

OV5640 SOC Auto Focus Application Notes

Last Modified: Jan 16th, 2012

Document Revision: 1.0

Auto Focus Firmware Verrsion: OV5640-2012STD(12mA-83mA).c

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Content

OV5640 SOC Auto Focus Application Notes.....	1
1. Auto Focus Control.....	3
1.1 Camera Module Reference Design.....	3
1.2 Auto Focus Controlled by SOC Camera.....	3
1.2.1 OV5640 Block Diagram.....	4
1.3 Auto Focus Controlled by Backend ISP.....	5
2. SOC Auto Focus.....	5
2.1 Auto Focus Related Registers of OV5640.....	5
2.2 Download Firmware.....	6
2.3 Function description.....	11
2.4.1 Continuous Auto Focus.....	12
2.4.2 Single Auto Focus.....	12
2.4.3 Touch Auto Focus.....	12
2.4.4 Face Tracking Auto Focus (Face Detection).....	12
2.4.5 Capture.....	12
2.4 Procedure of SOC Auto Focus.....	13
Revision History.....	14

1. Auto Focus Control

OV5640 supports 2 types of auto focus control: auto focus controlled by SOC camera and auto focus controlled by backend ISP.

1.1 Camera Module Reference Design

OV5640 built-in VCM driver is used to control VCM actuator. No external VCM driver required.

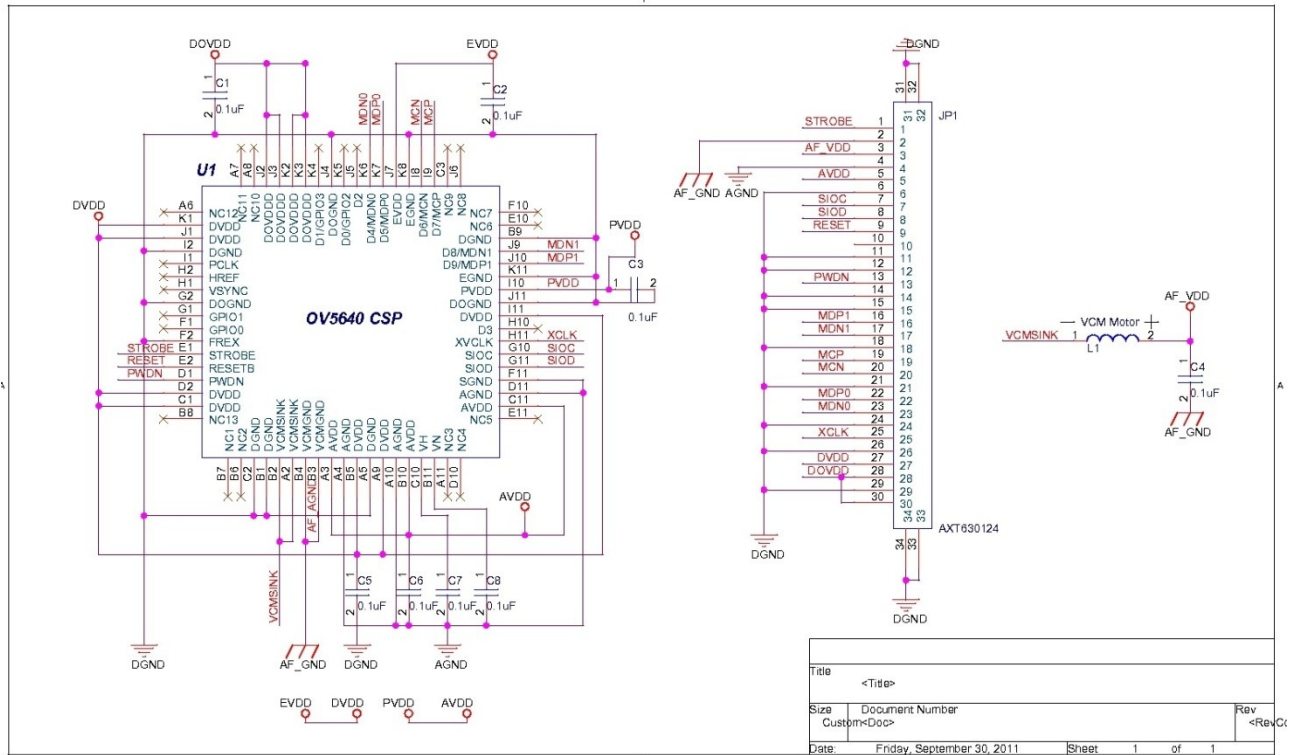


Figure 1 – Schematic of OV5640 auto focus camera module (MIPI output)

1.2 Auto Focus Controlled by SOC Camera

OV5640 camera auto focus is controlled by SOC function of OV5640 sensor.

