OM6802B

VGA CMOS camera module

Rev. 0.1, April 1 2004 **Preliminary Datasheet**

1. General description

The OM6802B is a highly integrated compact CMOS color camera module with embedded Camera Signal Processor (CSP) that supports up to VGA resolution formats in a small package including a focused optical system. It uses Philips SeeMOS^{TM} technology for high sensitivity and low noise. The device is programmable via an I^{2}C serial interface. The CCIR656 compliant YUV output stream enables easy integration into mobile phones or PDA's.

2. Features

- Compact size camera module with integrated triple element lens system
- On-chip CSP for color reconstruction and image enhance functions
- On-chip micro controller for auto functions (Auto White Balance, Auto Exposure, etc.)
- Supports (amongst others) VGA, CIF, QVGA, QCIF, QQVGA and QQCIF output formats
- Region Of Interest definition with up to 5 times H/V sub-sampling to enable digital zoom
- Horizontal / vertical mirroring
- 4.0 mm active image diagonal
- Active 5.0 x 5.0 µm pixels
- Bayer-RGB color filter array with micro lenses
- Real time white pixel blemish correction
- Lens shading correction
- 8-bit parallel YUV 4:2:2 output (CCIR656 / CCIR601 compliant)
- 8-bit parallel RGB 565, 555, 444 output, CCIR656 codes not supported
- Optional 10 bit raw RGB output available
- 12 bit Analog to Digital quantization
- 30 dB Digital programmable Gain Amplifier
- Single supply voltage range: 2.6 .. 3.6 Volt
- Low power, typ. 55 mW at 15 frames/sec VGA
- Power down mode accessible via I^{2}C, supply current typ. < 2 µA
- I2C serial interface, slave mode only
- Programmable output rise and fall times
- Master/slave operation
- Highly sensitive, low noise SeeMOS^{TM} technology
- Low fixed pattern noise

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3. Application

- Mobile phone
- PDA

4. Quick reference data

Table 1: Quick reference data

Symbol	Parameter	Conditions	Min.	Typ	Max	Unit
	Module dimensions [1]					
L	- length			8.0		mm
W	- width			8.0		mm
H	- height			5.5	5.76	mm
m	Weight of module[1]			t.b.d.		g
DFOV	Diagonal Field of View			60		^{0}
V_{DD}	Supply voltage		2.6	2.8	3.6	V
P	Power consumption	V_{DD} = 2.8 V		55 [2]		mW
SNR	Signal to Noise ratio	100 lux, 15 fps		t.b.d.		dB
CLK_IN	Input clock frequency			12 [3]	t.b.d.	MHz

[1] Camera body only, flex foil not included
[2] 15 fps VGA @ 2.8 volt, 12 MHz
[3] Up to 15 fps VGA

5. Ordering information

Table 2: Ordering information

Type number	Package		
	Name	Description	Version
OM6802BWC/M0	SOT794-AA1	Plastic window quad chip carrier; no leads; 32 terminals; with lens; body • customize flex on requirement by customer • standard flex	

6. Block diagram

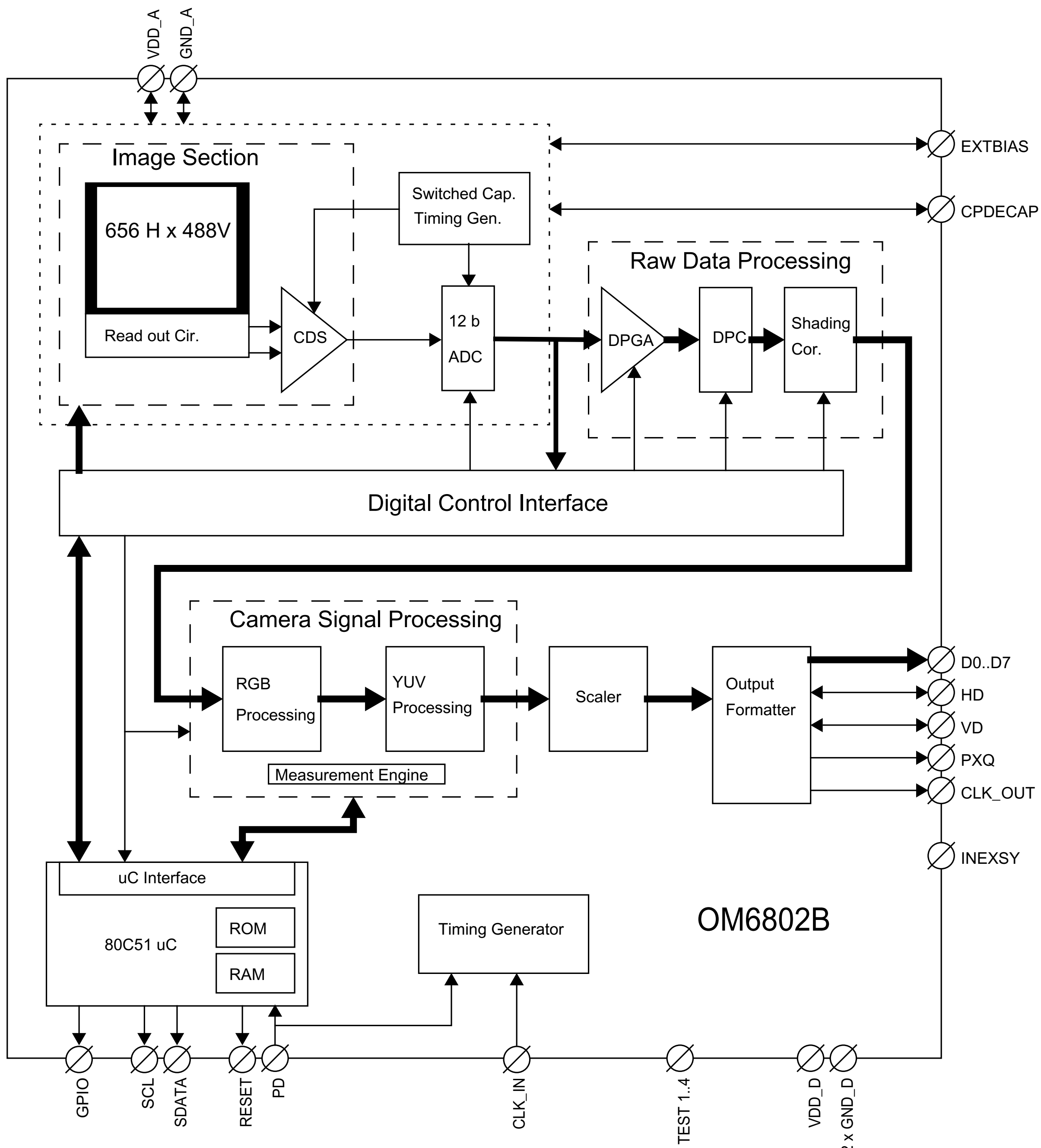


Fig. 1 Block diagram.

7. Pinning information

7.1 Pinning LCC package

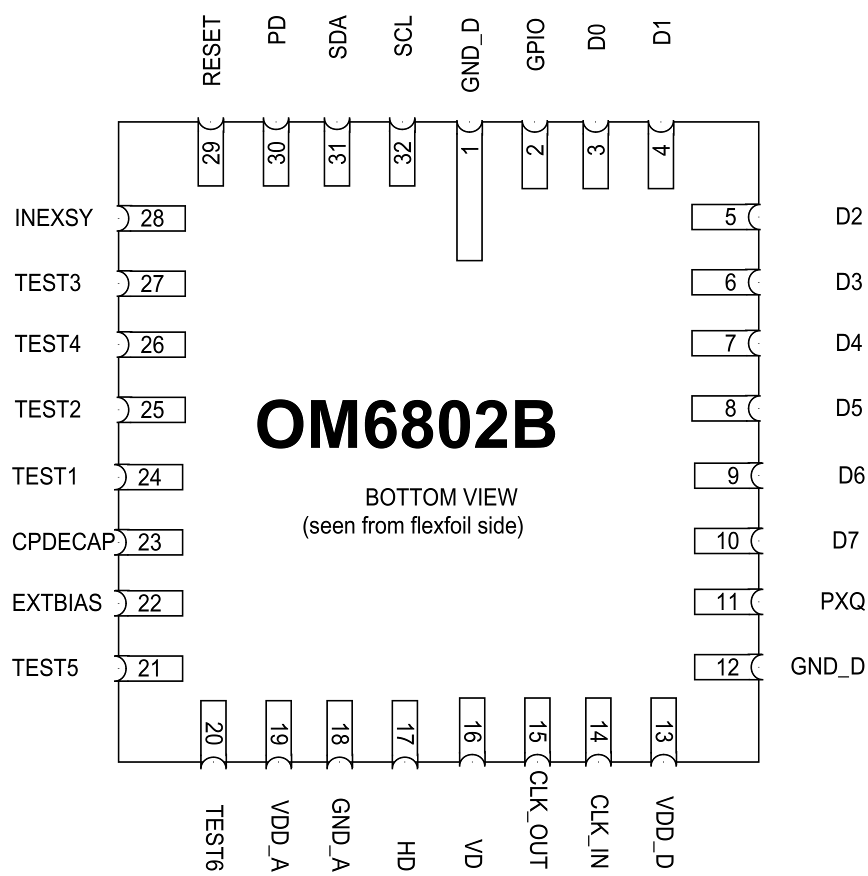


Fig. 2 Pin configuration (bottom view).

7.2 Pin description

Table 3: Pin description

Symbol	Pin	Type	Description
GND_D	1	Supply	digital ground
GPIO	2	I/O dig	general purpose I/ O, *(D0 i.c.o. raw RGB out)*
D0	3	O dig	digital output (LSB), *(D1 i.c.o. raw RGB out)*
D1	4	O dig	digital output, *(D2 i.c.o. raw RGB out)*
D2	5	O dig	digital output, *(D3 i.c.o. raw RGB out)*
D3	6	O dig	digital output, *(D4 i.c.o. raw RGB out)*
D4	7	O dig	digital output, *(D5 i.c.o. raw RGB out)*
D5	8	O dig	digital output, *(D6 i.c.o. raw RGB out)*
D6	9	O dig	digital output, *(D7 i.c.o. raw RGB out)*

Table 3: Pin description

Symbol	Pin	Type	Description
D7	10	O dig	digital output (MSB), *(D8 i.c.o. raw RGB out)*
PXQ	11	O dig	Pixel Qualifier, *(D9 i.c.o. raw RGB out)*
GND_D	12	Supply	digital ground
VDD_D	13	Supply	digital supply
CLK_IN	14	I dig	clock input
CLK_OUT	15	O dig	clock output
VD	16	I/O dig	vertical drive
HD	17	I/O dig	horizontal drive
GND_A	18	Supply	analog ground
VDD_A	19	Supply	analog supply
TEST6	20	I/O dig	do NOT connect (meant for additional features)
TEST5	21	I/O dig	do NOT connect (meant for additional features)
EXTBIAS	22	I ana	internal ref. voltage (100nF to VDD_A)
CPDECAP	23	I/O ana	internal ref. voltage (10nF to GND_A)
TEST1	24	I ana	connect to pin 22
TEST2	25	I/O ana	connect to pin 22
TEST4	26	I dig	connect to GND_D
TEST3	27	I dig	connect to GND_D
INEXSY	28	I dig	master / slave mode select input. (“low” or N.C. for master mode; internal pull-down)
RESET	29	I dig	reset input (active high; internal pull down)
PD	30	I dig	power down input (active high)
SDA	31	I^2C	I^2C data input
SCL	32	I^2C	I^2C clock input

8. Functional description

8.1 Image section

The image section consists of a pixel array, vertical and horizontal selection circuitry, a bench of column amplifiers and a read amplifier.The pixel array contains 708(H) x 494(V) pixels. The pixels are covered by red, green and blue color filters arranged in a RGB Bayer structure. A micro-lens array is placed on top of the color filters to increase the effective fill factor for higher sensitivity. For black reference purposes a number of rows and columns are shielded from light.

