# OV5640

# Embedded Firmware User Guide

# - VCM AF Module

Version 1.0

July.2010

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# Contents

# 1 Embedded Resources

- ☑ Embedded Micro-controller
- ☑ 4KB of embedded program memory
- ☑ Embedded VCM Controller.
- ☑ Built-in Auto Focus Control (AFC) functions. AFC module collects edge information for programmable zone.

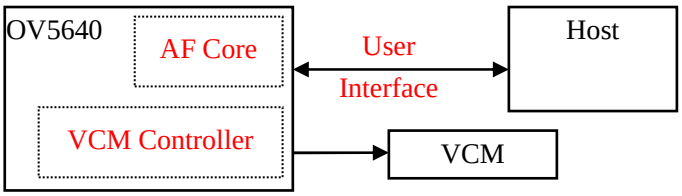
# 2 Auto Focus Solution

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 OV5640.

The advantages of embedded auto focus solution include:



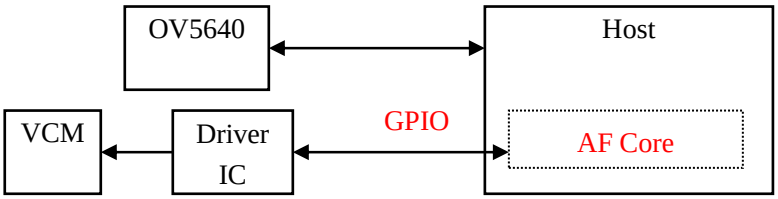

The auto focus function is built inside camera module. Baseband or Application Processor could use the module in the same way as fixed focus module.

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 the firmware of OV5640. This document is only for the firmware of this solution.

## 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 OV5640 by SCCB interface. Then it does auto focus calculation and send the actuator control commend by I2C. The I2c of actuator could be shared with the SCCB control of OV5640.




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 OV5640 firmware interface. **The MCU will auto clear *CMD_MAIN* to zero after the command is receipt, and auto clear *CMD_ACK* to zero when the command is completed.**

| Name | Register | Description | Read/Write | Notes |
|---|---|---|---|---|
| CMD_MAIN | 0x3022 | main command | W | (1) |
| CMD_ACK | 0x3023 | ACK of command | R/W | |
| CMD_PARA0 | 0x3024 | Parameter : Byte 0 | R/W | |
| CMD_PARA1 | 0x3025 | Parameter : Byte 1 | R/W | |
| CMD_PARA2 | 0x3026 | Parameter : Byte 2 | R/W | |
| CMD_PARA3 | 0x3027 | Parameter : Byte 3 | R/W | |
| CMD_PARA4 | 0x3028 | Parameter : Byte 4 | R/W | |
| FW_STATUS | 0x3029 | Running Status of firmware | R | |

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

## 3.2 Main Command Table

| Value | Main Command Description | tag/parameters |
|---|---|---|
| 0x03 | *Trig Auto Focus* | *no* |
| 0x07 | *Get Focus Result* | *need* |
| 0x08 | *Release Focus* | *no* |
| | | |
| 0x12 | *Re-launch Zone Configuration* | *no* |
| | | |
| 0x80 | *Launch default zone configuration* | *no* |
| 0x81 | *Set and launch touch mode zone configuration* | *need* |
| 0x8f | *Enable custom mode zone configuration* | *no* |
| 0x90 | *VVF coordinate: zone 0* | *need* |
| 0x91 | *VVF coordinate: zone 1* | *need* |
| 0x92 | *VVF coordinate: zone 2* | *need* |
| 0x93 | *VVF coordinate: zone 3* | *need* |
| 0x94 | *VVF coordinate: zone 4* | *need* |
| 0x98 | *Set weight of zones* | *need* |
| 0x9f | *Launch custom zone configuration* | *no* |
| | | |
| 0xEC | *Encrypt Command* | *need* |

## 3.3 Running Status of firmware

**FW_STATUS** is the current focus state:

0x7F S_FIRWARE
Firmware is downloaded and not run.