1.2.1 OV5640 Block Diagram

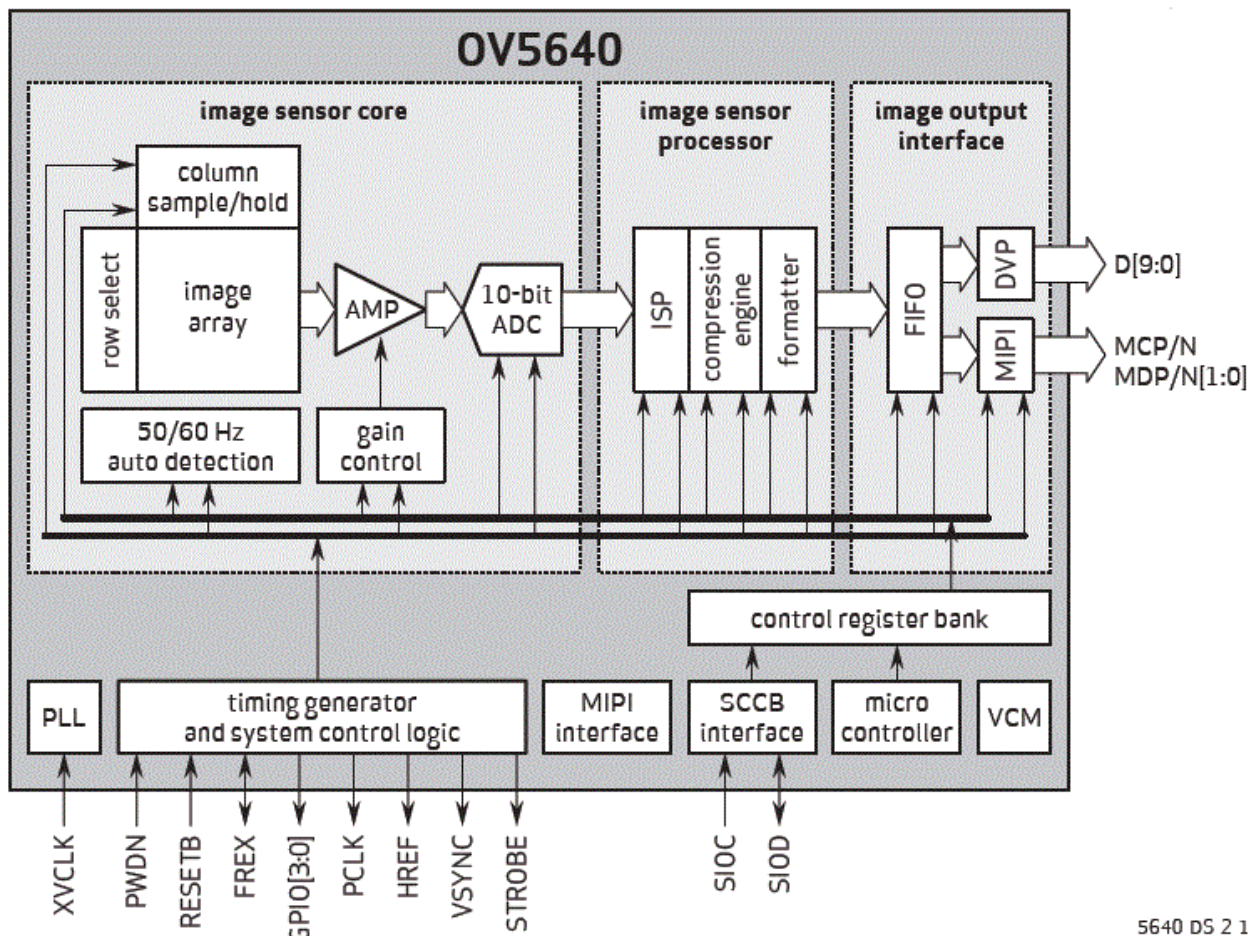


Figure 2 – OV5640 block diagram

The function blocks related to auto focus control includes SCCB interface, register bank, micro-controller and VCM driver. A more detailed block diagram of auto focus function blocks are as below:

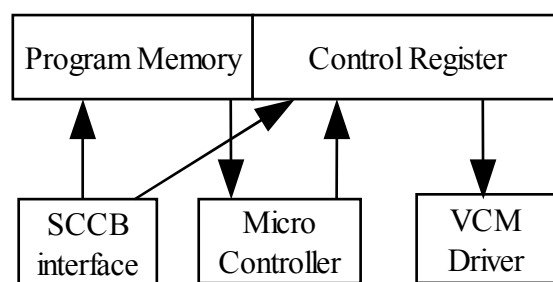


Figure 3 – Block diagram of OV5640 SOC auto focus function

The program area of micro-controlled in mapped into same address space as control registers. The auto focus firmware is downloaded from host into program memory. Micro-controller runs program firmware (auto focus algorithm) and take command from control registers and control VCM driver through control registers.

1.3 Auto Focus Controlled by Backend ISP

If auto focus is controlled by backend ISP, micro-controller of OV5640 is not used. Only VCM

driver is used. The control block diagram is as below:

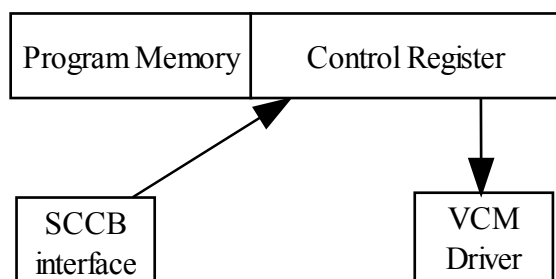


Figure 4 – Block diagram of OV5640 auto focus controlled by backend ISP

The auto focus algorithm is running in host ISP. ISP control VCM actuator movement by VCM driver built-in OV5640. Below is a sample function to control VCM driver built-in OV5640.

```
OV5640_move_focus(int position)
```

2. SOC Auto Focus

To use SOC auto focus of OV5640, we should download firmware into program memory of OV5640 first. Then send command to firmware to control auto focus functions.

2.1 Auto Focus Related Registers of OV5640

The registers below are related to function of auto focus. Please check register settings and make sure that the register settings are set correctly.

Table 1 – Auto focus related registers of OV5640

Function	Related Registers	Comment
Software Reset	0x3008[7]=1, reset 0x3008[7]=1, operation	After software reset, firmware and all register settings are lost. Download firmware is required.
Software Standby	0x3008[6]=1, standby 0x3008[6]=0, operation	VCM should be released before software standby.
MCU on	0x3000[6]=1 0x3000[5]=1 0x3004[6]=1 0x3004[5]=1	Register bits should be set to enable micro-controller.
MCU software reset	0x3f00[0]=1, MCU reset 0x3f00[0]=0, MCU normal operation	Reset firmware only. Firmware and register settings are not changed.
Auto focus on	0x3001[6]=0 0x3005[6]=1	Enable auto focus

2.2 Download Firmware

OV5640 has 4K bytes program memory from SCCB address 0x8000 to 0x8fff. Firmware code

should be downloaded into program memory from host. Please check with OmniVision FAE for up to date firmware code.

Firmware is downloaded into program memory by SCCB write operation. To minimize firmware download time, SCCB speed of 400K is recommended and SCCB group write is recommended.

Below is a sample of firmware code and sample C function to download firmware code into program memory.

