



OV5642

Embedded Firmware User Guide
- VCM AF Module

Version 0.21

Aug.2009

OmniVision reserves the right to make changes without further notice to any product herein to improve reliability, function or design. OmniVision does not assume any liability arising out of the application or use of any project, circuit described herein; neither does it convey any license under its patent nor the right of others.

This document contains information of a proprietary nature. None of this information shall be divulged to persons other than OmniVision Technologies, Inc. employee authorized by the nature of their duties to receive such information, or individuals or organizations authorized by **OmniVision Technologies, Inc**

Contents

OV5642 Embedded Firmware User Guide	1-1
1 Embedded Resources	1-4
2 Auto Focus Solution.....	2-5
2.1 Embedded Auto Focus Solution.....	2-5
2.2 External Auto Focus Solution	2-6
3 User Interface	3-7
3.1 Command and Status Registers.....	3-7
3.2 Main Command Table	3-7
3.3 Auto Focus Status	3-8
4 Firmware User Guide.....	4-9
4.1 Initialization	4-9
4.2 State Transition Diagram.....	4-9
4.3 Auto Focus Control	4-10
4.4 Step Focus Mode Commands.....	4-10
4.4.1 Step to Near Object	4-10
4.4.2 Step to Far Object.....	4-10
4.4.3 Step to Furthest Object.....	4-10
4.4.4 Step to Nearest Object.....	4-10
4.4.5 Step to Specified Position.....	4-10
4.4.6 Samples	4-10
4.5 Auto Focus Sample Flow	4-11
5 Motor Driver Mode.....	5-12
5.1 Normal Driver Mode.....	5-12
5.2 Special Driver Mode	5-12
5.3 Motor Driver Mode Setting.....	5-12
6 Auto Focus Zone	6-13
6.1 Zone(X0, Y0, X1, Y1).....	6-13
6.2 Zone Array Mode	6-13
6.2.1 Zone Array Mode 1 – center mode.....	6-13
6.2.2 Zone Array Mode 2 – 5x mode	6-14
6.2.3 Zone Array Mode 3 – 5+ mode	6-14
6.2.4 Zone Array Mode 4 – 5f mode	6-14
6.2.5 Zone Array Mode 5 –float center mode	6-14
6.2.6 Zone Array Mode Setting.....	6-14
6.3 Zone Selection Mode	6-15
6.3.1 Zone Selection Mode 1 – Auto Mode	6-15
6.3.2 Zone Selection Mode 2 – Semi Auto Mode	6-15
6.3.3 Zone Selection Mode 3 – Manual Mode	6-15
6.3.4 Zone Selection Mode Setting	6-15
7 Update History	7-17

1 Embedded Resources

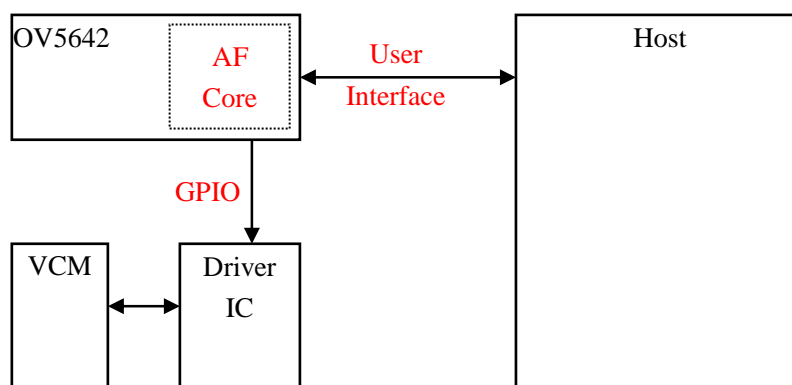
- ☑ Embedded Micro-controller
- ☑ 6KB of embedded program memory
- ☑ Two general purpose IO ports (GPIO0, GPIO1). If the output format of OV5642 is not 10-bit RGB RAW format, Y0, Y1 could also be used as GPIO.
- ☑ Built-in Auto Focus Control (AFC) functions. AFC module collects edge information for at least five programmable zones

2 Auto Focus Solution

There are two basic Auto Focus solutions: embedded auto focus solution and external auto focus solution.

