Application Note
24C1.3XDIG
rev 2.1

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Videology Imaging Solutions, Inc. USA
37M Lark Industrial Parkway
Greenville, RI 02828
Tel: 401-949-5332
Fax: 401-949-5276

Videology Imaging Solutions, B.V. Europe
Neutronenlaan 4
NL-5405 NH Uden, Netherlands
Tel: +31 (0) 413-256261
Fax: +31 (0) 413-251712

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1. Introduction

The 24C1.3xDIG is a CMOS based camera family with a digital output (CCIR656 based). It is mechanically comparable with Videology's 21K14/15DIG CCD camera family (identical dimensions -22x26mm- and mounting holes). However the sensor has no under plate, and is therefore mounted flat on the PCB. This could effect if the user would like to use a customized lens mount.

The digital output is described fully in this document. The camera must be connected via the 30-pin board-to-board connector. This 30-pin board-to-board connector can be used to "piggy-back" an application PCB.

Examples of application PCB's are:

- USB 2.0 Board: Videology product that has same dimensions (22x26mm). When two boards are stacked together a complete USB 2.0 camera is available.
- Ethernet interface (not yet available)
- Fire wire interface (not yet available)

This document is written to give technical background on specific features of this camera module.

2. Document History

Revision	Issue date	Reason
Rev 1.0	19-May-2008	Initial
Rev 1.1	26-June-2008	Update
Rev 1.2	16-July-2008	Update and additional information
Rev 1.3	19-August-2008	Adding additional features
Rev 1.4	26-Aug-2008	Updating AEX part
Rev 1.5	23-Sept-2008	Adding I2C commands
Rev 1.6	05-Oct-2008	Additional iris mode, gain boost and contrast and brightness control
Rev 1.7	15-Oct-2008	Remove gain boost, additional iris bits, shutter option in iris mode
Rev 1.8	27-Oct-2008	Changed memory map, Pan and tilt feature
Rev 1.9	05-Jan-2009	Adding feature command register 0x08
Rev 2.0	06-Febr-2009	Update command list, iris circuit
Rev 2.1	03-April-2009	Removed Auto Iris references (Rev B)
Rev 2.1	10-March-2010	Added dimensions to section 8.1 (p.21)

3. Specification

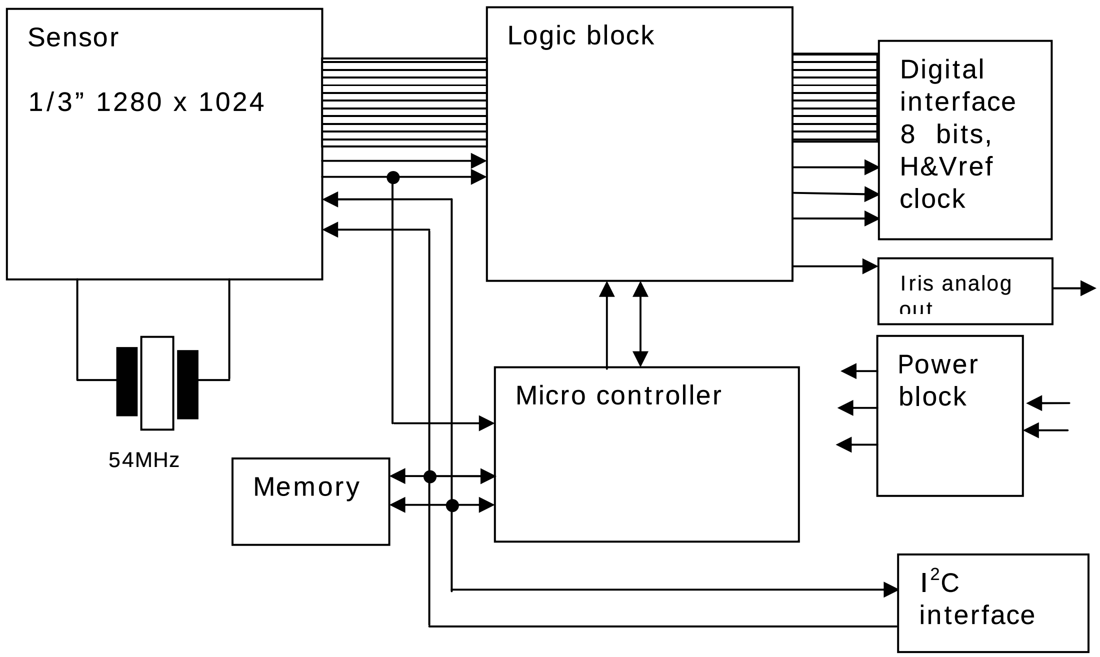
Standard basic features:

	24C1.3xDIG
sensor	CMOS sensor 1/3”
Resolution (HxV)	1280 x 1024 max
Max frame rate	12.5-15 fps SXGA mode
Sensitivity	< 2.0 Lux (50 IRE) F1.2 3200K, lens transmission 80%, scene reflection 75%, 5 fps
Signal to noise ratio	> 44 dB (AGC off) digital output
Gamma	0.45 default (1.0 via Software)
Gain control	Automatic 36 dB (AGC default) or Fixed options via software
Scan mode	Progressive scan
Mirror mode	Selectable via software
Synchronization	Internal
Back light compensation	Default on (selectable via software)
White balance mode	AWB auto white mode, Fixed modes selectable via software
Contour enhancement	Default on
Iris control	Electronic shutter
Shutter speeds	Automatic from 1/5 to 1/10,000 Fixed values
Video output	8/10-bit digital –output: YUV CCIR656 4:2:2 RGB modes
Control communication	I²C control
Power supply	5VDC ± 5% (not polarity protected)
Power consumption	< 0.6 W
Dimensions (HxV)	26 x 22 mm