The vertical selection circuitry has a double functionality. One is to select the line to be read, the other is to select the line to reset to determine the integration time period. The integration time is determined by a rolling shutter.

After a line has been selected and read by the column amplifiers, the horizontal selection circuitry takes care of the pixel data selection that is to be processed by the read amplifier.

The read amplifier performs Correlated Double Sampling (CDS) to suppress Fixed Pattern Noise (FPN).

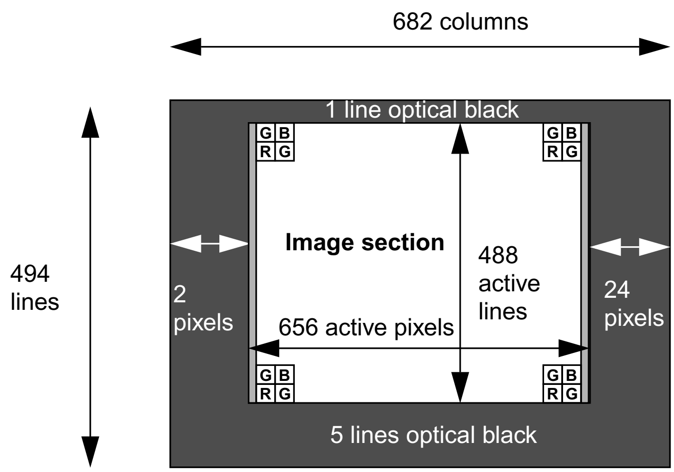


Fig. 3 Pixel array

Pixel array

Active image diagonal	4.0 mm
Pixel size	5.0 µm x 5.0 µm
Optical active pixels	656 (H) x 488 (V)
Total no. of pixels	682 (H) x 494 (V)
Optical black columns	Left: 2 Right: 24
Optical black lines	Top: 1 Bottom: 5

8.2 Signal Processing

8.2.1 Analog Signal Processing

The Correlated Double Sampling (CDS) output signal is applied to a high performance Analog to Digital Converter (ADC). The ADC converts the analog CDS output signal into a 12-bit digital video stream.

The input stage of the ADC converts the single ended input signal into a differential signal. Then a number of quantization stages take care for a high precision quantization.

A black loop is included around the ADC to have the average digital output code of the black reference pixels on a predefined level. The loop takes care for optimum use of the ADC input range under all operating conditions.

8.2.2 Raw Data Processing

Behind the ADC three raw data processing circuits are passed before the data is applied to the embedded Camera Signal Processing (CSP) function.

The first one is the Digital Programmable Gain Amplifier (DPGA). Because of the incorporated high performance ADC digital amplification is possible. This is justified because the noise of the analog core up to the output of the ADC is dominated by the pixel reset noise (kT/C noise). This means that the ADC is nicely quantizing the pixel noise and therefore analog gain is superfluous.

The DPGA gain range is 30 dB.

Next step is the on-the-fly Defect Pixel Correction (DPC). This circuit detects and corrects single white pixels. Neighboring pixels from the same color plane as well as pixels from the other color planes are used in a quasi two-dimensional way to detect defects. Although tuning options exists it is believed that the default DPC-settings offer optimum circuit performance.

Finally the data passes a shading correction (anti-vignetting) circuit to correct for shading caused in the optical path.

8.2.3 RGB processing

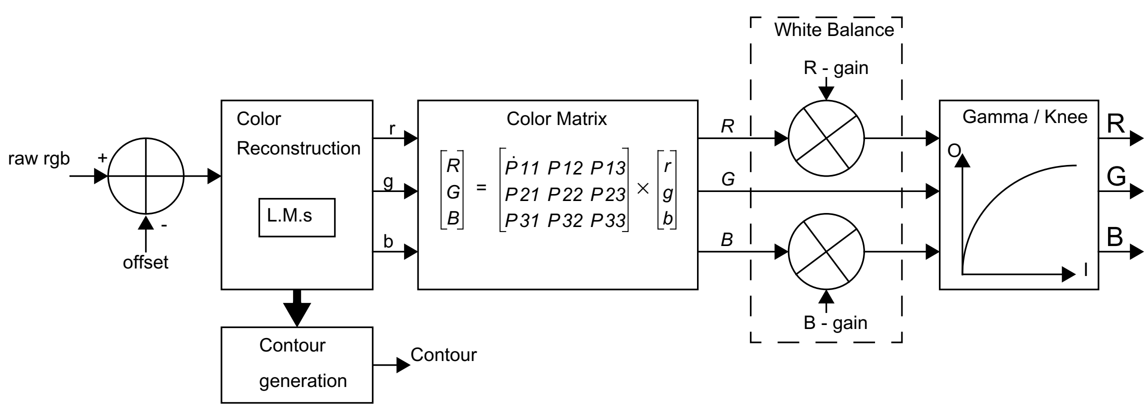


Fig. 4 RGB-processing

First the input black level is restored to have the data referred to digital code “0”. Then the raw RGB signal is applied to a reconstruction function. This function basically generates a triplet of raw RGB data for every pixel of the video stream. Red, green and blue information are recovered for every single pixel by means of spatial filtering, using the physically surrounding colored pixels.

Parallel to the reconstruction a contour signal is generated which is later on in the processing added to the video luminance signal to improve the sharpness impression of the final picture. Both horizontal and vertical contour information are generated.

Behind the reconstruction function a three by three color matrix corrects for the non-ideal spectral response of the colored pixels. The matrix takes care of the color fidelity in the finally displayed picture. It matches the spectral sensitivity of the image array with the color response of the displaying device (CRT is used for default settings).

The succeeding white balance circuit takes care of the color fidelity over a wide color temperature range. The white balance consists of controllable gain circuits in the red and blue channel. By default the gains are controlled by the Auto White Balance (AWB) loop which runs on the embedded micro-controller. The loop takes care that white parts in the scene remain white when the color temperature of the scene illumination changes.

Besides automatic white balance also fixed white balance settings can be applied. A set of settings is available for incandescent, fluorescent and daylight illumination conditions. If desired the white balance settings for the red and blue gain can be overruled by the application.

After white balancing the signals are applied to a gamma/knee correction circuit. Knee compression takes care for the visibility of details in highly illuminated areas. The gamma correction compensates for the non-linear response of the displaying Cathode Ray Tube (CRT). The applied gamma correction is programmable in 64 steps. By default the gamma correction is tuned to be compliant with the normalized ARD gamma-function (0.45 gamma).

8.2.4 YUV processing

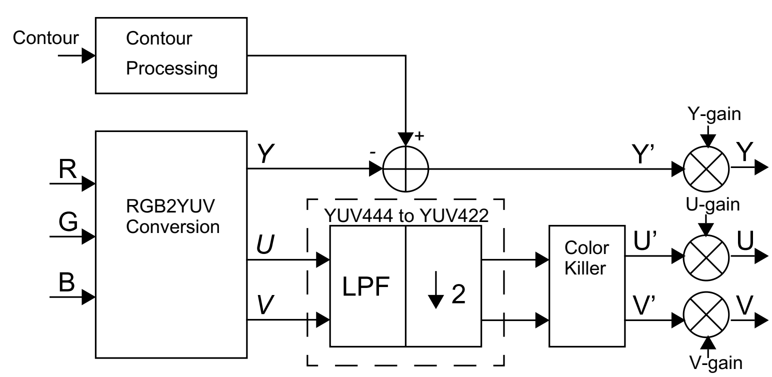


Fig. 5 YUV-processing

After RGB processing the channels are separated into a luminance (Y) and two color difference paths (UV). The signals are generated using the following formulas:

- Y = [19R + 38G + 7B] / 64
- U = B -Y
- V = R -Y

The YUV signal is converted into a YUV 4:2:2 format by a factor two down-sampling of the UV signals. In advance of the down-sampling the UV chrominance signals are low pass filtered to suppress aliasing artefacts.

Cosited positioning of the UV samples w.r.t. the Y sample as specified in the Rec. 601 specification is supported. Optionally this half pixel shift of UV w.r.t. Y can be suppressed to ease external conversion to a JFIF (MPEG1) compliant YUV 4:2:0 data format.

Parallel to the UV down scaling the contour signal is processed. The vertical contour gain can be tuned separately from the horizontal contour. This allows it to tune the amount of vertical contour w.r.t. the horizontal contour. Then the horizontal and vertical contour signals are added and applied to a contour coring and a contour gain circuit. Finally the contour signal is added to the luminance (Y) signal.

After the UV down-scaling the chrominance processing includes a false color killer. The color killer suppresses wrong colors which could occur in case parts of the scene are overexposed which causes pixels to saturate.

The YUV processing function continues with separate gain controls for the Y, U and V signals. These gains are used to fine tune the Y, U and V color balance and to adjust the luminance and color saturation level without disturbing the Auto Exposure (AE) and Auto White Balance (AWB) loops.

8.2.5 Measurement engine

The measurement engine extracts measurement data from different color domains of the camera signal processing chain. This measurement data is used by the auto-control loops which run on the embedded micro-controller.

The measurement windows can be tuned on a 40 x 40 pixels grid to enable the possibility for e.g. back light compensation.

For auto exposure five parallel measurements are done. The intensity levels of pixels falling in the different defined measurement windows are accumulated during each frame.

For auto white balance a single measurement window can be defined. Before a pixel contributes to the white balance measurement the color tone of the pixel is checked. When the color tone complies to the defined limited white area the signal levels are added to the measurement data.

During each frame, the micro-controller has access to the values measured in the previous frame.

8.3 Output formatting

8.3.1 Scaler

The scaler behind the signal processing chain guarantees an optimum quality video stream for sub-VGA resolution output formats. Limiting the resolution at the input of the CSP would lead to color aliasing effects from the reconstruction block because of low spatial correlation between the image data samples in high frequent areas.

The scaler function performs Region Of Interest (ROI) selection and sub-sampling.

The flexible ROI definition in combination with an up to 5 times sub-sampling ratio, in both horizontal and vertical direction, allows for zooming and a wide range of active resolution output formats.

In advance of sub-sampling the YUV data passes a selectable low pass filter to suppress aliasing artefacts.

8.3.2 Output formatter

Depending on the desired output format, first a YUV or RGB formatter is passed.

The YUV formatter performs a simple clipper function to limit the data according one of three supported data ranges.

In case of an RGB output format one can select between an RGB 565, RGB 555 or RGB 444 package formats. The RGB-data is regenerated from the YUV input signals. In this way the signal conditioning as performed on the YUV data is maintained. To mask the truncation for the different RGB output formats noise shaping can be applied.