0x7E S_STARTUP
Firmware is initializing.

0x70 S_IDLE
Idle state, focus is released; lens is located at the furthest position.

0x10 S_FOCUSED
Auto Focus is completed.

0x16 S_ZONE_CONFIG
Configure zone mode.

0x00-0x0F, 0x80-0x8F S_FOCUSING
Auto Focus is running.

# 4 Firmware User Guide

## 4.1 Stage - Sensor Init

1) Initialize sensor
2) Download firmware to sensor
3) Checking for the value of **FW_STATUS**.

if value ==S_IDLE
    Continue
else
    Go to 3

## 4.2 Stage - Preview

1) If sensor registers about resolution are changed, **Re-launch Zone Configuration** (Main command: 0x12) command is needed.

OV5640_Write( CMD_ACK, 0x01)
OV5640_Write( CMD_MAIN, 0x12)
Waiting for (OV5640_Read(CMD_ACK)==0)

## 4.3 Stage: Zone Configuration

Please refer to the chapter 5.

## 4.4 Stage: Auto Focus

1) Use **Trig Auto Focus** command to start auto focus

OV5640_Write( CMD_ACK, 0x01)
OV5640_Write( CMD_MAIN, 0x03)
Waiting for (OV5640_Read(CMD_ACK)==0)

2) Get Focus Result

OV5640_Write( CMD_ACK, 0x01)
OV5640_Write( CMD_MAIN, 0x07)
Waiting for (OV5640_Read(CMD_ACK)==0)
S_Zone[0]= OV5640_Read(CMD_PARA0)
S_Zone[1]= OV5640_Read(CMD_PARA1)
S_Zone[2]= OV5640_Read(CMD_PARA2)
S_Zone[3]= OV5640_Read(CMD_PARA3)
S_Zone[4]= OV5640_Read(CMD_PARA4)
if(S_Zone[i]==0) zone i is focused
if no zone is focused, the focus is failed.

## 4.5 Stage: Release Auto Focus

**1)** Use **Release Focus** command to release focus

OV5640_Write( CMD_ACK, 0x01)

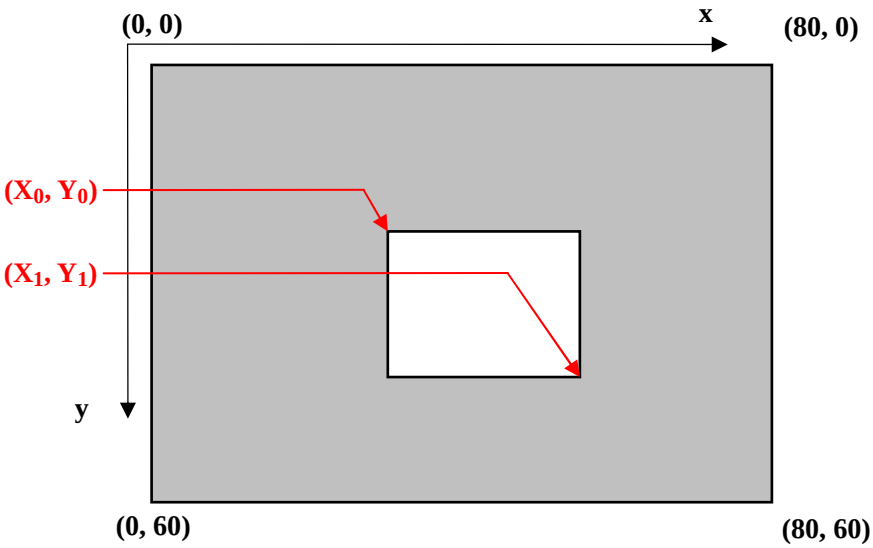
OV5640_Write( CMD_MAIN, 0x08)

Waiting for (OV5640_Read(CMD_ACK)==0)

# 5 Auto Focus Zone Configuration

The firmware supports 3 zone modes. If special Zone mode is required, please contact with OmniVision local FAE.