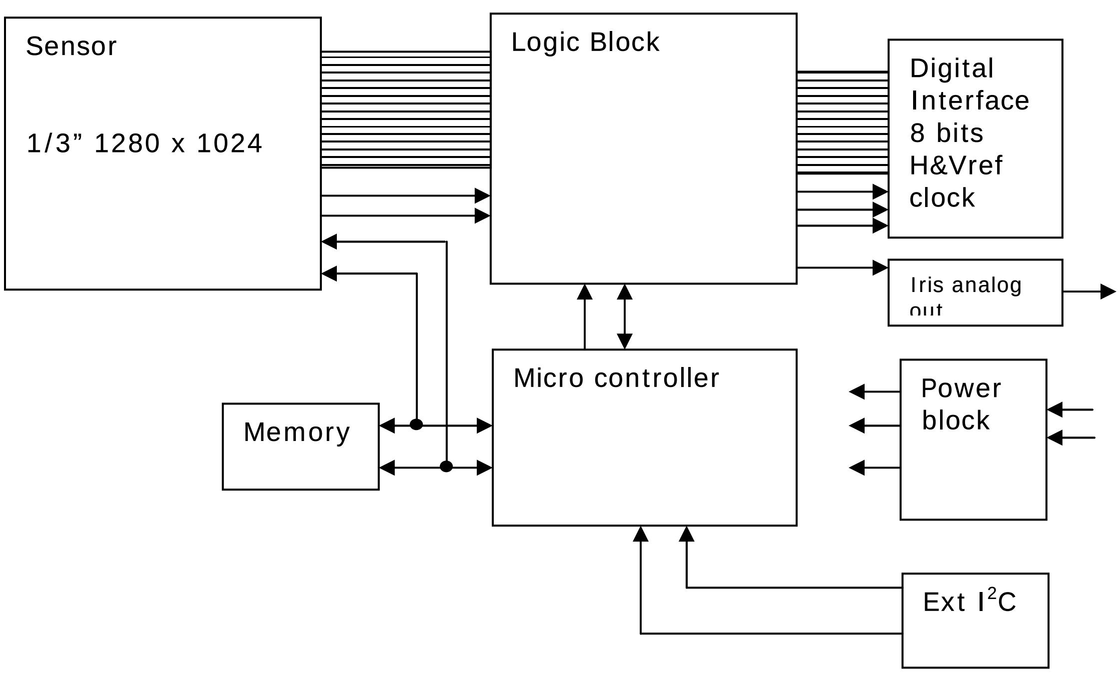
Lens options (X-value)
24C1.32DIG Pinhole lens
24C1.35DIG Board lens (M12 lens)
24C1.37DIG no lens mount (bare CCD)
24C1.38DIG C/CS-mount version
24C1.38DIG/500* customized version not regular available

4. Block Diagram

4.1. 24C1.3xDIG:



4.2. 24C1.38DIG/500:



5. Functional Description

5.1. Resolution

The camera can generate maximum up to 1280 (H) x 1024 (V) pixels per frame at 15 FPS.

The max FPS is determined by the main clock of the camera (54MHz) and the required resolution. This means when you decrease the resolution the number of frames per second will increase.

To set the resolution also to have minimum problems with flicker from the mains frequency (caused by the fact that light is switching on and of with the local mains frequency and the camera would run at an other frequency) it is advised to let the camera run on a multiple of 12.5 Hz for 50 Hz environments and 15 Hz for 60Hz environments.

The resolution is set via register 0x00 bits[15:14].

Mains frequency	Resolution	Num vert. act lines	Num vert blank lines	Num hor. act pixels	Num. hor. Blank pix	Frame/ sec
50 Hz	1280x1024	1024	261	1280	382	12.5 Hz
	800 x 600	600	261	800	454	25 Hz
	640 x 480	480	167	640	194	50 Hz
	320 x 240	240	167	320	194	100Hz
60 Hz	1280x1024	1024	45	1280	382	15 Hz
	800 x 600	600	45	800	595	30 Hz
	640 x 480	480	59	640	194	60 Hz
	320 x 240	240	59	320	194	120Hz

5.2. Auto Exposure

The 24C1.3xDIG camera module has a complex way of aligning the AEX value. To do this in a proper way, the camera has divided the complete range into 25 zones. In here zone 0 is for very bright circumstances. Here is in principal the area were only the shutter is active. Zones 1-24 are a combination of shutter and gain. To achieve the highest sensitivity the camera has the option to extend its integration time with the result that the number of frames per second will decrease.

For the complete AEX control the camera uses the following mechanisms:

- Electronic Shutter
- Analogue gain
- ADC conversion
- Digital gain (1&2)
- Optional Lens control.

In zone 0 the shutter gets to small shutters steps which can cause slight flicker effects depending on other settings. In the following zones the shutter makes steps of 1/100Sec (50 Hz mains) or 1/120Sec (60 Hz mains). This is a multiple of the mains frequency to avoid flicker effects. The analogue gain takes care that the exposure goes smooth from one zone to the other.

The maximum integration time can go up to 0.23 Sec (50Hz) and 0.19 Sec (60Hz) when the variable frame rate option is on.

Further the AEX speed can be selected (4 steps) as well the feedback from previous frames. To control this all the camera has an AEX control register: reg # 0x00:

register	Data bits:	Function: default value 0x0083
0x00	[0]	Flicker less operation. If bit[0]=1 the camera will operate in a flicker less mode. note that for very bright scene's this flicker less operation can not be maintained since the camera uses very short shutter times who are shorter than 1/100 or 1/120 sec.
	[1]	Variable frame rate. if bit[1] =0 than variable frame rate is aloud to get maximal sensitivity. if the bit is 1, the frame rate is fixed. *Note the function of this bit can be over ruled by the bits[3:2]*
	[3:2]	Shutter mode: 00 = electronic shutter 01 = electronic Lens control with fixed shutter (1/frame rate) 10 = electronic lens control with limited shutter steps (minimal 1/100 or 1/120 up to 1/frame rate) . 11 = fixed shutter speed.
	[5:4]	Fixed shutter value: 00 = shutter value 1/100 Sec or 1/120 Sec 01 = shutter value 1/50 Sec or 1/60 Sec 10 = shutter value 1/25 Sec or 1/30 Sec 11 = shutter value 1/12.5 Sec or 1/15 Sec
	[6]	Mains frequency: 0=50Hz 1= 60Hz.
	[8:7]	AEX control speed: 00 = slow 01 = moderate (default) 10 = fast 11 = very fast
	[11:9]	AEX stability. The mix of Luminance of the old level and the new level. 000 = current Luminance frame value 001 = 1/2 Luminance value1/2 old Luminance value 010 = 1/4 Luminance value 3/4 old Luminance value 011 = 1/8 Luminance value 7/8 old Luminance value 100 = 1/16 Luminance value 15/16 old Luminance value 101 = 1/32 Luminance value 31/32 old Luminance value 110 =1/64 Luminance value 63/64 old Luminance value 111 = 1/128 Luminance value 127/128 old Luminance value
	[12]	0=gamma 0.45, 1= gamma 1
	[13]	0=auto gain, 1=manual gain (reg 7=manual gain value)(1)
	[15:14]	Resolution selection 00 = SXGA 01 = VGA 10 = SVGA 11 = SIF

(1) if manual gain is selected shutter is fixed. If Auto shutter is selected it will go to max integration time. If a fixed shutter mode is selected this shutter time will be active.

