




INFINITE

i-movix[®]
extreme slow motion

1. INTRODUCTION

As the race for the highest possible frame rate has ended, television broadcasters are now looking for a technology enabling them to use their slow motion cameras in a more flexible and cost-effective way.

Initially, Ultra Motion cameras capable of frame rates higher than 3x were limited by their relatively small internal memory, as data rates were too high to be transferred to production servers. The arrival of Super Motion made it possible to record all the frames on the server, but the disadvantage of that workflow was the need to eventually dedicate a full server, sometimes only to one slow motion camera. Despite obvious operational benefits, this made the technology both expensive and a space-eater in precious truck rack space.

To combine the best of USM and SSM worlds and overcome their respective drawbacks, I-MOVIX have developed a new and unique trigger-less operation mode called **Extended Memory Mode (EMM)**, based on a patent-pending technology. **EMM** workflow on **INFINITE** enables high-speed loop recording for more than one hour (versus a few seconds previously) on its own internal memory, at up to 12x-speed in HD and is the first true 3x-slow motion solution in 4K; freeing server inputs and easing operator's work.

In addition to all the usability and image quality benefits for which the I-MOVIX technology has become renowned, **INFINITE** offers:

- more than one hour of continuous non-stop loop recording;
- two independent replay channels;
- the possibility to shrink production costs by reducing the number of server's input as only one is required to be part of the server's work flow;
- by extension, the possibility to work in stand-alone mode, without the need of an external server;
- production safety: no action is ever missed since triggering is no longer needed;
- an enhanced workflow that makes the system easier to use for the VT operator;
- reduced footprint in terms of rack space in the truck;
- workforce efficiency: no dedicated operator is needed as trigger-less operations allow more freedom for the VT operator.
- the possibility to use more of the content, that previously would have been lost.

INFINITE with **EMM** is therefore easier to use, cost-effective, space saving and license free.

2. OPERATIONAL MODES

INFINITE is the industry's most versatile slow motion solution supporting multiple resolutions (720, 1080, 4k) and multiple operational modes: Ultra Slow Motion mode (USM: high-speed recording in the camera memory, with trigger mode), Super Slow Motion mode (SSM: non-stop continuous super motion recording on a server) and now the innovative **Extended Memory Mode (EMM)**.

EMM combines the benefits of these first two approaches. In other words, everything happening in front of the camera is recorded at high speed directly in the extended memory of the **INFINITE** system itself. As the system doesn't require the operator to trigger, operators will not miss any of the action and the content recorded can be pushed directly to the video mixer.

Besides, the separate secondary replay output can be used to send clips straight to server's banks & playlists, through only one channel.

Taking advantage of the extended memory and clip management features, **EMM** will also offer the possibility to work in stand-alone mode without the need of an external server. Operators will be immediately familiar with the workflow as it remains nearly identical to the one that they are used to.

The table below provides a comparison between the Ultra Slow Motion Mode, the Super Slow Motion Mode and the new **Extended Memory Mode** in terms of frame rates, server congestion, buffer size and finally workflow.

	USM Ultra Slow Motion Mode	SSM Super Slow Motion Mode	EMM Extended Memory Mode
Frame Rate	Up to 3,000 in 720 Up to 2,000 in 1080 Up to 1,000 in 4k	4, 6 & 10xSSM in 720 and 1080 2xSSM in 4k	Up to 600fps in 720 and 1080 Up to 180fps in 4K
# of inputs on server	1	2, 4, 6 or 10 (licensed server required)	1 (no license required)
Buffer size	A few seconds (live action)	Up to 38h (live action)	Over 1h (depending on fps and format)
Work flow	Instant replay Optimized workflow with servers	Full LSM workflow	SSM-like workflow Multi-clip management Secondary output

Table 1: Comparison of operational modes

The table highlights the main advantages of the **EMM mode** in terms of efficiency and effectiveness.

INFINITE offers new features that clearly make the difference, such as:

- an extended camera memory (up to several hours) eliminating the need to trigger to capture the action;
- increased speed flexibility (from 2x to up to 12x), in addition to all of the benefits of continuous Super Slow Motion;
- an enhanced live signal with better S/N ratio;
- two separate replay outputs that allow various workflows within or outside a more complex server environment;
- an enhanced control of replays thanks to the new T-bar remote

3. EXTENDED INTERNAL MEMORY

INFINITE pushes the limits of technology by expanding the high-speed recording capabilities of the camera from a few seconds to up to several hours.

The table below shows the loop buffer size, in minutes, depending on format and frame rate.

FPS	HD720	HD1080	UHD-1 4K
120	508	226	57
180	339	150	38
300	203	90	/
360	169	75	/
500	122	54	/
600	101	45	/

Table 1: EMM recording times (in minutes)

As an example, at very common production speeds, **INFINITE** with **EMM** is able to record up to 75 minutes at 360fps in 1080i/p60 (which potentially represents 450 minutes of Replay).

INFINITE is also the very first system capable of providing Supermotion 3x in 4k. In that configuration, the loop buffer reaches 45 minutes at 150fps (50Hz).

4. OPERATIONS OVERVIEW

INFINITE with **EMM** brings together the best of high frame rates (typically available in USM mode) with the easiest workflow (typically available in SSM mode).

In Ultra Slow Motion (USM) mode, recording is done in the limited internal buffer memory of the camera and replays are operated using the I-MOVIX slow motion remote (JOG). In Super Slow Motion (SSM) mode, everything is recorded on the server side at high-speed, requiring up to 12 channels on a server; replays are done from the server remote directly.

INFINITE in **EMM** mode will offer the same functionalities as in USM mode while recording everything continuously in high-speed (as in SSM mode) thanks to its extended memory. Replays are done directly from the extended memory of the camera without any delay, and with full integration in the server work flow.

