VISION RESEARCH

PHANTOM

when it's too fast to see, and too important not to.®

DATA SHEET

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Phantom® Miro® Cameras

Phantom Miro LC320S with PL Mount (front) and Miro M320S with EOS Mount (rear)

Setup, capture, view, save, analyze. Powerful, high-speed imaging in the package of your choice.

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

See the previously unseen. Study and characterize phenomena that are too fast for human observation. Improve quality and reliability of products and processes. Share results with colleagues and clients.

Phantom Miro cameras come in a variety of models and a range of performance levels. There are three body styles. The **M-Series** is targeted at applications where computer control is preferred – for example, a fixed installation where high-speed cines[1] are immediately saved to a computer for viewing and analysis. The **LC-Series** has an integrated flip-out LCD touchscreen for on-camera control and viewing of recorded cines. It is best employed in applications where the camera will be used in a variety of applications, often requiring portability. The **R-Series** is also targeted at applications where computer control is used, and is packaged in a robust, shock-tolerant, all-metal body.

[1] Phantom cameras record into a file format called a *cine* file.
This is a raw file that holds all sensor data and camera metadata in an efficient format.

Key Features:

Small, rugged high-speed cameras

1, 2 or 4 megapixel, 12-bit CMOS sensors

4 performance levels

3 camera body styles

Flexible tools for qualitative and quantitative analysis

Our most accessible cameras ever

Nikon F/G, Canon EOS, 1" C, PL lens mounts

Phantom RCU[2] compatible

Rechargeable battery

Phantom CineFlash storage system
- CineFlash modules up to 240GB
- CineFlash Dock
- eSATA connectivity

[2] The M140 and M340 do not support use of the Phantom RCU

AMETEK®
MATERIALS ANALYSIS DIVISION

Miro® M-Series, LC-Series, R-Series

And, there are **a variety of performance levels** in each series. This table shows the various performance levels:

Key Specs	110		310		120		320S		M140		M340	
Maximum Resolution	1280 x 800		1280 x 800		1920 x 1200		1920 x 1200		2560 x 1600		2560 x 1600	
Maximum Frame Rate at Maximum Resolution	1600 fps		3200 fps		730 fps		1380 fps		410 fps		800 fps	
Throughput (Gpx/s)	1.6 Gpx/s		3.2 Gpx/s		1.6 Gpx/s		3.2 Gpx/s		1.6 Gpx/s		3.2 Gpx/s	
Sensor Size	25.6mm x 16.0mm		25.6mm x 16.0mm		19.2mm x 10.8mm		19.2mm x 10.8mm		25.6mm x 16.0 mm		25.6mm x 16.0 mm	
Pixel Pitch	20 µm		20 µm		10µm		10µm		10µm		10µm	
Minimum Exposure	2 µs		1 µs		1 µs		1 µs		1 µs		1 µs	
Native ISO (12232 SAT Method)	Mono	Color	Mono	Color	Mono	Color	Mono	Color	Mono	Color	Mono	Color
	16,000 T 6400 D	2000 T 2000 D	16,000 T 6400 D	2000 T 2000 D	12,500 T 5000 D	1600 T 1250 D	12,500 T 5000 D	1600 T 1250 D	12,500 T 5000 D	1600 T 1250 D	12,500 T 5000 D	1600 T 1250 D
Video System	NTSC/PAL		NTSC/PAL		NTSC/PAL		HD-SDI		None		None	

The **Miro 110** has a 1 megapixel (Mpx) sensor and can acquire images at up to 1.6 gigapixels-per-second (Gpx/s). The **Miro 310** is also a 1 Mpx sensor, but runs at twice the speed – up to 3.2 Gpx/s.

The **Miro 120** has a 2 Mpx, high-definition, sensor with 1.6 Gpx/s throughput. Where the **Miro 320S** has a 2 Mpx sensor with 3.2 Gpx/s throughput.

The **Miro M140** has a 4 Mpx sensor and 1.6 Gpx/s throughput. The **Miro M340** also has a 4 Mpx sensor and throughput of 3.2 Gpx/s.

