VISION RESEARCH

PHANTOM

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

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DATA SHEET

For the most current version visit www.phantomhighspeed.com
Subject to change Rev April 2016

Phantom® Miro® LAB-, LC- and R-Series Cameras

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

Phantom Miro LAB-, LC- and R-Series Cameras

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 **LAB-Series** is designed for laboratory/office-environment 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 where the camera will be used in a variety of applications, often requiring portability. The **R-Series** is also designed for applications where computer control is used, and is packaged in a robust, shock-tolerant, all-metal body for applications in outdoor and harsh environments.

[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:

Choose the resolution, performance level, and body style that best fits your application

1, 2 and 4 megapixel versions available

Choose the throughput you need: 1.6 Gpx/s or 3.2 Gpx/s

12-bit pixel depth

6GB or 12GB memory

Flexible tools for qualitative and quantitative analysis

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

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

Standard on the LC- and R-Series
Optional on the LAB-Series

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Miro® LAB-Series, LC-Series, R-Series

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

Performance Levels and Key Specifications	LAB110 LC110 R111	LAB310 LC310 R311	LAB3a10	LAB120 LC120 R121	LAB320 LC320S R321S	LAB140 R141	LAB340 R341
Maximum Resolution	1280x800	1280x800	1280x1280	1920x1200	1920x1200	2560x1600	2560x1600
Sensor Mpx	1Mpx	1Mpx	1.6Mpx	2.3Mpx	2.3Mpx	4Mpx	4Mpx
Maximum FPS at Maximum Resolution	1600 fps	3200 fps	1850 fps	730 fps	1380 fps	410 fps	800 fps
Throughput (Gpx/s)	1.6 Gpx/s	3.2 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	12.8mm x 12.8mm	19.2mm x 10.8mm	19.2mm x 10.8mm	25.6mm x 16mm	25.6mm x 16mm
Pixel Pitch	20 µm	20 µm	10µm	10µm	10µm	10µm	10µm
Minimum Exposure	2 µs	1 µs	1µs	1 µs	1 µs	1 µs	1 µs
Native *(ISO 12232 SAT Method)	2000 D* Color 2000 T* Color 6400 D* Mono 16,000 T Mono	2000 D* Color 2000 T* Color 6400 D* Mono 16,000 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono

Not all **performance levels** are available in all body styles.
Here is a table showing what is available.

Body Style	LAB-Series	LC-Series	R-Series
Miro 11x	✓	✓	✓
Miro 31x	✓	✓	✓
Miro 3a1x	✓		
Miro 12x	✓	✓	✓
Miro 32x	✓		
Miro 32xS		✓	✓
Miro 14x	✓		✓
Miro 34x	✓		✓

This table shows what **video system** is available on each model.

Video	LAB-Series	LC-Series	R-Series
Miro 11x	None	NTSC/PAL	NTSC/PAL
Miro 31x	None	NTSC/PAL	NTSC/PAL
Miro 3a1x	None	–	–
Miro 12x	None	NTSC/PAL	NTSC/PAL
Miro 32x	None	–	–
Miro 32xS	–	HD-SDI	HD-SDI
Miro 14x	None	–	None
Miro 34x	None	–	None

Resolution / speed charts

1Mpx Miro Cameras

	LAB110 LC110 R111		LAB310 LC310 R311		LAB3a10	
Resolution	FPS	Secs*	FPS	Secs*	FPS	Secs*
1280 x 1280	–	–	–	–	1850	2.7
1280 x 1024	–	–	–	–	2310	2.7
1024 x 1024	–	–	–	–	2780	2.7
1280 x 800	1630	4.7	3260	2.3	2950	2.7
1280 x 720	1810	4.7	3630	2.3	3280	2.6
896 x 720	2520	4.9	5040	2.4	4390	2.9
640 x 480	5090	5.1	10100	2.5	8450	3.2
512 x 512	5790	5.2	11500	2.6	9290	3.4
384 x 288	12900	5.6	25900	2.7	19400	3.9
256 x 256	19800	6.1	39700	3.0	27200	4.7
128 x 128	60400	8.0	120700	4.0	66600	7.7
128 x 64	113200	8.6	226300	4.3	114700	8.9
128 x 8	400000	19.5	650000	12.0	311000	26.0

2Mpx Miro Cameras

	LAB120 LC120 R121		R320S LC320S Mono		R320S LC320S Color		LAB320	
Resolution	FPS	Secs*	FPS	Secs*	FPS	Secs*	FPS	Secs*
1920 x 1200	730	4.7	1380	2.5	1380	2.5	1380	2.5
1920 x 1080	800	4.8	1540	2.5	1530	2.6	1540	2.5
1152 x 1152	1220	4.9	2250	2.6	2240	2.6	2250	2.6
1024 x 1024	1530	4.9	2780	2.7	2770	2.9	2780	2.7
1280 x 800	1600	4.8	2960	2.6	2940	2.7	2960	2.6
1280 x 720	1780	4.8	3280	2.6	3200	2.7	3280	2.6
896 x 720	2450	5.0	4400	2.8	4300	2.9	4400	2.8
640 x 480	4910	5.3	8490	3.0	8300	3.3	8490	3.0
512 x 512	5540	5.5	9330	3.2	9200	3.4	9330	3.2
384 x 288	12200	5.9	19600	3.6	19000	3.9	19600	3.6
256 x 256	18300	6.6	27600	4.4	26400	4.8	27600	4.4
128 x 128	52400	9.3	69000	7.0	62000	8.1	69000	7.0
128 x 64	95300	10.2	121900	8.0	102000	9.7	121900	8.0
128 x 8	250000	31.0	325000	25.0	240000	45.0	325000	25.0

