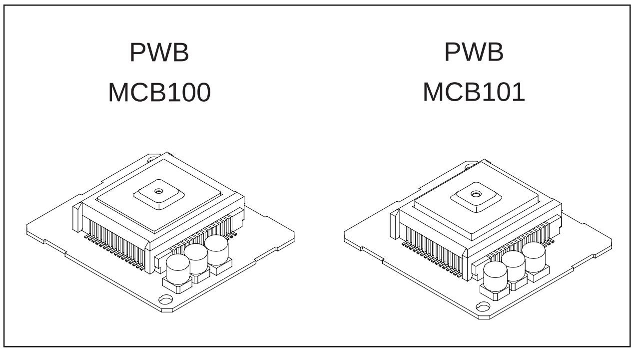
MCB100/101

Color CCD Camera Module

1. Features

The MCB100/101 are color CCD camera modules equipped with the micro unit CCD (MUC), MCX18N00A/B.

- Single +5V power supply (approximately 1.2W)
- NTSC video output
- AE with backlight compensation, auto trace type AWB function
- Small size (40.0mm × 36.5mm)



2. Options

2-1. MCB100EVB

This is a RS232C level shift circuit, and is connected between CN502 and the RS232C port of a personal computer.
An RS232C extension cable (DB9/male – DB9/female) is necessary for connection to a personal computer.

3. Part Names

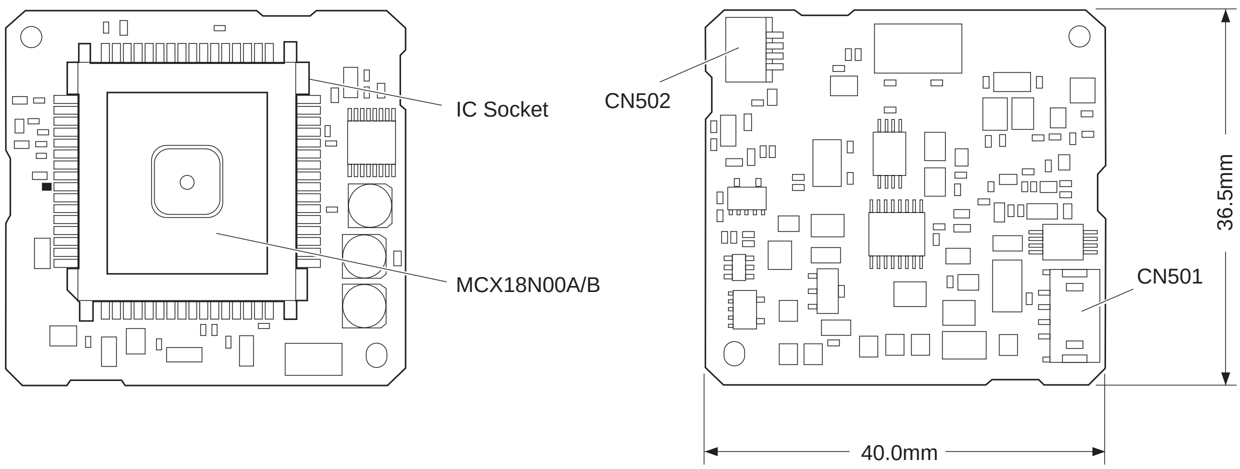


Fig. 3-1. Part Names

Table 3-1. CN501 Pin Arrangement

Pin No.	Signal
1	+5.0V
2	GND
3	GND
4	VIDEO output

Table 3-2. CN502 Pin Arrangement

Pin No.	Signal
1	SO
2	SI
3	+5.0V
4	GND

Note) The CN502 connector is for adjustment.

E97660A87

4. Connections

4-1. Board-mounted Connectors

CN501: J.S.T. Mfg. Co., Ltd.
ZR connector, 1.5mm pitch
S 4B-ZR-SM3A-TF

CN502: J.S.T. Mfg. Co., Ltd.
ZR connector, 1.0mm pitch
SM04B-SRSS-TB

4-2. Power Supply

The following DC power supply is required. (The current value is approximate.)
+5.0V (240mA)

Note) The MCB100/101 does not have an overcurrent protection circuit, so the supply voltage feed side must have a protective circuit or fuse to prevent smoke due to short circuits, etc.

4-3. Monitor

This module has an NTSC composite video output.
(1Vp-p, 75Ω, sync negative polarity)
Use a monitor with an NTSC video input.

