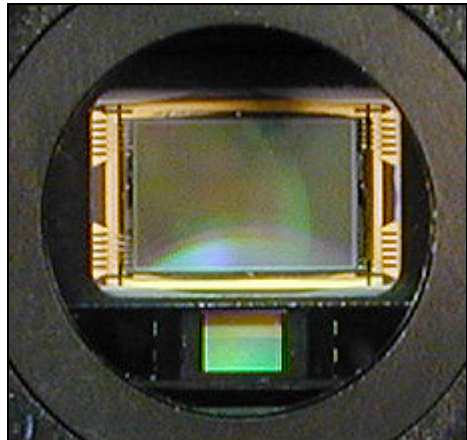
Cooling Performance (delta from ambient)	Typical	Minimum	Previous design
Standard single stage with water assist	-45° C	-40° C	not available
Standard single stage without water	-35° C	-30° C	-25° C

The standard cooling configuration is a single stage cooler with a newly designed heat exchanger that includes an inlet and outlet for water circulation should the user desire to maximize the cooling performance for hot climates. The new design does not require an additional power supply and may be operated with or without water supplied by the user. Even without water, the new design offers similar performance to two-stage cooling with much less current draw than a two-stage cooler. It is therefore less demanding on battery capacity when operating in the field.

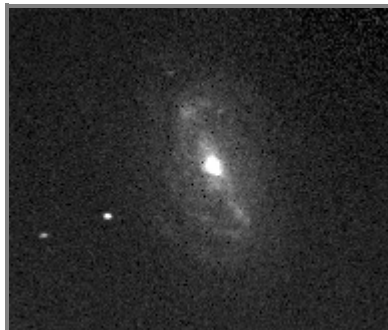
A circulating water pump and tubing are available from SBIG as optional accessories. In our experience, further cooling of Kodak CCDs beyond the performance above is unnecessary.

### BETTER AUTOGUIDING

The TC-211 tracking CCD has been replaced with a larger TC-237 in the ST-8/9/10XE models

Built-in Autoguider	Array	Pixel Size	CCD Dimension ----- ( Area )	Field of View at 80" FL
	TC-237 CCD	657 x 495	7.4 x 7.4 u  4.9 x 3.7 mm ----- 18.3 mm <sup>2</sup>	8.2 x 6.2 arcminutes ( 51 arcmin <sup>2</sup> )
	TC-211 CCD	192 x 164	~ 15 u  2.6 x 2.6 mm ----- 6.8 mm <sup>2</sup>	4.5 x 4.5 arcminutes ( 20 arcmin <sup>2</sup> )

The TC-237 autoguiding CCD is seen here just below the larger KAF-1602E in an ST-8XE camera is the same CCD used in our \$1300 ST-237A imaging camera and \$2300 STV autoguider. The TC-237 is 2.7X larger than the TC-211 CCD which means there is a more than double the chance you will find suitable guide stars anywhere you happen to be looking without searching. The images below demonstrate the difference in field of view.



#### Field of View of TC-211 autoguider through an 8" SCT at F/7

30 second unguided image centered on NGC 2903 taken with the **TC-211** tracking CCD.

192 x 164 pixels at ~15 microns (unbinned).



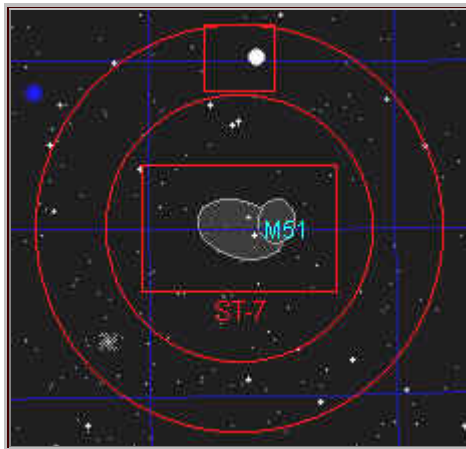
#### Field of View of TC-237 autoguider through an 8" SCT at F/7

30 second unguided image of the same area taken with the **TC-237** tracking CCD demonstrates the benefit of having 2.7X the field of view: An increase in the number of potential guide stars.

