

TECHNICAL NOTE:

MAXIMUM FRAME RATES IN FX10/FX10e AND FX17/FX17e

Maximum frame rate vs. illumination

FX-series cameras may reach high frame rates especially in MROI-mode. Using these speeds can be theoretical. High frame rate limits integration time which increases light intensity demand. In extreme frame rates and corresponding integration times may light intensity demand be unrealistic!

Frame rate vs. integration time

Integration time T_{int} and maximum integration time that it allows FPS_t have relation:

$$FPS_t = 1/(T_{int} + \text{frame_read_time}),$$

where frame-read-time is the time that is needed to get the image data out from the camera. It depends on camera, number of rows to be read (MROI total height) and in FX17/FX17e also on distance between first and last row to be read.

There are two modes in FX10/FX10e: Integrate-then-read (ITR) and integrate-while-read.

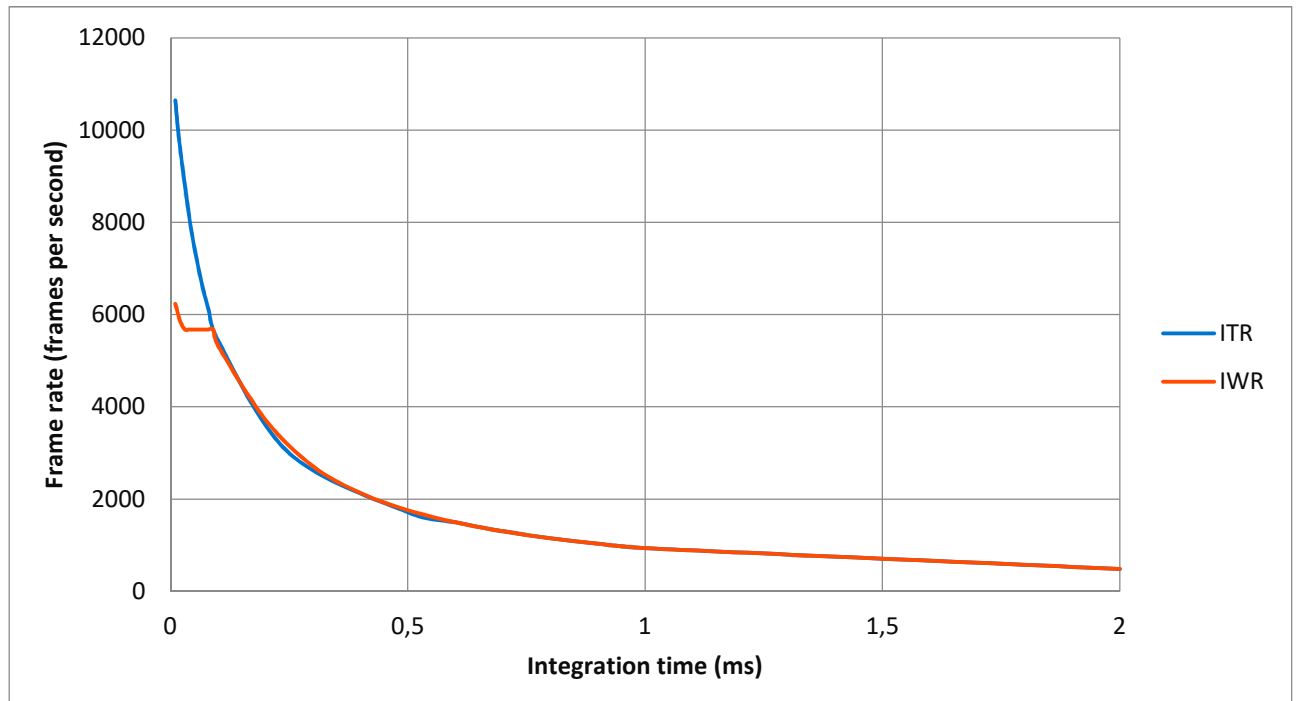


Figure 1. FX10/FX10e: Maximum possible frame rates with different integration times in ITR and IWR read out modes with smallest possible MROI (1 row).

