Vision Components

The Smart Camera People

VCSBC4018 Hardware and Programming manual

Hardware Specifications and additional VCRT Functions for VCSBC50 Cameras

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Foreword and Disclaimer

This documentation has been prepared with most possible care. However Vision Components GmbH does not take any liability for possible errors. In the interest of progress, Vision Components GmbH reserves the right to perform technical changes without further notice.

Please notify support@vision-components.com if you become aware of any errors in this manual or if a certain topic requires more detailed documentation.

This manual is intended for information of Vision Component's only. Any publication of this document or parts thereof requires written permission by Vision Components GmbH.

References

Since the VCSBC4018 employs a TI processor the programming environment and functions for the VC20XX cameras can be used for this camera (except video functions). This manual only lists the additional SW functions available for this camera.

Please also consult the following resources for further reference:

Type of resource	Name of file	Download location www.vision-comp.com
SW manual OS functions	VCRT5.pdf	Support->Reg. User Area->SW Manuals
SW manual Image Processing Functions	VCLIB_2_0.pdf VCLIB_300.pdf	Support->Reg. User Area->SW Manuals
Installation Manual	InstallVC20XX VC40XX	Support->Customer Area->Getting Started VC20XX …
Programming Tutorial Basic	Programming Tutorial for VC20XX and VC40XX Cameras	Support->Customer Area->Getting Started VC20XX …
Demontration Source code	Demofiles VC20XX+VC40XX …	Support->Customer Area->Demo Code

The Light bulb highlights hints and ideas that may be helpful for a development.

This warning sign alerts of possible pitfalls to avoid. Please pay careful attention to sections marked with this sign.

Table of Contents

1 General Information

VCSBC4018 Single Board Camera with detached head

VCSBC4018 Single Board Camera with mounted head (standard delivery)

The **VCSBC4018** is one of the fastest Smart Cameras on the market – designed for demanding OEM applications. The computational power of 3200 MIPS on a 60 by 80mm circuit board is equal to a 2.6 GHZ Pentium PC. The VCSBC4018 includes 16 MB DRAM and a 2 MB Flash EPROM for non-volatile program and data storage. The VCSBC4018 and can acquire full frame VGA images at 32 frames per second (progressive scan).

Like with all VC Smart Cameras with Texas Instruments DSP, the operation system VCRT allows multi- tasking. This means for instance that user interface commands can execute in parallel without stopping the inspection process. It is also possible to transfer live images via TCP/IP using a background task.

Whereas a standard progressive scan camera gets a trigger, starts exposure and then reads out the pixel data, the VCSBC4018 has optimized the image acquisition process so that exposure, image transfer into memory and image processing can be done in parallel. This means if exposure time and image processing time is not longer than the transfer time of around 31msec, the full frame rate can be maintained.

The VCSBC4018 offers an inexpensive entrance into the world of the high performance intelligent cameras. It has a video output onto a PC via 100MBit Ethernet interface, a high speed trigger input and output, 12-24 V digital IOs, additional TTL IOs and an illumination controller.

2 Basic Structure

The image is formed by a high-resolution progressive scan CCD sensor. One channel of video input is digitized. The image is stored in SDRAM memory using one of the 64 DMA channels (EDMA).

Unlike most other Vision Component Smart Cameras, the VCSBC4018 does not have a direct video output. However if monitoring of the camera image is required, this can be done by downloading via Fast Ethernet port to PC and display on screen (see "Image Transfer" demo software under "Support -> Customer Area -> Software Utilities").

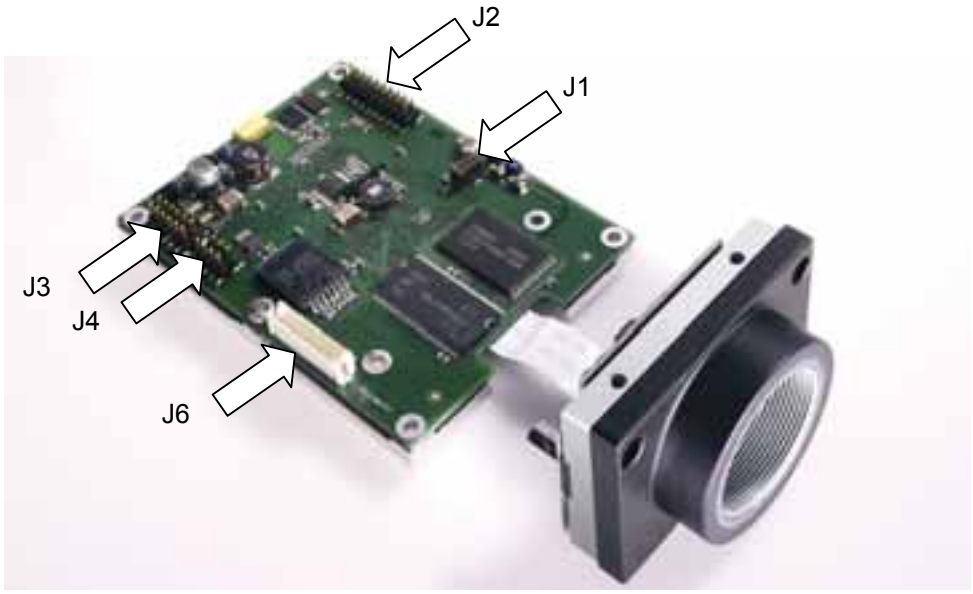
The TMS320C64xx DSP is one of the fastest 32bit DSPs. It features a RISC-like instruction set, up to 8 instructions can be executed in parallel, two L1 cache memories (16 Kbytes each) and a 128 Kbytes L2 cache on chip. Its high speed 64-channel DMA controller gives additional performance. The DSP uses fast external SDRAM as main memory. A flash EPROM provides non-volatile memory.