328 x 247 pixels at 14.8 microns (binned 2x2).

In the tracking configuration, the TC-237 CCD will normally be binned 2x2 for increased sensitivity. When binned 2x2 the field of view remains 2.7X that of the TC-211 however as the pixel size is increased to 14.8 microns. The user may also image with the TC-237 CCD in high resolution (unbinned) mode if desired.

Even with a smaller field of view, however, the TC-211 remains an excellent autoguider for the ST-7XE and ST-2000ME cameras. With ~15 micron pixels and low noise performance the TC-211 unbinned is more sensitive than the TC-237 in unbinned mode and as sensitive as the TC-237 in binned mode. In tests performed under moderate light pollution with an F/6 telescope, random pointing of the telescope in areas of the sky away from the Milky Way, we found stars on the TC-211 image bright enough to guide on 95% of the time. ThsSky software from Software Bisque automatically generates finder charts showing the correct placement of the guiding CCD field of view relative to the imaging CCD's field of view. Using this tool to plan your nights imaging is a great compliment to the self-guiding cameras.



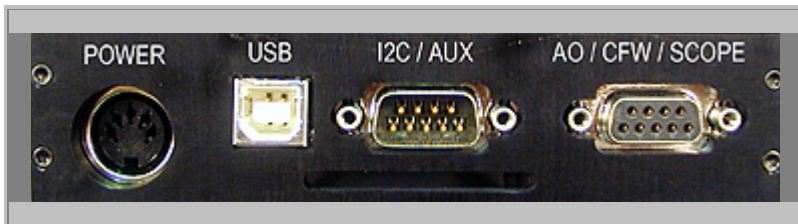
Previously, the camera had to be oriented so that the X and Y dimensions of the tracking CCD were aligned with the RA and DEC of the telescope, limiting the possible rotation of the camera to four possible positions around a target at at 90 degree steps. Now, with CCDSoftV5, the autoguiding capability of the TC-211 (and TC-237) is improved so that the camera may be placed in any orientation relative to the telescope's RA and DEC, allowing a full 360 degrees of rotation around a target for easier guide star acquisition.

Guiding with either the TC-211 or the TC237 tracking CCD means that the imaging CCD spends 100% of its time and quantum efficiency gathering the image. You are not required to compromise for half the quantum efficiency or twice exposure time as you might with other self-guiding designs.

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### GREATER EXPANSION CAPABILITY

All new production USB cameras and upgrades will include a bi-directional I<sup>2</sup>C accessory port.



The new I<sup>2</sup>C accessory port adds bi-directional communication capability for the development of a new family of "smart" accessories. The standard accessory port is also provided in order to maintain backwards compatibility with our existing accessories (CFW8, AO-7, Relay Adapter Box) and customer's existing telescope interface cables.

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## COMPLETE SYSTEMS

It is the little things that count:



These cameras are complete systems. There is no need to add in the additional cost of an interface or an autoguider or a nosepiece or better software to make these cameras actually operate as they should. Everything that is needed to make these camera systems operational is included in the base price. We even include some non-essential, but desirable, items such as a custom hard carrying case and extra nosepiece.

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Each ST-7XE, ST-8XE, ST-9XE, ST-10XE/XME and ST-2000XM camera system **INCLUDES** at no additional cost:

