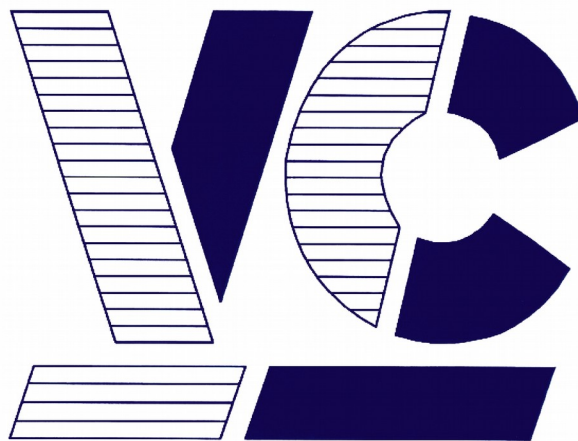


**It's no trick...
it's a vision system**



**Vision
Components**®
The Smart Camera People

VC 3D Laser Scanner

Version 55

Manual

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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.

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References

Since the VC4XXX smart camera family employs a TI processor, the programming environment and functions for the VC20XX cameras can be used for this camera.

Further References under “Support + Download” on www.vision-components.com:

„**Support News**“ – for up to date information on VC Software and Documentation.

„**Knowledge Base / FAQ**“ - searchable Database with latest software developments, frequently asked questions and demo programs.

“**Download Areas**” for all documentation and Software downloads – refer to the following table:









Description	Title on Website	Download Area
Schnellstart VC – Deutsche Version dieses Handbuchs 	 Schnellstart VC Smart Kameras	Registered User Area ▶ Getting Started VC SDK TI
Introduction to VC Smart Camera programming	 Programming Tutorial for VC20XX and VC40XX Cameras	Registered User Area ▶ Getting Started VC SDK TI
Demo programs and sample code used in the Programming Tutorial	 Tutorial_Code	Registered User Area ▶ Getting Started VC SDK TI
VC4XXX Hardware Manual	 VC4XXX Smart Cameras Hardware Documentation	Public Download Area ▶ Hardware Documentation VC Smart Cameras
VCRT Operation System Functions Manual	 VCRT 5.0 Software Manual	Registered User Area ▶ Software documentation VC Smart Cameras
VCRT Operation System TCP/IP Functions Manual	 VCRT 5.0 TCP/IP Manual	Registered User Area ▶ Software documentation VC Smart Cameras
VCLIB 2.0 /3.0 Image Processing Library Manual	 VCLIB 2.0/ 3.0 Software Manual	Registered User Area ▶ Software documentation VC Smart Cameras

Table of Contents

1 Introduction	4
1.1 General features	4
1.2 Standard accessories for VC 3D nano	4
2 Working with the VC 3D Laser Scanner Software	5
2.1 Laser Scanner Camera Demo Program (LaserScanner_Main_VXX.c)	5
2.2 Laser Scanner Library (VC3D LaserScanner VXX.lib)	5
2.3 Laser Scanner Windows PC Program	5
3 VC 3D Laser Scanner Camera Demo Program	5
3.1 Menu “m” (main menu)	7
3.2 Menu “p” (standard parameter menu)	7
3.3 Menu “e” (expert parameter menu)	7
3.4 Menu “d” (debug parameter menu)	8
4 VC 3D Laser Scanner Library	8
4.1 Function ScannerInit()	8
4.2 Function ScannerDetection()	9
4.3 Function ImgToWorldCoord()	9
4.4 Function WorldToImgCoord()	9
5 VC 3D Laser Scanner connection to Windows	10
5.1 Camera Hardware Connection	10
5.2 PC Connection	10
6 Windows program “VC 3D SmartShape”	10
7 Important Remarks	11
7.1 Laser Power Module	11
7.2 Double Exposure	11
7.3 Fast Floating Point Calculation	11
8 New Version Changes	12