2.1 Embedded Auto Focus Solution

For Embedded auto focus solution, the auto focus function is controlled by the built-in micro-controller of OV5642.



The advantages of embedded auto focus solution include:

The auto focus function is built inside camera module. Baseband or Application Processor could use the module in the same way as fixed focus module.

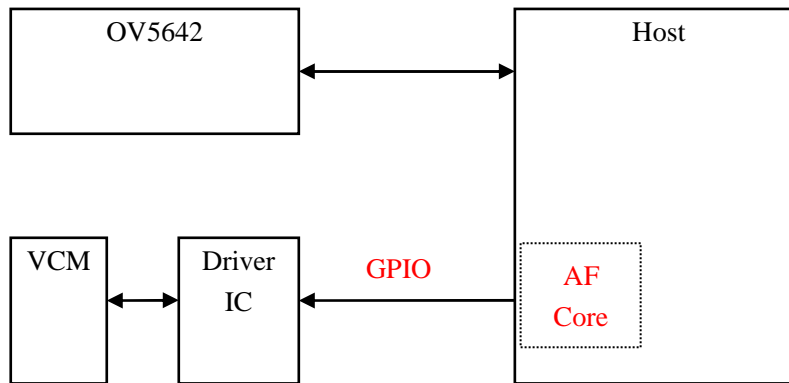
The auto focus information is accessed by built-in micro controller in real time. The auto focus calculation is also done by built-in micro-controller. The speed of auto focus is very fast compared to external auto focus solution.

OmniVision had built-in the embedded auto focus control in firmware of OV5642. This document is only for the firmware of this solution. Currently, the auto focus firmware supports following auto focus camera modules:

1. OV5642 + VCM + AD5820
2. OV5642 + VCM + AD5822
3. OV5642 + VCM + AD5827
4. OV5642 + VCM + DW9710

If you need to support other VCM driver IC, please contact with OmniVision local FAE.

2.2 External Auto Focus Solution



For External AF solution, the auto focus control is implemented in Baseband or Application Processor. Baseband or application processors get auto focus information of OV5642 by SCCB interface. Then it does auto focus calculation and send the actuator control command by I2C. The I2c of actuator could be shared with the SCCB control of OV5642.

The advantage of external auto focus control is that customer could implement its own auto focus algorithms. The disadvantage is the auto focus speed is not as fast as embedded auto focus.

Since embedded auto focus solution has many advantages over external auto focus solution, only embedded auto focus solution is discussed in details in this document.

3 User Interface

3.1 Command and Status Registers

Eight registers are used for OV5642 firmware interface. **The MCU will auto clear *CMD_MAIN* to zero after the command is receipt, and auto clear *CMD_TAG* to zero when ready to receive next command.**

Name	Register	Description	Read/Write	Notes
CMD_MAIN	0x3024	main command	Write only	(1)
CMD_TAG	0x3025	command tag	Write only	
CMD_PARA3	0x5082	parameter hh byte	read/write	
CMD_PARA2	0x5083	parameter hl byte	read/write	
CMD_PARA1	0x5084	parameter lh byte	read/write	
CMD_PARA0	0x5085	parameter ll byte	read/write	
STA_ZONE	0x3026	zone status	read only	
STA_FOCUS	0x3027	focus status	read only	

(1) If the command needs tag and parameters, the main command must be the last register to be sent.