Please contact with OmniVision local FAE to get auto focus firmware update.

```
int firmware[]={
    //0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07, 0x08, 0x09, 0x0a, 0x0b, 0x0c, 0x0d, 0x0e, 0x0f
    0x02, 0x0f, 0xd6, 0x02, 0x0a, 0x39, 0xc2, 0x01, 0x22, 0x22, 0x00, 0x02, 0x0f, 0xb2, 0xe5, 0x1f, //0x8000,
    0x70, 0x72, 0xf5, 0x1e, 0xd2, 0x35, 0xff, 0xef, 0x25, 0xe0, 0x24, 0x4e, 0xf8, 0xe4, 0xf6, 0x08, //0x8010,
    0xf6, 0x0f, 0xbf, 0x34, 0xf2, 0x90, 0x0e, 0x93, 0xe4, 0x93, 0xff, 0xe5, 0x4b, 0xc3, 0x9f, 0x50, //0x8020,
    0x04, 0x7f, 0x05, 0x80, 0x02, 0x7f, 0xfb, 0x78, 0xbd, 0xa6, 0x07, 0x12, 0x0f, 0x04, 0x40, 0x04, //0x8030,
    0x7f, 0x03, 0x80, 0x02, 0x7f, 0x30, 0x78, 0xbc, 0xa6, 0x07, 0xe6, 0x18, 0xf6, 0x08, 0xe6, 0x78, //0x8040,
    0xb9, 0xf6, 0x78, 0xbc, 0xe6, 0x78, 0xba, 0xf6, 0x78, 0xbf, 0x76, 0x33, 0xe4, 0x08, 0xf6, 0x78, //0x8050,
    0xb8, 0x76, 0x01, 0x75, 0x4a, 0x02, 0x78, 0xb6, 0xf6, 0x08, 0xf6, 0x74, 0xff, 0x78, 0xc1, 0xf6, //0x8060,
    0x08, 0xf6, 0x75, 0x1f, 0x01, 0x78, 0xbc, 0xe6, 0x75, 0xf0, 0x05, 0xa4, 0xf5, 0x4b, 0x12, 0x0a, //0x8070,
    0xff, 0xc2, 0x37, 0x22, 0x78, 0xb8, 0xe6, 0xd3, 0x94, 0x00, 0x40, 0x02, 0x16, 0x22, 0xe5, 0x1f, //0x8080,
    0xb4, 0x05, 0x23, 0xe4, 0xf5, 0x1f, 0xc2, 0x01, 0x78, 0xb6, 0xe6, 0xfe, 0x08, 0xe6, 0xff, 0x78, //0x8090,
    0x4e, 0xa6, 0x06, 0x08, 0xa6, 0x07, 0xa2, 0x37, 0xe4, 0x33, 0xf5, 0x3c, 0x90, 0x30, 0x28, 0xf0, //0x80a0,
    0x75, 0x1e, 0x10, 0xd2, 0x35, 0x22, 0xe5, 0x4b, 0x75, 0xf0, 0x05, 0x84, 0x78, 0xbc, 0xf6, 0x90, //0x80b0,
    0x0e, 0x8c, 0xe4, 0x93, 0xff, 0x25, 0xe0, 0x24, 0x0a, 0xf8, 0xe6, 0xfc, 0x08, 0xe6, 0xfd, 0x78, //0x80c0,
    0xbc, 0xe6, 0x25, 0xe0, 0x24, 0x4e, 0xf8, 0xa6, 0x04, 0x08, 0xa6, 0x05, 0xef, 0x12, 0x0f, 0x0b, //0x80d0,
    0xd3, 0x78, 0xb7, 0x96, 0xee, 0x18, 0x96, 0x40, 0xd0, 0x78, 0xbc, 0xe6, 0x78, 0xb9, 0xf6, 0x78, //0x80e0,
    0xb6, 0xa6, 0x06, 0x08, 0xa6, 0x07, 0x90, 0x0e, 0x8c, 0xe4, 0x93, 0x12, 0x0f, 0x0b, 0xc3, 0x78, //0x80f0,
    0xc2, 0x96, 0xee, 0x18, 0x96, 0x50, 0xd0, 0x78, 0xbc, 0xe6, 0x78, 0xba, 0xf6, 0x78, 0xc1, 0xa6, //0x8100,
    0x06, 0x08, 0xa6, 0x07, 0x78, 0xb6, 0xe6, 0xfe, 0x08, 0xe6, 0xc3, 0x78, 0xc2, 0x96, 0xff, 0xee, //0x8110,
    0x18, 0x96, 0x78, 0xc3, 0xf6, 0x08, 0xa6, 0x07, 0x90, 0x0e, 0x95, 0xe4, 0x18, 0x12, 0x0e, 0xe9, //0x8120,
    0x40, 0x02, 0xd2, 0x37, 0x78, 0xbc, 0xe6, 0x08, 0x26, 0x08, 0xf6, 0xe5, 0x1f, 0x64, 0x01, 0x70, //0x8130,
    0x4a, 0xe6, 0xc3, 0x78, 0xc0, 0x12, 0x0e, 0xdf, 0x40, 0x05, 0x12, 0x0e, 0xda, 0x40, 0x39, 0x12, //0x8140,
    0x0f, 0x02, 0x40, 0x04, 0x7f, 0xfe, 0x80, 0x02, 0x7f, 0x02, 0x78, 0xbd, 0xa6, 0x07, 0x78, 0xb9, //0x8150,
    0xe6, 0x24, 0x03, 0x78, 0xbf, 0xf6, 0x78, 0xb9, 0xe6, 0x24, 0xfd, 0x78, 0xc0, 0xf6, 0x12, 0x0f, //0x8160,
    0x02, 0x40, 0x06, 0x78, 0xc0, 0xe6, 0xff, 0x80, 0x04, 0x78, 0xbf, 0xe6, 0xff, 0x78, 0xbe, 0xa6, //0x8170,
    0x07, 0x75, 0x1f, 0x02, 0x78, 0xb8, 0x76, 0x01, 0x02, 0x02, 0x4a, 0xe5, 0x1f, 0x64, 0x02, 0x60, //0x8180,