After the YUV/RGB data formatting following functions are passed successively:

- Inactive video level insertion. Blanking levels for Luminance (by) and Chrominance (bc) can be selected. (by/bc = #10/#80 or by/bc= #00/#00).
- YUV swapping. This function will swap the bytes of UYVY to VYUY, YUYV or YVYU (the inactive levels are also swapped)
- Synchronization code insertion. Optionally synchronization codes according the CCIR656 standard can be merged into the digital video stream.
- Data spreading. When the output resolution is reduced by means of sub-sampling, this function enables it to have a continuous or broken Pixel Qualifier signal during a line period.

8.4 Micro-controller (μC)

The device is equipped with a 80C51 micro-controller core.

The controller takes care of:

- Controlling of auto-loops (AE, AWB, NGC, etc.)
- I2C command handling
- Power Down
- Request processing

8.5 Digital Control Interface

This block basically generates all timing signals required for the read out of the image array and processing of the raw RGB output signal.

The block takes care of:

- Video frame format definition
  The number of clocks per line and the number of lines per frame can be programmed (max. 1023 clocks/line and 1023 lines/frame).The video frame should have at least 484 lines / frame and 800 clocks/line.
- Vertical / horizontal mirroring
- DPGA gain
- Exposure time
- Timing windows for analog signal processing
- Interfacing with the embedded micro-controller
- Shading correction

8.6 Timing generator

This circuit generates the clock signals required by the different functions incorporated. To avoid interference from the digital into the analog core the overall chip timing is properly tuned.

The timing generator supports the option to have different frame rates available at stable input clock. Clock division factors of 2, 4, 8 and 16 can be selected. For the default 12 MHz input clock the device supports frame-rates from 15 down to 1.875 fps. The maximum frame-rate is 30 fps VGA for a minimum input clock frequency of 24 MHz.

9. Device control

9.1 Master / slave mode operation

The device supports master/slave mode operation. In master mode the horizontal (HD) and vertical (VD) synchronization signals are generated by the sensor. In slave mode these signals have to be supplied.

When pin INEXSY is left unconnected (or logic “low” level applied) the master mode is defined by means of an internal pull down resistor. The HD and VD output signals are programmable with the pixel clock resolution. This allows it to shape these signals with respect to the digital video stream.
The slave mode is activated when pin INEXSY is connected to a logic high level. Now the HD and VD pins are input. In this mode it is not possible to tune the position of the digital video with respect to the applied HD and VD signals.

For external synchronization the device performs a rising edge detection on both the HD and VD input signals. To avoid sensitivity for glitches some digital filtering is performed. The high and low duration of the applied HD signal should be at least 3 clock periods to be detected as a valid HD signal. For VD the minimum duration should be at least 2 clock periods. The maximum supported frame-format is 1023 clks/line and 1023 lines/frame
.

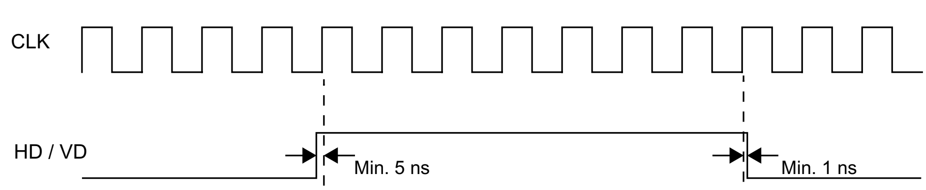


Fig. 6 HD/VD setup timing

9.2 Device reset

For automatic device initialisation a Power On Reset (POR) function is included. When the supply voltage level raises above a certain trip-level (about 2 volt) the initialisation is triggered. The register settings are programmed now to its default settings as they are stored in the embedded ROM.

A separate RESET input is available to trigger the initialisation process independent from the POR function. The RESET is active at a logic high level.

9.3 Power Down (PD)

The power down function can be activated via the PD pin. When pulling this pin to a logic 'high' level, the embedded micro-controller generates the signals to put the device into power down. The applied input clock as well as the supply voltage do not have to be suppressed externally to reach a typical power down current of 1.3 uA. Keeping the supply voltage up maintains the register settings in the device.

The PD mode can also be activated via an I2C command. In this case the input clock has to be suppressed externally to reach the low power down current.

9.4 I^2C interface

The standard I^2C interface is used with a maximum clock frequency of 400 kHz. The communication is two wire and the sensor operates always in the slave mode. The sensor device slave address is (starting with MSB AD7) 0110100(0). The LSB determines read/write mode: 0 = write, 1 = read. In read mode the sensor ID can be checked. For this module it is (MSB....LSB) 00101011. See table 55

10. Data output formats

The supported output formats are given in table 4.

Table 4: Output formats

Output pin	4:2:2 CCIR-656 (8 bit)				RGB 565		RGB 555		RGB 444	
D7	U_{07}	Y_{07}	V_{07}	Y_{17}	R_4	G_2	X	G_2	X	G_3
D6	U_{06}	Y_{06}	V_{06}	Y_{16}	R_3	G_1	R_4	G_1	X	G_2
D5	U_{05}	Y_{05}	V_{05}	Y_{15}	R_2	G_0	R_3	G_0	X	G_1
D4	U_{04}	Y_{04}	V_{04}	Y_{14}	R_1	B_4	R_2	B_4	X	G_0
D3	U_{03}	Y_{03}	V_{03}	Y_{13}	R_0	B_3	R_1	B_3	R_3	B_3
D2	U_{02}	Y_{02}	V_{02}	Y_{12}	G_5	B_2	R_0	B_2	R_2	B_2
D1	U_{01}	Y_{01}	V_{01}	Y_{11}	G_4	B_1	G_4	B_1	R_1	B_1
D0	U_{00}	Y_{00}	V_{00}	Y_{10}	G_3	B_0	G_3	B_0	R_0	B_0

Remark:
An option exists to internally bypass the CSP and to have 10 bits raw RGB data externally available. In this case the output clock is suppressed. The data capturing device should use the input clock to capture the sensor data.

10.1 YUV data ranges

Following data ranges are supported:

1 Data clipping according the CCIR601 standard
- Y-range : 16 .. 235 (220 levels)
- U-range: 16 .. 240 (225 levels; colorless at 128)
- V-range : 16 .. 240 (225 levels; colorless at 128)

Optionally CCIR656 synchronization codes can be merged into the digital video stream.

2 Data clipping between levels 1 and 254.
A maximum dynamic range maintaining the option to use CCIR 656 synchronization codes is achieved.

3 No data clipping.
Data acquisition should be performed by using the PXQ and VD signals.

For all ranges the video blanking codes can be selected between 10/80 or 00/00.

10.2 YUV swapping

Following YUV formats are supported:

- CCIR 656 standard. The data sequence is:
  $U_0Y_0V_0Y_1$ $U_1Y_2V_1Y_3$ $U_2Y_4V_2Y_5$
- FOURCC definition YUY2. Swapping of Y/UV data. In this mode the sequence becomes:
  $Y_0U_0Y_1V_0$ $Y_2U_2Y_3V_2$ $Y_4U_4Y_5V_4$
- FOURCC definition YVYU. Swapping of Y/UV and U/V data. In this mode the sequence becomes:
  $Y_0V_0Y_1U_0$ $Y_2V_2Y_3U_2$ $Y_4V_4Y_5U_4$
- U/V swapping.In this mode the sequence becomes:
  $V_0Y_0U_0Y_1$ $V_1Y_2U_1Y_3$ $V_2Y_4U_2Y_5$

10.3 RGB output data

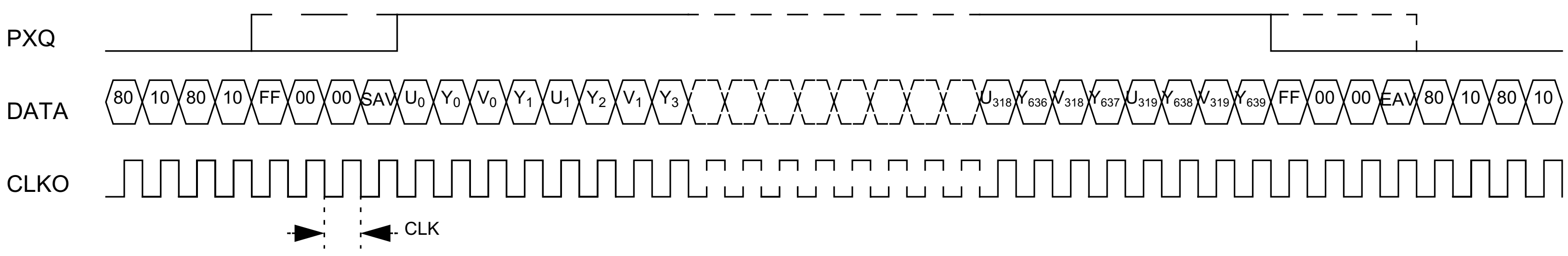
The RGB data stream is regenerated from the processed YUV data stream. Because of the limited word length of the different RGB formats truncation errors are introduced. To mask these truncation errors noise-shaping is applied.

CCIR656 synchronization codes are not supported for the RGB output streams.

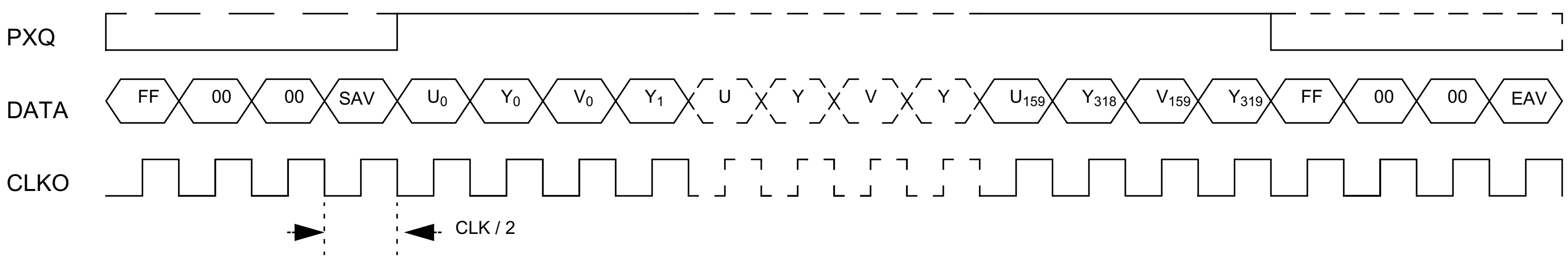
11. Video timing

The timing diagrams on the next pages depict the waveforms for two and four times sub-sampling in both horizontal and vertical direction. For three and five times sub-sampling the waveforms look similar.

