RMK D™
CAMERA SYSTEM
Exceed Your High-Accuracy, High-Resolution Requirements
SUPERIOR MEDIUM-FORMAT CAMERA EXCEEDS YOUR ACCURACY AND RESOLUTION REQUIREMENTS

INTERGRAPH®’S Z/I IMAGING® RMK D™ is the industry’s first medium-format metric digital camera system, an ideal solution for companies who want to enter the digital market and gain unmatched geometric and radiometric image quality with the latest camera technology available. The RMK D carries a lower price point when compared to large-format cameras and exceeds the high-accuracy/high-resolution requirements for most engineering mapping and remote-sensing tasks.

Inside cover: This color-infrared image of Brombach Lake in Bavaria, Germany, was captured using the RMK D system.
The RMK D addresses a wide range of applications, from large-scale engineering-type mapping to high-quality orthophoto production. Because the RMK D has four color channels (red, green, blue, and near-infrared) at 1:1 full-color resolution, it is also a perfect solution for vegetation classification and other remote-sensing applications. Four camera heads allow you to simultaneously capture RGB and NIR images. The camera’s compact design requires minimal space, so you can install it in smaller aircrafts.

The complete data acquisition system delivers small-scale or large-scale images with high-quality resolution at engineering-scale accuracy, supplying images with ground resolutions of less than four centimeters (1.5 inches). The modular system consists of state-of-the-art components centered on frame sensor technology and solid state data storage to enhance all aspects of the digital workflow. The components ensure longer lifetime, lower failure rate, and stability in rough and changing environments.

The RMK D exceeds the level of expectation for the industry for reliability and accuracy, ensuring high-geometric and radiometric resolution. The system delivers images digitally, enabling direct production of a wide range of mapping and image analysis deliverables, including orthophotos, digital terrain models (DTMs), and more. The combination of innovative components makes the RMK D ideal for capturing data for all of your mapping applications, including agriculture, cadastral mapping, cartography, forestry, land use/land cover mapping, environmental studies, natural hazard assessment, flood risk management, transportation engineering, urban planning, civil engineering, oil and gas exploration, and geology.

GO DIGITAL

Intergraph’s RMK D is the perfect solution for companies who want to make the transition from flying with film cameras to digital technology. Digital camera technology has matured since it was first introduced in 2003. The RMK D helps smaller operations apply digital data acquisition at a price they can afford. In addition, Z/I Imaging’s smooth workflow eases the transition from analog to digital cameras.

Film, scanning, and processing account for the majority of costs for typical photo flights using a film-based camera. With a digital camera, you can eliminate the laborious and time-consuming tasks of processing and scanning film, which results in significant time and cost savings.

The camera’s extended operation range, wide range of applications, and high-image quality will improve your return on investment.
Custom-Designed Charge Coupled Device (CCD) Sensors Record Precise Geometry

Employing custom-designed CCD frame (matrix) sensor technology allows the RMK D to meet rigorous goals and offers advantages not seen with small-format framing-sensor technology or line-sensor technology. The technology ensures rigid image geometry in a fashion analogous to a precision film platen. The RMK D does not depend on a global positioning system (GPS), if used. Even if GPS lock is completely lost, flight conditions are severely turbulent, or light conditions are poor, you can be assured that high-quality metric imagery is “in the can” and ready to exploit using traditional photogrammetric methods. You can view a real image with the integrated video camera.

Features such as completely electronic forward motion compensation (FMC) and 14-bit per pixel radiometric resolution for each of the color channels ensure stunning image quality compared to scanned aerial films. Because the RMK D exposes a square pixel footprint and all camera heads simultaneously, the image is frozen in one shot, which minimizes adverse influences due toairspeed fluctuation, sudden aircraft movement, or objects moving within the frame.

The CCDs are full-framed sensors with high optical fill factor and sensitivity. RMK D offers pixel size of 7.2 microns by 7.2 microns (square) and with a high linear dynamic range of 12-bit. The architecture of the CCDs offers parallel readout registers on two corners of the chip.

Because of the two-dimensional area sensor, the image data has a known and precise geometry in both X and Y directions. This provides a repetition rate for the system of one image every 1.1 seconds and high readout rates, which is important for a good signal-to-noise (S/N) ratio. The RMK D ensures optimum precision results. For example, a photo flight at an altitude of 500 meters (1,640 feet) at an approximate speed of 200 knots produces images with 80 percent overlap in the flight direction and with a ground sampling distance of eight centimeters (3.1 inches).