When the camera is put in a fixed shutter mode the camera can still run in auto gain mode. This means that the gain will try to compensate the video level when the signal is higher or lower than the reference. This mode is also used when the electronic lens control with fixed shutter is selected.
When the camera is put in a fixed gain mode the camera will automatically select a fixed shutter speed of 1/12.5 or 1/15 sec.

5.3. Gamma Function:

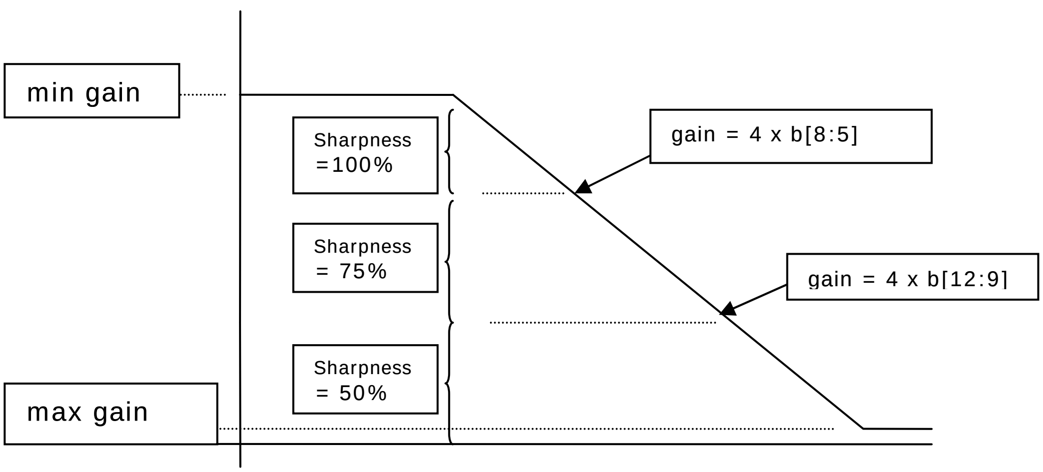
Gamma function corrects the non-linear behaviour of the CRT monitor (note that most TFT monitors also require gamma correction). The gamma curve of the camera is default 0.45. With this gamma setting the monitor is able to display the scene to get a so optimal natural impression.

However, if the camera video signal is processed for pattern recognition this gamma function may not be desirable. To make this adjustment, the 24C13DIG has a gamma option that can be selected via the software serial interface.
Gamma is controlled via register 0x01 bit[12].

5.4. Edge Enhancement

Edge enhancement will increase the sharpness impression of the camera. As downside of this it will accentuate the noise at lower light conditions. For this reason we have to set several parameters to get an optimal working edge enhancement feature.
To do this we use register 0x01 as shown in the table below:

register	Data bits	Function: default 0x106b
0x01	B[2:0]	Max edge enhancement
	B[3]	Auto edge correction on/off on=1
	B[4]	Clip small apertures to reduce noise.
	B[8:5]	If gain < 4x(b[8:5]) edge enhancement 100%
	B[12:9]	If 4x(b[8:5])>gain>4x(b[12:9]) edge enhancement 75% If gain>4x(b[12:9]) edge enhancement 50%
	B[15:13]	Not used yet

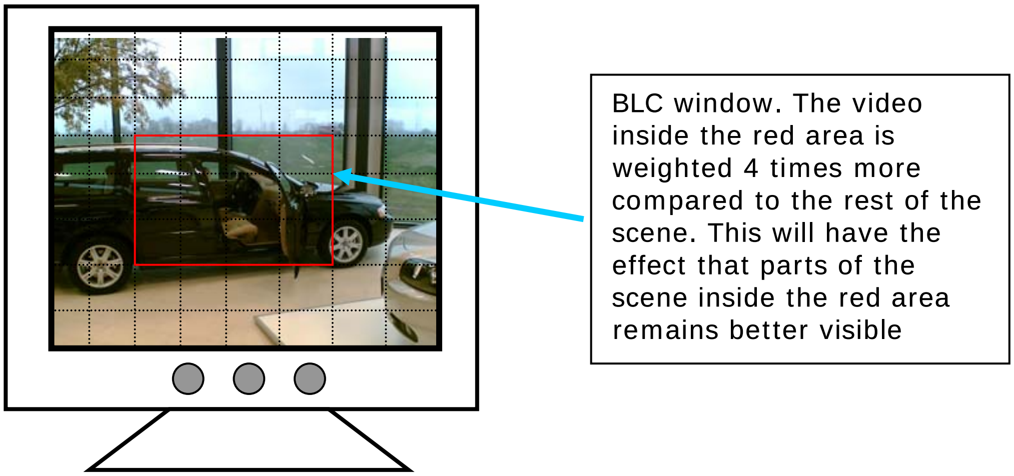


5.5. Back Light Compensation

The camera has a default setting of standard back light compensation (BLC) off. This means that for the electronic iris circuit only the main part of the scene is taken into account to determine the level of the sensor output (see figure). When fixed shutter speeds are used this function has only effect on the gain level.

Sometimes it may be required that the complete image should be used to determine the sensor output level. This function can be addressed via register 0x02h bit 15. When this bit is set (=1) means the BLC function is on.

The image of the camera is divided in 64 blocks (8H x 8V). These blocks can be used to determine the BLC window. Please note that only one window can set, and this window should be a rectangle or a square.