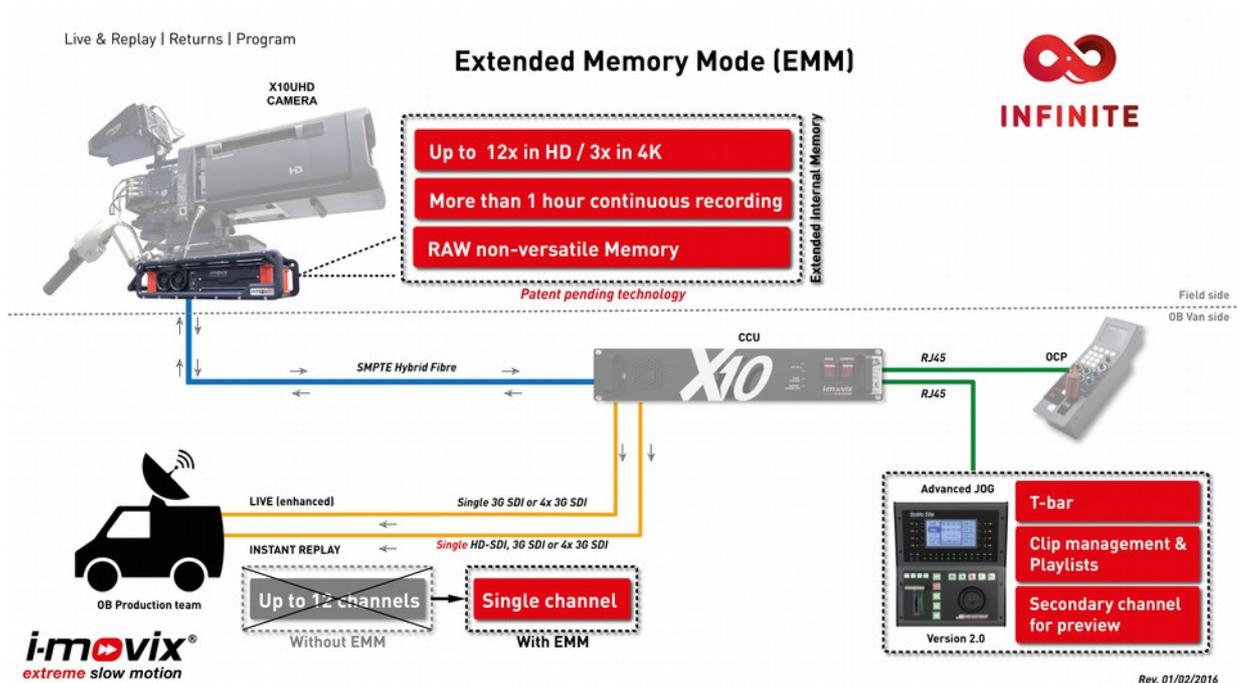
In its advanced version, **INFINITE** is operated from a **new slow motion remote** featuring two independent replay channels, a T-bar for extra-smooth speed transitions, an in-depth clip management solution with full timecode including pages, banks & playlists, integration options within common server networks...

It is important to notice that all this is achieved with the same server footprint than in USM mode. This will lead to easier implementation into the production workflows, requiring less equipment in the truck, no extra server licenses and less personnel to operate the system. As a comparison, in SSM mode, recording everything at 600FPS in HD (or 180 FPS in 4K), occupies 12 inputs on a dedicated licensed server.

On top of truck footprint, improved operations also have a direct effect on the return on investment for the camera. Indeed, since none of the content is lost and operations are made easier, operators can select more content, more easily. They can create more packages to be used during live action, but also for analysis in after-show talks, for commercials, for beauty shots or even to be resold to teams for their performance analysis process.

Finally, since the buffering is done upstream and the replay occurs on only one output, the real-time d-flicker system by I-MOVIX integrates smoothly into the chain in order to get rid of any potentially disturbing flickering effect.

A. CONFIGURATION OVERVIEW



B. SYSTEM COMPONENTS

The system is made up of the following components:

- Field side:
 - Camera head (Flex 4K)
 - Camera Box (Camera interface) with extended memory
- OB truck side:
 - Camera Control Unit (CCU)
 - Operation Control Panel (OCP)
 - Advanced Slow-motion remote (Advanced JOG)

C. ADVANCED SLOW MOTION REMOTE (JOG)



Figure 1: Advanced JOG

Some of the Advanced JOG's main functionalities are listed below:

- Second output channel, which allows you to continue editing clips while playing a different content on the other feed.
- T-bar control for smooth replay transitions;
- Frame-accurate ramping of speed within a replay;
- T-bar with multiple speed range selection;
- Transport control;
- Cue points: set and recall;
- Clip creation;
- Clip edition (incl. guard bands);
- Playlists;
- 10 pages, 10 banks per page and 10 clips per bank;
- Timecode
- Jump-to-timecode function
- Detailed screen (Timecode, progress bar, remaining time, ...);
- Shortcuts for main settings.

5. CONCLUSIONS

In conclusion, the **Extended Memory Mode** aims at answering a double need from broadcasters: the increasing need for slow motion replays and the need for operational and financial efficiency.

It brings the best of Ultra Slow Motion and Super Slow Motion workflows together whilst being independent from third party equipment; it does not require any license. It allows smoother replays and accurate variation of speeds. It requires less workforce to operate and saves space in the truck. The secondary replay output and enhanced controls of the advanced version make its use a breeze for production teams. And if needed, it can even be operated in stand-alone mode in a smaller setup.

All these qualities truly bring new options and greater flexibility to broadcasters in an effort to smoothen production work flow for slow-motion solutions.

Cherry on the pie: **INFINITE** sets I-MOVIX ready for the future and coming IP solutions.