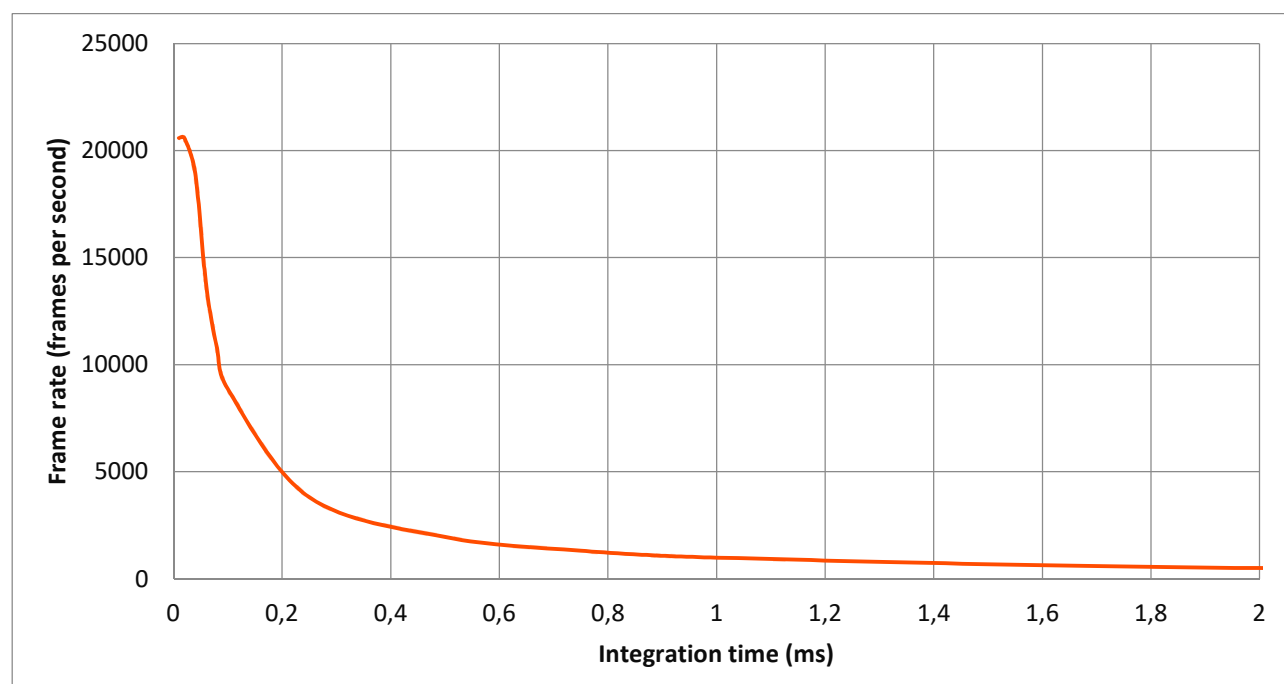


Figure 2. FX17/FX17e: Maximum possible frame rates with different integration times with smallest possible MROI (2 rows).

Frame rate examples

Table 1. Maximum possible frame rates for FX10 and FX10e cameras with IWR (integrate while read) and ITR (integrate then read) modes with four different integration times. With default binning each band includes two rows.

FX10/FX10e											
	WL Range	Bands	htot	FPS (0.01 ms)		FPS (0.5 ms)		FPS (1.0 ms)		FPS (2.0 ms)	
				IWR	ITR	IWR	ITR	IWR	ITR	IWR	ITR
Full Image	~600 nm	224	448	~320	~320	~320	~240	~320	~240	~320	~190
1/2 Image	~300 nm	112	224	~630	~630	~620	~480	~620	~390	~480	~280
1/4 Image	~150 nm	56	112	~1200	~1200	~1170	~750	~920	~540	~480	~350
	~75 nm	28	56	~2180	~2180	~1710	~1050	~920	~690	~480	~360
	~38 nm	14	28	~3660	~3660	~1710	~1310	~920	~790	~480	~440
	~19 nm	7	14	~5540	~5550	~1710	~1490	~920	~850	~480	~460
	~8,0 nm	3	6	~6220	~7860	~1750	~1620	~930	~890	~480	~470
	~2,7 nm	1	2	~6220	~9940	~1750	~1690	~930	~910	~480	~470
	~1,3 nm	0,5	1	~6220	~10640	~1750	~1710	~930	~920	~480	~480

Table 2. Maximum possible frame rates for FX17 and FX17e cameras with single, contiguous MROI with four different integration times. "htot" is the number of rows in MROI.

FX17/FX17e - single MROI										
	WL Range	Bands/htot	FPS (0.01 ms)		FPS (0.5 ms)		FPS (1.0 ms)		FPS (2.0 ms)	
			FX17	FX17e	FX17	FX17e	FX17	FX17e	FX17	FX17e
Full Image	~785 nm	224	~670	~500	~670	~500	~670	~500	~490	~490
1/2 Image	~392 nm	112	~1320	~1000	~1320	1000	~980	~980	~490	~490
1/4 Image	~196 nm	56	~2520	~2000	~1950	~1950	~980	~980	~490	~490
	~98 nm	28	~4630	~4630	~1950	~1950	~980	~980	~490	~490
	~49 nm	14	~7970	~7970	~1950	~1950	~980	~980	~490	~490
	~21 nm	6	~13530	~13530	~1950	~1950	~980	~980	~490	~490
	~14 nm	4	~16390	~16390	~1950	~1950	~980	~980	~490	~490
	~7 nm	2	~20590	~20590	~1950	~1950	~980	~980	~490	~490

Table 3. Maximum possible frame rates for FX17 and FX17e cameras with at least to MROI with maximum possible distance (number of rows) in between of the first row of the first and the last row of last MROI with four different integration times. "htot" is the total number of rows in all MROI's together.

FX17/FX17e - max MROI distance										
	WL Range	Bands/htot	FPS (0.01 ms)		FPS (0.5 ms)		FPS (1.0 ms)		FPS (2.0 ms)	
			FX17	FX17e	FX17	FX17e	FX17	FX17e	FX17	FX17e
Full Image	~785 nm	224	~670	~500	~670	~500	~980	~980	~490	~490
1/2 Image	~392 nm	112	~1270	~1000	~1270	~1000	~980	~980	~490	~490
1/4 Image	~196 nm	56	~2300	~2000	~1950	~1950	~980	~980	~490	~490
	~98 nm	28	~3850	~3850	~1950	~1950	~980	~980	~490	~490
	~49 nm	14	~5810	~5810	~1950	~1950	~980	~980	~490	~490
	~21 nm	6	~8170	~8170	~1950	~1950	~980	~980	~490	~490
	~14 nm	4	~9100	~9100	~1950	~1950	~980	~980	~490	~490

Notes

- Binning does not increase frame rates in CameraLink versions but it is possible to increase FX17e maximum frame rate with bigger MROI than about 30 rows (un-binned bands) using binning.
- MROI is always specified as "native" rows on detector. Note that FX10/FX10e contains two rows per default band (spectrally binned by two).
- IWR-mode enables faster frame rates for FX10/FX10e in most of use cases. Note that for very small MROI with very short integration times (e.g. 5 rows, 0.06 ms) ITR mode is faster!