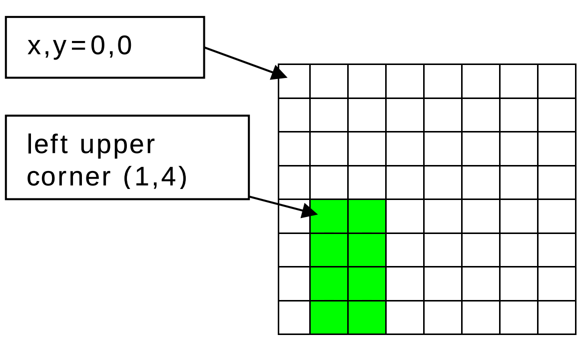


The size of the window can be set via the lowest 6 bits of register 0x02. The lowest 3 bits determine the H size. Note that the size is b[2:0] +1. Bits[5:3] are giving the V-size by its value +1 again. The position is given in H direction by the bits[8:6] and in V direction by the bits[11:9]. Note that the H and V position point to the upper left block of the window.
The weighting factor is four. This means that the video in the window is weighted 4 times more than the area outside the window.

register	Data bits	Function: default 0x8492
0x02	B[2:0]	Size of window horizontal: size = value + 1
	B[5:3]	Size of window vertical: size = value + 1
	B[8:6]	Horz pos upper left corner window. pos = value
	B[11:9]	Vert pos upper left corner window. pos = value
	B[12]	Not used
	B[13]	Display BLC window in video. if 1= window is visible
	B[14]	If set there is no weight factor. Only the window is used for AEX, not the rest of the image!
	B[15]	BLC on/off. on=1, off = 0.

example: value of register 0x02= 0x8859

- b[15]→ BLC is on.
- b[2:0]→ horizontal size= value + 1= 1+1=2. So the window has a width of 1 block.
- b[5:3]→ vertical size = value +1 = 3+1=4. The window is 4 blocks high.
- b[8:6]→ pos horizontal left upper corner: value= 1
- b[11:9]→pos vertical left upper corner: value=4



5.6. White Balance

The white balance correction in the 24C13 has 3 different modes. One is the fully automatic world under the “world is gray” concept (simple mode). This means that all information in the scene is used to determine the correct RG gain values (and the corresponding color correction matrix).

The second mode is also automatic. This will not use the strongly saturated color area’s of the scene, this is a more a real world mode.

The third one is the manual mode. In this mode the user determines manual the color values for blue and red and if required also the matrix values.
With register 0x01 these modes can be set.

White Balance Modes:

register	Data bits	Function: default 0x612
0x03	B[1:0]	00 = Wb manual mode, 01 = Auto simple mode, 10 = Auto high end mode, 11 = Freeze mode
	B[2]	Freeze wb: while b[2]=1 do awb, till it turns to 0. at this moment these settings will be used and stored.
	B[6:4]	Step size wb correction: 000: current gain = new gain 001: current gain = ½ new+ ½ old gain 010: current gain = ¼ new + ¾ old gain 011: current gain = 1/8 new + 7/8 old gain 100: current gain = 1/16 new + 15/16 old gain 101: current gain = 1/32 new + 31/32 old gain 110: current gain = 1/64 new + 63/64 old gain 111: current gain = 1/128 new + 127/128 old gain
	B[9:7]	AWB stability level (set to avoid overshoot) 000= high stability 111= low stability (fast).
	B[12:10]	Color attenuation High Luminance (will be done linear to level 224 for no color): 000: no attenuation 001: attenuation starts at 0xf0 010: attenuation starts at 0xeb 011: attenuation starts at 0xe7 100: attenuation starts at 0xe3 101: attenuation starts at 0xdf
	B[15:13]	Color saturation level: 000= full saturation 001=75% sat 010=50% sat 011=37.5 sat 100=25% sat 101=150%sat 110=b/w

Fixed gain values for R-gain and B-gain when the camera operates in the fixed WB-mode:

register	Data bits	Function: Default 0x8080
0x04	B[7:0]	Fixed Red gain (only valid if camera is in fixed WB mode)
	B[15:8]	Fixed Blue gain(only valid if camera is in fixed WB mode)

Color matrix selection:

register	Data Bits	Function: Default0x02d
0x05	B[6:0]	Matrix position in fixed wb mode: • data 0x7f= outdoor light (>5600K) • data 0x2d= fluorescent light (4800 K) • data 0x00 = indoor light (3200 K)

5.7. Low Light Color Attenuation

At low light the noise will increase due to the fact that the gain will increase. Beside the luminance signal also the colors are amplified. This will result in a relative low frequency color noise. This noise has no added value for the image and will only increase the amount changing data. This will have a negative effect on eventual compression algorithms.

Therefore the 24C13 has the feature to reduce to amount of color signal at the moment the gain increases. For this function the start point (from were the color kill starts) must be set as well the gain factor (how fast the color will be reduced). The attenuation points for low light are the same as those of the edge enhancement paragraph (5.3). They need to be set via register 0x03.

Via register 0x06 b[12] the Low light color attenuation can be enabled. Further the type of gain that will be used for the color attenuation. The gain selection can be done for both points on the gain curve (see paragraph 5.3).
The last item that can be set is the gain level from were no changes to the matrix will be made anymore. This because signal levels will become to small so that a reliable control is not possible anymore.

register	Data bits	Function: default 0x1040
0x06	B[7:0]	Gain threshold to disable the color correction matrix function
	B[9:8]	Select gain type for automatic saturation control 00=Virtual analog gain 01=ADC Vref_lo 10=Digital gain 11=LC digital gain
	B[11:10]	Select gain type for automatic saturation control 00=Virtual analog gain 01=ADC Vref_lo 10=Digital gain 11=LC digital gain
	B[12]	1=enable automatic low light color saturation control

5.8. Auto Gain and Manual Gain

The camera has an automatic gain control in default mode. This function assures that the output signal remains constant at a certain level. This control circuit works with an integrator. The average signal is compared with an internal reference and depending on the outcome of the gain will increase or decrease.

However for some application it is required that the AGC is overruled by a fix gain level. This mode we call the manual gain control.

register	Data bits	Function default 0x0000
0x07	B[7:0]	Manual gain level

The manual gain has a range from 0db (b[7:0]=00) to 18 dB (b[7:0]=0xff). The gain is linear.

5.8.1. Auto Gain Settings

Sometimes it is required to limit the Auto gain range either at the max or minimal gain level. With register 0x09 the gain limits for the auto mode can be set.

Register	Data bits	Function default 0x7810
0x09	B[7:0]	Minimal gain value for the AGC
	B[15:8]	Maximal gain value for the AGC

The value of register 0x09 is copied direct to sensor register 0x236.