3.2 Main Command Table

Value	Main Command Description	tag/parameters
0x01	<i>Enable Overlay</i>	<i>no</i>
0x02	<i>Disable Overlay</i>	<i>no</i>
0x03	<i>Single focus mode</i>	<i>no</i>
0x04	<i>Const focus mode</i>	<i>no</i>
0x05	<i>Step mode</i>	<i>need</i>
0x06	<i>Pause(const focus mode)</i>	<i>no</i>
0x07	<i>Reserved</i>	<i>*</i>
0x08	<i>Return to Idle mode</i>	<i>no</i>
0x09- 0x0F	<i>Reserved</i>	<i>no</i>
0x10	<i>Set Zone mode</i>	<i>need</i>
0x12	<i>Update Zone</i>	<i>no</i>
...	<i>*</i>	<i>*</i>
0x20	<i>Set Motor mode</i>	<i>need</i>
...	<i>*</i>	<i>*</i>
0x30	<i>Set Scan mode</i>	<i>need</i>
~ 0xFF*	<i>*</i>	<i>*</i>

⚠ For commands without tag/parameter, set the *CMD_TAG* to value that not equal to zero.

3.3 Auto Focus Status



STA_FOCUS is the current focus state:

0xFF	S_FIRMWARE	Firmware is downloaded and not run.
0xFA	S_STARTUP	Firmware is initializing.
0xFE	S_ERROR	Unknown Firmware state
0xEE	S_DRVICERR	Driver IC is not found.
0x00	S_IDLE	Idle state, lens is located at the furthest position.
0x01	S_FOCUSING	Auto Focus is running.
0x02	S_FOCUSED	Auto Focus is stopped.
0x12	S_CAPTURE	Read to capture
0x20	S_STEP	Manual mode

Other values are not defined.



STA_ZONE is the current zone state:

BIT7	Zone 4 is focused
BIT6	Zone 3 is focused
BIT5	Zone 2 is focused
BIT4	Zone 1 is focused
BIT3	Zone 0 is focused
BIT2-BIT0	The Zone ID of current selected zone. The valid value is [0, 4]

4 Firmware User Guide

4.1 Initialization

🕒 Sensor Initialization

Please contact with OmniVision local FAE for OV5642 initialization setting.

🕒 Download firmware to built-in memory

Please contact with OmniVision local FAE to get OV5642 auto focus firmware. The format of firmware is same as register setting file. It should be downloaded to OV5642 as writing register one by one byte. Please don't modify the firmware. After download firmware, Baseband or application processor could also modify other registers (except for some registers internal used by firmware) of OV5642 as fixed focus (FF) applications.

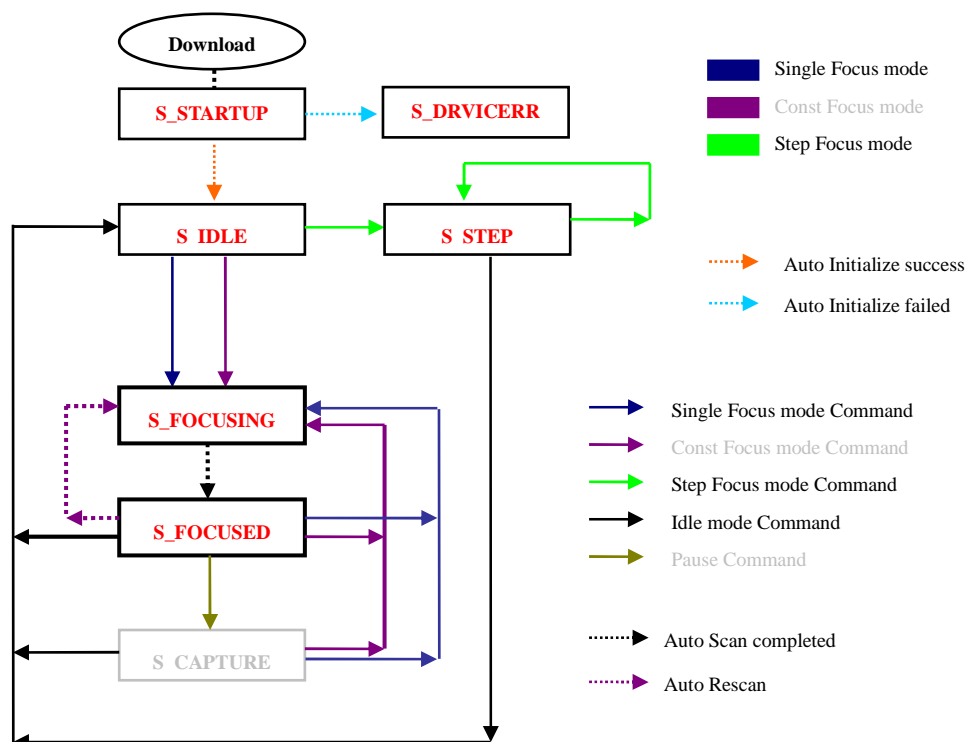
🕒 Host Communicate with firmware to control Auto Focus