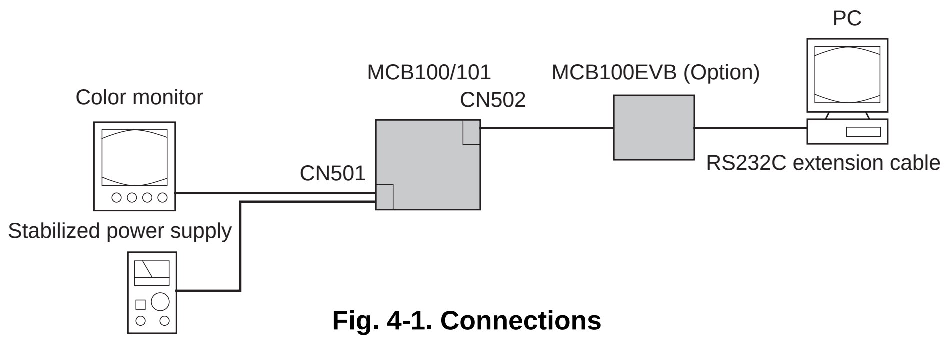


Fig. 4-1. Connections

5. Mounting Method

Fix the module using tapping screws with a nominal diameter of 2.0mm in the two mounting holes.

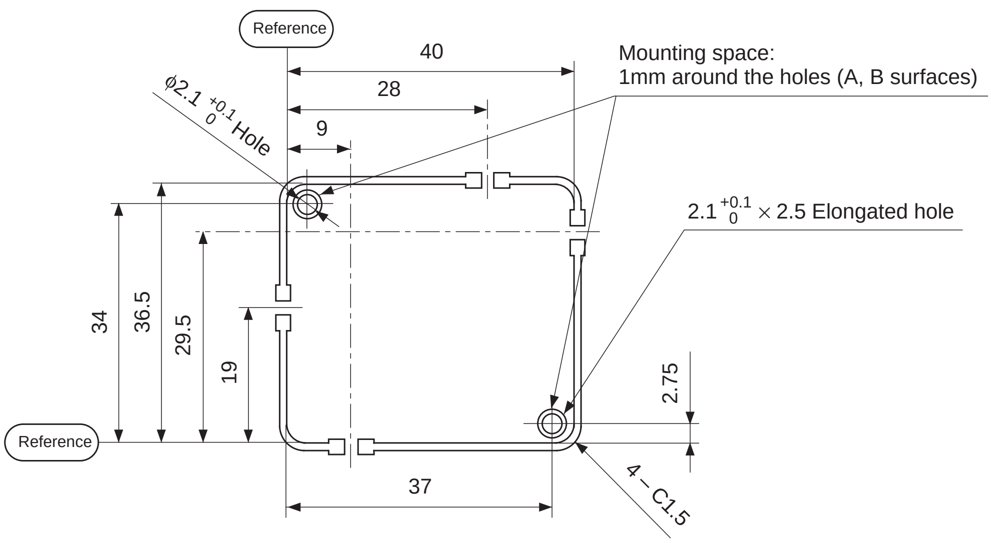


Fig. 5-1. Mounting Hole Positions

6. Characteristic Phenomenon of CCD Image Sensors

The following phenomenon may occur depending on the conditions of use.

6-1. Smear
When imaging a high luminosity subject, the light may stretch in a band above and below the subject.

6-2. Patterned Noise
When operated at high temperatures, noise with a certain pattern may appear over the entire screen.

6-3. Reflected Distortion
When imaging vertical stripes or lines, the lines may appear jagged.

6-4. Image Retention
If CCD image sensors are exposed to strong light for long periods, the color filters may become discolored.

7. Product Specifications

Image sensor:	1/5-inch interline transfer system CCD
Color filters:	Ye, Cy, Mg and G complementary color mosaic filters
Number of effective pixels:	362 (H) × 492 (V)
Total number of pixels:	381 (H) × 506 (V)
Unit cell size:	8.10µm (H) × 4.45µm (V)
Optical black:	H: Front 2 pixels, rear 17 pixels, V: Front 12 pixels, rear 2 pixels
Number of dummy bits:	H: 14, V: 1 (EVEN fields only)