See Appendix A: Block diagram VCSBC4018

3 Technical Specifications VCSBC4018

Component / Feature	Specification
CCD Sensor:	1/3" SONY ICX424AL
eff. no. of pixels:	640(H) x 480(V)
Pixel size:	7.4(H) x 7.4(V) µm
Chip size:	5.79(H) x 4.89(V) mm
High-speed shutter:	33.3, 95.7, 158.1 microseconds, increasing with steps of 62.4 microseconds (full-frame shutter)
Low-speed shutter:	up to 2 sec. adjustable integration time
Integration:	full-frame
Picture taking:	program-controlled, trigger controlled (interrupt); full-frame / 32 frames per second, **external high speed trigger**
Clamping:	zero offset digital clamping
A/D conversion:	12.5 MHz / 10 bit,
Input LUT	none
Image Display	Via 100 Mbit Ethernet onto PC
Processor:	Texas Instruments TMS320C64XX signal processor 400 MHz, 3200MIPS
RAM:	16 Mbytes SDRAM (synchronous dynamic RAM)
Memory capacity:	40 full-size images in format 640x480
Flash EPROM:	2 Mbytes flash EPROM (nonvolatile memory) for programs and data, in-system programmable, 1 MB available to user
MMC:	Not available
Process interface:	2 inputs / 4 outputs, outputs 4x400 mA
Additional LVTTL IOs:	4 Inputs, 4 Outputs, I2C Clock and Data outputs
Illumination Controller:	Illumination Enable LVTT output, Duration / Boost LVTTL output
Ethernet interface:	100 Mbit
CE certification:	No CE Certification from Vision Components as the OEM customer is required to certify entire system (including housing, cabling, etc.).

4 Camera Interfaces



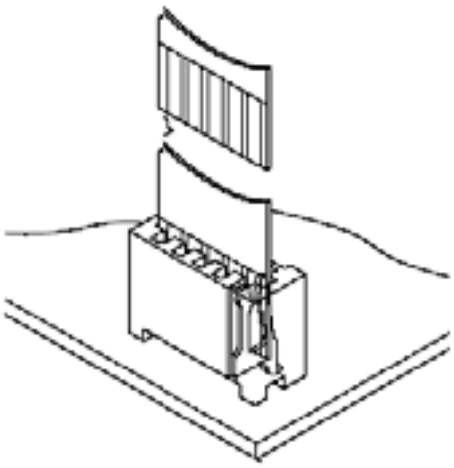
The VCSBC4018 camera board incorporates the following connector interfaces:

J 1 : Illumination Connector
J 2: Expansion Port Connector
J 3: VCSBC4018/ VCSBC50 Power and IO Connector[1]
J 4: Ethernet Connector
J 6: Emulator Connector

The pin assignments, electrical specifications as well as available accessories are shown for each interface connector in the following sections:

[1] Deviating from the image, the VCSBC4018 is now shipped with a wall plug with center polarization slot.

4.1 J1 : Illumination Interface



Pin Locations

Blank side of ribbon cable

4	3	2	1

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Isolated side of ribbon cable

4.1.1 Pin Assignments J1 camera socket

Pin	Signal
1	GND
2	+3.3V out
3	Illumination Enable, LVTTL
4	Duration / Boost LVTTL

4.1.2 Electrical specifications J1 camera socket

- Output Voltage on Pin 2 is filtered but not regulated. Maximum current 100 mA.
- Outputs Pin 3 and 4 are Cmos low level TTL signals, intended to switch the illumination.

In exposure controlled mode (default) the “Illumination Enable” output high during exposure. Trig_out, pin 16, connector J2 is high at the same time, so controlling an external light source can be done using either output.

-

Caution: Do not reverse the flat cable connected to this socket!

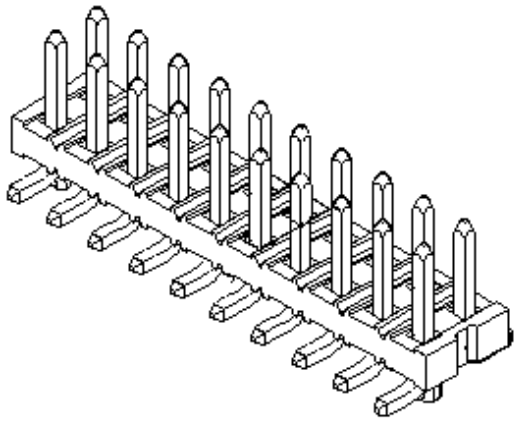
4.1.3 Available accessories for this J1 camera socket

Part number of the J1 socket: 04FM-1.0BP-TF , manufactured by JST (www.jst.com)
The matching flat cable (at 38mm length) for this connector can be ordered from Vision Components:
Order number: Ek000377

4.2 J2: Expansion Port / Trigger Interface

4.2.1 Pin Assignments J2 camera socket

Pin Number	Signal
1	Q00
2	Q01
3	Q02
4	Q03
5	GND
6	GND
7	I00
8	I01
9	I02
10	I03
11	I2C_Clock
12	I2C_Data
13	NC
14	NC
15	Trig_in
16	Trig_out
17	NC
18	NC
19	Vcc (3.3V)
20	GND



Pin Locations

2	4	6	8	10	12	14	16	18	20
1	3	5	7	9	11	13	15	17	19

▽

Q00 – Q03	digital LVTTL outputs
I00 – I03:	Digital LVTTL input (without pull-up resistor)
Vcc	3.3V board main voltage, Imax = 100mA
I2C_Clock and I2C_Data	I2C serial Bus Interface for additional peripherals (Refer to the Texas Instruments documentation for further details)
Trig_in and Trig_out 	Same electrical specification as with the VC20xx camera series. However both – Trig_in and Trig_out – are not opto isolated, so special care must be taken or Isolation has to be done externally!