    0x03, 0x02, 0x02, 0x2a, 0x78, 0xbe, 0xe6, 0xff, 0xc3, 0x78, 0xc0, 0x12, 0x0e, 0xe0, 0x40, 0x08, //0x8190,
    0x12, 0x0e, 0xda, 0x50, 0x03, 0x02, 0x02, 0x28, 0x12, 0x0f, 0x02, 0x40, 0x04, 0x7f, 0xff, 0x80, //0x81a0,
    0x02, 0x7f, 0x01, 0x78, 0xbd, 0xa6, 0x07, 0x78, 0xb9, 0xe6, 0x04, 0x78, 0xbf, 0xf6, 0x78, 0xb9, //0x81b0,
    0xe6, 0x14, 0x78, 0xc0, 0xf6, 0x18, 0x12, 0x0f, 0x04, 0x40, 0x04, 0xe6, 0xff, 0x80, 0x02, 0x7f, //0x81c0,
    0x00, 0x78, 0xbf, 0xa6, 0x07, 0xd3, 0x08, 0xe6, 0x64, 0x80, 0x94, 0x80, 0x40, 0x04, 0xe6, 0xff, //0x81d0,
    0x80, 0x02, 0x7f, 0x00, 0x78, 0xc0, 0xa6, 0x07, 0xc3, 0x18, 0xe6, 0x64, 0x80, 0x94, 0xb3, 0x50, //0x81e0,
    0x04, 0xe6, 0xff, 0x80, 0x02, 0x7f, 0x33, 0x78, 0xbf, 0xa6, 0x07, 0xc3, 0x08, 0xe6, 0x64, 0x80, //0x81f0,
    0x94, 0xb3, 0x50, 0x04, 0xe6, 0xff, 0x80, 0x02, 0x7f, 0x33, 0x78, 0xc0, 0xa6, 0x07, 0x12, 0x0f, //0x8200,
    0x02, 0x40, 0x06, 0x78, 0xc0, 0xe6, 0xff, 0x80, 0x04, 0x78, 0xbf, 0xe6, 0xff, 0x78, 0xbe, 0xa6, //0x8210,
    0x07, 0x75, 0x1f, 0x03, 0x78, 0xb8, 0x76, 0x01, 0x80, 0x20, 0xe5, 0x1f, 0x64, 0x03, 0x70, 0x26, //0x8220,
    0x78, 0xbe, 0xe6, 0xff, 0xc3, 0x78, 0xc0, 0x12, 0x0e, 0xe0, 0x40, 0x05, 0x12, 0x0e, 0xda, 0x40, //0x8230,
    0x09, 0x78, 0xb9, 0xe6, 0x78, 0xbe, 0xf6, 0x75, 0x1f, 0x04, 0x78, 0xbe, 0xe6, 0x75, 0xf0, 0x05, //0x8240,
    0xa4, 0xf5, 0x4b, 0x02, 0x0a, 0xff, 0xe5, 0x1f, 0xb4, 0x04, 0x10, 0x90, 0x0e, 0x94, 0xe4, 0x78, //0x8250,
    0xc3, 0x12, 0x0e, 0xe9, 0x40, 0x02, 0xd2, 0x37, 0x75, 0x1f, 0x05, 0x22, 0x30, 0x01, 0x03, 0x02, //0x8260,
    0x04, 0xc0, 0x30, 0x02, 0x03, 0x02, 0x04, 0xc0, 0x90, 0x51, 0xa5, 0xe0, 0x78, 0x93, 0xf6, 0xa3, //0x8270,
    0xe0, 0x08, 0xf6, 0xa3, 0xe0, 0x08, 0xf6, 0xe5, 0x1f, 0x70, 0x3c, 0x75, 0x1e, 0x20, 0xd2, 0x35, //0x8280,
    0x12, 0x0c, 0x7a, 0x78, 0x7e, 0xa6, 0x06, 0x08, 0xa6, 0x07, 0x78, 0x8b, 0xa6, 0x09, 0x18, 0x76, //0x8290,
    0x01, 0x12, 0x0c, 0x5b, 0x78, 0x4e, 0xa6, 0x06, 0x08, 0xa6, 0x07, 0x78, 0x8b, 0xe6, 0x78, 0x6e, //0x82a0,
    0xf6, 0x75, 0x1f, 0x01, 0x78, 0x93, 0xe6, 0x78, 0x90, 0xf6, 0x78, 0x94, 0xe6, 0x78, 0x91, 0xf6, //0x82b0,
    0x78, 0x95, 0xe6, 0x78, 0x92, 0xf6, 0x22, 0x79, 0x90, 0xe7, 0xd3, 0x78, 0x93, 0x96, 0x40, 0x05, //0x82c0,
    0xe7, 0x96, 0xff, 0x80, 0x08, 0xc3, 0x79, 0x93, 0xe7, 0x78, 0x90, 0x96, 0xff, 0x78, 0x88, 0x76, //0x82d0,
    0x00, 0x08, 0xa6, 0x07, 0x79, 0x91, 0xe7, 0xd3, 0x78, 0x94, 0x96, 0x40, 0x05, 0xe7, 0x96, 0xff, //0x82e0,
    0x80, 0x08, 0xc3, 0x79, 0x94, 0xe7, 0x78, 0x91, 0x96, 0xff, 0x12, 0x0c, 0x8e, 0x79, 0x92, 0xe7, //0x82f0,
    0xd3, 0x78, 0x95, 0x96, 0x40, 0x05, 0xe7, 0x96, 0xff, 0x80, 0x08, 0xc3, 0x79, 0x95, 0xe7, 0x78, //0x8300,
    0x92, 0x96, 0xff, 0x12, 0x0c, 0x8e, 0x12, 0x0c, 0x5b, 0x78, 0x8a, 0xe6, 0x25, 0xe0, 0x24, 0x4e, //0x8310,
    0xf8, 0xa6, 0x06, 0x08, 0xa6, 0x07, 0x78, 0x8a, 0xe6, 0x24, 0x6e, 0xf8, 0xa6, 0x09, 0x78, 0x8a, //0x8320,
    0xe6, 0x24, 0x01, 0xff, 0xe4, 0x33, 0xfe, 0xd3, 0xef, 0x94, 0x0f, 0xee, 0x64, 0x80, 0x94, 0x80, //0x8330,
```