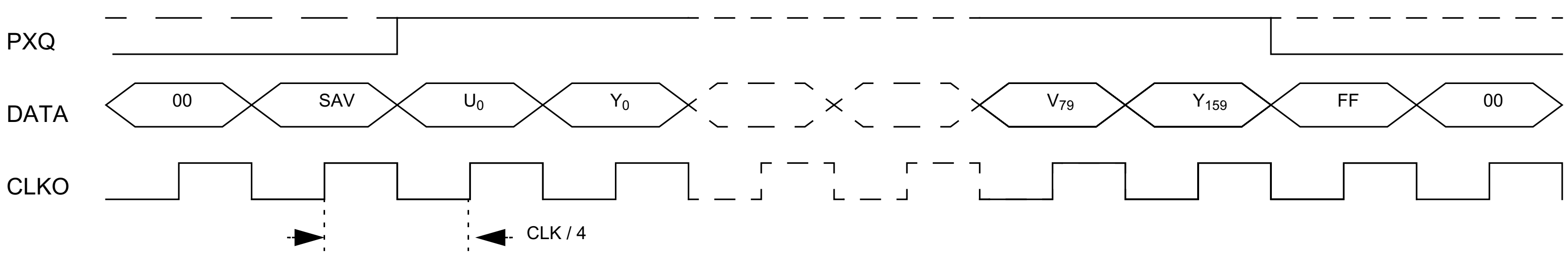
Full resolution VGA output stream



Sub-sampling by 2, QVGA continuous data stream



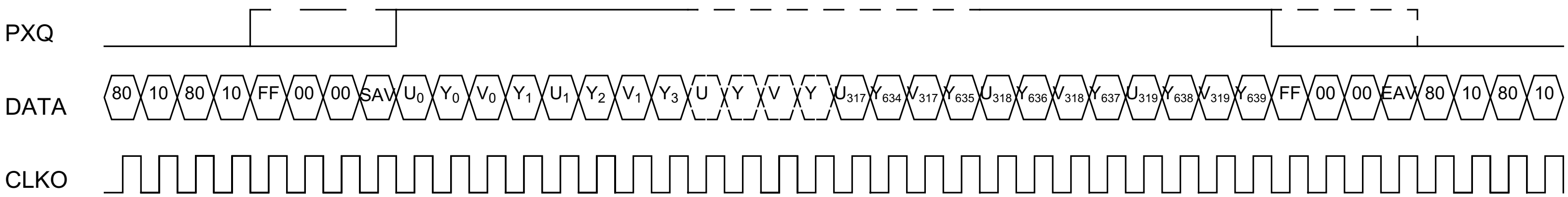
Sub-sampling by 4, QQVGA continuous data stream



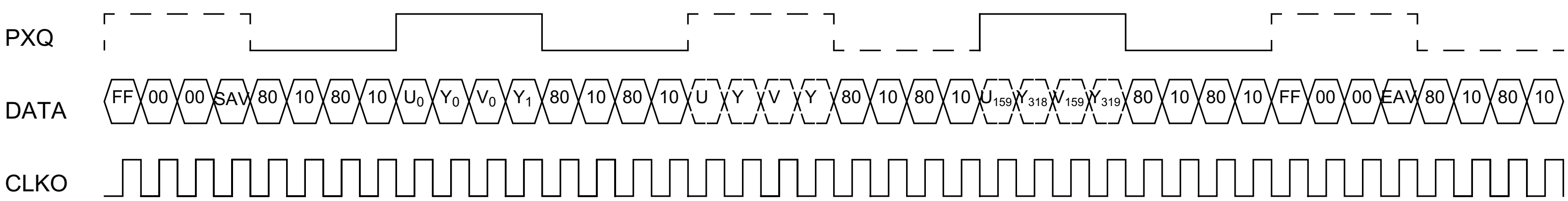
* Above timing diagrams depict 2 and 4 times sub-sampling. 3 and 5 times subsampling is done in a comparable way.

* Used bc / by codes are #80 / #10

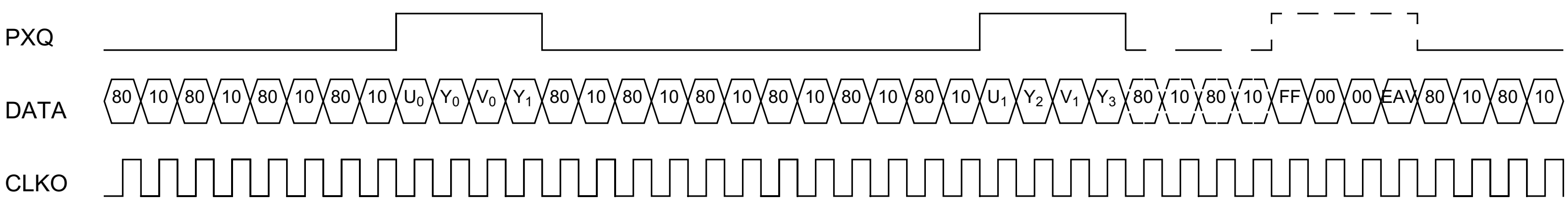
Full resolution output stream



Sub-sampling by 2, QVGA discontinuous data stream

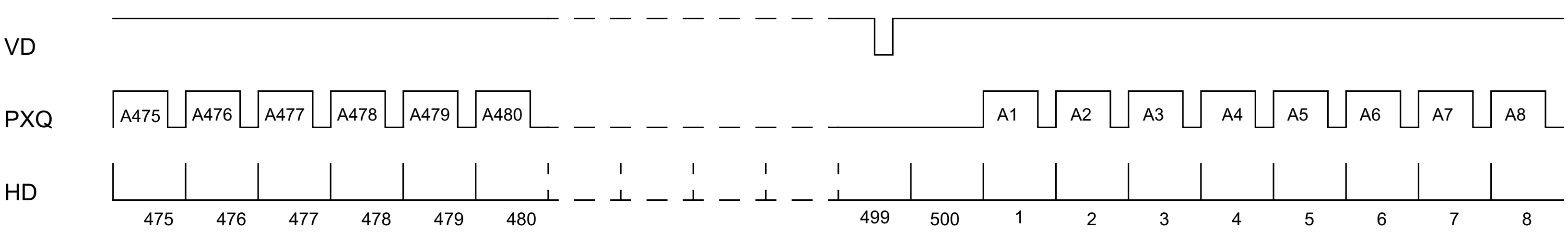


Sub-sampling by 4, QQVGA discontinuous data stream

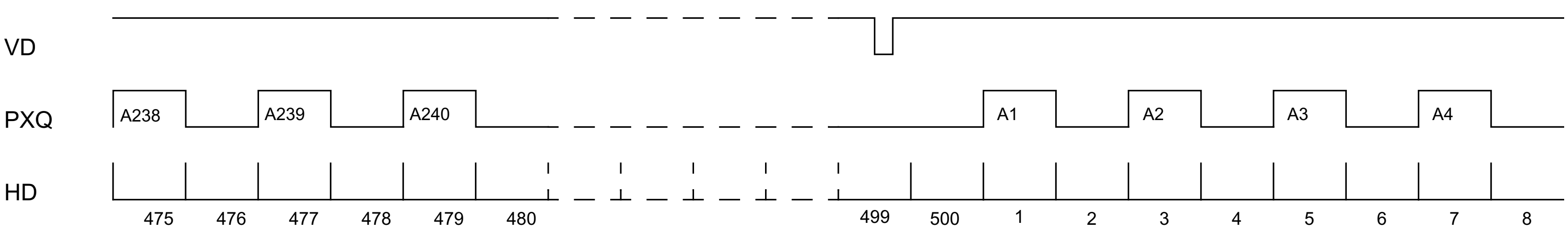


* Above timing diagrams depict 2 and 4 times sub-sampling. 3 and 5 times subsampling is done in a comparable way.
* Used bc / by codes are #80 / #10

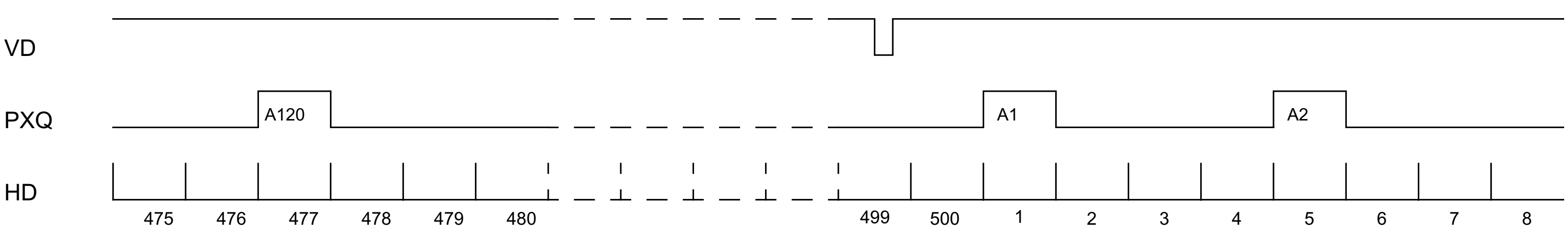
Full resolution VGA output stream



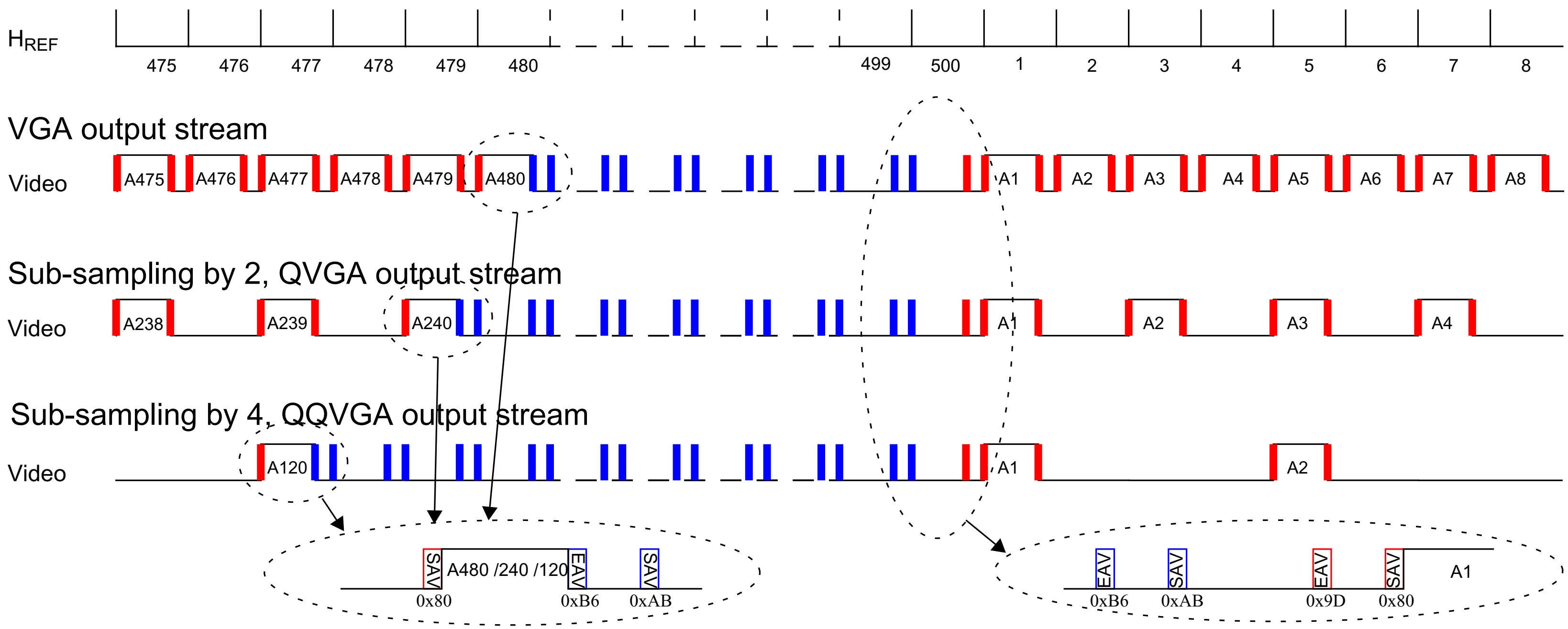
Sub-sampling by 2, QVGA output stream



Sub-sampling by 4, QQVGA output stream



* Above timing diagrams depict 2 and 4 times sub-sampling. 3 and 5 times subsampling is done in a comparable way.