In exposure controlled mode (default) the trigger output is high during exposure.

4.2.2 Electrical specifications J2 camera socket

All Signals are Low Level TTL (3.3V), not opto isolated.

The following Signals have a 4k7 resistor on board:

- I2C_Clock
- I2C_Data
- Trig_in

Trigger IO Specifications:

The board features a dedicated fast TTL trigger input (for use as image capture trigger) and a fast TTL trigger output (as strobe-light trigger). Since both signals are fast at a very low noise margin, it is recommended to keep the cable as short as possible. Use twisted pair or even coaxial cable for this purpose. The trigger input and output are not galvanically separated. The connected circuits should, therefore provide galvanic isolation.

Please note that input and output are not protected against over current. The output is neither protected against short circuit nor reverse voltage spikes from inductive loads.
Trigger input assures constant delay without jitter.

Electrical Specification of trigger input:

input voltage:	3-5 V (TTL, CMOS)
input current:	5mA @ 3V / 11mA @ 5V
limiting resistor:	built in, 330 Ohm
knee voltage:	1.5 V
reverse voltage protection:	shunt diode
switching delay:	max. 2µsec + interrupt latency

Electrical Specification of trigger output:

output voltage:	max. 7V
output current:	max. 50mA
pull-up resistor:	none, external resistor required

Caution: Place the connectors at the correct position – not reversed or shifted. The position of Pin 1 for each connector is marked in Appendix C: Drawing Circuit Board VCSBC4018.

4.2.3 Matching connector and cable for J2 camera socket

The socket J2 has the following part number: 8775967-2050, manufacturer Molex (www.molex.com)
The matching connector has the following part number: 51110-2050

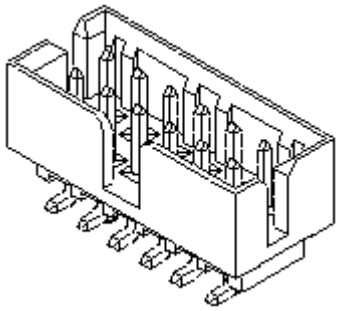
Vision Components does not currently manufacture a cable for this connector. Please order the matching connector from the manufacturer Molex.

4.3 J3: Power Supply and IO Interface

The J3 connector includes the camera power supply and the digital IOs.

4.3.1 Pin Assignments J3 camera socket

Pin Number	Signal
1	Out0
2	Power (24V)
3	Out1
4	Power GND
5	Out2
6	NC
7	Out3
8	GND
9	In0
10	NC
11	In1
12	GND



J3 Standard VCSBC4018 socket:
Molex: 8783212-20 with center polarization slot (different to camera images in this manual!)

Pin Locations

2	4	6	8	10	12
1	3	5	7	9	11

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4.3.2 Electrical specifications digital IO s J3 interface

The camera has two optically decoupled inputs and four decoupled outputs for controlling machines and processes.
A protective diode ensures, the poles of the supply voltage from the power supply of the PLC can not be swapped.

Input Signals

Nominal voltage:	12 – 24 V
Absolute maximum voltage:	voltages greater than 40 V can destroy the inputs
Type:	Circuit GND directly connected
Input current:	1 mA @ 24V
Threshold value:	10 V
Internal signal delay:	- No delay for direct IO access - 10ms delay for DSP polling

The PLC-compatible inputs (24-V level, the positive signal is connected) include input protection circuits. A minimum voltage of 10V is required to reliably sense a logic high signal.

Output Signals

Operating voltage:	external source 12 – 24 V
Absolute maximum voltage:	voltages greater than 40 V can destroy the outputs
Type:	Circuit GND directly connected
Switching voltage:	positive switching
Current:	max. 400 mA per output
Absolute maximum current:	total currents greater than 1000 mA can destroy plugs and cables Always consider the total sum of all output currents
Total current / over current output protection	Yes – if Σ iout > 1A $\rightarrow$ all Outputs are switched off – Retry after 30 seconds
Switching power:	max. 9.6 W (24 V * 400 mA) per output
Reverse voltage protection	yes, for external voltage
Protection against inductive loads:	yes
Resistance when switched on:	0.2 - 0.8 Ohm
Short circuit protection:	full protection

The PLC outputs feature a highly integrated MOSFET, high-side switch with built-in protection . It is possible to switch inductive or capacitive loads. The protective feature of the outputs will produce pulses on the outputs, if the limiting values are exceeded.
Output drivers feature short circuit end thermal overload protection
For additional protection of the output drivers, the I/O processor monitors the total PLC current, and switches off all outputs if the maximum threshold value is exceeded.