0x40, 0x04, 0x7f, 0x00, 0x80, 0x05, 0x78, 0x8a, 0xe6, 0x04, 0xff, 0x78, 0x8a, 0xa6, 0x07, 0xe5, //0x8340,
 0x1f, 0xb4, 0x01, 0x0a, 0xe6, 0x60, 0x03, 0x02, 0x04, 0xc0, 0x75, 0x1f, 0x02, 0x22, 0x12, 0x0c, //0x8350,
 0x7a, 0x78, 0x80, 0xa6, 0x06, 0x08, 0xa6, 0x07, 0x12, 0x0c, 0x7a, 0x78, 0x82, 0xa6, 0x06, 0x08, //0x8360,
 0xa6, 0x07, 0x78, 0x6e, 0xe6, 0x81, 0x78, 0x8c, 0xf6, 0x78, 0x6e, 0xe6, 0x78, 0x8d, 0xf6, 0x7f, 0x01, //0x8370,
 0xef, 0x25, 0xe0, 0x24, 0x4f, 0xf9, 0xc3, 0x78, 0x81, 0xe6, 0x97, 0x18, 0xe6, 0x19, 0x97, 0x50, //0x8380,
 0x0a, 0x12, 0x0c, 0x82, 0x78, 0x80, 0xa6, 0x04, 0x08, 0xa6, 0x05, 0x74, 0x6e, 0x2f, 0xf9, 0x78, //0x8390,
 0x8c, 0xe6, 0xc3, 0x97, 0x50, 0x08, 0x74, 0x6e, 0x2f, 0xf8, 0xe6, 0x78, 0x8c, 0xf6, 0xef, 0x25, //0x83a0,
 0xe0, 0x24, 0x4f, 0xf9, 0xd3, 0x78, 0x83, 0xe6, 0x97, 0x18, 0xe6, 0x19, 0x97, 0x40, 0x0a, 0x12, //0x83b0,
 0x0c, 0x82, 0x78, 0x82, 0xa6, 0x04, 0x08, 0xa6, 0x05, 0x74, 0x6e, 0x2f, 0xf9, 0x78, 0x8d, 0xe6, //0x83c0,
 0xd3, 0x97, 0x40, 0x08, 0x74, 0x6e, 0x2f, 0xf8, 0xe6, 0x78, 0x8d, 0xf6, 0x0f, 0xef, 0x64, 0x10, //0x83d0,
 0x70, 0x9e, 0xc3, 0x79, 0x81, 0x78, 0x83, 0x96, 0xc3, 0xf6, 0x19, 0xe7, 0x18, 0x96, 0x08, 0x84, //0x83e0,
 0xf6, 0x08, 0xa6, 0x07, 0xc3, 0x79, 0x8c, 0xe7, 0x78, 0x8d, 0x96, 0x08, 0xf6, 0xd3, 0x79, 0x81, //0x83f0,
 0xe7, 0x78, 0x7f, 0x96, 0x19, 0xe7, 0x18, 0x96, 0x40, 0x05, 0x09, 0xe7, 0x08, 0x80, 0x06, 0xc3, //0x8400,
 0x79, 0x7f, 0xe7, 0x78, 0x81, 0x96, 0xff, 0x19, 0xe7, 0x18, 0x96, 0xfe, 0x78, 0x86, 0xa6, 0x06, //0x8410,
 0x08, 0xa6, 0x07, 0x79, 0x8c, 0xe7, 0xd3, 0x78, 0x8b, 0x96, 0x40, 0x05, 0xe7, 0x96, 0xff, 0x80, //0x8420,
 0x08, 0xc3, 0x79, 0x8b, 0xe7, 0x78, 0x8c, 0x96, 0xff, 0x78, 0x8f, 0xa6, 0x07, 0xe5, 0x1f, 0x64, //0x8430,
 0x02, 0x70, 0x69, 0x90, 0x0e, 0x91, 0x93, 0xff, 0x18, 0xe6, 0xc3, 0x9f, 0x50, 0x72, 0x12, 0x0c, //0x8440,
 0x4a, 0x12, 0x0c, 0x2f, 0x90, 0x0e, 0x8e, 0x12, 0x0c, 0x38, 0x78, 0x80, 0x12, 0x0c, 0x6b, 0x7b, //0x8450,
 0x04, 0x12, 0x0c, 0x1d, 0xc3, 0x12, 0x06, 0x45, 0x50, 0x56, 0x90, 0x0e, 0x92, 0xe4, 0x93, 0xff, //0x8460,
 0x78, 0x8f, 0xe6, 0x9f, 0x40, 0x02, 0x80, 0x11, 0x90, 0x0e, 0x90, 0xe4, 0x93, 0xff, 0xd3, 0x78, //0x8470,
 0x89, 0xe6, 0x9f, 0x18, 0xe6, 0x94, 0x00, 0x40, 0x03, 0x75, 0x1f, 0x05, 0x12, 0x0c, 0x4a, 0x12, //0x8480,
 0x0c, 0x2f, 0x90, 0x0e, 0x8f, 0x12, 0x0c, 0x38, 0x78, 0x7e, 0x12, 0x0c, 0x6b, 0x7b, 0x40, 0x12, //0x8490,
 0x0c, 0x1d, 0xd3, 0x12, 0x06, 0x45, 0x40, 0x18, 0x75, 0x1f, 0x05, 0x22, 0xe5, 0x1f, 0xb4, 0x05, //0x84a0,
 0x0f, 0xd2, 0x01, 0xc2, 0x02, 0xe4, 0xf5, 0x1f, 0xf5, 0x1e, 0xd2, 0x35, 0xd2, 0x33, 0xd2, 0x36, //0x84b0,
 0x22, 0xef, 0x8d, 0xf0, 0xa4, 0xa8, 0xf0, 0xc3, 0x8c, 0xf0, 0xa4, 0x28, 0xce, 0x8d, 0xf0, 0xa4, //0x84c0,
 0x2e, 0xfe, 0x22, 0xbc, 0x00, 0x0b, 0xbe, 0x00, 0x29, 0xef, 0x8d, 0xf0, 0x84, 0xff, 0xad, 0xf0, //0x84d0,
 0x22, 0xe4, 0xcc, 0xf8, 0x75, 0xf0, 0x08, 0xef, 0x2f, 0xff, 0xee, 0x33, 0xfe, 0xec, 0x33, 0xfc, //0x84e0,
 0xee, 0x9d, 0xec, 0x98, 0x40, 0x05, 0xfc, 0xee, 0x9d, 0xfe, 0x0f, 0xd5, 0xf0, 0xe9, 0xe4, 0xce, //0x84f0,
 0xfd, 0x22, 0xed, 0xf8, 0xf5, 0xf0, 0xee, 0x84, 0x20, 0xd2, 0x1c, 0xfe, 0xad, 0xf0, 0x75, 0xf0, //0x8500,
 0x08, 0xef, 0x2f, 0xff, 0xed, 0x33, 0xfd, 0x40, 0x07, 0x98, 0x50, 0x06, 0xd5, 0xf0, 0xf2, 0x22, //0x8510,
 0xc3, 0x98, 0xfd, 0x0f, 0xd5, 0xf0, 0xea, 0x22, 0xe8, 0x8f, 0xf0, 0xa4, 0xcc, 0x8b, 0xf0, 0xa4, //0x8520,
 0x2c, 0xfc, 0xe9, 0x8e, 0xf0, 0xa4, 0x2c, 0xfc, 0x8a, 0xf0, 0xed, 0xa4, 0x2c, 0xfc, 0xea, 0x8e, //0x8530,
 0xf0, 0xa4, 0xcd, 0xa8, 0xf0, 0x8b, 0xf0, 0xa4, 0x2d, 0xcc, 0x38, 0x25, 0xf0, 0xfd, 0xe9, 0x8f, //0x8540,
 0xf0, 0xa4, 0x2c, 0xcd, 0x35, 0xf0, 0xfc, 0xeb, 0x8e, 0xf0, 0xa4, 0xfe, 0xa9, 0xf0, 0xeb, 0x8f, //0x8550,
 0xf0, 0xa4, 0xcf, 0xc5, 0xf0, 0x2e, 0xcd, 0x39, 0xfe, 0xe4, 0x3c, 0xfc, 0xea, 0xa4, 0x2d, 0xce, //0x8560,
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 0x9a, 0xec, 0x99, 0xe5, 0x82, 0x98, 0x40, 0x0c, 0xf5, 0x82, 0xee, 0x9b, 0xfe, 0xed, 0x9a, 0xfd, //0x8590,
 0xec, 0x99, 0xfc, 0x0f, 0xd5, 0xf0, 0xd6, 0xe4, 0xce, 0xfb, 0xe4, 0xcd, 0xfa, 0xe4, 0xcc, 0xf9, //0x85a0,
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 0x99, 0xfb, 0x0f, 0xd8, 0xe5, 0xe4, 0xf9, 0xfa, 0x22, 0x78, 0x18, 0xef, 0x2f, 0xff, 0xee, 0x33, //0x85e0,
 0xfe, 0xed, 0x33, 0xfd, 0xec, 0x33, 0xfc, 0xc9, 0x33, 0xc9, 0x10, 0xd7, 0x05, 0x9b, 0xe9, 0x9a, //0x85f0,
 0x40, 0x07, 0xec, 0x9b, 0xfc, 0xe9, 0x9a, 0xf9, 0x0f, 0xd8, 0xe0, 0xe4, 0xc9, 0xfa, 0xe4, 0xcc, //0x8600,
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0x08, 0x76, 0x08, 0xc3, 0x78, 0x5d, 0xe6, 0x94, 0x08, 0x18, 0xe6, 0x94, 0x00, 0x50, 0x05, 0x76, //0x87d0,
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0x3e, 0x46, 0x85, 0x3d, 0x45, 0x80, 0x06, 0x02, 0x06, 0xd7, 0x12, 0x0d, 0x7e, 0x90, 0x30, 0x24, //0x8a10,
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0x03, 0xd3, 0x80, 0x01, 0xc3, 0x92, 0x09, 0x30, 0x02, 0x06, 0x30, 0x33, 0x03, 0xd3, 0x80, 0x01, //0x8a90,
0xc3, 0x92, 0x0a, 0x30, 0x33, 0x0c, 0x30, 0x03, 0x09, 0x20, 0x02, 0x06, 0x20, 0x01, 0x03, 0xd3, //0x8aa0,
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0xe5, 0x32, 0x30, 0xe1, 0x14, 0x30, 0x34, 0x11, 0x90, 0x30, 0x22, 0xe0, 0xf5, 0x08, 0xe4, 0xf0, //0x8ac0,
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0xf6, 0x18, 0xe6, 0x9e, 0xf6, 0x22, 0xff, 0xe5, 0xf0, 0x34, 0x60, 0x8f, 0x82, 0xf5, 0x83, 0xec, //0x8ba0,
0xf0, 0x22, 0x78, 0x52, 0x7e, 0x00, 0xe6, 0xfc, 0x08, 0xe6, 0xfd, 0x02, 0x04, 0xc1, 0xe4, 0xfc, //0x8bb0,
0xfd, 0x12, 0x06, 0x99, 0x78, 0x5c, 0xe6, 0xc3, 0x13, 0xfe, 0x08, 0xe6, 0x13, 0x22, 0x78, 0x52, //0x8bc0,
0xe6, 0xfe, 0x08, 0xe6, 0xff, 0xe4, 0xfc, 0xfd, 0x22, 0x7e, 0xc4, 0xf8, 0x54, 0xf0, 0xc8, 0x68, //0x8bd0,
0xf7, 0x09, 0xe7, 0xc4, 0x54, 0x0f, 0x48, 0xf7, 0x22, 0xe6, 0xfc, 0xed, 0x75, 0xf0, 0x04, 0xa4, //0x8be0,
0x22, 0x12, 0x06, 0x7c, 0x8f, 0x48, 0x8e, 0x47, 0x8d, 0x46, 0x8c, 0x45, 0x22, 0xe0, 0xfe, 0xa3, //0x8bf0,