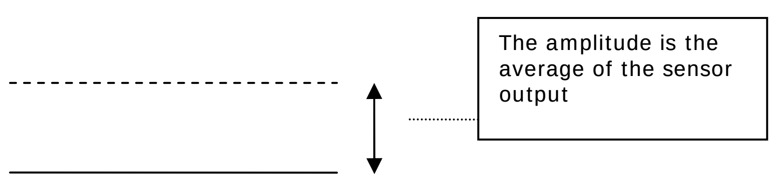
5.9. Mirror and Flip Function

The camera has the possibility to flip the image in horizontal direction (mirror) and vertical direction. This is controlled by register 0x08.

register	Data bits	Function default 0x0000
0x08	B[0]	Flip (vertical) 0=normal, 1=flipped.
	B[1]	Mirror (horizontal) 0=normal, 1=mirror
	B[4:3]	Stop processing during V-blanking of iris signal. When b[3]=1, there will be no iris signal processing after power up of the camera, until a ‘0’ is written in b[4]. If there is a b[4:3] are loaded with 11, there will also be no iris signal processing, this means the iris signal level will stay as it is currently, even when the scene or illumination will change.
	B[13:12] Read only in iris signal mode	Iris signal indication bits, 01= signal to small 10= signal ok 11= signal to large
	B[14]	Iris signal mode (0= standard, 1 = special mode)
	B[15]	If set switch on auto iris lens adjustment tool.

5.10. Iris Output Signal

The camera features also an created analogue iris output signal. This signal is not as normal iris signals a kind of analogue video signal. This signal has already the integration done of the video. This signal is purely a DC signal. It’s amplitude is reversed iow the higher the sensor signal is, the lower the iris output signal. The iris signal will look as in the figure below.



analog iris output signal

The signal level can be changed by an offset. This offset is stored in the EEprom 0xae/0xaf .

The level is stored in register 0xe0. A change of this value will only be active after a new power up of the camera.

In the past analogue cameras had a potentiometer to control the level of the iris signal, to drive a passive iris lens further open or close it. The 24C1.3xDIG has a feature to control the level of the iris signal via software.

register	Data bits	Function default 0x0880
0x0a	B[7:0]	Relative iris level (decrease iris level)
	B[11:9]	Selection of fixed shutter value in auto-iris signal mode 1 (bits[3:2] command register 0x00 are 01

If the value in register 0x0a[7:0] is 0xff (256) the max iris level signal is reached.

If the value is smaller the output of the will decrease with the factor→ value reg 0x0a/0xff.

5.10.1. Iris Output Signal Standard

For most circumstances were a lot of light condition changes take place it is adviced to use the standard mode. This is the most stable mode, and is relative easy to adjust. See paragraph 5.10.1 for the alignment of the lens.

Note that it is recommend to use an iris gain of lower than 0x40 (register 0x0a), this to avoid instability due to a to large loop gain.

5.10.2. Iris Output Signal Special Mode

In case the camera is operated in a rather constant or slow changing light condition environment, this special mode can be used. The major difference is that the lens can be controlled more precise and also lower levels can be achieved. However at large light changes the lens requires a longer time to reach it's stable condition.

In this mode the lens <u>must</u> be aligned as described in paragraph 5.10.1.

5.10.3. Fixed Shutter Value in Iris Signal Mode

Via the highest byte of register 0x0a one of the 8 fixed shutter speeds can be selected.
If a change is made to the highest byte of command register 0x0a, also command register 0x00 must be reloaded to activate the new shutter speed. In the following table the selected shutter speed can be found:

Value b[15:8]	Fixed shutter speed (sec) 50-60 Hz
0x00	1/100 - 1/120
0x01	1/100 - 1/120
0x02	1/50 - 1/60
0x03	3/100 - 1/40
0x04	1/25 - 1/30
0x05	1/20 - 1/24
0x06	3/50 - 1/20
0x07	7/100 - 7/120
0x08	1/12.5 - 1/15
>0x08	1/12.5 - 1/15

After changing register 0x0a (highest byte) you must reload command register 0x00 to activate the new shutter value.

This fixed shutter value can only be used when the camera is set to the first iris signal mode (command register 0x00[3:2] must be 01!)

5.10.4. Reading Gain and Shutter Value (only for 24C1.3xDIG/500)

To be able to read the current shutter and gain values command 0x0b can be used.

register	Data bits	Function default : Read Only
0x0b	B[7:0]	Actual gain value
READ ONLY!!	B[15:8]	Actual shutter zone value.

In the table below there is an overview were the readings are translated in shutter times:

Value bits[15:8]	Shutter time 50 Hz	Shutter time 60 Hz
0	<1/100 sec	< 1/120 sec
1	1/100 sec	1/120 sec
2	1/50 sec	1/60 sec
3	3/100 sec	1/40 sec
4	1/25 sec	1/30 sec
5	1/20 sec	1/24 sec
6	3/50 sec	1/20 sec
7	7/100 sec	7/120 sec
8	1/12.5 sec	1/15 sec

5.11. **Writing to Camera eeprom** (only for 24C1.3xDIG/500)

To changes some fixed settings it is required to be able to write to the camera's EEPROM.

This is done by replacing the command number/register by the write address of the Eeprom page (0xa8, 0xaa, 0xac or 0xae). The third byte is the register address of the EEProm that needs to be changed and the last (fourth) byte is the required data. So a write string would look like:

<start><0x78>A<example: 0xae>A<register: 0xe0>A<data>A<stop>.

Note it is only possible to write 1 byte at the time! Also a changed Eeprom setting cannot be recovered by pressing a reset option or so. So please be very careful using this option.

5.12. Contrast and Brightness Control

To allow to fine tune the camera's output signal to a large variety of monitors the camera is equipped with a contrast and a brightness control.

For the contrast control it is advised not to use values outside the range of 0x40-0xb0 (0x80 is default).

For the brightness control the value is protected and will not go below 0x10. This means if the user loads a value below 0x10, the loaded value in the sensor will be 0x10.

register	Data bits	Function default : 0x8020
0x0d	B[7-0]	Brightness control
	B[15-8]	Contrast control

5.13. Reset and Software Version

The software revision of the camera can be read back by sending a read command to:

- For 24C1.3xDIG: register 0x0e.
- For 24C1.3xDIG.500: register 0x0c.