4Mpx Miro Cameras

	LAB140 R140		LAB340 R340	
Resolution	FPS	Secs*	FPS	Secs*
2560 x 1600	410	4.7	800	2.5
1600 x 1600	650	4.7	1220	2.5
1920 x 1200	730	4.7	1380	2.5
1920 x 1080	800	4.8	1530	2.6
1280 x 1280	1000	6.3	1850	2.7
1024 x 1024	1530	5.2	2780	2.7
1280 x 800	1530	4.9	2960	2.6
1280 x 720	1600	4.8	3280	2.6
640 x 480	1780	4.8	8490	3.0
512 x 512	5540	5.5	9330	3.2
256 x 256	18300	6.6	27600	4.4
128 x 128	52400	9.3	69000	7.0
128 x 64	95300	10.2	121900	8.0
128 x 8	250000	31.0	325000	25.0

** Record time into maximum memory of 12GB*

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Camera throughput specifies the number of pixels the camera can acquire each second. So, for example, a Miro LAB310 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 most models.

Optionally, **segment memory** into as many as 63 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 ISO rating** using straight-forward image processing settings.

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 for automatic/remote black referencing. (The internal mechanical shutter in the R-Series

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

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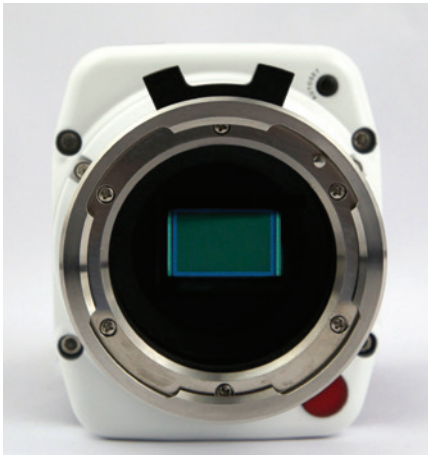

Combining **award-winning** technology from Phantom cinema cameras and Phantom industrial/scientific cameras, the Miro LAB-Series, Miro LC-Series, and Miro R-Series cameras take quality, portability and performance to the next level.

can be removed with an option at the time you order the camera. Removing the shutter allows the camera to be used in more extreme environments.)

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 you have programmed, such as AutoSave.

View

Immediately view the slow-motion cine on a video monitor, Phantom Remote Control Unit (RCU)[2], computer screen, 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.

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.

[2] Not all camera models support video output. And, the RCU is not supported on models without video output. See Video System table on a page 2.

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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, AVI, and Apple ProRes.

CineFlash modules can be removed from a camera and inserted into the included **CineFlash Dock** connected to a computer with a USB or eSata connection. Third party drivers required to access the cines are included. 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 LAB3a10

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 allows you to track points, 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 Miro 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.phantomhighspeed.com/PhantomZone.

Phantom CineFlash Drive & CineFlash Dock

DATA SHEET

Phantom® Miro® LAB-, LC- and R-Series Cameras

	LC-Series	R-Series	LAB-Series
On-Camera Controls	Yes, LCD touchscreen	Trigger	Trigger
Battery Power Option	Yes	Yes	No
CineFlash Compatible	Yes	Yes	Yes
Shock Rating	Not specified	100G, sawtooth wave, 11ms, 10 pulses, all axes, no lens, no internal shutter 30G rating with internal shutter installed and BP30 battery	30G, sawtooth wave, 11ms, 10 pulses, all axes, no lens
Operating Temperature	0°C to +40°C @ 8% to 80% RH	-10°C to +50°C @ 10% to 95% RH	0°C to +40°C @ 8% to 80% RH
Storage Temperature	-20°C to 70°C	-20°C to 70°C	-20°C to 70°C
Size*	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	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	3.5 lbs, 1.6 kg, without CineFlash, battery or lens	3.0 lbs, 1.4 kg, without CineFlash or lens
Battery Power	Sony BP-U30 or BP-U60 rechargeable, external charger required	Sony BP-U30 or BP-U60 rechargeable, external charger required	None
Internal Mechanical Shutter	Standard	Standard, option to remove for increased shock ratings	Standard
Junction Box Compatibility	Yes	Yes	No
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

* Size and weight can vary with lens mount selection.

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)
Not available on the LAB-Series

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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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.

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