4.3.3 Electrical specifications of the VCSBC4018 Power Supply J3 interface

Nominal Voltage:	12V – 24V
Minimum operational voltage (including ripple):	9V
Maximum operational Voltage (including ripple):	30V

Power must be connected to the 12pin I/O connector.
Camera power is regulated and galvanically separated inside the camera, so only an unregulated power source of 12 V +/- 24V is required. The camera is, however, very sensitive to power supply interruption. Please make sure, that the voltage never exceeds the limits of < 9V, > 30V even for a short period of time. In case of trouble it is recommended to backup the power supply by a capacitor or a battery large enough to prevent power interruptions.

4.3.4 Matching connector and cable for J3 camera socket

J2 Standard VCSBC4018 socket: Molex: 8783212-20 with center polarization slot (see above)

The wall socket with polarization slot has been used for this camera in order to avoid camera damage caused by shifted or reversed plug connections.
The standard VCSBC50 cable can be used to prevent shifted plug mounting:
Order Number VCSBC50 Power / PLC cable: VK000173

For additional safety against reversed connections, please order one of the following connectors from the manufacturer Molex:

Part numbers: 87568-1263, 87568-1264, 87568-1273, 87568-1274

4.4 J4: Ethernet Interface

4.4.1 Pin Assignments J4 camera socket

Pin Number	Signal
1	TXD+
2	TXD-
3	GND
4	GND
5	RXD+
6	RXD-
7	GND
8	GND

Pin locations:

2	4	6	8
1	3	5	7

∇

4.4.2 Electrical specifications J4 camera interface

Galvanically separated with transformer. For all connections follow standard Ethernet specifications.

4.4.3 Matching connector and cable for J4 camera socket

Socket J4 on circuit board: Part number: 87759-0850, manufacturer: Molex
Matching connector: Part number: 51110-0850, manufacturer: Molex

Cable with MOLEX-Connector: VK000206 from Vision components:
Pin Assignment:

PIN	Signal	Cable Color
1	TXD+	blue
2	TXD-	red
3	GND	N/C
4	GND	N/C
5	RXD+	Pink / black
6	RXD-	green
7	GND	N/C
8	GND	N/C

4.5 J6: Emulator Interface

4.5.1 Pin Assignments J6 camera socket

Pin Number	Signal
1	Vcc (3.3V)
2	GND
3	NC
4	EMU0
5	EMU1
6	TRST
7	TCU
8	TDI
9	TD0
10	TMS

Pin Locations

10	9	8	7	6	5	4	3	2	1
									∇

4.5.2 Electrical specifications J6 camera socket

At request from Vision Components.

4.5.3 Matching connector and cable for J6 camera socket

The standard VCSBC11 / and VCSBC38 cable fits this connector.
Order Number from Vision Components: VK000086

5 Accessories

For interface cables and connectors available also consult the corresponding section in chapter 4 of this manual.

The following accessories are available for the VCSBC4018:

Product description	Order Number
Power adapter for rail mounting Input Voltage 100 - 240VAC 50/60 Hz Output Voltage DC 24V +/-5%, max. 300 mA (7.5 W) Equipped with connecting clamps for AC input and 24V output, CE certified	VK000036
Ethernet Cable for J4	VK000206
Power Supply and IO Interface cable for J3	VK000173
Flat Ribbon Cable for J1 Illumination Controller	Ek000377
Expansion Port / Trigger Interface cable for J2	N/A
Cable set for VCSBC4018 (containesVK000206 and VK000173)	VK000229
Cable for Emulator interface J6	VK000086
Clear glass protective sensor window (replaces IR filter in camera head)	EK000624
IR cut filter (camera is shipped with this filter mounted) refer to Appendix D	EK000625
Flex cables for detached Camera Head mounting:	
30mm x 20 core (part of standard delivery)	EK000321
80mm x 20 core	EK000322
200mm x 20 core	EK000629
1000mm x 20 core	EK000631
1800mm x 20 core	EK000630

All cable length are 0.5m unless stated otherwise.

Please also refer to the VC website www.vision-components.com for an up to date list of accessories:

6 Programming VCSBC4018 Cameras

The VCSBC4018 operating system includes some additional functions, mainly for the control of the additional interfaces. Without direct VGA output some video control functions are not implemented for this camera.
This manual describes the differences between the standard VCRT 5 operating system functions and the special function library of the VCSBC40. For programming please also consult the VCRT 5 and VCLIB 2.0 and VCLIB 3.0 manuals (see the list of references at the beginning of this manual).

6.1 Special Software requirements and compiler settings for programming the VCSBC4018

The following table shows the compatible setup options using the VCSBC4018 camera:

Code Composer Studio Version	VCRT PC Lib Version	VCLIB Version	VCRT Camera OS Version:
CCS 2.1 (C6000)	VCRT 5.18	VCLIB 2.0 and 3.0	VCRT 5.93

The VCRT PC lib Operation System PC library, the VCLIB Image Processing Library as well as the VCRT Camera Operation System can be downloaded from Support section of the Vision Components Website.
Software manuals are located in the “Registered User Area”. This download area can be accessed after registration and log in on the VC Website.
Software updates are available from the “Customer Area”. For access to the customer area please register your Vision Components development software for VC cameras with TI processor. Software registration can be done after logging in using the license key code shipped with each development bundle. For this please follow the “Register your Software” link under the “User Menu”.