1 Introduction

Vision Components introduces the VC nano 3D, an ultra-compact machine vision system that can be freely configured for 3D and 2D inspection tasks, providing a cost-efficient solution for a wide range of applications. Measuring merely 140 x 70 x 35 mm, its housing includes an intelligent camera and a line laser with up to 100 mW performance which enables the real-time recording of images at a scan rate of up to 400 Hz according to the triangulation method. The images can be analyzed by the DSP processor of the Smart Camera which has a computing power of 5,600 MIPS. Additionally, images can also be analyzed

1.1 General features

- ⤴ Scan rate: up to 400 Hz
- ⤴ Laser: Class 1 / 2, wave length 635 nm, power 30 mW / 100 mW
- ⤴ Interface: 2 x Input, 4 x Output à 400 mA, 100 Mbit Ethernet
- ⤴ Processor: high-end DSP, 5,600 MIPS
- ⤴ Supply Voltage: 24 V +/- 20%
- ⤴ Dimensions: 140 x 70 x 35 mm, ca. 400 gr.

1.2 Standard accessories for VC 3D nano

- ⤴ LAN cable 6-pin C6/C4, 5 m long (Product no. VK000149)
- ⤴ Power/PLC cable 12-pin C6/C4, 5 m long (Product no. VK000008)

2 Working with the VC 3D Laser Scanner Software

Vision Components offers three software packages for an easy setup and hardware check:

2.1 Laser Scanner Camera Demo Program (LaserScanner_Main_VXX.c)

The demo program includes the main function calls of the Laser Scanner library and an example for TCP/IP connection to the outer world. It shows, how to use the parallel image acquisition and processing and provides a menu to change all sensor parameters as well as the debug parameters.

2.2 Laser Scanner Library (VC3D LaserScanner VXX.lib)

The library includes the high performance detection of the laser line and the main calibration functions for the system. Additionally there are filters and different detection modes implemented. The individual calibration parameters are stored in the Laser Scanner camera flash memory (Cxxxxxxx or LensCal).

2.3 Laser Scanner Windows PC Program

The Windows PC program displays the results of the Laser Scanner camera. It allows an easy setting of all scanner parameters. You can use the program to show the real 2D image from the sensor as well as the measured 3D data. It works together with the standard TCP/IP protocol from the Laser Scanner demo program.

3 VC 3D Laser Scanner Camera Demo Program

In the software package you will find the LaserScanner_Main_VXX program as an executable file (vc3d_xx.cex) for the camera and the source code (.c) as well. Please download the demo file to the camera and start it. If necessary, change the source code and adapt the TCP/IP connection to your requirements.

After starting the camera file the following messages appears:

```
Set own task 'loader' to prio 7! (oldprio=8)
Checking   VCLib Licence: OK.
Checking ColorLib Licence: OK.
Checking   ExtLib Licence: OK.

Linked with following library versions:
VCLIB   : 314_6 VCLIB   Version=314   SubVersion=6   Date:Dec 16 2014   Time=10:50:56
VCRTLIB : 531_2 VCRTLIB Version=531   SubVersion=2   Date:Oct 26 2015   Time=15:25:42
```

```
Compiled with following header versions:
FLIB.H   : 314.6
VCLIB.H  : 314.6
VCRT.H   : 531.2

VC/RT OS   running   with Version: 531.2

Compiled at Jun  9 2016 13:59:56 Camera=6211

Kanatani Calibration Ready.

Reading sensor parameter file fd:/VC3DPar.001 successful.
The missing 16 Sensor Parameter(s) will be replaced by default values.

Reading product parameter file fd:/ProdPar.001 successful.
The missing 4 Product Parameter(s) will be replaced by default values.

Open Port 1096
New stream socket created at port 1096 at SocketAdr=0x80322b68

Open Port 1097
New stream socket created at port 1097 at SocketAdr=0x80322c44

--- VC 3D Laser Scanner Version: Main=55.3.0 / Lib=55 / Product=55 ---

Press ENTER for hand operated scan
Press  ESC  to quit program
Press  'm'  to change parameter
Press  's'  to save BMP image for debug
Press  'r'  to read BMP image for debug
```

Especially in multitask mode, it is sometimes necessary to adjust the task priorities. The demo file shows all important commands to settle it. Low values means high priority. The standard priority is 8.