P-code table for SAV/EAV-codes

‘1’	F	V	H	P3	P2	P1	P0	XAV
1	0	0	0	0	0	0	0	80
1	0	0	1	1	1	0	1	9D
1	0	1	0	1	0	1	1	AB
1	0	1	1	0	1	1	0	B6
1	1	0	0	0	1	1	1	C7
1	1	0	1	1	0	1	0	DA
1	1	1	0	1	1	0	0	EC
1	1	1	1	0	0	0	1	F1

H = ‘1’ in case of EAV and ‘0’ in case of SAV

* Above timing diagrams depict 2 and 4 times sub-sampling. 3 and 5 times subsampling is done in a comparable way.

12. Sunshade

Figure 7 is intended to serve as a guideline for designing the sunshade in the application:

- DFOV: Diagonal field of view. (60 degrees)
- A: Mechanical free field of view.
- B: Opening diameter. Exact dimension depend on the module alignment accuracy in the application.
- C: Partly covered area outside DFOV. Should be minimized for optimum sunshade performance.
- D: Fully covered area
- E: Sunshade thickness. Largely determines the sunshade quality.

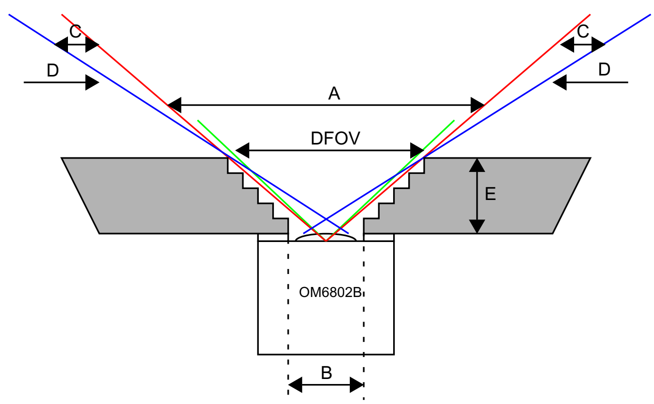


Fig. 7 Optical design information

It is recommended to contact Philips sales office for support in sunshade design.

13. Limiting values

Table 5: Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	Supply voltage		-0.5	4.6	V
I_{DD}	Supply current		-	40	mA
I_I	DC input current at any input		-10	+10	mA
I_O	DC output current at any output		-10	+10	mA
V_I	DC input voltage (not exceeding 4.6 V)		-0.5	V_{DDD}+ 0.5	V
T_{amb}	Ambient temperature [1]		- 20	70	°C
T_{stg}	Storage temperature		- 40	75	°C
	Pressure on barrel			t.b.d.	Pa
	Torque on barrel			t.b.d.	Nm

[1] Image quality might degrade at high temperature range and condensation might occur at low temperature range. These effects will slowly disappear when the device is brought back to standard operating conditions.

14. Device Characteristics

14.1 Interface characteristics

Table 6: Timing and levels of control, sync and output signals (default operation, V_{DDD} = V_{DDA} =2.8 V, f_{clk} = 12 MHz, T_{amb} = 25 °C)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{cl}	Clock frequency			12	t.b.d.	MHz
	Input levels HD, VD (INEXSY = 1)					
V_{IH}	Input High voltage		0.7*V_{DDD}			V
V_{IL}	Input Low voltage				0.3*V_{DDD}	V
	Output levels HD, VD, D0...D7 (INEXSY = 0)					
I_{OH}	High level output current	V_{OH} = V_{DDD} - 0.4 V	-2			mA
I_{OL}	Low level output current	V_{OL} = 0.4 V	2			mA
V_{OH}	High level output voltage		V_{DDD} - 0.4			V
V_{OL}	Low level output voltage				0.4	V
t_{PHL}, t_{PLH}	Output transition time	load = 30 pF,				
	- D0..7, HD, VD, PXQ	10 - 90 %	8.0	13.5	18	ns
	- CLK_OUT		4.0	6.5	9	ns
	Timing HD, VD, RESET (Inputs)					
t_{SETUP}	Set-up time		5			ns
t_{HOLD}	Hold time		1			ns

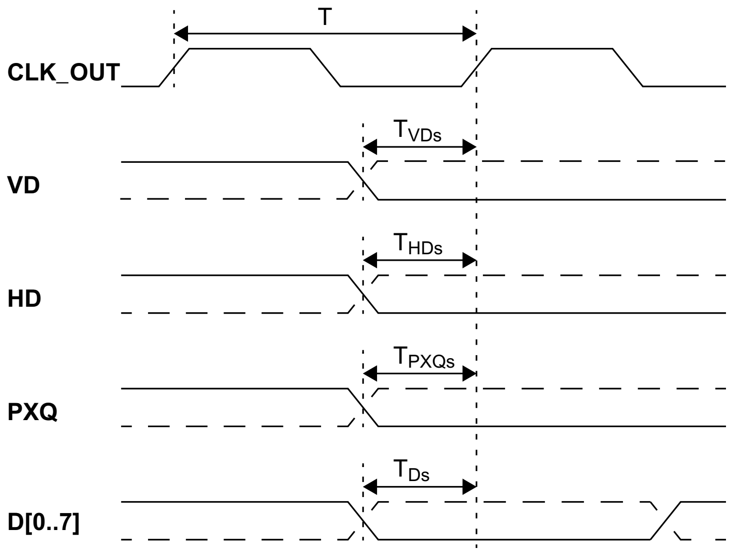


Fig. 8 Set-up and hold output timing

Table 7: Setup and hold times related to CLK_OUT [1] [2] [3]

Time	Description	Min. (ns)	Max. (ns)
T_{VDs}	Setup time for VD	(T/2) - 2	(T/2) + 2
T_{HDs}	Setup time for HD	(T/2) - 2	(T/2) + 2
T_{PXQs}	Setup time for PXQ	(T/2) - 2	(T/2) + 2
T_{Ds}	Setup time for D0..7	(T/2) - 2	(T/2) + 2
T_{Dh}	Hold time for D0..7	(T/2) - 2	(T/2) + 2

[1] Figures refer to a full CLK_OUT period having 50 % duty cycle
[2] For highest frame-rate CLK_OUT is equal to the device input clock. In this case the tabulated figures have to be corrected according the duty cycle of the applied input clock.
[3] Figures are valid for equal capacitive loads on device outputs. Capacitive load dependency is given in table 8.

Table 8: Data output delay vs. capacitive load

	Propagation delay (ns)		
	C_{load} = 5 pF	C_{load} = 12 pF	C_{load} = 30 pF
Rising Edge	4.0	5.4	7.9
Falling Edge	4.9	6.4	9.1

14.2 Optical characteristics

Table 9: Optical characteristics (V_{DDD} = V_{DDO} = V_{DDA} =2.8 V, f_{clk} = 12 MHz, T_{amb} = 25 °C)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
SNR	Signal to noise ratio for Luminance	Applied light intensity is 100 lux		46		dB
F	Aperture			2.5		
f	Focal length			3.6		mm
	Focal range - nearest point - farest point			 35 inf.		 cm cm
D_{FOV}	Diagonal field of view - Horizontal F.O.V. - Vertical F.O.V.			60 48 36		o
	MTF 25 cy/mm [1]	**Position in image field** - center - 60 % image height	 70 50			 % %
	Distortion	Total field		3		%
	Relative illumination (vignetting)	At 100% of image height [2]	40	48		%
	Flare ratio	According to ISO/DIS 9358			6	%

[1] MTF definition and relevant conditions

- The MTF in a Window of interest is defined as:
- $MTF = \frac{Max - Min}{Max + Min} \cdot \frac{1}{C} \cdot 100\%$, with C the contrast of the scene, *max* the highest pixel signal and *min* the lowest signal in the WOI.
- The MTF is determined with a special test chart at 50 cm distance from the module.
- The test chart consists of a chess pattern -horizontal and vertical repetition of black and white squares- with a frequency of 25 cy/mm on the sensor.
- The MTF is measured in 5 Windows of interest as indicated in figure 9
- MTF is measured on only green pixels on raw RGB video output.

[2] Checked during final test with shading correction active

Fig. 9 Position of MTF measurement windows

Table 10: Pixel characteristics (T_{int} = 1/30 sec, T_{colour} = 3200 K)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{sat}	Output saturation voltage	At analog sensor output, Gain = 0dB	t.b.d.	t.b.d.		mV
CF	Conversion Gain	At analog sensor output, Gain = 0dB		52		µV/e-
I_d	Photodiode dark current	T_{amb} = 25 ºC		0.1	0.2	nA/cm^2
		T_{amb} = 60 ºC		1.6	3	nA/cm^2
FPN	Fixed pattern noise	T_{amb} = 25 ºC		0.3	0.5	mV_{rms}
		T_{amb} = 60 ºC		2.4	4	mV_{rms}
Noise	Random noise	T_{amb} = 25 ºC		1.7	2.0	mV_{rms}
DR	Dynamic Range	T_{amb} = 25 ºC	54	56		dB
SEN	Sensitivity	At image centre, gain = 0 dB, IR cut-off @ 650 nm				
	- red			70		mV/lx
	- green			67		mV/lx
	- blue			44		mV/lx

14.3 Power Consumption

Table 11: Operating conditions (f_{clk} = 12 MHz, 15fps VGA, T_{amb} = 25 °C, outputs D0-D7 loaded with 5pF)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DDD}	Supply voltage	$V_{DD\_D} = V_{DD\_A}$	2.6	2.8	3.6	V
I_{DD}	Supply current	$V_{DD\_D} = V_{DD\_A} =$ 2.8V				
		- from V_{DD_D}		13.7	16	mA
		- from V_{DD_A}		7.5	13.0	mA
		- power down		0.8	2	µA

15. Camera modes

Three camera modes are available, which can be selected via the REQ_ENTER_FACTORY_MODE request.

These modes are the following:
- Normal mode: the default mode
- Factory mode: a debug mode
- Register access mode: a debug mode

15.1 Normal mode

This is the default operating mode. Desired changes of camera settings can be done via the different available SW requests. Only a limited set of embedded registers is directly accessible (table 12) to change default settings.