This same register has for the 24C1.3DIG (only) a double function. By writing the following code to the camera will restart the camera (soft reset): 0x6a95.

6. Software Control

The camera has a serial control interface via three wires:

- Data wire
- Clock wire
- Ground wire

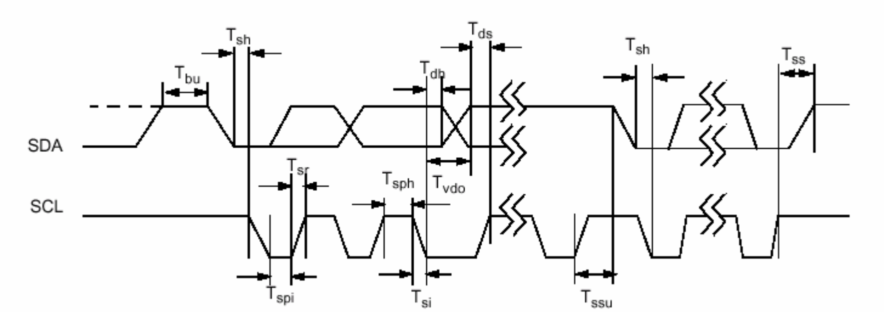
This interface operates similar as to the I^2C-protocol.

Data, address and registers are all 8-bit words. The timing is shown in the figure below. The maximum speed limitation is 100kHz. The minimum speed should be higher than 1KHz.

The write action to the EEPROM needs to be done with a delay time between the write actions of at least 10msec. This is due to fact the data needs to be stored after is has been received. This takes a short time.

A wait time is further required between commands, so that the internal communication has the time to make the required internal communication. The delay time between the commands should be at least 40msec (since with most commands an EEPROM write action is involved).

Note that some commands require some additional communication after 500mS.



6.1. Communication Timing

6.1.1. 24C1.3xDIG:

I^2C timing basic freq=100KHz				
name		**unit**	**min**	**max**
T_{bu}	High stable period data	us	4	
T_{sh}	Start hold time	us	2.5	
T_{db}	Data hold time	us	1	
T_{ds}	Data stable time rising clock	us	1.5	
T_{ss}	Stop time	us	2.5	
T_{sr}	Rising time clock			0.5
T_{sph}	Clock high period	us	4.2	
T_{spi}	Clock low period		4.2	
T_{si}	Faling time clock			0.5
T_{ssu}				
F_{clk}	Clock frequency	KHz	1	110

I^2C address camera: 0x7a/7b
The communication-structure is the standard I2C protocol with 16 bits data.

6.1.2. 24C1.38DIG/500:

I^2C timing basic freq=75KHz				
name		**unit**	**min**	**max**
T_{bu}	High stable period data	us	5.53	
T_{sh}	Start hold time	us	3.33	
T_{db}	Data hold time	us	1.5	
T_{ds}	Data stable time rising clock	us	1.75	
T_{ss}	Stop time	us	3.4	
T_{sr}	Rising time clock			0.8
T_{sph}	Clock high period	us	5.5	
T_{spi}	Clock low period		5.5	
T_{si}	Faling time clock			0.8
T_{ssu}				
F_{clk}	Clock frequency	KHz	1	80

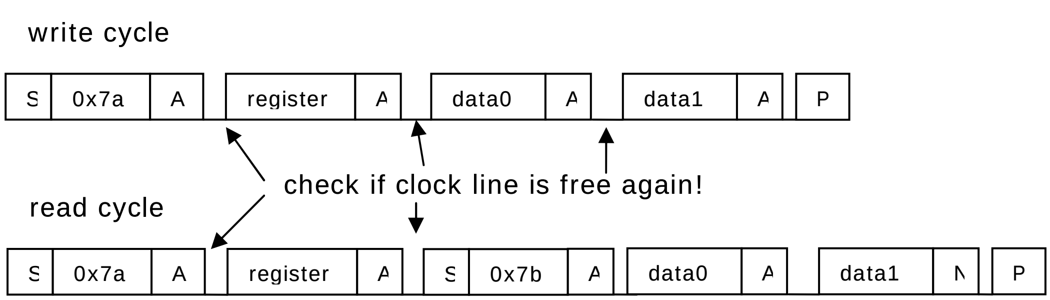
I^2C address camera: 0x7a/7b
The communication-structure is the standard I2C protocol with 16 bits data.

Cam_address	Sensor address	EEPROM
0x7a (write) and 0x7b(read)	0xba (write) and 0xbb(read)	0xa8-aa-ac-ae (write) and 0xa9-ab-ad-af (read)

write string:
<START> < addressW>ackn<register>ackn <data1>ackn<data2>ackn <STOP>

Read string:
<START> < addressW>ackn<register>ackn<addressR>ackn<start><data1>ackn <data2>Nackn <STOP>

When the camera is addressed via its write or read address it will generate acknowledges. After an acknowledge from the camera the master/host who is addressing the camera should check if the clock line is free again as being a sign that the camera is ready to receive more data. This checking should take place after each acknowledge or not-acknowledge. This is part of the standard I2C specification.



6.2. Camera Configuration

The device addresses have two values, one for read, and one for a write action. The difference is that the last bit (LSB) is set to ***1***. For communication, the following device addresses are available:

Device	Device write	Device read
EEPROM page 1	0xa8	0xa9
EEPROM page 2	0xaa	0xab
EEPROM page 3	0xac	0xad
EEPROM page 4	0xae	0xaf
Sensor	0xba	0xbb

Table 1. Device addresses

Note: In the 24c1.38DIG/500 these devices above in table 1 are not addressable!

6.3. I^2C Address

The camera has an extra I^2C address, which can be programmed so that more than one camera can be connected to I^2C bus. **The camera has address 0x7a/0x7b.**

6.4. EEprom Map

The camera has an 8K EEprom. The 8K are spread over 4 pages of each 256 bytes (2Kbits). The first 3 pages are/can be used for default camera settings.

6.4.1. The Fourth Page

The fourth page is used for the features. The registers 0x00 to 0x16 are used to store the functions as described above. Since the functions have 2 bytes data each function needs two memory places. The order of storage is identical with the order of command register numbers. To find the correct position in the EEPROM multiply the command register number by two. This will give you the highest of the two bytes.