6.2 Ethernet Communication

The default camera IP address is 192.168.0.65 – as with all Ethernet cameras from VC.
The IP address can be changed to a different loading a #IP file into camera memory. (see Support->Customer Area->Getting Started VC20XX … Programming Tutorial Basic for details).
The camera supports DHCP server IP address allocation. In order to use DHCP allocation, the entry “DHCP” needs to be added to the #IP file as shown:

```
DHCP
IP:  192.168.0.81
MSK: 255.255.255.0
GTW: 192.168.0.1
```

The camera uses the specified IP address if DHCP allocation is not successful. If no IP address is specified in the #IP file, the camera falls back to the default address: 192.168.0.65

Please use DHCP server functions to determine the IP address allocated to the camera. Determine the mac address of the camera using the shell command “type #ID” to determine the camera’s mac address prior to using DHCP IP address allocation!

6.3 Using FTP with the VCSBC4018

With VCRT 5.18 and higher, the use of any standard ftp client is now possible. The following server commands have been added: SYSTEM,PWD,CWD,LIST,DEL
Programs have to be uploaded as “out” files into the camera flash memory. Ascii files like the autoexec or #IP files can be uploaded as “*.txt” files – the conversion into *.msf” files is not required.

6.4 Preventing Autoexec Execution / IP number reset

Preventing the execution of an Autoexec file by attempting a connection with the camera does not work (see Programming Tutorial). Use the following workaround to prevent the autoexec form starting a hanging / crashing program:

- Upload an empty autoexec file via FTP into the camera memory, overwriting the existing file
- Hardware reset of camera

If it is not possible to overwrite the autoexec file, a CPU reset can be done with help of an Emulator. If an emulator is not available, the camera needs to be shipped to Vision Components.

The reset of IP numbers that can be done with help of the keypad with VC20XX cameras is not possible. Avoid using invalid IP numbers (like 0.0.0.0). Cameras with invalid IP numbers have to be shipped to VC for repair.

We are currently working on a simple solution for resetting the IP number and preventing autoexec execution. Until this is implemented, please take extra care using autoexec and #IP files.

6.5 Special VCRT functions for programming VCSBC4018 cameras

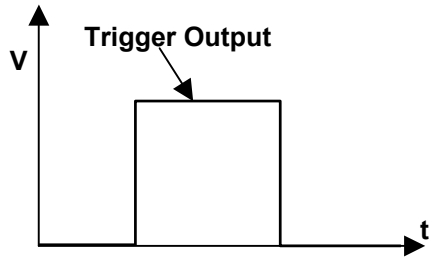
6.5.1 Trigger Functions

The trigger works like with the VC20XX cameras. Please refer to the VCRT5.pdf manual – available form the Registered User Area of the VC website.

The following command checks the status of the trigger input:

```
…
if (GET_TRIG_SIGNAL() & 1)
  print("external trigger = 1\n");
else
  print("external trigger = 0\n");
…
```

The trigger output can be set to exposure controlled mode – for instance to control a light source. With Trigout_EXP() combined with TRIGOUT_POS(), the trigger output is high during exposure.
Trigout_EXP() combined with TRIGOUT_NEG(), the trigger output is high during exposure.



Trigger Output Signal in Exposure Controlled Mode:
TRIGOUT_EXP();
AND
Trigger output set positive:
TRIGOUT_POS();

6.5.2 Controlling the Illumination Interface J1

The Illumination Interface has proven useful with the VCSBC50 camera and has therefore been also integrated into the VCSBC4018. Due to the different processor, the use of this interface is slightly different.

There are two different modes for switching the Illumination Enable Signal (Pin 3, J1).

- User Mode and
- Exposure Mode

In Exposure mode (default) the “illumination enable” signal on socket J 1 is coupled to the trigger output on socket J 2, allowing to switch the a light source during image acquisition with either contact. In user mode, the Illumination enable signal can be switched independent from the image acquisition. The corresponding commands are:

```
ILLU_USR();
ILLU_EXP();
```

The functions ILLU_POS() and ILLU_NEG() can be used to inverse the Illumination voltage.
Calling the function “ILLU_USR()” and then “ILLU_NEG” sets “Illumination Enable” high, independent from the image acquisition.

6.5.3 Controlling the TTL IOs on socket J2

Setting and reading the 4LVTTL inputs and outputs is done with help of the hardware registrers.

The folllowing macros are available for easier operation (see “vcrt.h”):