Table 12:

Register address	Register mnemonic
0x05 .. 0x0D	addr_cic_tbg_05…addr_cic_tbg_13
0x15 .. 0x1D	addr_cic_rgb_matrix_00….addr_cic_rgb_matrix_08
0x20	addr_cic_gamma_00
0x29	addr_cic_lum_process_04
0x2A	addr_cic_lum_process_05
0x2B .. 0x3D	addr_cic_scaler_00 .. addr_cic_scaler_18
0x6B	DCI_CR10
0x86	DCI_DPC_PARAM
0x90	DCI_HDREL
0x91	DCI_HDFEL
0x92	DCI_HDRCL
0x93	DCI_VDFCL
0x94	DCI_VDRLL
0x95	DCI_VDFLL
0x96	DCI_VRFLH
0x97	DCI_VHRFCH
0xA5	addr_af_0

The way to access these registers is described hereafter (compare to the I2C requests):

Control identifier code = Register address

Control Mnemonic = Value to be written in the register

15.2 Factory mode

A **debug mode,** which is not meant to be used in the application.

In factory mode, the auto-loops are switched off, but all hardware registers are accessible via I2C.

15.3 Register access mode

This mode is the association of the 2 previous ones: in this mode, auto loops are running and all hardware registers are accessible.

16. Camera Requests

To ease the device application a high level interface is defined for easy access and tuning of the most commonly used camera parameters. Settings like, contrast, brightness, color saturation, sharpness, etc. are easily accessible via the defined request bytes.

After sending a command to one of the request registers the embedded micro-controller takes care of a proper device programming. All internal registers related to the request are properly set.

When settings different from the predefined request bytes have to be changed contact should be taken with the sales office for further application support.

16.1 Status Requests

Table 13:

Control identifier code	Control Mnemonic
0xFC	REQ_RESTORE_FACTORY_DEFAULTS
Data byte value	0x11
Function	The purpose of this request is to restore the default configuration by downloading the default settings (called factory settings), which are the following: • auto exposure on/off - flicker less mode - backlight compensation mode - auto_ngc - auto_contour - white balance mode - black & white / color mode • default ngc_contrast_preset • default awb_manual_red_gain • default awb_manual_blue_gain • default exposure time • default gain • default brightness • default gamma • default contour • default Saturation
Default value	**Not applicable**

Table 14:

Control identifier code	Control Mnemonic				
0xFD	REQ_RESOLUTION_FRAMERATE_ZOOM				
Data byte value	Bits	ID	Description		
	bit 7		**Scan direction Left / Right**		
		0	Left to right		
		1	Right to left (horizontal mirror)		
	bit 6		**Scan direction Up / Down**		
		0	Top to bottom scan (vertical mirror)		
		1	Bottom to top scan		
	Bits[5..0]		**Resolution**	**Frame_rate**	**Zoom**
		0	VGA	15	no
		1	VGA	7.5	no
		2	VGA	3.75	no
		3	VGA	1.875	no
		4	QVGA	15	No
		5	QVGA	7.5	No
		6	QVGA	3.75	No
		7	QVGA	1.875	No
		8	QVGA	15	Max
		9	QVGA	7.5	Max
		10	QVGA	3.75	Max
		11	QVGA	1.875	Max
		12	QQVGA	15	No
		13	QQVGA	7.5	No
		14	QQVGA	3.75	No
		15	QQVGA	1.875	No
		16	QQVGA	15	Max
		17	QQVGA	7.5	Max
		18	QQVGA	3.75	Max
		19	QQVGA	1.875	Max
		20	Sub-QCIF	15	No
		21	Sub-QCIF	7.5	No
		22	Sub-QCIF	3.75	No
		23	Sub-QCIF	1.875	No
		24	Sub-QCIF	15	Max

Table 14:

	25	Sub-QCIF	7.5	Max
	26	Sub-QCIF	3.75	Max
	27	Sub-QCIF	1.875	Max
	28	CIF	15	No
	29	CIF	7.5	No
	30	CIF	3.75	No
	31	CIF	1.875	No
	32	QCIF	15	No
	33	QCIF	7.5	No
	34	QCIF	3.75	No
	35	QCIF	1.875	No
	36	QCIF	15	Max
	37	QCIF	7.5	Max
	38	QCIF	3.75	Max
	39	QCIF	1.875	Max
	40	QQCIF	15	No
	41	QQCIF	7.5	No
	42	QQCIF	3.75	No
	43	QQCIF	1.875	No
	44	QQCIF	15	Max
	45	QQCIF	7.5	Max
	46	QQCIF	3.75	Max
	47	QQCIF	1.875	Max
	48	QQSIF portrait	15	No
	49	QQSIF portrait	7.5	No
	50	QQSIF portrait	3.75	No
	51	QQSIF portrait	1.875	No
Function	This request defines the different frame rate and video resolutions If value above 51 is specified, the frame rate (LSB 2 bits) is changed and the format is threated as custom (i.e. user has to update related registers).			
Default value	**0x40**			

Table 15:

Control identifier code	Control Mnemonic		
0xEF	REQ_SET_AUTO_FRAME_RATE_MODE		
data byte value	Bits	ID	Description
	7		**Lowest Frame rate @ 12 MHz input clock**
		0	7.5 fps
		1	10 fps
	6		**Contour Gain**
		0	Leave Contour Gain as defined
		1	Force Contour gain to be set to 0 (at lowest frame) rate
	5		**YUV Filter**
		0	Disable [12221]/4 YUV filter
		1	Enable [12221]/4 YUV filter (at lowest frame rate)
	4		**Matrix**
		0	Normal Matrix
		1	Alternate Matrix (at lowest frame rate) When this bit is set one four alternate matrices is used when the lowest frame-rate is reached. Alternate matrix can be set via bits 5..7 of request REQ_SET_COLOUR_MODE.
	[3..0]		**Gain Milestone Level**
		0x0 up to 0xF	When 0x0 the Auto Frame Rate (AFR) function is switched off. When different from 0x0 AFR is ON, and the **value** represents the Gain Milestone Value. When AFR is ON, the bit **Low light condition** is ignored (bit 7 of request REQ_SET_LUMINANCE_MODE). Auto Frame Rate can work only if Auto Exposure Mode has been set to ON (bit 6 of REQ_SET_LUMINANCE_MODE).
Function	Request defines the Auto Frame Rate settings		
Default value	**0x00**		

Table 16:

Control identifier code	Control Mnemonic		
0xDD	REQ_YUV_RGB_OUTPUT		
data byte value	bits	ID	Description
	7		**YUV/ RGB out**
		0	RGB
		1	YUV
	[6..5]		**YUV swapping**
		00	$U_0Y_0V_0Y_1$
		01	$V_0Y_0U_0Y_1$
		10	$Y_0U_0Y_1V_0$
		11	$Y_0V_0Y_1U_0$
	[4..3]		**RGB format**
		00	RGB 444
		01	RGB 555
		10	RGB 565
		11	Raw RGB
	2		**YUV MPEG/JPEG (1/2 T UV shift)**
		0	no T U/V shift
		1	T U/V shift, REC 601 compliant
	[1..0]		**Data clipping**
		00	No clipping
		01	CCIR 601 compliant
			Y[16..235]; U[16..240]
		1X	YUV[1..254]
Function	Defines the YUV and RGB output format		
Default value	**0x93**		

Table 17:

Control identifier code	Control Mnemonic		
0xDE	REQ_SYNCHRONISATION		
data byte value	bits	ID	Description

Table 17:

	7		**SAVEAV codes on/off**
		0	Off
		1	On
	6		**SAVEAV codes inactive lines**
		0	Off
		1	On
	5		**XAV-code bit 6**
		0	Low
		1	High
	4		**XAV-code bit 7**
		0	Low
		1	High
	3		**Output clock period**
		0	Output clock equal to pixel clock. Data qualification in combination with PXQ
		1	Output clock qualifies data on every clock
	2		**Inactive level select**
		0	00 00 00 00
		1	80 10 80 10
	1		**One and a half time frequency divisor**
		0	Disabled
		1	Enabled (3/2 divisor)
	0		**Output clock polarity**
		0	not inverted
		1	inverted
Function	Defines output format and CCIR656 synchronization codes		
Default value	**0x5C**		

Table 18:

Control identifier code	Control Mnemonic
0xDF	REQ_ENTER_FACTORY_MODE
data byte value	Password (0x6D = factory mode; 0x12 = register access mode, 0x00 return to normal mode)
Function	By default the NORMAL mode is active (only some specific embedded registers can be accessed). In FACTORY_MODE, the picture processing is OFF (auto loops are not running), but access to all hardware registers is possible. In REGISTER ACCESS_MODE, the picture processing is running (auto loops) and access to all hardware registers is possible. In this case, the auto loops behavior can not be guaranteed due to the fact that the hardware registers can be modified. Note that you can leave factory or register access mode with reset or with calling the same request with 0x00 password.
Default value	**Not applicable**

Table 19:

Control identifier code		Control Mnemonic
0xAE	Bits	REQ_SET_AFR_EXTENDED_MODE
	0	1 = enable extended auto frame (frame rate decreased if maximum number of lines and gain are reached) 0 = disabled (default)
	1	1 = enable awb parameter A to be set to 0 if frame rate is decreased. 0 = disable
Function		Bit 0, if enabled, auto frame rate is active and maximum number of lines and maximum gain are reached, current frame rate is automatically decreased (only once). So, minimum frame rate depends on the setting of bit 7, register 0xEF. Bit 1, if enabled, the awb parameter A is set to 0 if the numer of integration lines is above those set in requests 0xED/0xEE. This is done to improve low light performance.
Default value	0x00	

16.2 Luminance Requests

Table 20:

Control identifier code	Control Mnemonic
0xE0	REQ_GET_GAIN_LSB

Table 20:

data byte value	Returns LSB of the Gain value
Function	Reads LSB part of gain value When handling this request, the returned value of request REQ_GET_GAIN_MSB, REQ_GET_ITLSB, REQ_GET_IT_MSB are frozen to keep coherent values.
Default value	**Not applicable**

Table 21:

Control identifier code	Control Mnemonic
0xE1	REQ_GET_GAIN_MSB
data byte value	returns MSB of the Gain value (as it was last time when requiring REQ_GET_GAIN_LSB).
Function	Reads MSB part of gain value
Default value	**Not applicable**

Table 22:

Control identifier code	Control Mnemonic
0xE2	REQ_GET_IT_LSB
data byte value	Returns LSB part of the Integration Time value (as it was last time when requiring REQ_GET_GAIN_LSB) in number of lines
Function	Reads LSB part of integration time value
Default value	**Not applicable**

Table 23:

Control identifier code	Control Mnemonic
0xE3	REQ_GET_IT_MSB
data byte value	Returns MSB part of the Integration Time value in number of lines (as it was last time when requiring REQ_GET_GAIN_LSB).
Function	Reads MSB part of integration time value
Default value	**Not applicable**

Table 24:

Control identifier code	Control Mnemonic
0xE4	REQ_PRESET_SHUTTER
data byte value	0x00 .. 0xFF
Function	When AE is switched OFF, the value represents the integration time used Note that if AE is switched back to ON, auto exposure algorithm starts from the values set in this request and request 0xE5..
Default value	**Not applicable because AE is ON by default**

Table 25:

Control identifier code	Control Mnemonic
0xE5	REQ_PRESET_AGC
data byte value	0x00 .. 0xFF
Function	When AE is switched OFF, the value multiplied by 2*max_agc_value/255 represents the gain used. See REQ_SET_MAX_AGC_VALUE for setting of max_agc_value. Note that if AE is switched back to ON, auto exposure algorithm starts from the values set in this request and request 0xE4..
Default value	**Not applicable because AE ON by default**