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0xe0, 0xfd, 0xee, 0xf6, 0xed, 0x08, 0xf6, 0x22, 0x13, 0xff, 0xc3, 0xe6, 0x9f, 0xff, 0x18, 0xe6, //0x8c00,
0x9e, 0xfe, 0x22, 0xe6, 0xc3, 0x13, 0xf7, 0x08, 0xe6, 0x13, 0x09, 0xf7, 0x22, 0xad, 0x39, 0xac, //0x8c10,
0x38, 0xfa, 0xf9, 0xf8, 0x12, 0x05, 0x28, 0x8f, 0x3b, 0x8e, 0x3a, 0x8d, 0x39, 0x8c, 0x38, 0xab, //0x8c20,
0x37, 0xaa, 0x36, 0xaf, 0x35, 0xa8, 0x34, 0x22, 0x93, 0xff, 0xe4, 0xfc, 0xfd, 0xfe, 0x12, 0x05, //0x8c30,
0x28, 0x8f, 0x37, 0x8e, 0x36, 0x8d, 0x35, 0x8c, 0x34, 0x22, 0x78, 0x84, 0xe6, 0xfe, 0x08, 0xe6, //0x8c40,
0xff, 0xe4, 0x8f, 0x37, 0x8e, 0x36, 0xf5, 0x35, 0xf5, 0x34, 0x22, 0x90, 0x0e, 0x8c, 0xe4, 0x93, //0x8c50,
0x25, 0xe0, 0x24, 0x0a, 0xf8, 0xe6, 0xfe, 0x08, 0xe6, 0xff, 0x22, 0xe6, 0xfe, 0x08, 0xe6, 0xff, //0x8c60,
0xe4, 0x8f, 0x3b, 0x8e, 0x3a, 0xf5, 0x39, 0xf5, 0x38, 0x22, 0x78, 0x4e, 0xe6, 0xfe, 0x08, 0xe6, //0x8c70,
0xff, 0x22, 0xef, 0x25, 0xe0, 0x24, 0x4e, 0xf8, 0xe6, 0xfc, 0x08, 0xe6, 0xfd, 0x22, 0x78, 0x89, //0x8c80,
0xef, 0x26, 0xf6, 0x18, 0xe4, 0x36, 0xf6, 0x22, 0x75, 0x89, 0x03, 0x75, 0xa8, 0x01, 0x75, 0xb8, //0x8c90,
0x04, 0x75, 0x34, 0xff, 0x75, 0x35, 0x0e, 0x75, 0x36, 0x15, 0x75, 0x37, 0x0d, 0x12, 0x0e, 0x9a, //0x8ca0,
0x12, 0x00, 0x09, 0x12, 0x0f, 0x16, 0x12, 0x00, 0x06, 0xd2, 0x00, 0xd2, 0x34, 0xd2, 0xaf, 0x75, //0x8cb0,
0x34, 0xff, 0x75, 0x35, 0x0e, 0x75, 0x36, 0x49, 0x75, 0x37, 0x03, 0x12, 0x0e, 0x9a, 0x30, 0x08, //0x8cc0,
0x09, 0xc2, 0x34, 0x12, 0x08, 0xcb, 0xc2, 0x08, 0xd2, 0x34, 0x30, 0x0b, 0x09, 0xc2, 0x36, 0x12, //0x8cd0,
0x02, 0x6c, 0xc2, 0x0b, 0xd2, 0x36, 0x30, 0x09, 0x09, 0xc2, 0x36, 0x12, 0x00, 0x0e, 0xc2, 0x09, //0x8ce0,
0xd2, 0x36, 0x30, 0x0e, 0x03, 0x12, 0x06, 0xd7, 0x30, 0x35, 0xd3, 0x90, 0x30, 0x29, 0xe5, 0x1e, //0x8cf0,
0xf0, 0xb4, 0x10, 0x05, 0x90, 0x30, 0x23, 0xe4, 0xf0, 0xc2, 0x35, 0x80, 0xc1, 0xe4, 0xf5, 0x4b, //0x8d00,
0x90, 0x0e, 0x7a, 0x93, 0xff, 0xe4, 0x8f, 0x37, 0xf5, 0x36, 0xf5, 0x35, 0xf5, 0x34, 0xaf, 0x37, //0x8d10,
0xae, 0x36, 0xad, 0x35, 0xac, 0x34, 0x90, 0x0e, 0x6a, 0x12, 0x0d, 0xf6, 0x8f, 0x37, 0x8e, 0x36, //0x8d20,
0x8d, 0x35, 0x8c, 0x34, 0x90, 0x0e, 0x72, 0x12, 0x06, 0x7c, 0xef, 0x45, 0x37, 0xf5, 0x37, 0xee, //0x8d30,
0x45, 0x36, 0xf5, 0x36, 0xed, 0x45, 0x35, 0xf5, 0x35, 0xec, 0x45, 0x34, 0xf5, 0x34, 0xe4, 0xf5, //0x8d40,
0x22, 0xf5, 0x23, 0x85, 0x37, 0x31, 0x85, 0x36, 0x30, 0x85, 0x35, 0x2f, 0x85, 0x34, 0x2e, 0x12, //0x8d50,
0x0f, 0x46, 0xe4, 0xf5, 0x22, 0xf5, 0x23, 0x90, 0x0e, 0x72, 0x12, 0x0d, 0xea, 0x12, 0x0f, 0x46, //0x8d60,
0xe4, 0xf5, 0x22, 0xf5, 0x23, 0x90, 0x0e, 0x6e, 0x12, 0x0d, 0xea, 0x02, 0x0f, 0x46, 0xe5, 0x40, //0x8d70,
0x24, 0xf2, 0xf5, 0x37, 0xe5, 0x3f, 0x34, 0x43, 0xf5, 0x36, 0xe5, 0x3e, 0x34, 0xa2, 0xf5, 0x35, //0x8d80,
0xe5, 0x3d, 0x34, 0x28, 0xf5, 0x34, 0xe5, 0x37, 0xff, 0xe4, 0xfe, 0xfd, 0xfc, 0x78, 0x18, 0x12, //0x8d90,
0x06, 0x69, 0x8f, 0x40, 0x8e, 0x3f, 0x8d, 0x3e, 0x8c, 0x3d, 0xe5, 0x37, 0x54, 0xa0, 0xff, 0xe5, //0x8da0,
0x36, 0xfe, 0xe4, 0xfd, 0xfc, 0x78, 0x07, 0x12, 0x06, 0x56, 0x78, 0x10, 0x12, 0x0f, 0x9a, 0xe4, //0x8db0,
0xff, 0xfe, 0xe5, 0x35, 0xfd, 0xe4, 0xfc, 0x78, 0x0e, 0x12, 0x06, 0x56, 0x12, 0x0f, 0x9d, 0xe4, //0x8dc0,
0xff, 0xfe, 0xfd, 0xe5, 0x34, 0xfc, 0x78, 0x18, 0x12, 0x06, 0x56, 0x78, 0x08, 0x12, 0x0f, 0x9a, //0x8dd0,
0x22, 0x8f, 0x3b, 0x8e, 0x3a, 0x8d, 0x39, 0x8c, 0x38, 0x22, 0x12, 0x06, 0x7c, 0x8f, 0x31, 0x8e, //0x8de0,
