



SOFTHARD

MR4021x

(C and B)

Camera Core

Specification

August 24, 2009

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2 Revision History

Revision	Date	Who	What
0.10	10.11.2006	ML	Initial draft created
0.20	01.12.2006	ML	Binning modes added
0.30	04.01.2007	ML	Updated with CCD vs. housing tolerances, quantum efficiency, power consumption, storage and transportation environments, absolute maximum operation conditions
0.40	11.11.2007	ML	Mode table updated
0.50	13.08.2009	ML	Template updated, optical path and cooling performance added
0.51	17.08.2009	RT	Size of the cosmetics defects free aperture on filter updated. Firmware/Host driver/API features – refresh rates updated. Lens adapter C-mount corrected to M50x1.5
0.52	24.08.2009	ML	Variable Gain Amplifier data updated

3 Disclaimers

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4 Privacy Information

This document contains information of a sensitive nature. This information should not be given to persons other than those who are involved in the MR4021 project or who will become involved during the lifecycle.

5 Trademarks

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6 Glossary of Terms, Acronyms and Abbreviations

ADU	Analog to Digital Units
API	Application Program Interface
CCD	Charge Coupled Device
DDRAM	Dual Data rate Random Access Memory
DLL	Dynamic Link Library
FPGA	Field Programmable Gate Array
FWC	Full Well Capacity
GUI	Graphical User Interface
OHCI	Open Host Controller Interface
PC	Personal Computer
PCB	Printed Circuit Board

7 Document Scope and Purpose

The purpose of this document is to specify MR4021 camera core parameters and their dependencies.

8 Referenced Documents

- MR4021 Validation and Verification plan revision 0.10 (MR4021VVP)

9 Parameter tables

9.1 Mechanical

Description	Symbol	Value	Units
Height	H	32	mm
Width	W	60	mm
Depth	D	60	mm
Weight	M	100	g
Alignment of CCD chip sensitive area relative to the housing		±0.25	mm

9.2 Sensors

Description	MR4021C	MR4021M	Units
Brand	Kodak KAI-4021CM	Kodak KAI-4021M	
Kodak Datasheet	Revision 2.0 MTD/PS-0719, January 25, 2006		
Type	Interline Progressive CCD image sensor		
Pixel resolution	2048 (H) × 2048 (V)		pixels
Chip size	15.2(H) × 15.2(V)		mm
Unit cell size	7.4(H) × 7.4(V)		µm
Color filter	RGB Bayer mosaic	None	
Quantum Efficiency, max	45, 42, 35 (RGB)	55	%
FWC (*), typical	40.000		ē
Dark current (**), typical	40		ē/p/s

All parameters in this table are reprinted from the respective Kodak datasheet

(*) – Saturation signal.

(**) – Dark current, limit specified by CCD chip vendor is 350ē/p/s. A typical value provided here is for informational purposes only. It cannot be used as a unit qualification parameter.

9.3 Optical path

9.3.1 BH housing

Description	MR4021Cx_BH	MR4021Mx_BH	Units
Filter Brand	Hoya E-CM500S	BK7-AR2X	
Filter Thickness	1.0±0.1	1.0±0.1	Mm
Filter Tilt	0.0	0.0	°
Specification	HOYA 8405E	NA	
Coating	NA	Multispectral AR both sides	
CCD Spot blemishes and stain specification	Kodak datasheet	Kodak datasheet	
Filter cleanliness (spots, scratches)	±5 (*)	±5 (*)	%

Size of the cosmetics defects free aperture on filter	21.5	21.5	mm
Lens mount	C-mount	C-mount	
Back focal distance in the air	17.52/+0.0/-0.2	17.52/+0.0/-0.2	mm

(*) – Filter cleanness is measured with the method and set of tools described in MR4021CTP.

9.3.2 VELETA housing

Description	MR4021MC_VELETA	Units
Filter Brand	BK7-AR2X	
Filter Thickness	1.0±0.1	mm
Filter Tilt	0.0	°
Coating	Multispectral AR both sides	
CCD Spot blemishes and stain specification	Kodak datasheet	
Filter cleanness (spots, scratches)	±5 (*)	%
Size of the cosmetics defects free aperture on filter	29.5	mm
Lens mount	M50x1.5	
Back focal distance in the air	TBD	mm

(*) – Filter cleanness is measured with the method and set of tools described in MR4021CTP.