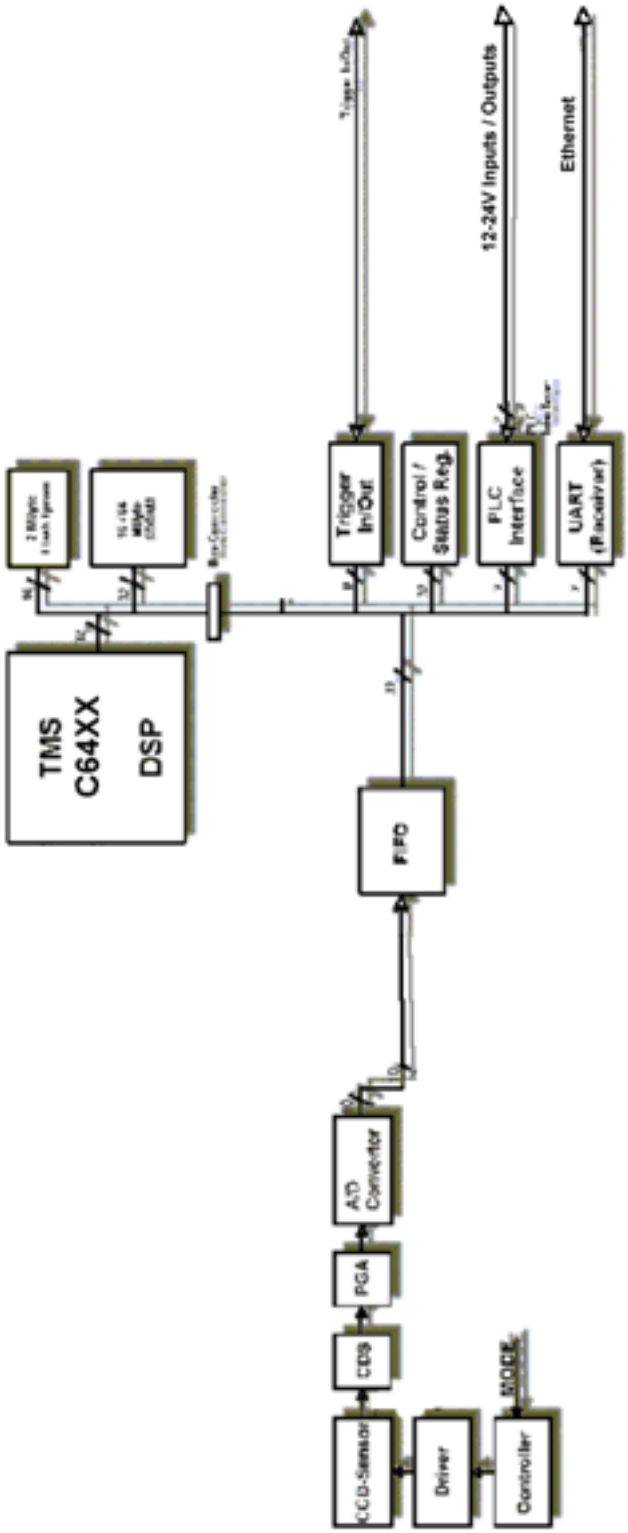
- Setting the 4 outputs is done with help of a 4 bit value:

  ```
  #define TTL_OUT(x)   *((volatile int *)FA40_LED) = x              /* SBC4018 TTL output */
  ```

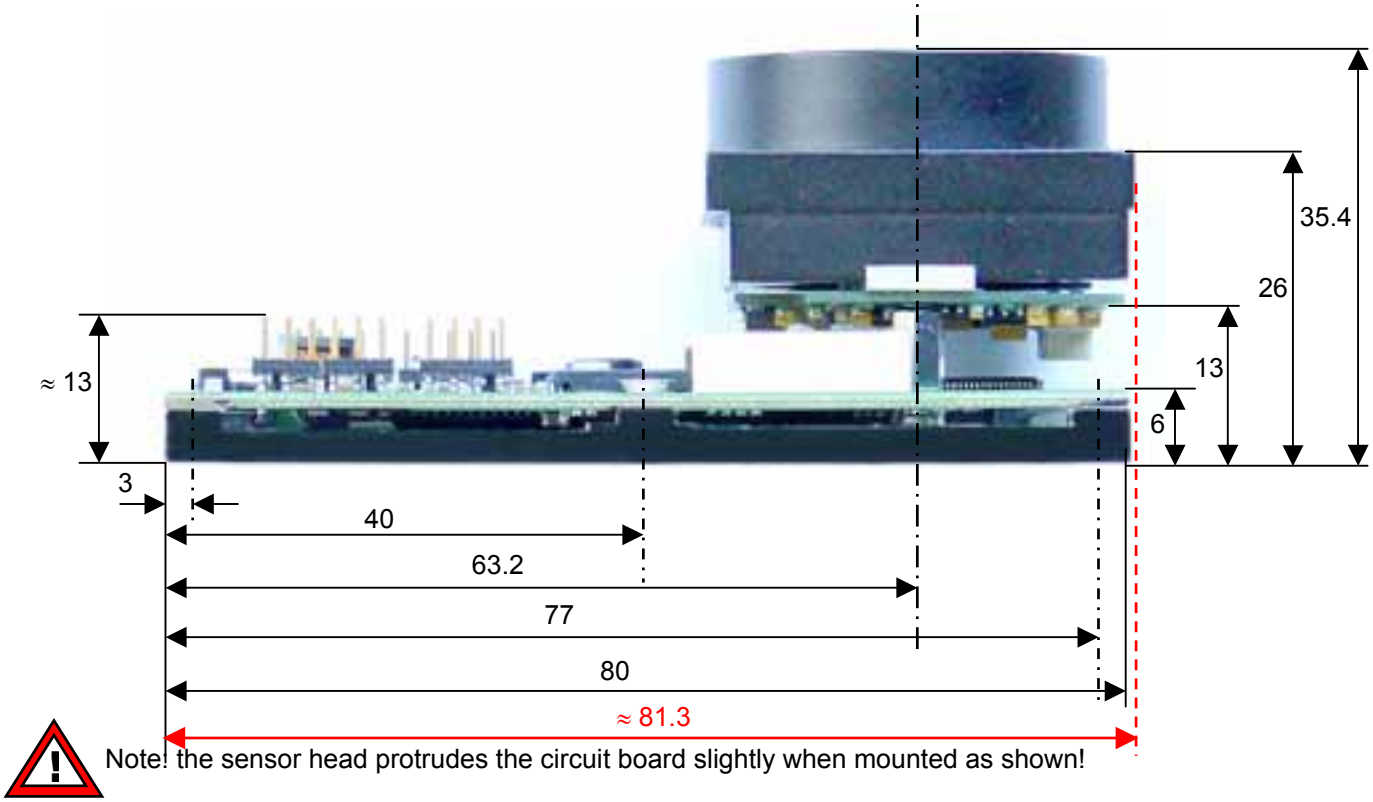
- For quering the TTL inputs use the following function:

  ```
  #define GET_TTL_IN()  (*((volatile int *)FA40_TTL) & 0x0F)      /* SBC4018 TTL input */
  ```