0x30, 0x8d, 0x2f, 0x8c, 0x2e, 0x22, 0x93, 0xf9, 0xf8, 0x22, 0x06, 0x69, 0x00, 0x00, 0x00, 0x00, //0x8df0,
0x12, 0x01, 0x17, 0x08, 0x31, 0x15, 0x53, 0x54, 0x44, 0x20, 0x20, 0x20, 0x20, 0x20, 0x13, 0x01, //0x8e00,
0x10, 0x01, 0x56, 0x40, 0x1a, 0x30, 0x29, 0x7e, 0x00, 0x30, 0x04, 0x20, 0xdf, 0x30, 0x05, 0x40, //0x8e10,
0xbf, 0x50, 0x03, 0x00, 0xfd, 0x50, 0x27, 0x01, 0xfe, 0x60, 0x00, 0x11, 0x00, 0x3f, 0x05, 0x30, //0x8e20,
0x00, 0x3f, 0x06, 0x22, 0x00, 0x3f, 0x01, 0x2a, 0x00, 0x3f, 0x02, 0x00, 0x00, 0x36, 0x06, 0x07, //0x8e30,
0x00, 0x3f, 0x0b, 0x0f, 0xf0, 0x00, 0x00, 0x00, 0x00, 0x30, 0x01, 0x40, 0xbf, 0x30, 0x01, 0x00, //0x8e40,
0xbf, 0x30, 0x29, 0x70, 0x00, 0x3a, 0x00, 0x00, 0xff, 0x3a, 0x00, 0x00, 0xff, 0x36, 0x03, 0x36, //0x8e50,
0x02, 0x41, 0x44, 0x58, 0x20, 0x18, 0x10, 0x0a, 0x04, 0x04, 0x00, 0x03, 0xff, 0x64, 0x00, 0x00, //0x8e60,
0x80, 0x00, 0x00, 0x00, 0x00, 0x00, 0x02, 0x04, 0x06, 0x06, 0x00, 0x03, 0x51, 0x00, 0x7a, //0x8e70,
0x50, 0x3c, 0x28, 0x1e, 0x10, 0x10, 0x50, 0x2d, 0x28, 0x16, 0x10, 0x10, 0x02, 0x00, 0x10, 0x0c, //0x8e80,
0x10, 0x04, 0x0c, 0x6e, 0x06, 0x05, 0x00, 0xa5, 0x5a, 0x00, 0xae, 0x35, 0xaf, 0x36, 0xe4, 0xfd, //0x8e90,
0xed, 0xc3, 0x95, 0x37, 0x50, 0x33, 0x12, 0x0f, 0xe2, 0xe4, 0x93, 0xf5, 0x38, 0x74, 0x01, 0x93, //0x8ea0,
0xf5, 0x39, 0x45, 0x38, 0x60, 0x23, 0x85, 0x39, 0x82, 0x85, 0x38, 0x83, 0xe0, 0xfc, 0x12, 0x0f, //0x8eb0,
0xe2, 0x74, 0x03, 0x93, 0x52, 0x04, 0x12, 0x0f, 0xe2, 0x74, 0x02, 0x93, 0x42, 0x04, 0x85, 0x39, //0x8ec0,
0x82, 0x85, 0x38, 0x83, 0xec, 0xf0, 0xd, 0x80, 0xc7, 0x22, 0x78, 0xbe, 0xe6, 0xd3, 0x08, 0xff, //0x8ed0,
0xe6, 0x64, 0x80, 0xf8, 0xef, 0x64, 0x80, 0x98, 0x22, 0x93, 0xff, 0x7e, 0x00, 0xe6, 0xfc, 0x08, //0x8ee0,
0xe6, 0xfd, 0x12, 0x04, 0xc1, 0x78, 0xc1, 0xe6, 0xfc, 0x08, 0xe6, 0xfd, 0xd3, 0xef, 0x9d, 0xee, //0x8ef0,
0x9c, 0x22, 0x78, 0xbd, 0xd3, 0xe6, 0x64, 0x80, 0x94, 0x80, 0x22, 0x25, 0xe0, 0x24, 0x0a, 0xf8, //0x8f00,
0xe6, 0xfe, 0x08, 0xe6, 0xff, 0x22, 0xe5, 0x3c, 0xd3, 0x94, 0x00, 0x40, 0x0b, 0x90, 0x0e, 0x88, //0x8f10,
0x12, 0x0b, 0xf1, 0x90, 0x0e, 0x86, 0x80, 0x09, 0x90, 0x0e, 0x82, 0x12, 0x0b, 0xf1, 0x90, 0x0e, //0x8f20,
0x80, 0xe4, 0x93, 0xf5, 0x44, 0xa3, 0xe4, 0x93, 0xf5, 0x43, 0xd2, 0x06, 0x30, 0x06, 0x03, 0xd3, //0x8f30,
0x80, 0x01, 0xc3, 0x92, 0x0e, 0x22, 0xa2, 0xaf, 0x92, 0x32, 0xc2, 0xaf, 0xe5, 0x23, 0x45, 0x22, //0x8f40,
0x90, 0x0e, 0x5d, 0x60, 0x0e, 0x12, 0x0f, 0xcb, 0xe0, 0xf5, 0x2c, 0x12, 0x0f, 0xc8, 0xe0, 0xf5, //0x8f50,
0x2d, 0x80, 0x0c, 0x12, 0x0f, 0xcb, 0xe5, 0x30, 0xf0, 0x12, 0x0f, 0xc8, 0xe5, 0x31, 0xf0, 0xa2, //0x8f60,
0x32, 0x92, 0xaf, 0x22, 0xd2, 0x01, 0xc2, 0x02, 0xe4, 0xf5, 0x1f, 0xf5, 0x1e, 0xd2, 0x35, 0xd2, //0x8f70,
0x33, 0xd2, 0x36, 0xd2, 0x01, 0xc2, 0x02, 0xf5, 0x1f, 0xf5, 0x1e, 0xd2, 0x35, 0xd2, 0x33, 0x22, //0x8f80,
0xfb, 0xd3, 0xed, 0x9b, 0x74, 0x80, 0xf8, 0x6c, 0x98, 0x22, 0x12, 0x06, 0x69, 0xe5, 0x40, 0x2f, //0x8f90,
0xf5, 0x40, 0xe5, 0x3f, 0x3e, 0xf5, 0x3f, 0xe5, 0x3e, 0x3d, 0xf5, 0x3e, 0xe5, 0x3d, 0x3c, 0xf5, //0x8fa0,
0x3d, 0x22, 0xc0, 0xe0, 0xc0, 0x83, 0xc0, 0x82, 0x90, 0x3f, 0x0d, 0xe0, 0xf5, 0x33, 0xe5, 0x33, //0x8fb0,
0xf0, 0xd0, 0x82, 0xd0, 0x83, 0xd0, 0xe0, 0x32, 0x90, 0x0e, 0x5f, 0xe4, 0x93, 0xfe, 0x74, 0x01, //0x8fc0,
0x93, 0xf5, 0x82, 0x8e, 0x83, 0x22, 0x78, 0x7f, 0xe4, 0xf6, 0xd8, 0xfd, 0x75, 0x81, 0xcd, 0x02, //0x8fd0,
0x0c, 0x98, 0x8f, 0x82, 0x8e, 0x83, 0x75, 0xf0, 0x04, 0xed, 0x02, 0x06, 0xa5, //0x8fe0

```