Please find more detail information from other sections.

🕒 If reset OV5642, restart the flow.

4.2 State Transition Diagram

The focus state is transmitted after special command or running event.



4.3 Auto Focus Control

The AF function can run in different control mode. **If only Firmware is in S_IDLE state, host can change the control mode for next AF.** At present, the following control modes are support:

- ✓ Motor Driver Mode
- ✓ AF Zone Array Mode
- ✓ AF Zone Selection Mode

4.4 Step Focus Mode Commands

4.4.1 Step to Near Object

CMD_TAG	0x01
CMD_MAIN	0x05

4.4.2 Step to Far Object

CMD_TAG	0x02
CMD_MAIN	0x05

4.4.3 Step to Furthest Object

CMD_TAG	0x03
CMD_MAIN	0x05

4.4.4 Step to Nearest Object

CMD_TAG	0x04
CMD_MAIN	0x05

4.4.5 Step to Specified Position

CMD_TAG	0x10	
CMD_PARA0	Sp	//Specified Position. 0 is Furthest, 255 is nearest.
CMD_MAIN	0x05	

4.4.6 Samples

CMD_TAG	0x03	
CMD_MAIN	0x05	//Reset to furthest

Waiting for CMD_TAG reset to zero

```

CMD_TAG      0x01
CMD_MAIN     0x05  //Move 1 step to near
Waiting for CMD_TAG reset to zero
CMD_TAG      0x01
CMD_MAIN     0x05  //Move 1 step to near
Waiting for CMD_TAG reset to zero
CMD_TAG      0x01
CMD_MAIN     0x05  //Move 1 step to near
Waiting for CMD_TAG reset to zero
CMD_TAG      0x04
CMD_PARA0    0xFF
CMD_MAIN     0x05
Waiting for CMD_TAG reset to zero
CMD_TAG      0x04
CMD_PARA0    0x80
CMD_MAIN     0x05
Waiting for CMD_TAG reset to zero

```

4.5 Auto Focus Sample Flow

- 1) Initialize sensor
- 2) Download firmware to sensor
- 3) Checking for status.
 - If **S_STARTUP**, then retry.
 - If **S_DRVICERR**, then return error.
 - If **S_IDLE**, then continue to 4.
- 4) If not using default Motor Driver mode, change it
- 5) If not using default Scan mode, change it
- 6) If not using default Zone Array mode, change it
- 7) If not using default Zone Selection mode, change it
- 8) Send Single focus mode command to firmware.
- 9) Checking for status.
 - If **FOCUSING**, then retry.
 - If **S_FOCUSED**, then continue to 10.
- 10) If need to focus again, go to 8.
- 11) Host capture image.
- 12) Send idle mode command to firmware.
- 13) Host send setting to change resolution
- 14) Send update zone command (0x12) to firmware.
 - ⚠ If sensor registers about resolution are changed, update zone is needed.**
- 15) Go to 4.