Registers 0xc0-0xdf contain the values for the different timing modes. Registers 0xc0-0xcf are for 50Hz environments, 0xd0-0xdf are for 60 Hz.

On register 0xe0 the low value of the iris signal is stored. This is the value during the blanking.

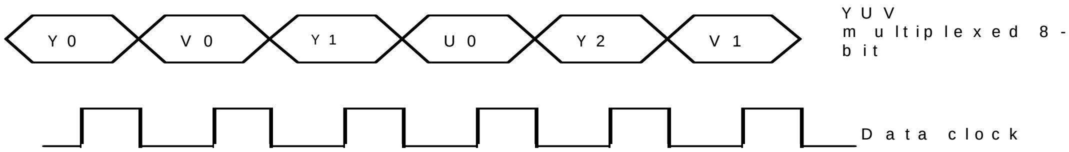
Registers 0xe1-0xec contains the gamma 0.45 table, 0xed-0xf8 contains the gamma=1 table.

Register 0xf9 and 0xfa stores the AEX reference value. Register 0xf9 stores the hysteresis window for the AEX function. 0xfa stores the real AEX target value.

Register 0xfb can stop the complete command structure. By loading the value 0xBA in this register, the camera will not listen to the I2C address any more and also the command settings will not be loaded at start up.

7. The Digital Output Format

The 8-bit data format is shown in the figure below:



YUV CCIR656 4:2:2

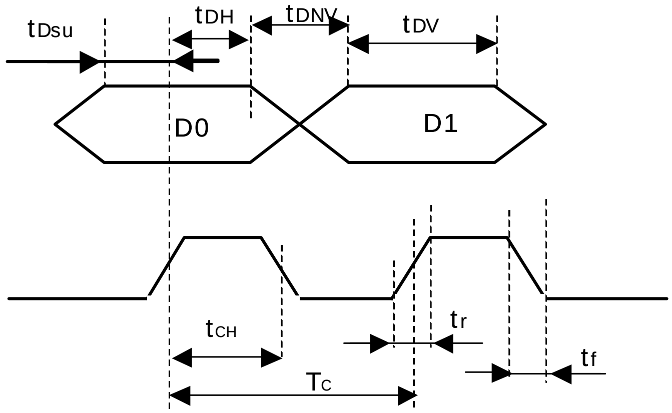
Note that the camera can offer two additional bits (lower). So the total data has is 10 bits wide. See also the connector pin out.

7.1. Timing

The camera data clock tolerance is 50ppm. A crystal with the same tolerance is used to generate the camera timing. The data clock frequency is:

TV-standard	Nominal frequency	Tolerance +/-
na	54000000 Hz (54.0 Mhz)	1200 Hz

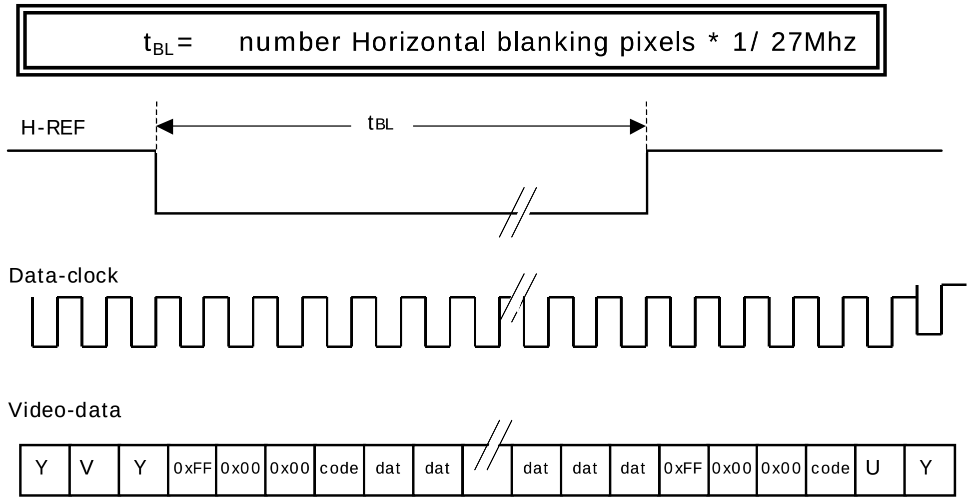
The timing is shown in figure below:



Pixel Timing

Item	Description	24C13xDIG	
		min(ns)	max(ns)
T_C	Clock period	18.517	18.519
t_{CH}	Clock high time	7	11
t_r	Rise time		3
t_f	Fall time		3
t_{Dsu}	Data setup	9	
t_{DH}	Data Hold	10	
t_{DNV}	Data not valid		6
t_{DV}	Data valid	8	

The timing relationship between HREF, pixel clock and synchronization data is shown in the figure below:



Pixel sequence during the horizontal blanking (8-bit format)

The synchronization code is a combination of 4 bytes. The first three bytes are always the same. The sequence is [0xFF], [0x00] and [0x00]. The values 0xFF and 0x00 will not occur in the normal video. The fourth byte gives the synchronization position. It makes use of 3 different signals: FIELD, VD and HD. The last 4 bits contain a protection code to check if an error occurred during the transfer of this position code's byte.

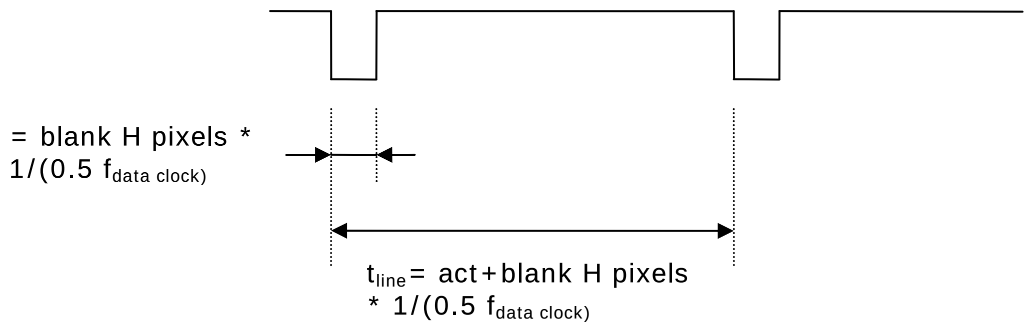
Function	**Bit 7:**	**Bit 6: FIELD**	**Bit 5: VD**	**Bit 4: HD**	**Bit 3: P3**	**Bit 2: P2**	**Bit 1: P1**	**Bit 0: P0**
0	1	0	0	0	0	0	0	0
1	1	0	0	1	1	1	0	1
2	1	0	1	0	1	0	1	1
3	1	0	1	1	0	1	1	0
4	1	1	0	0	0	1	1	1
5	1	1	0	1	1	0	1	0
6	1	1	1	0	1	1	0	0
7	1	1	1	1	0	0	0	1