Table 26:

Control identifier code	Control Mnemonic
0xE6	REQ_PRESET_BRIGHTNESS
data byte value	0x80 .. 0x7F (-128 .. 127)
Function	Controls the video brightness level
Default value	**0x00**

Table 27:

Control identifier code	Control Mnemonic
0xE7	REQ_PRESET_CONTRAST
Data byte value	0x80 .. 0x7F (-128 .. 127)
Function	Controls the video contrast level
Default value	**0x00**

Table 28:

Control identifier code	Control Mnemonic
0xE8	REQ_PRESET_GAMMA
Data byte value	0x00 .. 0x3F
Function	Controls the gamma curve applied on the video signal
Default value	**0x31**

Table 29:

Control identifier code	Control Mnemonic		
0xE9	REQ_SET_LUMINANCE_MODE		
data byte value	Bits	ID	Description

Table 29:

	7		**Low light condition**
		0	OFF
		1	ON
			When Auto Frame Rate is ON, this mode is ignored
	6		**Auto Exposure mode**
		0	OFF
		1	ON
	5..4		**Flicker less mode**
		00	OFF
		01	50 Hz
		10	60 Hz
		11	unused
	3..2		**Backlight compensation**
		00	OFF
		01	ON
		11	AUTO
	1		**Auto NGC Mode**
		0	OFF
		1	ON
			When ON, the noise gain control function will improve the picture quality under low light conditions.
	0		**Auto Contour Mode**
		0	OFF
		1	ON
			When ON, the contour gain is decreased under low light conditions. The default contour gain can be set via request REQ_PRESET_AUTO_CONTOUR.
			Request is only functional when NGC mode is ON.
Default value	**0x5F**		

Table 30:

Control identifier code	Control Mnemonic
0xEA	REQ_PRESET_AUTO_CONTOUR
data byte value	0x00 .. 0x7F (register range)
Function	Defines the default value for the contour gain
Default value	**0x38**

16.3 Chrominance Requests

Table 31:

Control identifier code			Control Mnemonic
0xF0			REQ_SET_WB_MODE_AE_SPEED
data byte value	Bits	ID	Description
	7..4	0x0	**Auto exposure speed**
		up to	from 0x0 (low) to 0xF (fast)
		0xF	The four bits control the Auto Exposure convergence speed.
	3..0		**White balance mode**
		0x0	incandescent
		0x1	daylight cloudy
		0x2	fluorescent
		0x3	freeze
		0x4	auto RGB
		0x5	auto YUV
		0x6	daylight sunny
			The white balance request defines the control of the white balance mode: incandescent, daylight and fluorescent modes are predefined values for R & B gains. Freeze mode freezes the current status of the R & B gains. The auto mode controls the R and B gains in an automatic way.
Function	Controls the Auto Exposure speed and White Balance mode		
Default value	**0x74**		

Table 32:

Control identifier code	Control Mnemonic		
0xF1	REQ_SET_COLOUR_MODE		
data byte value	Bits	ID	Description
	7.. 6		**Alternate matrix** Selects one of 4 available alternate matrices (the selected matrix is used when bit4 of request REQ_SET_AUTO_FRAME_RATE_MODE (0xEF) is set to 1. Each matrix is calculated as (x+1)*25% unity matrix plus (3-x)*25% current color matrix and x, 0 ≤x≤.3, is the specified parameter. Used under low light only.
	5		**Changes in alternate and color matrix (addr. 0x15 .. 0x1D), contour and YUV filter become active immediatly**
		0	Keep old 6802 behaviour, changes become active under certain conditions
		1	Activate changes immediatly
	4		**Alternative auto exposure algorithm including subrow exposure**
		0	Disabled
		1	Enabled Note that you can use only one of the two autoexposure algorithms (default and that one) and this should be set on initialization.
	3		**Balance weight compensation algorithm**
		0	Disabled
		1	Enabled
	2		**Contrast stretch**
		0	Disabled
		1	Enabled
	1.. 0		**Color mode**
		00	Black & white
		01	SEPHIA mode
		1x	Color mode
Function	Selection of the Alternate matrix used by the AFR function. Selection of the color mode		
Default value	**0x02**		

Table 33:

Control identifier code	Control Mnemonic
0xF2	REQ_PRESET_SATURATION
data byte value	Decimal: -100%-1% 0% 1% 100% Hex: 0x9C 0xFF 0x00 0x01 0x64
Function	Controls the color saturation level by modifying the U and V gains (no saturation means a black and white picture)
Default value	**0x00**

Table 34:

Control identifier code	Control Mnemonic
0xF3	REQ_PRESET_MANUAL_RED_GAIN
data byte value	0x00 .. 0xFF
Function	Preset value for the white balance red gain in case the white balance FREEZE mode selected
Default value	**0x80**

Table 35:

Control identifier code	Control Mnemonic
0xF4	REQ_PRESET_MANUAL_BLUE_GAIN
data byte value	0x00 .. 0xFF
Function	Preset value for white balance blue gain in case the white balance FREEZE mode is selected
Default value	**0x40**

16.4 Auto focus requests

Table 36:

Control identifier code		Control Mnemonic
0xA5	Bits	REQ_SET_AF_0
	6	Use very detail search (sharper image, but 9 frames slower). Default 0 (=disabled).
	5,4,3	Focus plane (each plane except No 6 has 400 X 240 points) : 0 - central, 1- top, 2 - right 3 - bottom, 4- left, 5- whole area
	2	Auto focus lock (1=lock, 0=unock)
	1	Auto focus mode (1=automatic, 0=manual)

Table 36:

	0	Hardware request for auto focus (1=enabled, 0=disabled).
Function		Set focus plane and lock/unlock the focus.
Default value		0x00 (AF disabled)

Table 37:

Control identifier code		Control Mnemonic
0xA6	Bits	REQ_SET_AF_1
	0-7	Value between 0 (infinity) and 255 (near-by) corresponding to the focus position of the lenses
Function		Used to set focus position
Default value		0x00

Table 38:

Control identifier code		Control Mnemonic
0xA7	Bits	REQ_SET_AF_2
Function		If this request is called, refocusing is started.
Default value	0xF8	

Table 39:

Control identifier code		Control Mnemonic
0xAF	Bits	REQ_GET_BEST_FOCUS
Function		Returns the best focused position requested with 0xA7. User have to wait n+2 frames before requesting this information, where n is number of focused positions.
Default value	n.a.	

16.5 Flash control requests

Table 40:

Control identifier code		Control Mnemonic
0xA8	Bits	REQ_SET_FLASH_CRIT_COND
	4-7	If 0, do not use this criteria; Otherwise to have stable condition, the difference between the numbers of exposed lines in 2 consequtive frames must not exceed 2 times specified parameter.

Table 40:

	0-3	If 0, do not use this criteria; Otherwise to have stable condition, the difference between the gain in centibells in 2 consequtive frames must not exceed 2 times specified parameter.
Function		This request sets condition to detect whether we have stable picture; this is needed to make a photo shot.
Default value		0x00

Table 41:

Control identifier code		Control Mnemonic
0xA9	Bits	REQ_SET_FLASH_TIME
	4-7	If 0, do not use this criteria; Otherwise even if we do not have stable conditions based on the other requests, if the number of frames exceed 2 times specified parameter, we act in the same way like we have stable conditions.
	0-3	If 0, do not use this criteria; Otherwise to have stable condition, the difference between the numbers of both red and blue gain in 2 consequtive frames must not exceed 2 times specified parameter.
Function		After this request, we start taking the picture. This means that requests 0xA8 and 0xAA should be called before this one.
Default value		0x00

Table 42:

Control identifier code		Control Mnemonic
0xAA	Bits	REQ_SET_FLASH_MODE
	4-7	Gain used in auto flash mode only; If the current value of gain is higher than this parameter, LED is used.
	3	If 0, switch the LED off; If 1, no change of LED
	2	unused
	0-1	Flash mode: 00 - No flash 01 - Auto Flash 10 - Use Flash always 11 - LED ON We do not use maximum waiting time for LED ON
Function		Sets gain to use flash and mode; switch off LED on request
Default value		0x08

16.6 AWB request

Table 43:

Control identifier code		Control Mnemonic
0xAB	Bits	REQ_SET_AWB_LIMITS
	6,7	Sets maximum temperature as 70000+p*30000 K, $0 \le p \le 3$
	3,4,5	Sets minimum temperature as 20000+p*2000 K, $0 \le p \le 7$
	0,1,2	Sets the temperature offset as 15000+p*3000 K, $0 \le p \le 6$ If p=7, constant value of 65000K is used (i.e. maximum offset).
Function		This request sets the limit conditions for auto white balance (rgb mode)
Default value		0xD8

16.7 Noise gain control requests

Table 44:

Control identifier code		Control Mnemonic
0xAC		REQ_SET_VAR_IDX
	0-7	Sets the index of variable initialized in request 0xAD. The following index - variable correspondence is set: Noise Gain Correction variables: 0x00 - ngc_noise_control_top, default 0x78 0x01 - ngc_noise_g_control_bottom, default 0x40 0x02 - ngc_noise_uv_control_bottom, default 0x40 0x03 - ngc_noise_c_control_bottom, default 0x20 0x04 - ngc_gamma_end_level, default 0x16 0x05 - ngc_u_gain_end_level, default 0x30 0x06 - ngc_v_gain_end_level, default 0x30 0x07 - ngc_congain_end_level, default 0x00 0x08 - Gain level (centibells) above YUV filter is switched on if auto_frame_rate is off. Auto Focusing variables: 0x10 - tmAutoFocus_first 0x11 - tmAutoFocus_last 0x12 - tmAutoFocus_step (0x7F) and direction (& 0x80 == 1 is negative direction)
Function		
Default value		n.a.

Table 45:

Control identifier code		Control Mnemonic
0xAD	Bits	REQ_SET_VAR_VALUE

Table 45:

	0-7	Sets the value of variable specified in request 0xAC, range 0x00 .. 0xFF
Function		Noise Gain Correction: Recalculate relevant coefficients using the following formulas: coeff = (ngc_preset_value - ngc_x_end_level) / (ngc_noise_control_top-ngc_noise_x_control_bottom) and in low light conditions ngc values (gamma, u & v gain, contour) are decreased by coeff * (gain/2 - ngc_noise_x_bottom) Auto Focus: Stable Conditions indicates max number of lines + gain between 2 frames while we still have stable picture, def. 3 Portrait focus is the position which has to be applied to get portrait photo FramesStableAE is dependent on the AE algorithm used and equals to number of frames + 4 for which AE will get stable after refocusing, default 10. LuminanceChanged is % above which we consider that luminance is changed not because of refocusing, but because of camera move during the refocusing. As a result, we stop refocusing and wait to stabilize.
Default value		n.a.