The next three lines indicates that all VC Libs are properly initialized (value 0). Please check your VC library license code, if you will get a different value, for example -5.

The next lines reports the version number of all used libraries and header files as well as the camera operation system. It also shows the compilation date and time of the demo file.

If the calibration file is missing on the sensor flash memory, the demo file still works but could not calculate the detection results in [mm]. Instead it gives the laser line position in pixel. You can verify with the shell command "dir -x", if the file "Cxxxxxxx" (xxxxxxx = camera SNR) or "LensCal.002t" exists. Please contact Vision Components in order to receive the calibration file.

Customers settings can be stored on the flash memory as well. The software will start with the new parameter values. If the file "VC3DPar.txt" is not available, the demo file starts with the standard

parameter setting. You can store your settings inside the menu 'm'. It is possible to change the VC3DPar.txt file with an editor.

All new 3D sensor will have the accurate Kanatani calibration. For this sensors the Tsai calibration file is not necessary.

Only in the product version of the 3D scanner the Product Setting File fd:/ProdPar.001 will be read.

The standard TCP/IP connection will be at port 1096. You can change the port number inside the source code.

```
// TCP / IP
#define SERVER_PORT      1096  /* scanner communication port */
```

Next line shows the program version and a short menu.

3.1 Menu “m” (main menu)

The menu gives you the possibility to change all sensor parameters manually. An other way to change the parameter is with the PC Windows Client. All the parameters are described in the documentation “Laser Scanner Protocol & Parameters”.

Setup Parameter

p: set standard parameter
e: set expert parameter
r: reset all counters
s: save sensor / product parameter
l: load sensor / product parameter
d: debug parameters
w: show parmeter at telnet port
t: load product parameter

q: quit Menu

3.2 Menu “p” (standard parameter menu)

Set Laser: 0=OFF 1=ON = 0 [0 - 1]
Set Trigger: 0=OFF 1=PosEdge 2=NegEdge -1=AutoTrigger -2=AutoTrigPos -3=AutoTrigNeg = 0 [-3 - 2]
Set ROI Area X [Pixel] = 0 [0 - 1277]
Set ROI Area Y [Pixel] = 0 [0 - 1021]
Set ROI Area DX [Pixel] = 1280 [6 - 1280]
Set ROI Area DY [Pixel] = 1024 [6 - 1024]
Set Nr_Lines at Port 0: -1=endless X=NrImages -2=FromPort1 = 0 [-2 - 10000]
Set Nr_Lines at Port 1: -1=endless X=NrImages -2=FromPort0 = 0 [-2 - 10000]
Set Data Mode at Port 0 = 0 [-1 - 9]
Set Data Mode at Port 1 = 0 [-1 - 9]

Set Exposure Mode: 0=FIX_EXPOSURE 1=AUTO_EXPOSURE 2=DOUBLE_EXPOSURE = 0 [0 - 3]
 Set Shutter [us] = 500 [5 - 500000]

3.3 Menu “e” (expert parameter menu)

Set GAINVAL = 64 [0 - 1023]
 Set Methode = 2 [0 - 2]
 Set Algorithm (0=I16 / 1=F32) = 0 [0 - 1]
 RLC Threshold = 48 [1 - 254]
 Image Sub Sample = 0 [0 - 2]
 Step Dx [Pixel] = 1 [1 - 8]
 Min. Laser Width [Pixel] = 1 [1 - 100]
 Max. Laser Width [Pixel] = 30 [1 - 100]
 Ethernet Line Package Nr = 1 [0 - 100]
 Ethernet Send No Wait Mode = 1 [0 - 1]
 Laser Detection Filter = 0 [-8 - 8]
 Median Filter: 0=no filter 1=3x1 2=5x1 3=7x1 4=9x1 = 0 [0 - 4]
 Speckle Filter: 0=no filter 1=3x3 2=5x5 3=7x7 4=9x9 = 3 [0 - 4]
 Skip no laser detections points = 1 [0 - 1]