## 5.1 Zone($X_0$, $Y_0$, $X_1$, $Y_1$)




The zone definition is base on the virtual viewfinder (VVF). The full size of VVF is 80 x 60.

## 5.2 Zone Mode

There are 3 zone mode supported: default zone mode, touch mode, and custom mode. In run-time, the size and position of zones are fixed in default mode, the size is fixed and position can be specified in touch mode. If needing to update the zone size and position in run-time, please use custom mode. If only need to focus on center region, the default mode is better.

### 5.2.1 Zone Mode 1 – Default zone mode

After initialization, this mode is auto launched.

- Zone (32, 24, 48, 36)

- How to launch this mode

```
OV5640_Write( CMD_ACK,    0x01)
OV5640_Write( CMD_MAIN,   0x80)
Waiting for (OV5640_Read(CMD_ACK)==0)
```

### 5.2.2 Zone Mode 2 – Touch zone mode

- ZoneEx($X_0$,$Y_0$, $X_0$+16, $Y_0$+12)
  **Xc<=72**
  **Yc<=54**
  Other values are invalid.

- How to set and launch this mode
  OV5640_Write( CMD_PARA0, $X_0$)
  OV5640_Write( CMD_PARA1, $Y_0$)
  OV5640_Write( CMD_ACK, 0x01)
  OV5640_Write( CMD_MAIN, 0x81)
  Waiting for (OV5640_Read(CMD_ACK)==0)

### 5.2.3 Zone Mode 3 – Custom mode

In this mode, all the zones is free in run-time. The zones can be defined by User.

- Zone($X_0$, $Y_0$, $X_1$, $Y_1$)
  $X_0$ , $X_1$ <=80 , $X_1 – X_0$ >=8
  $Y_0$ , $Y_1$ <=60 , $Y_1 – Y_0$ >=8

  **Note: If need to use zone 0, the $Y_1$ of zone 0 must be the max in the all zones!!!**

- Zone Weight[i] zone=0,1,2,3,4
  0<=ZoneWeight[i]<=8
  ZoneWeight[i] = 0 means this zone is not to be care of .

- How to set and launch this mode
  1. Enable custom mode zone configuration
     OV5640_Write( CMD_ACK, 0x01)
     OV5640_Write( CMD_MAIN, 0x8f)
     Waiting for (OV5640_Read(CMD_ACK)==0)

  2. Set VVF coordinate for Zone i
     OV5640_Write( CMD_PARA0, $X_0$)
     OV5640_Write( CMD_PARA1, $Y_0$)
     OV5640_Write( CMD_PARA2, $X_1$)
     OV5640_Write( CMD_PARA3, $Y_1$)
     OV5640_Write( CMD_ACK, 0x01)
     OV5640_Write( CMD_MAIN, (0x90+i))
     Waiting for (OV5640_Read(CMD_ACK)==0)

3. Set Weight for All zones

OV5640_Write( CMD_PARA0, ZoneWeight[0])
OV5640_Write( CMD_PARA1, ZoneWeight[1])
OV5640_Write( CMD_PARA2, ZoneWeight[2])
OV5640_Write( CMD_PARA3, ZoneWeight[3])
OV5640_Write( CMD_PARA4, ZoneWeight[4])
OV5640_Write( CMD_ACK, 0x01)
OV5640_Write( CMD_MAIN, 0x98)
Waiting for (OV5640_Read(CMD_ACK)==0)

4. Launch custom mode zone configuration

OV5640_Write( CMD_ACK, 0x01)
OV5640_Write( CMD_MAIN, 0x9f)
Waiting for (OV5640_Read(CMD_ACK)==0)

# 6 Update History

- **July 30, 2010 Version 1.0**
  **Firmware Version V1.00**
  **P3-7, new define of STA_STATUS**