	110		310		120		M140		320S Mono		320S Color		M340	
Resolution	FPS	Secs*	FPS	Secs*	FPS	Secs*	FPS	Secs*	FPS	Secs*	FPS	Secs*	FPS	Secs*
2560 x 1600	N/A	-	N/A	-	N/A	-	410	4.9	N/A	-	N/A	-	800	2.5
2048 x 1600	N/A	-	N/A	-	N/A	-	510	4.9	N/A	-	N/A	-	980	2.5
1920 x 1200	N/A	-	N/A	-	730	4.7	730	4.9	1380	2.5	1380	2.5	1380	2.5
1920 x 1080	N/A	-	N/A	-	800	4.8	810	4.9	1540	2.5	1530	2.6	1540	2.6
1280 x 1024	N/A	-	N/A	-	1250	4.8	1250	5.1	2310	2.5	2300	2.6	2310	2.6
1280 x 800	1630	4.7	3260	2.3	1600	4.8	1600	5.1	2960	2.6	2940	2.7	2950	2.7
1280 x 720	1810	4.7	3630	2.3	1780	4.8	1770	5.1	3280	2.6	3200	2.7	3200	2.7
1152 x 1152	N/A	-	N/A	-	1220	4.9	1220	5.1	2250	2.6	2240	2.7	2240	2.7
1024 x 1024	N/A	-	N/A	-	1530	4.9	1530	5.2	2780	2.7	2770	2.9	2770	2.9
896 x 720	2520	4.9	5040	2.4	2450	5.0	2450	5.3	4400	2.8	4300	2.9	4390	2.9
640 x 480	5090	5.1	10,100	2.5	4910	5.3	4900	5.5	8490	3.0	8300	3.3	8450	3.2
512 x 512	5790	5.2	11,500	2.6	5540	5.5	5530	5.8	9330	3.2	9200	3.4	9280	3.4
384 x 288	12,900	5.6	25,900	2.7	12,200	5.9	13,600	6.3	19,600	3.6	19,000	3.9	19,400	3.9
256 x 256	19,800	6.1	39,700	3.0	18,300	6.6	18,100	7.1	27,600	4.4	26,400	4.8	27,200	4.7
128 x 128	60,400	8.0	120,700	4.0	52,400	9.3	51,000	10.0	69,000	7.0	62,000	8.1	66,600	7.1
128 x 64	113,200	8.6	226,300	4.3	95,300	10.2	90,800	11.3	121,900	8.0	102,000	9.7	114,700	8.9
128 x 8	400,000	19.5	650,000	12.0	250,000	31.0	250,000	32.8	325,000	25.0	240,000	39.0	311,000	26.4
64 x 8	400,000	41.0	650,000	25.0	250,000	65.0	250,000	65.7	325,000	50.0	240,000	68.0	325,000	50.5

** Record time into maximum memory of 12GB.*

Camera throughput specifies the number of pixels the camera can acquire each second. So, for example, a Miro 310 with 3.2Gpx/s, can acquire and save up to 3200 one-megapixel frames each second! Another way to specify speed is in frames-per-second (fps) at a given resolution.

Let's explore these cameras in more detail by following a typical workflow of setup, capture, viewing, saving and analyzing the results.

Setup

Phantom Miro cameras are **easy to set up and control**. Use our Phantom Camera Control (PCC) software over a Gb Ethernet connection, a hand-held Phantom RCU, or the on-board LCD touchscreen (on the LC-Series only) to access and control the camera's features. (An SDK enabling custom software interfaces and LabView drivers are also popular ways to set up and control Phantom cameras.)

Change **resolution, frame-rate and exposure** and see the results immediately on a live image. As you decrease resolution, you have access to higher and higher frame rates.

A short exposure time will help **freeze motion and eliminate blurry images** (but, also requires more light.) Exposure times as short as 1 microsecond (µs) are available on some models.

Optionally, **segment memory** into as many as 16 segments to capture multiple shots back-to-back – tailored to your record time and shot sequencing needs.

The native **light sensitivity** of a camera is specified by its ISO rating – the higher the rating, the greater the light gathering capability of the sensor. Greater light sensitivity means you can achieve shorter exposure times with a given amount of light, or you need less supplemental light at very short exposures. You have more flexibility to adapt to various shooting conditions and greater depth-of-field with higher ISO ratings. The ISO 12232 standard specifies several ways to determine light sensitivity. We use the S_{SAT} method to determine the minimum native rating for our cameras. You can **boost the native ISO rating** on any Phantom Miro cameras by adjusting the Exposure Index (EI).

Select a **triggering strategy** appropriate to your application – you can trigger at the beginning of an event, after an event, or anywhere in between. Select your trigger source from among many alternatives: on-camera button, remote hardware trigger, soft trigger via software, or even automatically trigger based on changes in the live image using our unique **Image-Based Auto-Trigger** technology.