3.4 Menu “d” (debug parameter menu)

The menu “d” gives you additional information about the scanner and offers a fast way for debugging the software. You have the opportunity to find memory leaks, display the measure time or shutter time. You also can display the position of the laser line detection. In order to debug the TCP/IP host communication please select the necessary values.

Debug Print: 1=Memory 2=fps 3=Shutter 4=ImgAdr 5=TCP/IP 6=ImgToWorld 7=ProdRes 8=ParSet 9=SendData = 0 [0 - 9]
 Debug Draw: 1=LaserCenter 2=LaserDetection 3=ProductResults = 0 [0 - 3]
 Debug Commands: Bit0=Host->Cam Bit1=Cam->Host Bit2=SendData Bit3=GlobalHeader = 0 [0 - 15]

4 VC 3D Laser Scanner Library

The VC 3D Lib enables the real-time recording of images according to the triangulation method. The images can be analyzed by the internal DSP processor of the Smart Camera which has a computing power of 5,600 MIPS.

The lib works on all VC 3D Laser Scanner cameras with the standard license code:

```
LsPar->LicenceCode1 = 0x674F27A1;
LsPar->LicenceCode2 = 0x2E05F267;
```

Before you can use the lib on other VC cameras, please initialize both license codes in the structure. You will get the license code from Vision Components. Every camera needs a different license code. In case of wrong initialization, you can use the compiled program for 90 minutes or a maximum of 10000 scans.

The lib offers a wide variety of settings. They are mainly described at the documentation “Laser Scanner Protocol & Parameters”.

Use the following functions from the Library:

4.1 Function ScannerInit()

```
I32 ScannerInit (LsParameter *LsPar, I32 Mode);
```

Call the function `ScannerInit(LsPar, MEM_INI)` at the beginning of your program and `ScannerInit(LsPar, MEM_DEINI)` at the end in order to allocate and release necessary memory. The function should be called only once in your program.

4.2 Function ScannerDetection()

```
I32 ScannerDetection (LsParameter *LsPar, image *ImgArea);
```

The function `ScannerDetection()` detects the position of the laser line at maximum speed. It works on the image structure `ImgArea`.

The laser line search area is defined as:

```
ImageAssign(&ImgArea, ScrByteAddr(0, 0), LsPar->ImgDX, LsPar->ImgDY, ScrGetPitch);
```

The results from the function will be transferred to the structure parameters:

```
// laser line positions
I32 LaserPoints; (number of detected laser points)
I32 *pLaserPosZ; (center of the laser line position z, accuracy factor 64)
I32 *pLaserPosX; (laser line position x, accuracy factor 64)
U8 *pLaserVal; (average brightness at the laser line position x)
```

Notice that the array `*pLaserPosZ` and `*pLaserPosX` for the laser position have a sub pixel accuracy and are multiplied with the factor 64 in order to get sub pixel accuracy. Both values (x and z) can be used to calculate the attitude in real world coordinates. The laser brightness at that position is stored in the array `*pLaserVal`.

4.3 Function ImgToWorldCoord()

```
void ImgToWorldCoord (LsParameter *LsPar, I32 Nr, I32 *restrict pImgX, I32 *restrict pImgZ, float *restrict pWorldX, float *restrict pWorldY);
```

With the function `ImgToWorldCoord()` you can convert the sub pixel values in the array `pLaserPosX` and `pLaserPosZ` to real world coordinates in mm, if Kanatani or Tsai calibration is available. If the calibration file is missing, the function doesn't change the values.