16.8 General purpose requests

Table 46:

Control identifier code	Control Mnemonic
0xEB	REQ_WRITE_CLKLINL
data byte value	0x00 .. 0xFF
Function	LSB part to define the number of clocks per line (HEX value) **Also the MSB part has to be send before the value is used (request 0xEC).**
Default value	**0x20** (=LSB of 800 lines)

Table 47:

Control identifier code	Control Mnemonic
0xEC	REQ_WRITE_CLKLINH
data byte value	0x00 .. 0x03
Function	MSB part to define the number of clocks per line (HEX value)
Default value	**0x03** (= MSB of 800 lines)

Table 48:

Control identifier code	Control Mnemonic
0xED	REQ_WRITE_LINFIL
data byte value	0x00 .. 0xFF
Function	LSB part to define the number of lines per field (HEX value) **Also the MSB part has to be send before the value is used (request 0xEE).**
Default value	**0xF4** (= LSB of 500 lines)

Table 49:

Control identifier code	Control Mnemonic
0xEE	REQ_WRITE_LINFIH
data byte value	0x00 .. 0x03
Function	MSB part to define the number of lines per field (HEX value) This request will be executed in next frame after the request.
Default value	**0x01** (= MSB of 500 lines)

Table 50:

Control identifier code	Control Mnemonic
0xF5	REQ_GET_VERSION
data byte value	Returns the embedded software version
Function	Returns the embedded software version (**0x01** for 6802B)
Default value	**Not applicable**

Table 51:

Control identifier code	Control Mnemonic
0xF6	REQ_SET_POWER_MODE
data byte value	0x11 for FULL_POWER 0xEE for POWER_SAVE
Function	To select between FULL_POWER or POWER_SAVE mode
Default value	**Not applicable**

Table 52:

Control identifier code	Control Mnemonic
0xF7	REQ_STOP_FRAME

Table 52:

data byte value	0x11 to enable video 0xEE to stop video
Function	This request is used to stop or enable the video output
Default value	**Not applicable**

Table 53:

Control identifier code		Control Mnemonic
0xF8		REQ_GET_FRAME_IS_STOPPED
data byte values	Bits	
	0	0 if Frame is not stopped 1 if Frame is Stopped
	1	0 if no stable conditions (for taking picture) are present 1 if such conditions are present
	2	0 LED is OFF 1 LED is ON
Function		This requests sends back the status of the video streaming: stopped or running and information for taking picture..
Default value		**Not applicable**

Table 54:

Control identifier code	Control Mnemonic
0xF9	REQ_SET_INPUT_FREQUENCY_LSB
data byte value	LSB of (Frequency in kHZ * 2)
Function	In case an input clock frequency different from the default frequency (12MHz) is used, the exact input clock frequency should be specified via this request. This request represents the LSB part of the applied input clock. The MSB part in request FA has to be specified as well to validate the adapted input frequency (send first LSB-part then MSB-part!)
Default value	**0xC0** (= LSB of 2 x 12000 kHz)

Table 55:

Control identifier code	Control Mnemonic
0xFA	REQ_SET_FREQUENCY_MSB

Table 55:

data byte value	MSB of (Frequency in kHZ * 2)
Function	In case an input clock frequency different from the default frequency (12MHz) is used, the exact input clock frequency must be specified via this request. This request represents the MSB part of the applied input clock. The LSB part in request F9 has to be programmed first to guarantee proper operation.
Default value	**0x5D** (= MSB of 2 x 12000 kHz)

Table 56:

Control identifier code	Control Mnemonic
0xFB	Not used
data byte value	0xEE
Function	
Default value	**0xEE**

Table 57:

Control identifier code	Control Mnemonic
0xFE	REQ_SET_MAX_AGC_VALUE
data byte value	range: [0x00..0xFF] When 0x00 the default ROM value is used. Values different from 0x00 represent a maximum gain value used by the Auto Exposure algorithm.
Function	Controls the maximum gain used by the AE algorithm.
Default value	**0x5B**

Table 58:

Control identifier code	Control Mnemonic
0xFF	REQ_IDENT
data byte value	Returns **0x2B** as OM6802B module identification
Function	Returns the OM6802B identification byte.
Default value	**Not applicable**

17. Application information

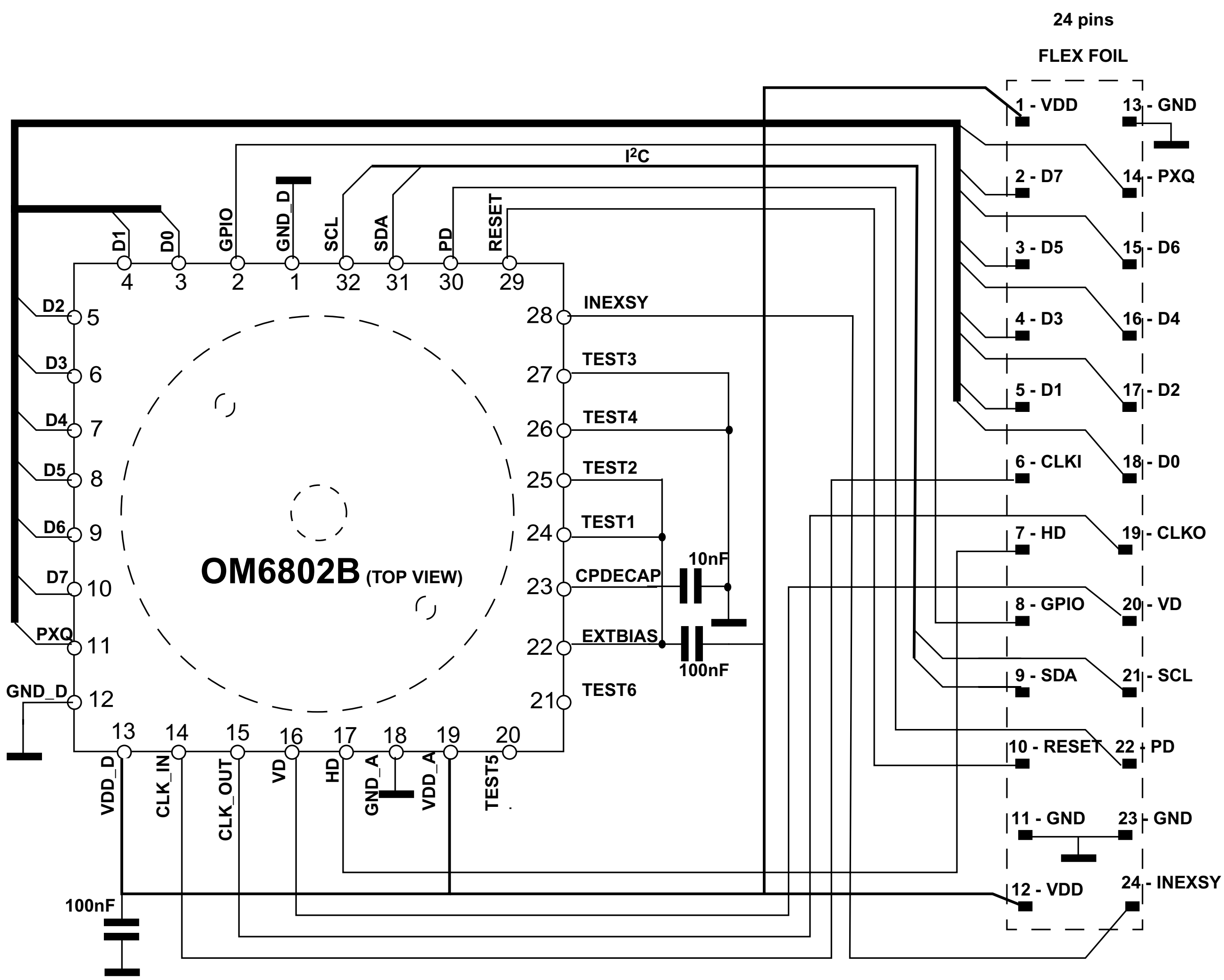


Fig. 10 Flex foil circuit diagram for OM6802B

Note:

The flexfoil configuration (layout, size, shape) can be customized. Also the type of connector can be subject to customization.

18. Mechanics

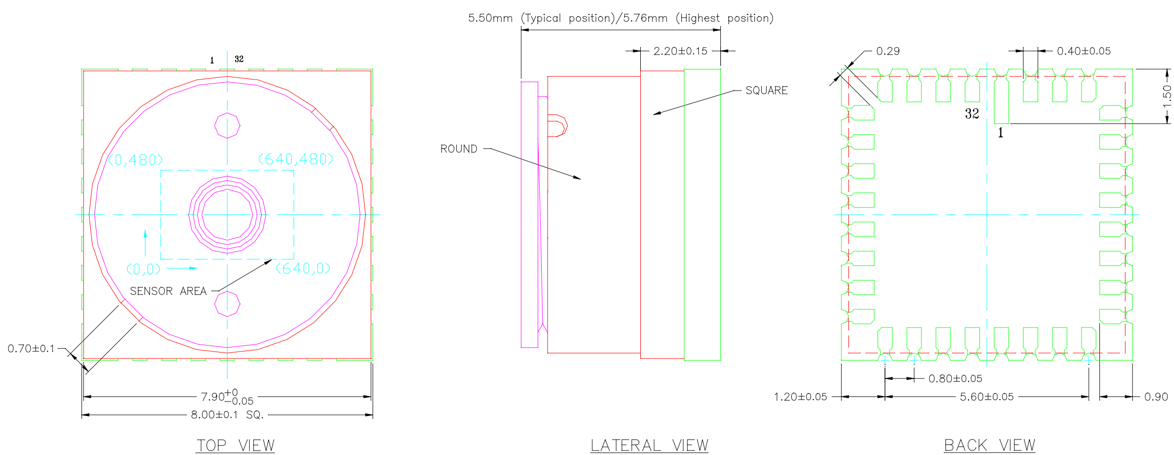


Fig. 11 Mechanical dimensions OM6802B

19. Handling information

The CMOS module is a device which can be destroyed by ESD (Electro static discharge). Therefore the device should be handled with care, using ESD protection and in an ESD safe environment.

Due the fact the module has a highly sensitive optical lens, the module is limited in the applicable temperature range.

In addition to this it should be avoided to contaminate the lens with dirt and or with solvents, which both can limit the optical functions of the lens.

If these boundaries are considered, the optical parts do not have to be cleaned due the fact the module is completely functional tested before shipment to the customer.

20. Soldering

The CMOS module is not to be used for reflow soldering due the fact a highly vulnerable lens is present in the lensbarrel. It should be avoided at all times that the lens temperature is elevated to temperatures above the storage temperature!

So the preferred module assembly on a printed circuit board is the use of an appropriate flex foil connector.

21. Marking

Marking of the product is at the bottom side of the base module, or of the stiffener of the flexfoil, applied by ink.

Marking used (3 lines, preceded by Philips logo):

Line A:	Type
Line B:	Diffusion lot number
Line C:	Manufact. Code + mask version (acc. SNW-SZ-602) + status (acc. SNW-SQ-002)

Actual marking content:

Line A:	OM6802B
Line B:	<diffusion code from received wafer>
Line C:	TWN YY ww M Q

Legend:

P: product version

YY: Year number (03 = 2003)
ww: week number
M: maskset

Q: Qualification state (X = Not qualified, Y =Partly qualified, blank = fully qualified)

22. Revision history

Table 59: Revision history

Rev	Date	CPCN	Description
0.1	040101	-	Draft version for internal review.