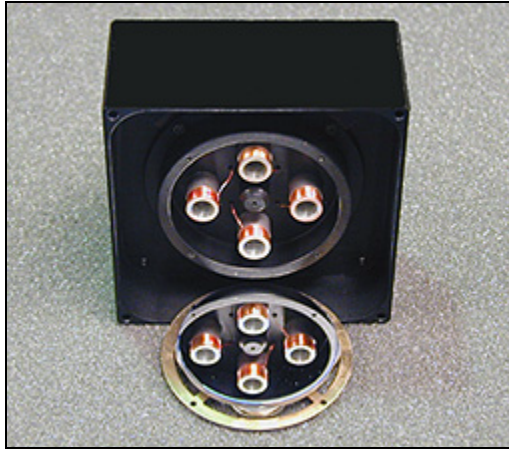
- Camera body with imaging CCD and new analog and digital electronics
  - New I<sup>2</sup>C bi-directional expansion port
  - Standard accessory / telescope port
  - **High speed USB interface (up to 421,000 pixels per second)**
  - **Built-in TC-237 autoguider in ST-8XE, ST-9XE and ST-10X(M)E**
  - **Built-in TC-211 autoguider in ST-7XE and ST-2000XM**
  - User rechargeable desiccant plug (no need to return camera to the factory for frosting problems)
  - "Dummy" desiccant plug for dust prevention during recharging procedure
  - Internal shutter
  - 2 Nosepieces (1.25" and 2")
  - Cooling Fan
  - New heat exchanger design with water cooling capability
  - Tripod mount 1/4-20 threaded side plate
  - T-thread ring
  - 15 foot USB cable (third party extenders available for up to 500 meters!)
  - Adapter plug for telescope interface cable
  - Telescope interface cable (for autoguiding)
  - Universal 90-240VAC power supply with remote on/off switch
  - SBIG's CCDOPS version 5 camera control software
  - **Software Bisque's CCDSoftV5** camera control and image processing software
  - Software Bisque's TheSky version 4, level II
  - Operating Manual
  - Custom design hard carrying case with pre-cut foam for your camera
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## MORE OPTIONS

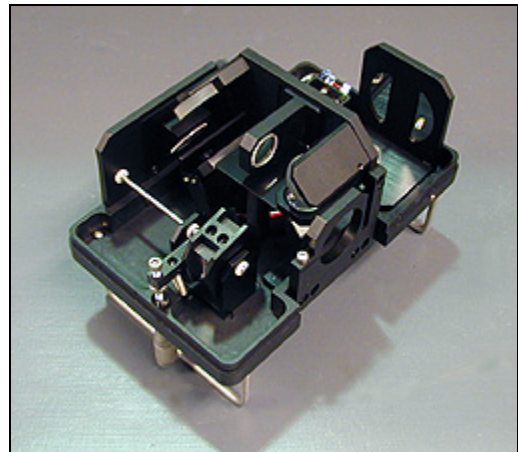
SBIG continues to explore new methods and accessories to make professional quality imaging an achievable standard for amateurs.



SBIG is the only company offering adaptive optics and a self-guiding spectrograph to the amateur astronomy community at an affordable price. Both the AO-7 Adaptive Optics device and the SGS Self-Guiding Spectrograph are available to amateurs because of our patented dual sensor self-guiding camera design. In the case of the AO-7, the smaller tracking CCD is exploited to monitor star motion and drive the AO-7's mirror at correction rates up to 50Hz. SBIG is exploring the possibility of an on-axis AO device in the near future. The Self-Guiding spectrograph uses both CCDs in the camera head to provide simultaneous images of the object, slit location and spectra. It then guides itself during the exposure to keep the object on the slit.

The following options and accessories are available for the ST-XE and XM cameras:

- Integrated CFW8 color filter wheel with research grade, custom RGB interference (dichroic) filters
- Research grade UBVRI Photometric filters and extra carousel for CFW8
- AO-7 adaptive optics device
- SGS Self-guiding spectrograph
- Industrial camera models including C-mount adapters
- Relay adapter box
- T-thread visual back for threaded connection to SCT
- 35mm camera lens adapters
- 12VDC power supply with battery clips
- 110VAC submersible water pump and tubing
- CCDSharp Lucy-Richardson deconvolution software
- Hartmann mask analysis software



## PRICE vs. PERFORMANCE

We feel that if one compares all of the included parts, features and costs of the camera / autoguider system with any competitor, SBIG remains a leader in price vs. performance. For example, simply adding in the cost of a TC-237 based autoguider and premier software comparable to CCDSoftV5 could run well over \$1000. Instead of charging \$50 extra for a nosepiece, we give you two at no additional charge. Water cooling capability is now standard, as is high speed USB. There is no extra charge for a custom hard carrying case, etc.

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