*** Please note: The **HREF** pulse is **Negative** going polarity
The **VREF** pulse in **positive** going polarity

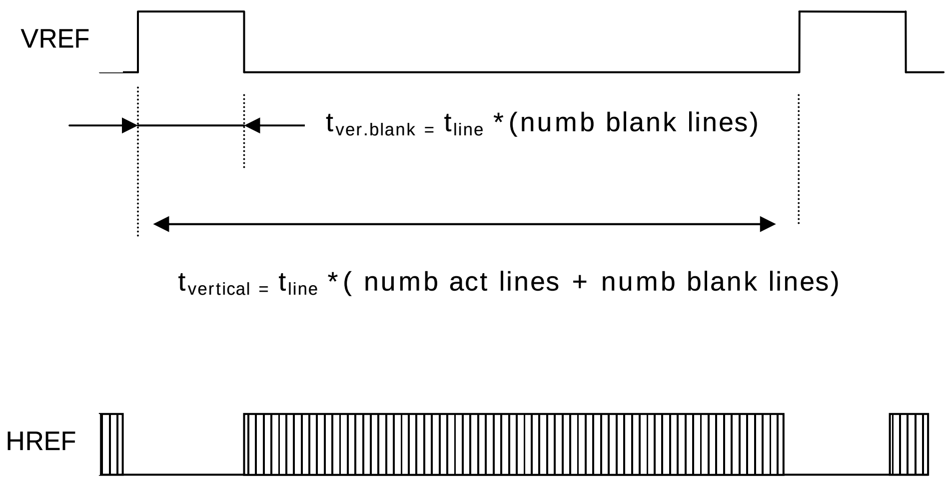
7.2. Horizontal and Vertical Synchronization

The camera has two independent synchronization signals in the digital format.

- One sync signal is HREF. HREF is a negative oriented pulse, which means that the pulse is low during the horizontal blanking period. Note that during the vertical blanking the HREF signal is low.
- The other sync signal is VREF. VREF is a positive oriented pulse, which means that it is high during the vertical blanking period. VREF also indicates the vertical period when video is not active.



HREF signal



8. Connector

The camera has a board-to-board connector (J1) to make interconnections as easy as possible.

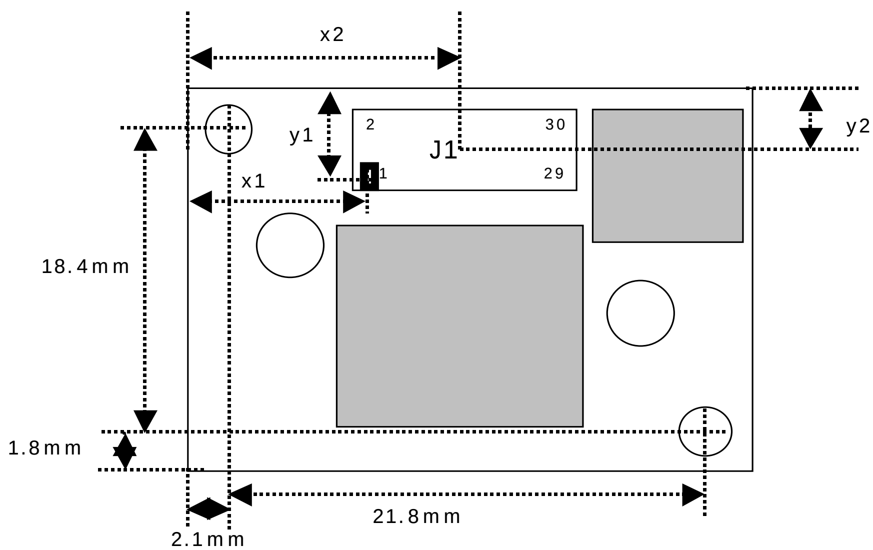
8.1. Board-to-Board Connector J1

This connector is by Molex with type number: MOLEX-52991-0308 (Female). The mating part is MOLEX-50192-03001 (Male), and must be used on the application side.

The connector is 30-pole and the pin out can be found in the table below:

Pin number	Function	Pin number	Function
1	GROUND	16	nc
2	GROUND	17	YUV7 CCIR656 4:2:2
3	YUV0 CCIR656 4:2:2	18	nc
4	LSB0 (additional bit 10 bits)*	19	Data Clock
5	YUV1 CCIR656	20	IR-filter control switch
6	LSB1 (additional bit 10 bits)*	21	iris out
7	YUV2 CCIR656 4:2:2	22	GROUND
8	nc	23	HREF
9	YUV3 CCIR656 4:2:2	24	VREF
10	nc	25	**DO NOT CONNECT!**
11	YUV4 CCIR656 4:2:2	26	**DO NOT CONNECT!**
12	nc	27	I^2C data
13	YUV5 CCIR656 4:2:2	28	I^2C clock
14	nc	29	nc
15	YUV6 CCIR656 4:2:2	30	+5V power supply in

*note *these pins can move to an other position in later redesigns!*



Camera Backside

X1 = 8.65mm
Y1 = 4.75mm
X2 = 12.2mm
Y2 = 3.0mm

9. Contact Information

For technical assistance with this product, please contact the supplier from whom the product was purchased.

For OEM inquiries, contact Videology Imaging Solutions:

North/South America	Europe
Videology Imaging Solutions Inc. 37M Lark Industrial Parkway Greenville, RI 02828 USA Tel: (401) 949-5332 Fax: (401) 949-5276	Videology Imaging Solutions Europe Neutronenlaan 4 NL-5405 NH Uden, Netherlands Tel: +31 (0) 413 256 261 Fax: +31 (0) 413 251 712

Please visit our WEB-site at: http://www.videologyinc.com/

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