Custom-Designed Innovative Camera, Lens, and Shutter Technology

Z/I Imaging partnered with Carl Zeiss to develop a unique lens design, minimizing distortion and maximizing resolution. The RMK D possesses a unique lens system, featuring minimal distortion, large (f/4) aperture, high resolution, and homogenous field response.

On opposite page: A city wall built during the Middle Ages surrounds the city of Nördlingen, Germany. This image was captured using the RMK D system.
The four individual camera modules are autonomous units and capture a central perspective view. Each of the four camera heads uses a separate lens, resulting in images with higher radiometric performance than those from a single camera head using BAYER color filter technology. The high-resolution camera heads contain customized 42 MPixel CCD chips and high-performance lenses with 45-millimeter focal length at a maximum aperture of f/4. For the simultaneous collection of color and false color infrared images and high-quality separation, each channel features a high-performance filter based on non-organic material. The cameras are mounted in nadir view inside a rigid optics frame designed specifically to ensure precise alignment of the optical axes.

The front-end electronics, with signal conditioning, analog-to-digital conversion, CCD timing, and processing, are directly integrated inside the camera module. This integrated design technique ensures a very high S/N of the CCD and minimizes the electromagnetic interference (EMI) within the system. Shutter development focused on achieving precise synchronization to exclude geometric errors. A piezo-driven electromechanical shutter placed in the center of each of the camera lenses exposes all image points through the optical paths at the same moment, resulting in a distortion-free image. The RMK D shutters give you superior performance over slit shutters used in standard reflex cameras by preventing geometric distortion inside the image field caused by aircraft movement during exposure time. The long lifetime of the shutter will provide you with more than 100,000 exposures.

On top of the optics frame is the camera electronics that controls the camera modules, includes the power electronics for the shutters, collects the image data, and communicates with the camera control unit. The camera control unit configures the complete system, communicates with the external systems, monitors the data flow, and stores data on solid state disks (SSD).

**Forward Motion Compensation**

Electronic FMC is an absolute necessity for acquiring a blur-free image under large-scale mapping conditions. To allow fully electronic FMC of the digital image, the CCD matrix sensors used in the RMK D camera heads operate in time-delayed integration (TDI) mode.

This technique is similar to the image blur removal concepts used in film cameras, but without the limitation and potential failure modes of moving parts. The FMC used within the RMK D is capable of compensating for much higher velocity/height (V/H) ratios than mechanical systems, thus greatly extending the operating envelope of the system.
RMK D CAMERA SYSTEM KEY BENEFITS

- Superior radiometric resolution
- Increased accuracy of photogrammetric measurements
- Reduction of materials and labor costs to produce digital imagery
- Faster turnaround time from flight to image data
- CIR and RGB image acquisition during one flight
- Highest image quality with compensation for image blur (FMC)
- Clean digital data for better-quality image products (orthos)
- More potential flying days and flying hours per day
- Completely digital workflow throughout GIS and remote-sensing projects

The RMK D system gives you a complete digital workflow, from acquisition to processing.

At left: This color-infrared image of Aalen, Germany, was captured using the RMK D system.
RMK D. A large sensor area along the flight strip allows long exposure times, while maintaining a high enough air speed for a photo flight with a fixed wing aircraft at low altitudes. This type of FMC cannot be achieved in standard linear CCD or “push broom” sensors. Electronic FMC, with the combination of precision optics and framing CCDs, allows the RMK D to achieve high-ground resolutions of only a few centimeters.

Flexible On-board System
To ensure a smooth transition when replacing cameras in the aircraft, the RMK D fits into the same form factors as existing film-based cameras, such as the RMK A and RMK TOP family of cameras, the LMK, or the RC camera series. This eliminates the need, in most cases, to modify the dimensions of an existing camera hole in the aircraft floor. The RMK D also takes into account the maximum operational flexibility needed while transitioning to an all-digital configuration. Included as part of the system is Z/I Inflight, an integrated flight management system (FMS), that can also manage film-based cameras. You can also use Z/I Track as an alternative flight management system, based on TRACK’ AIR software and running on Z/I Inflight hardware.