9.4 Camera core

Description	Symbol	Value	Units
Digitization		14	Bit
Supported bit resolutions		8, 10, 12 and 14	Bit/pix
Exposure time	EXP	20µs ... 500sec	
Variable Gain Range	VGA	-3.0...41.3	dB
Default Gain, Typical	DG	+3.0	dB
Refresh rate	MRR	5.5	Fps
Trigger/sync input (r)		Asynchronous CMOS 3.3V	
Trigger/sync output (rr)		CMOS 3.3V	
Dynamic range, Typical	DR	~70	dB
Linearity (*)	Lin	<1	%
Acquisition Gain	G	2.5 ±0.3	ē/ADU
External interface		IEEE1394A	
Acquisition noise (**), typical	AN _{typ}	3.0	ē
Acquisition noise (**), max	AN _{max}	5.0	ē
Readout noise (***), typical	RN _{typ}	7.5	ē
Readout noise (***), max	RN _{max}	NA	ē

All parameters in this table are subject to qualification measurements specified in MR4021VVP and Kodak data sheet

(r) – Pull up resistor of 100kΩ

(rr) – Serial resistor of 1kΩ

(*) – Linearity of 1% guaranteed in the range of exposures 1ms to 16s.

(**) – Acquisition noise means noise generated by the camera with ADC input connected to ground via resistor equivalent to CCD output impedance of 130Ω.

(***) – Readout noise means noise generated by the camera with ADC input connected to CCD chip. Typical value provided here is for informational purposes only. It can not be used as a unit qualification parameter.

9.5 Power

Description	Symbol	Value	Units
Power supply, via IEEE1394 system connector	V _{nom}	12 ±10%	V

Consumption, typical no cooling	P_{nom}	1.8	W
Consumption, maximum no cooling	P_{max}	2.5	W
Consumption, typical cooling on (MR4021xC only)	$P_{nom-cool}$	3.8	W
Consumption, maximum cooling on (MR4021xC only)	$P_{max-cool}$	6.0	W

All parameters in this table are subject to qualification measurements specified in MR4021VVP

9.6 Cooling performance (MR4021xC_yy only)

Description	Symbol	Value	Units
Lowest possible temperature on the CCD chip	T_{chip}	10	°C
Housing temperature accuracy	T_{h-acc}	2	°C
CCD chip temperature accuracy	T_{c-acc}	3	°C
Maximum achievable temperature difference between housing and chip	T_{diff}	26	°C

All parameters in this table are subject to qualification measurements specified in MR4021VVP

9.7 Environment

Description	Symbol	Value	Units
Ambient temperature operation	T_{norm}	+10 ... +25	°C
Absolute maximum of ambient temperature operation (*)	T_{max}	+5 ... +60	°C
Ambient temperature for storage and transportation	$T_{storage}$	-25 ... +70	°C
Relative Humidity, non condensing	RH	80	%

All parameters in this table are subject to qualification measurements specified in MR4021VVP

(*) – Under absolute maximum ambient conditions the following parameters are not guaranteed:

Dark current, Dynamical Range, Linearity, Acquisition and readout noise, S/N ratio.

9.8 Firmware/Host driver/API features

Description	Symbol	Value	Units
Interpolation method		9331	
White balance coefficients ranges		0.0 ... 3.9	x
Sharpness filter		0 ... 100	%
Gamma		0.3 ... 1.0	
Full color correction matrix (3+1)x3 coefficients ranges		-3.9 ... 3.9	x
Partial readout granularity @ (1x binning)		2 (H) x 2 (V)	pixels
Max refresh rate x1 binning		5.5	Frames/s
Refresh rate x2 binning		11	Frames/s
Refresh rate x3 binning		15	Frames/s
Refresh rate x4 binning		19	Frames/s

All parameters in this table are subject to qualification measurements specified in MR4021VVP

9.9 Supported readout modes

Binning	Effective FWC $\bar{\epsilon}$	Noise $\bar{\epsilon}$	S/N dB	Mode MR4021C	Mode MR4021B	Pixels	F/s
1x1	40.000	7.5	70	Color	B/W	2048 (H) × 2048 (V)	5.5
2x2	150.000	15	75	B/W	B/W	1024 (H) × 1024 (V)	11
3x3	290.000	20	78	B/W	B/W	680 (H) × 680 (V)	15
4x4	500.000	30	82	B/W	B/W	512 (H) × 512 (V)	19
4x4 HS	TBD	TBD	TBD	B/W	B/W	512 (H) × 512 (V)	32

All parameters in this table are subject to qualification measurements specified in MR4021VVP