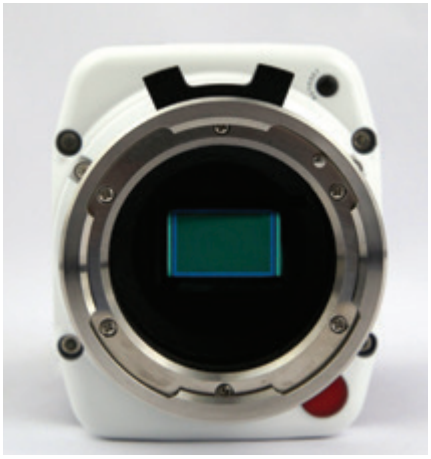
Timing is critical in most high-speed applications. Choose a timing reference from the internal camera clock, external IRIG, external Frame Sync signal, or even from another camera for multi-camera setups. All Miro cameras have 20 ns timing accuracy with resolution dependent upon the source.

For the ultimate in image quality from a CMOS sensor, it is important to black reference the sensor any time the camera setup changes or if temperatures change over time. Most cameras require you to manually cap the lens to provide a black reference. This is inconvenient since you need to have physical access to the camera, find the right lens cap, and manually cap the lens while taking the black reference. Phantom Miro cameras have an **internal mechanical shutter** mechanism that closes off all light to the sensor

Setup is easy.

There are even several common setups pre-installed on the LC-Series. Just select the one you want with a tap on the screen.

Phantom Miro LC320S with Canon EOS Mount



Combining **award-winning** technology from Phantom cinema cameras and Phantom industrial/scientific cameras, the Miro M-Series, Miro LC-Series, and Miro R-Series cameras take quality, portability and performance to the next level.

for automatic/remote black referencing. (The R-Series comes standard without the shutter, enabling high-g operation. If an optional shutter is installed, the shock specification is lower.)

Other setup controls are available including hardware signals for Strobe (active during frame exposure), Ready (indicates camera is ready for trigger), Event (mark events during recording), Memgate (temporarily stop image acquisition during recording.) (Not all control signals are available simultaneously.) These signals make it possible to integrate a Miro camera with popular data acquisition hardware, for example.

On cameras equipped with a Canon EF/EFS lens mount, lens aperture and focus can be remotely controlled. Other **lens mounts** available include: 1" C-mount; Nikon F-mount that supports F and most G style lenses; PL mount.

Finally, select **end-of-recording actions** that include automatically saving an acquired cine to the CineFlash non-volatile memory module; playback of the recorded cine; and, rearming the camera for the next shot.

Capture

Once set up, **image acquisition is really quite easy**. Just trigger the camera.

When armed, the camera will start acquiring images into its high-speed RAM memory buffer. When memory is full, the oldest image will be dropped and replaced with a new image. We call this a "**circular buffer**" and it helps ensure you will get the shot you need. It enables you to place the trigger frame anywhere in the buffer. This makes it easier to capture unpredictable events—just trigger somewhere in the middle of the buffer. Frames in memory prior to the trigger (pre-trigger frames) will be retained and the remainder of the buffer will store frames acquired after the trigger (post-trigger frames.)

When all post-trigger frames are in memory, the camera will execute any end-of-recording actions.

View

Immediately view the slow-motion cine on a video monitor, computer screen, Phantom Remote Control Unit (RCU) or the LCD touchscreen on the LC-Series. You have video controls available to view the cine forward or backward, sped-up or slowed-down, even single-step through your cine! You can mark in- and out-points to surround only those frames with content of interest.

The Miro 110, 310 and 120 all have NTSC/PAL video output ports. The Miro 320S has an HD-SDI output port. (The M140 and M340 do not have video-out and cines must be viewed on a computer.)

Once you are sure you have the shot you need and have optionally trimmed the cine to include only the frames of interest, you are ready to save the cine.

Save

Of course, if you set up an end-of-recording action to automatically save the cine, it will be saved to **CineFlash** at about 4GB per minute. If not, then you can manually save the cine to CineFlash after viewing and optionally trimming it.

Once on the CineFlash module, the cine file is safely stored in non-volatile memory and you are free to re-arm the camera and take your next shot.

A cine file can be viewed in Phantom Camera Control (PCC) software or in our free Phantom Cine Viewer. You can convert the cine file to a number of common file formats from either software package making it easy to archive and share your slow-motion content. Save your file as a raw cine, or stack of TIFF, JPG or DNG files. Supported movie formats include h.264, .mov and AVI. And, with an upcoming version of PCC, h.264 formats will also be available.

CineFlash modules can be removed from a camera and inserted into the included **CineFlash Dock** connected to a computer (3rd party drivers may be required.) The CineFlash module then mounts on your computer as an external disk drive and you can easily "drag and drop" cine files from the CineFlash to local storage.