```
};
```

```
// I2C single write
```

```
int OV5640_write_i2c(int address, int data);
```

```
// I2c group write
```

```
int OV5640_write_i2c_group(int address, int* data, int length);
```

```
// download firmware by single i2c write
```

```
int OV5640_download_firmware()
{
    int i, length, address;

    OV5640_write_i2c(0x3000, 0x20);    // reset MCU

    length = sizeof(firmware)/sizeof(int);
    address = 0x8000;
    for(i=0; i<length; i++) {
        OV5640_write_i2c(address, firmware[i]);
        address++;
    }

    OV5640_write_i2c(0x3022, 0x00);
    OV5640_write_i2c(0x3023, 0x00);
    OV5640_write_i2c(0x3024, 0x00);
    OV5640_write_i2c(0x3025, 0x00);
    OV5640_write_i2c(0x3026, 0x00);
    OV5640_write_i2c(0x3027, 0x00);
    OV5640_write_i2c(0x3028, 0x00);
    OV5640_write_i2c(0x3029, 0x7f);
    OV5640_write_i2c(0x3000, 0x00);    // start firmware

    return 0;
}
```

```
// download firmware by group i2c write
```

```
int OV5640_download_firmware_group()
{
    int i, j, length, address, group;
    int group_size = 255;

    OV5640_write_i2c(0x3000, 0x20);    // reset MCU

    length = sizeof(firmware)/sizeof(int);
    address = 0x8000;
    group = int(length/group_size);

    // download firmware in group
    for(i=0; i<group; i++) {
        OV5640_write_i2c_group(address, &(firmware[i*group_size]), group_size);
        i++;
    }

    // download firmware less than 1 group
    address = i*group_size;
    for (j=i*group_size; j<length; j++) {
        OV5640_write_i2c(address, firmware[j]);
        address++;
    }

    OV5640_write_i2c(0x3022, 0x00);
    OV5640_write_i2c(0x3023, 0x00);
    OV5640_write_i2c(0x3024, 0x00);
    OV5640_write_i2c(0x3025, 0x00);
    OV5640_write_i2c(0x3026, 0x00);
    OV5640_write_i2c(0x3027, 0x00);
    OV5640_write_i2c(0x3028, 0x00);
    OV5640_write_i2c(0x3029, 0x7f);
    OV5640_write_i2c(0x3000, 0x00);    // start firmware

    return 0;
}
```

2.3 Function description

Auto focus functions are controlled by auto focus command which is write to command registers by host. The address of command registers are listed in table 2 below. The command registers should be set to initial value after firmware download.

Table 2 – Auto focus command registers

Address	Initial value	explanation
0x3022	0x00	Main command
0x3023	0x00	flag of command
0x3024	0x00	Argument 1
0x3025	0x00	Argument 2
0x3026	0x00	reserved
0x3027	0x00	reserved
0x3028	0x00	Status of command
0x3029	0x7f	reserved

The auto focus function of OV5640 is listed in table 3

Table 3 – OV5640 auto focus command

Command	0x3022	0x3023	0x3024	0x3025	0x3023	Comment
Single Focus	0x03	0x01	-	-	0: command finished	Check register 0x3028 0: fail other: success
Continuous Focus	0x04	0x01	-	-	0: command set	Firmware auto detect change of scene and trigger auto focus
Pause auto focus	0x06	0x01	-	-	0: command finished	Auto focus paused, VCM stay in current position. VCM current is on.
Release focus	0x08	0x01	-	-	0: command finished	Auto focus paused, VCM release to infinite. VCM current is turned off.
Set Focus Zone	0x81	0x01	X center	Y center	0: command finished	Set focus zone based virtual view finder (VVF). Used for touch auto focus and face tracking auto focus.
Re-launch default focus zone	0x80	0x01	-	-	0: command finished	Re-launch default focus zone.

2.4.1 Continuous Auto Focus

OV5640 SOC auto focus supports continuous auto focus. Continuous auto focus should be enabled when enter preview or video mode, paused before capture.

2.4.2 Single Auto Focus

OV5640 SOC auto focus supports single auto focus. Single auto focus should be triggered when snap key is pressed.

2.4.3 Touch Auto Focus

OV5640 SOC auto focus supports touch auto focus. When user touch screen, application get touch position and set to firmware by 'Set Focus Zone'.

2.4.4 Face Tracking Auto Focus (Face Detection)

OV5640 SOC auto focus supports face tracking auto focus. Though face detection software could find multiple faces, because of limitation of OV5640 program memory, only 1 face could be used as auto focus window. Application should select on face and set position of face by 'Set Focus Zone'

2.4.5 Capture

Before capture picture, auto focus should be paused to keep VCM at focus position. After capture picture, VCM should be released to infinite position.

2.4 Procedure of SOC Auto Focus

1. Sensor power up

2. Send initial setting
3. Download the auto focus firmware, and delay 10ms.
4. Waiting for the complete signal from auto focus firmware.
Read 0x3029, if the value equal to 0x70, go to step 5. Otherwise, delay 5ms and loop. (After firmware start, the default ratio of focus zone is 4:3.)
5. Start preview/video (setting for preview/video resolution, etc.).
6. If the ratio of resolution is changed, set re-launch default focus zone command (refer to table 3) .
7. If continue focus mode is on, set continue focus command (refer to table 3).
8. Running in preview/video mode
9. Waiting for capture signal, if not signal, loop.
10. If capture signal for Single focus, go to step 15.
11. If capture signal for touch focus, go to step 13.
12. If capture signal for continue focus, go to step 17.
13. set coordinate for the touch position:
 $X_c = (X \text{ in the preview window} * 80) / \text{width of the preview window};$
 $Y_c = (Y \text{ in the preview window} * 60) / \text{height of the preview window};$ //for 4:3 aspect ratio
 $Y_c = (Y \text{ in the preview window} * 45) / \text{height of the preview window};$ // for other aspect ratio
14. Launch touch focus zone (refer to table 3). After command is completed, delay 5ms.
15. Single focus command (0x03, refer to table 3).
16. If needed, update the color of overlay on the screen according to the focus result. Go to step 18.
17. Pause auto focus command (refer to table 3). After command is completed, delay 5ms.
18. Change sensor output resolution to capture size, capture image
19. Release command (0x08, refer to section table 3).
20. Go to step 5.

Revision History

R 1.0 Initial Release.