5 Motor Driver Mode

5.1 Normal Driver Mode

5.2 Special Driver Mode

5.3 Motor Driver Mode Setting

Normal Driver mode


CMD_TAG 0x01

CMD_MAIN 0x20

Special Driver mode

CMD_TAG 0x02

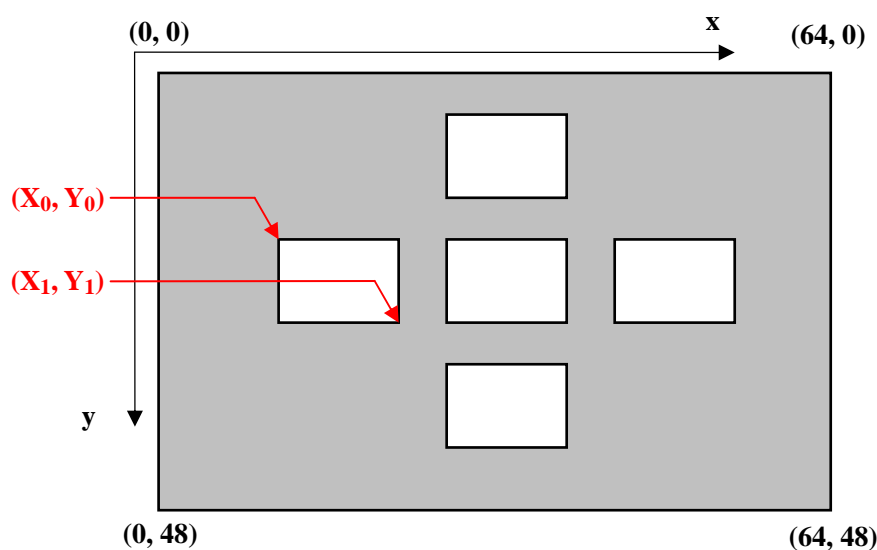
CMD_MAIN 0x20

 Normal motor driver is the default motor driver mode.

6 Auto Focus Zone

The firmware supports 4 Zone Array modes and 2 Zone Selection modes. If special Zone Array mode is required, please contact with OmniVision local FAE.

6.1 Zone(X0, Y0, X1, Y1)

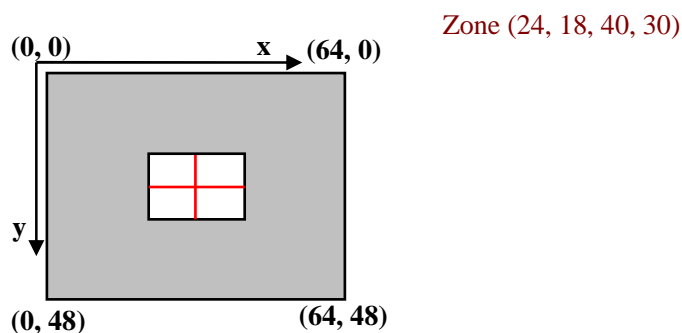


The zone definition is base on the virtual viewfinder (VVF). The full size of VVF is 64 x 48.

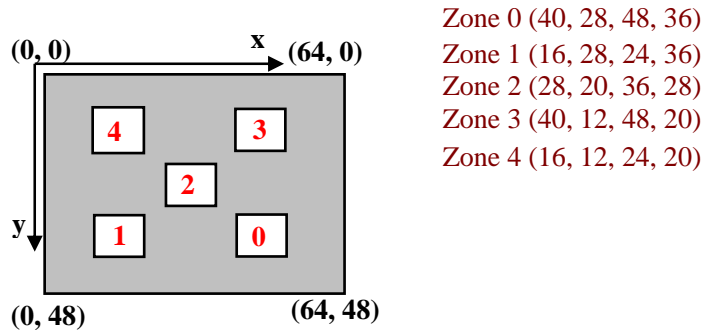
6.2 Zone Array Mode

There are four zone array mode supported: Center mode, 5x mode, 5+ mode and 4f mode. In run-time, the size and position of zones are fixed in Center mode, 5x modes and 5+ mode. If needing to update the zone size and position in run-time, please use 4f mode. If only need to focus on center region, the center mode is better.