If the parameter `pWorldY` is equal to `NULL`, the world coordinates will be stored in `pWorldX` like `x0, z0, x1, z1, x2, z2, ...`

4.4 Function WorldToImgCoord()

```
void WorldToImgCoord (LsParameter *LsPar, I32 Nr, float *restrict pWorldX, float *restrict pWorldZ,  
float *restrict pImgX, float *restrict pImgY);
```

The function `WorldToImgCoord()` converts mm coordinates into pixel values. Just the opposite way of the funktion `ImgToWorldCoord()`. Use this function, if you know the dimensions of your measure target and you want to calculate the necessary image region (ROI). This function is not time optimized and takes more processor time.

5 VC 3D Laser Scanner connection to Windows

We recommend to use our new "VC3D Smart Shape" PC program as a Host client.

The software works together with the VC 3D Laser Scanner Cameras from Vision Components and the camera demo program `vc3d_XX.cex`. The cameras are based on Texas Instruments DSP's. A large variety of different Laser Scanner Camera types and resolution are available.

5.1 Camera Hardware Connection

A 100 Mbit TCP/IP connection is necessary in order to communicate with the camera. You can directly connect the scanner camera to a TCP/IP Hub or just use a TCP/IP cross cable for a direct camera connection to your PC. A cross cable is available from Vision Components.

The scanner camera listen to the TCP/IP Port 1096. This port number can be changed in the camera source code. The standard IP address of the laser camera is 192.168.0.65. The IP address could be different, if there is a "#IP" file on the camera flash memory (fd:\). You will find an example of the #IP file and some instruction how to select a different IP address in the camera demo files of vision components. Additional settings for gateway or MASK are possible.

Example:

IP: 192.168.0.65

MSK: 255.255.255.0

5.2 PC Connection

First you have to start the Laser Scanner camera software (`vc3d_XX.cex`) if the shell autoexec file is not available. Then start the VC 3D PC program and try to establish a TCP/IP connection to the camera. Choose the right IP and port address and press the Connect Button of the VC 3D PC application.

If the standard IP doesn't work and if you don't know the IP address of the camera, please follow the instructions of the VCNet Recovering Tool from Vision Components.

6 Windows program “VC 3D SmartShape”

The VC 3D PC SmartShape is a MS Windows PC program for displaying the results from the Laser Scanner camera. It allows an easy setting of the scanner parameters.

We recommend to use this new VC3D Smart Shape PC program for all VC 3D Laser Scanners. Please follow the program description in the documentation “VC 3D SmartShape Manual.pdf”.

7 Important Remarks

7.1 Double Exposure

In double exposure mode the scanner takes two images. The first image is the main image and will be taken at the shutter time `DoubleShutter[0]`. The second image, with the shutter time `DoubleShutter[1]`, will be taken directly after the first image. If a laser detection at any x position is not possible in the first image, it will try to find the laser in the second image for that x positions only.

Double Exposure mode reduce the scan rate!

The first image can be triggered by hardware or auto trigger as well as in free running mode. The second image will always be triggered directly after the first one. It doesn't wait for hardware or auto trigger.

Please note, that Double Exposure doesn't work correctly at the xr Laser Scanners due to a different shutter time procedure. If you want to use Double Exposure, please select a yr or higher model.

7.2 Fast Floating Point Calculation

For fast floating point calculation use the TI FastRTS fast floating point library. If you need the FastRTS please contact VC.

The use is really simple:

- (1) copy `fastrts64x.lib` into `\\ti\c6000\cgtools\lib`
- (2) include the line `"-l fastrts64x.lib"` in `cc.cmd`

that's it. Your floating point applications will run about factor 2 - 3 faster



8 New Version Changes

A short history of the changes is documented in the head of the file `LaserScanner_Main_VXX.c`. Please have a look for more information.

Version 55:

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