

DATA SHEET

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

Phantom® Miro® Cameras

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 cines¹ 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 RCU² 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

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.

| Resolution | 110 | | 310 | | 120 | | M140 | | 320S Mono | | 320S Color | | M340 | |
|-------------|---------|-------|---------|-------|---------|-------|---------|-------|-----------|-------|------------|-------|---------|-------|
| | 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.

Miro® M-Series, LC-Series, R-Series

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 (μ s) 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.

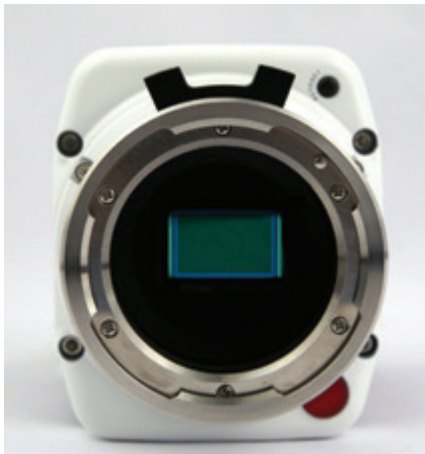
There are even several common setups pre-installed on the LC-Series.

Just select the one you want with a tap on the screen.



Phantom Miro LC320S with Canon EOS Mount

Miro® M-Series, LC-Series, R-Series



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.

Miro® M-Series, LC-Series, R-Series

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.

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.

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/



Phantom Miro M320S



Phantom CineFlash Drive & CineFlash Dock

DATA SHEET

Phantom® Miro® Cameras

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.



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| | 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 lens |
| 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.