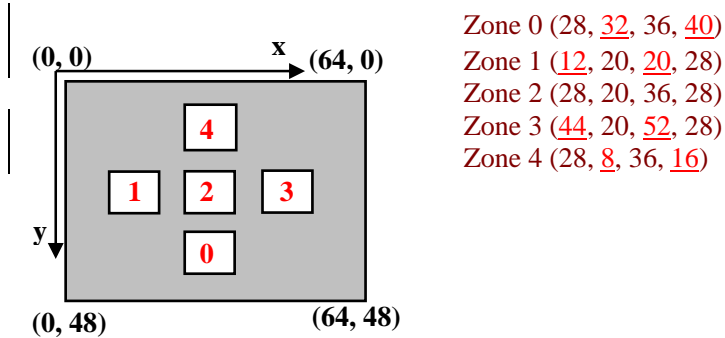
6.2.1 Zone Array Mode 1 – center mode



6.2.2 Zone Array Mode 2 – 5x mode



6.2.3 Zone Array Mode 3 – 5+ mode



6.2.4 Zone Array Mode 4 – 5f mode

In this mode, the four zones (0, 1, 2, 3, and 4) are all free in run-time. All the zones can be defined by User.

6.2.5 Zone Array Mode 5 –float center mode

This mode is same as center mode except the center point is controlled by HOST

6.2.6 Zone Array Mode Setting

🚩 Zone Array Mode 1 – Center mode

CMD_TAG 0x01

CMD_MAIN 0x10

🚩 Zone Array Mode 2 – 5x mode

CMD_TAG 0x02

CMD_MAIN 0x10

Zone Array Mode 3 – 5+ mode


CMD_TAG 0x03
CMD_MAIN 0x10

Zone Array Mode 4 – 5f mode

If you need to support this function, please contact with OmniVision local FAE.

Zone Array Mode 5 – float center mode

CMD_TAG 0x11
CMD_PARA1 Xc // X of Center
CMD_PARA0 Yc // Y of Center
CMD_MAIN 0x10

 Zone Array Mode 1 is the default zone array mode.

6.3 Zone Selection Mode

If there are multi zones, zone selection will decide which zone is the focused zone. For center zone array mode and float center mode, the zone selection mode is invalid. In zone selection mode 2 and 3, the selected zone is updated by host driver.

6.3.1 Zone Selection Mode 1 – Auto Mode

In this mode, system will auto select the focus zone.
This mode is supported in Zone Array Mode 2, 3 and 4.

6.3.2 Zone Selection Mode 2 – Semi Auto Mode

In this mode, system will auto select the focus zone based one the zone selected by user.
This mode is supported in Zone Array Mode 2 and 3.

6.3.3 Zone Selection Mode 3 – Manual Mode

In this mode, the focused zone will be selected by user.
This mode is supported in Zone Array Mode 2, 3 and 4.

6.3.4 Zone Selection Mode Setting

Auto Zone Selection Mode

CMD_TAG 0x0B
CMD_MAIN 0x10

Semi Auto Zone Selection Mode

CMD_TAG 0x0C
CMD_MAIN 0x10

**Manual Zone Selection Mode**

CMD_TAG 0x0D

CMD_MAIN 0x10

**Rotate Selected Zone**

CMD_TAG 0x0E

CMD_MAIN 0x10



Auto Zone selection mode is the default zone selection mode for Zone Array Mode 2, 3 and 4. After Zone Array Mode commands is sent, the auto zone selection will reset to default.



STA_ZONE[2:0] is the current selected zone

7 Update History

July-13-2009 Version 0.10

Firmware Version update to V1.00

Aug-11-2009 Version 0.20

Firmware Version update to V1.05

Aug-11-2009 Version 0.21

Removed the bug about [Step to Specified Position] Command in this document.