Appendix A: Block diagram VCSBC4018 Smart Camera

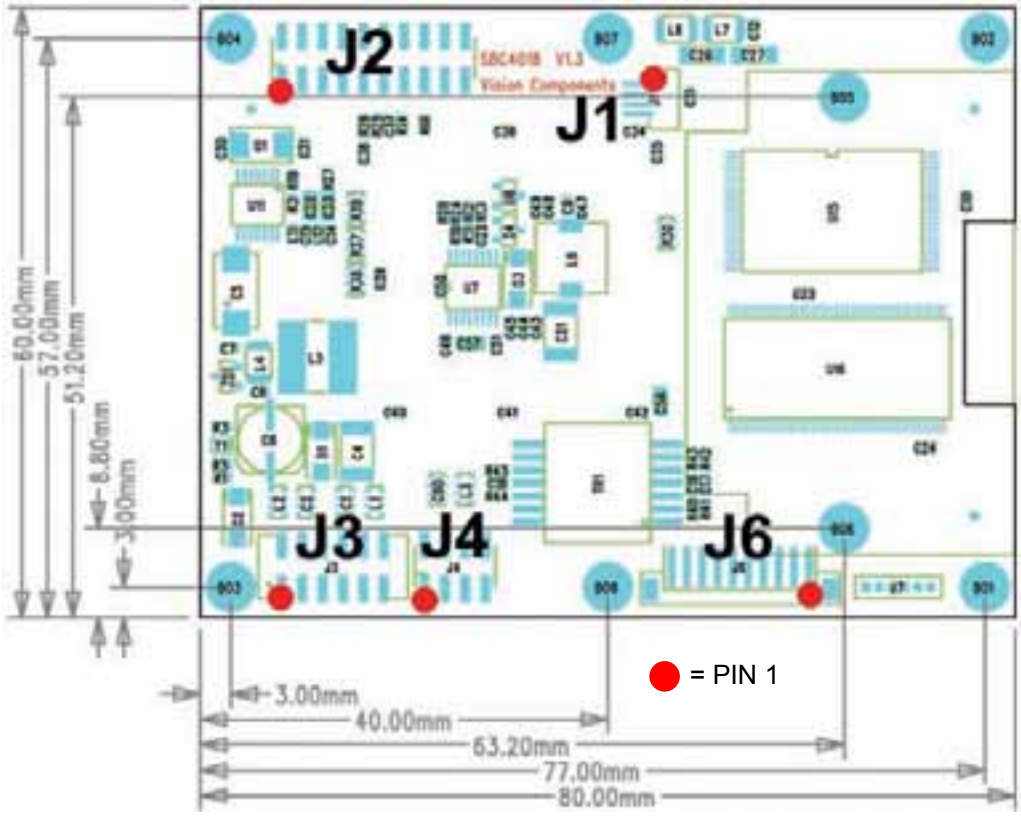


Appendix B: Overall Dimensions VCSBC4018

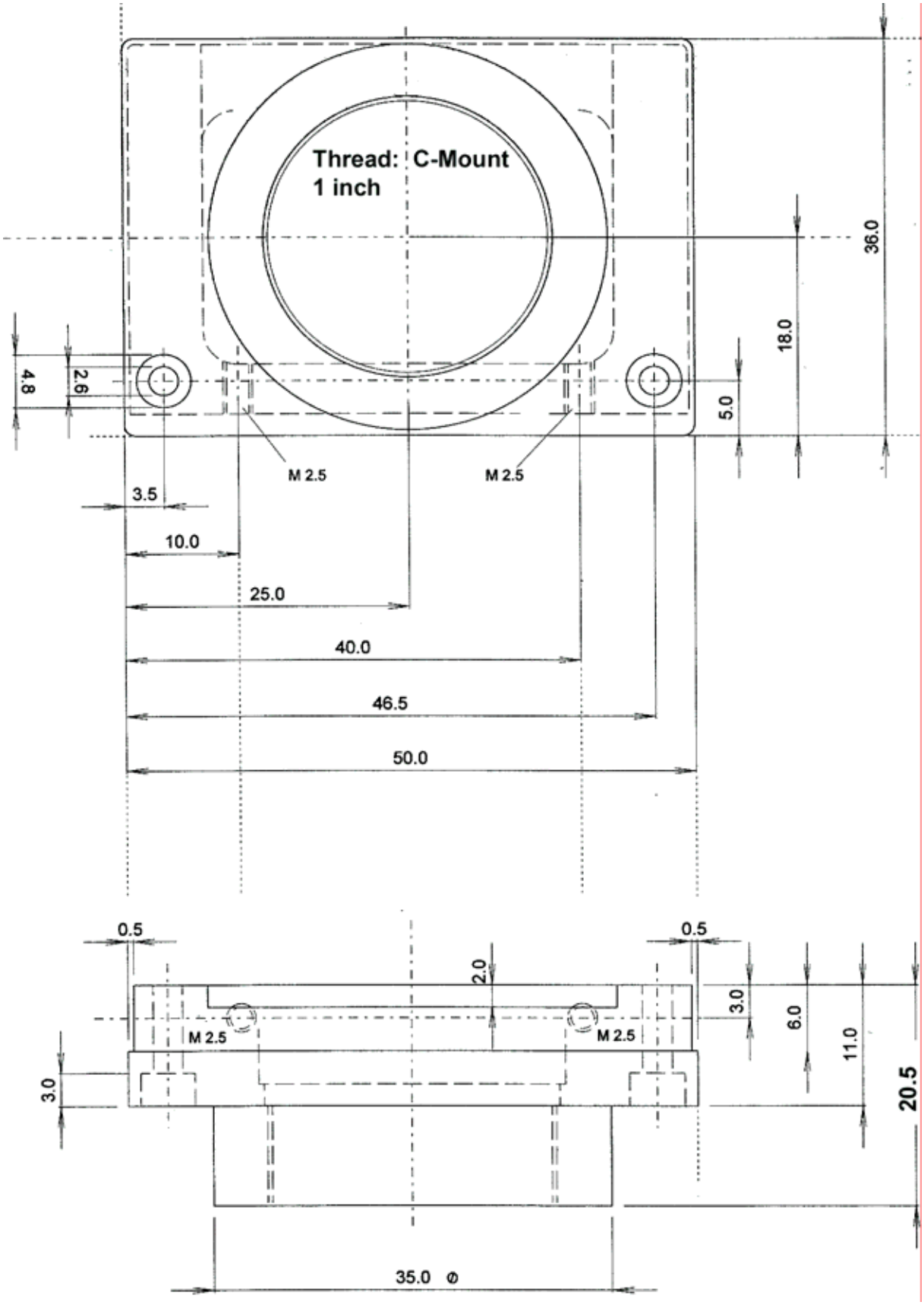


Note! the sensor head protrudes the circuit board slightly when mounted as shown!

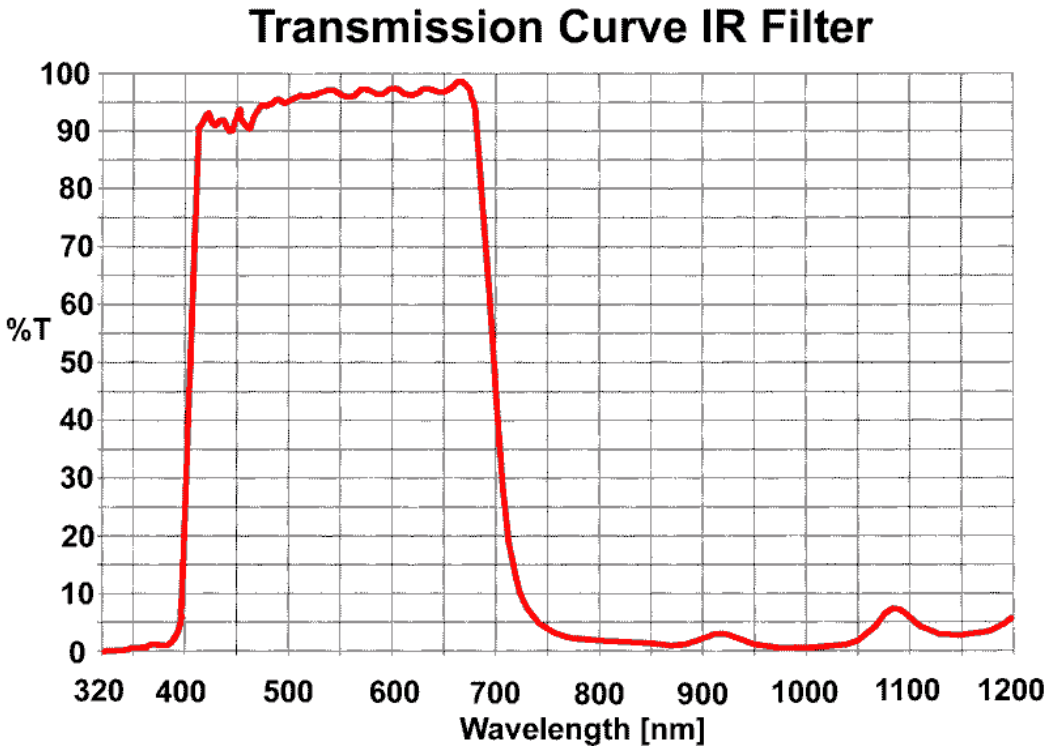
Appendix C: Drawing Circuit Board VCSBC4018



Appendix D: Drawing Camera Head VCSBC4018



Appendix E: Spectral Transmission of IR Filter



Note:

This IR cut filter is incorporated in every VCSBC4018 camera. The IR filter can be removed if required without loosing Vision Component's manufacturers warranty. In this case, special care must be taken not to damage the CCD sensor.

If the camera is used without IR filter it is important to replace it by a clear glass filter of the same size. The C-mount flange distance from the CCD is accurately adjusted for the use of the IR filter – removing the filter decreases the length of the optical path and it may become impossible to focus some lenses to a larger working distance.

If the IR filter is not to be used, please order your camera with a clear glass filter or contact Vision Components for obtaining a glass filter.

The order numbers for the clear glass filter is:	EK000624
The order number for the IR cut filter (standard) is:	EK000625

Index