CineFlash modules currently come in 120GB and 240GB sizes. Not only can you conveniently save multiple cine files on-camera in non-volatile memory for later retrieval, CineFlash modules are specially designed for high throughput which translates into save and retrieval times far better than what you get with commercial solutions designed for slow-speed cameras. The ability to save data at rates up to 70 megabytes per second translates into less downtime due to long file save times and higher camera productivity. This means higher productivity because you don't have to wait for a lengthy download between shots.

Alternatively, for computer-connected cameras, you can download the cine file from high-speed memory to a local disk drive over Gb Ethernet, typically around 50 MB/s.

Phantom Miro M320S

Analyze

Now what? You have an amazing slow-motion movie of phenomena that cannot be seen by the human eye. Of course, the ability to play a slow-motion movie, stop it, rewind, fast-forward and single step gives you the ability to tap into the human brain for qualitative insights and analysis. You will find yourself saying "I didn't know that!" Or, "I would never have believed it!"

But, you are not limited to qualitative analysis of your movies. When performing your experiment or test, you can **simultaneously acquire data about your subject using data acquisition** (DAQ) modules from National Instruments. PCC natively supports camera synchronization to NI M- and X-Series DAQ modules and the data acquired is saved with the cine file. Use PCC to view quantitative data synchronized to the playback of a cine file.

And, **PCC supports a suite of measurement tools** that allow you to estimate distance, velocity, acceleration and angles based on points in the cine file. These tools are in both the PCC and the Cine Viewer software packages.

Phantom CineFlash Drive & CineFlash Dock

Vision Research Global Support - for wherever you are

Our Ultra High-Speed camera line is supported by Vision Research's Global Service and Support network offering AMECare Performance Services from multiple sites around the globe. Maximize the value of your Phantom camera by learning more about our service and support options at www.visionresearch.com/Service--Support/

DATA SHEET

Phantom® Miro® Cameras

	M-Series	LC-Series	R-Series
Camera Body	Standard	Standard	Ruggedized
On-Camera Controls	No	Yes, LCD touchscreen	No
Battery Power Option	Yes	Yes	Yes, BP-U30 only to maintain shock rating
CineFlash Compatible	Yes	Yes	Yes, adapter required (supplied with camera)
Shock Rating	25G, half sine wave, 11 ms, 10 times, 3 axes (without lens)	Not specified	125G, sawtooth wave, 11 ms, 30 times, 3 axes (without lens and without internal shutter)
Random Vibration	Not specified	Not specified	15 Grms, 20Hz-2KHz, all axes, 10 min/axis, in accordance with MIL-STD-810G
Operating Temperature	0°C to +40°C @ 8% to 80% RH	0°C to +40°C @ 8% to 80% RH	-10°C to +50°C @ 10% to 95% RH
Storage Temperature	-20°C to 70°C	-20°C to 70°C	-20°C to 70°C
Size*	7.5 x 3.5 x 4 in 19 x 8.8 x 10 cm without battery	7.4 x 3.85 x 4 in 19 x 9.8 x 10 cm without battery	7.5 x 3.5 x 4 in 19 x 8.8 x 10 cm without battery
Weight*	3.0 lbs, 1.4 kg, without CineFlash, battery or lens	3.0 lbs, 1.4 kg, without CineFlash, battery or lens	3.5 lbs, 1.6 kg, without CineFlash, battery or len
Battery Power	Sony BP-U30 or BP-U60 rechargeable, external charger required	Sony BP-U30 or BP-U60 rechargeable, external charger required	Sony BP-U30 only, rechargeable, external charger required
Internal Mechanical Shutter	Standard	Standard	Optional, if equipped shock rating limited to 40G maximum
Junction Box Compatibility	Yes	Yes	Yes
Data Acquisition	Native Support in PCC for National Instruments X- and M-Series	Native Support in PCC for National Instruments X- and M-Series	Native Support in PCC for National Instruments X- and M-Series
Operational Altitude	Not specified	Not specified	0 - 50,000 ft 0 - 15,240 meters

* Size and weight can vary with lens mount selection.

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

Additional Features:

Image-Based Auto-Trigger (IBAT)

Burst Mode

Continuous Recording

Auto-Exposure

Multi-cine Acquisition

Internal Mechanical Shutter (optional on the R-Series)

Gb Ethernet

Rechargeable Battery (Sony BP-U30 or BP-U60)

Tiered Service Contracts to protect your investment

Focused

Since 1950, Vision Research has been designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.

VISION RESEARCH

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