On-board Data Storage Capacity
When operated in full-color, 14-bit per pixel mode, the camera system generates about 320 megabytes of raw image data per exposure. Therefore, each camera head includes PCI-Express-Bus-based control electronics using special high-throughput interface technology, which is capable of managing this data stream. A Microsoft® Windows®-embedded master slot PC coordinates communication between the individual components. The image data is transferred via a SATA interface onto a removable, ruggedized storage system. This solid state disk system is a removable, solid state RAM storage cartridge with a capacity of 2,000/4,000 images or 660 gigabytes. Intergraph was
# TECHNICAL SPECIFICATIONS: DMC® – RMK D

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>DMC</th>
<th>RMK D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pixel across track</td>
<td>13824</td>
<td>5760</td>
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<tr>
<td>Pixel along track</td>
<td>7640</td>
<td>6400</td>
</tr>
<tr>
<td>FoV across track</td>
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<td>FoV along track</td>
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<td>Focal length</td>
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<td>GSD@500m</td>
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<td>8.0 cm</td>
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<tr>
<td>B/H</td>
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<tr>
<td>Pixel size</td>
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<td>Number of camera heads</td>
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<td>PAN : Color resolution</td>
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<td>Frame rate</td>
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<tr>
<td>A/D resolution per pixel</td>
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<td>14 bit</td>
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<tr>
<td>FMC</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>CCD dynamic range</td>
<td>72 dB</td>
<td>71 dB</td>
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<tr>
<td>On-board storage</td>
<td>2500 images</td>
<td>2000/4000</td>
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<tr>
<td>Weight (including SSD)</td>
<td>88 kg</td>
<td>59 kg</td>
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<td>Power consumption (including SSD)</td>
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<td>350 watt</td>
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<td>Altitude non-pressurized</td>
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</tr>
<tr>
<td>Operating temperature</td>
<td>0°C - 40°C</td>
<td>0°C - 40°C</td>
</tr>
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</table>

(Components external to the aircraft operate in temperatures up to -20 C.)
the first in the industry to use this high-speed, high-capacity solid state/storage, which provides unlimited storage with the use of multiple cartridges. You can swap out these low-weight, compact units during the mission for unprecedented storage capacity and reliability. Since they are incorporated within the camera body itself, the space, weight, and power consumption of disk drive units are completely eliminated. This allows you to fly the RMK D system in an aircraft as small as a Cessna 206. Another important point to note is the SSD storage devices used for RMK D are compatible with previous SSDs delivered with our Digital Mapping Camera (DMC®), protecting your investment in Intergraph’s data acquisition solutions.

**Simplified Post-Processing**

Once you acquire images and complete the photo flight, you can download the imagery and actual mission parameters from the SSD cartridge for straightforward post-processing. The RMK D post-processing system outputs images from the raw image data stored on the SSD. You can use the ImageViewer software to preview actual post-flight image data, particularly for multi-day missions unable to return to home base.

Post-processing is completed in two steps: radiometric processing and geometric processing. Through the RMK D post-processing software interface, you can enter parameters that specify the processing step options. First, it radiometrically processes the raw image data from the SSD to compensate for the effects of vignetting, aperture, and other radiometric factors. The intermediate images, generated from radiometric processing, are written to the RAID storage. Once this step is complete, you can remove the SSD and return it to the camera. The intermediate images are then geometrically corrected for lens distortion and tilt and combined by a mosaicking module.

The post-processing software can produce several different types of output files from the set of raw images stored on the SSD. These outputs include high-resolution 5670 x 6400 color (RGB), color infrared (CIR), and four-band images (RGB,IR).

With even higher geometric accuracy and 1:1 color resolution, the post-processing system produces the highest possible quality output data in high-throughput data-processing situations.

The RMK D camera allows smaller operations to apply digital data acquisition at a price they can afford.
Intergraph is the leading global provider of engineering and geospatial software that enables customers to visualize complex data. Businesses and governments in more than 60 countries rely on Intergraph’s industry-specific software to organize vast amounts of data into understandable visual representations and actionable intelligence. Intergraph’s software and services empower customers to build and operate more efficient plants and ships, create intelligent maps, and protect critical infrastructure and millions of people around the world.

Intergraph operates through two divisions: Process, Power & Marine (PP&M) and Security, Government & Infrastructure (SG&I). Intergraph PP&M provides enterprise engineering software for the design, construction, and operation of plants, ships, and offshore facilities. Intergraph SG&I provides geospatially powered solutions to the defense and intelligence, public safety and security, government, transportation, photogrammetry, utilities, and communications industries.

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On adjacent page: This aerial image of Bergheim, Germany, near Cologne, was captured using the RMK D system.