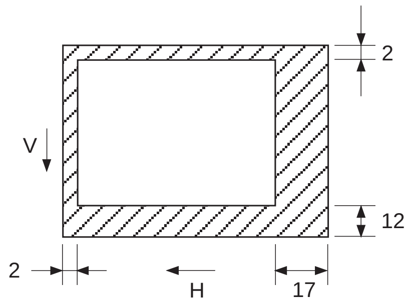


Fig. 7-1 Optical Black

Lens:	MCB100: F2.8, f = 2.9mm
	MCB101: F2.8, f = 4.0mm
Signal system:	EIAJ standard NTSC color system
Scanning system:	525 scanning lines, 2:1 interlace, approximately 30 frames/s
Sync system:	Internal
Horizontal resolution:	Approximately 220 TV lines (in the center of the screen)
Minimum subject illumination:	40 lux (F2.8, AGC: ON)
Sensitivity:	2,000 lux (F2.8, AGC: ON)
Video output:	VBS: 1Vp-p, 75Ω, sync negative polarity
Video S/N:	40dB or more (AGC: OFF)

AE	(factory settings)	
	Backlight compensation:	Weighted average only (Histogram compensation OFF)
	Flickerless:	OFF
	Convergence level:	100 IRE
	AGC maximum gain:	Approximately 30dB
	AGC minimum gain:	Approximately 10dB
	Response speed:	Approximately 1s
	Electronic shutter:	1/60 to 1/100,000s
White balance	(factory settings)	
	Mode:	ATW (Auto trace)
	Pull-in range:	All areas
	Response speed:	Approximately 10s
Input pins	SI, SCK	
	H level minimum:	V+ = 2.53V
	L level maximum:	V– = 0.69V
	Hysteresis:	TH = 0.6V
	Input leak current:	IL = –10 to +10µA
Output pins	SO	
	H level minimum:	VOH = V_{CC} – 0.8 V (IOH = –1.2mA)
	L level maximum:	VOL = 0.4V (IOL = 2.4mA)
Supply voltage	V_{CC}	
	DC 4.75 to 5.25V	
Power consumption:	Approximately 1.2W	
Operating temperature:	0 to +40°C	
Storage temperature:	–30 to +80°C	
Package dimensions:	MCB100: 40.0 × 36.5 × 12.9 mm	
	MCB101: 40.0 × 36.5 × 14.1 mm	
Mass:	12g	

8. Service Information

8-1. MUC Removal

The IC socket for mounting the MUC on the MCB100/101 is not designed for repeated insertion and removal. Therefore, avoid frequent MUC replacement and use a special tool when removing the MUC.

8-2. MUC Mounting

Align MUC Pin 1 (marked with a small square pattern on the side of the case) with IC socket Pin 1 (indicated by a square mark in the IC socket land on the board) when mounting the MUC.

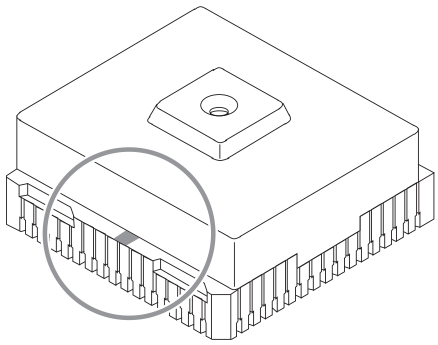


Fig. 8-1. MUC Pin 1

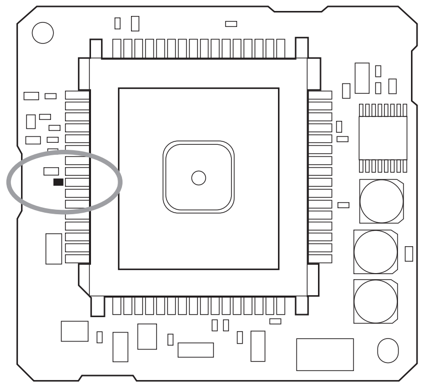


Fig. 8-2. IC Socket Pin 1 Indication

8-3. Static Charge Prevention

The MUC are easily damaged by static discharge. Be sure to take sufficient protective measures before handling.

8-4. Lens Dust and Dirt Protection

Operate in clean environments. Also, do not either touch the lens by hand or allow any object to come into contact with the lens surface. Should dirt stick to the lens surface, blow it off with an air blower. Clean with a cotton bud and ethyl alcohol if grease stained. Be careful not to scratch the lens.

9. Description of Circuits

9-1. MUC Block

The MUC contains a CCD image sensor that changes light into electric signals. A total of 192,786 photo sensors arranged on the chip surface of this CCD image sensor: 381 in the horizontal direction and 506 in the vertical direction. Of these, 362 in the horizontal direction and 492 in the vertical direction for a total of 178,104 photo sensors are valid pixels which output signals according to the brightness. The photo sensors convert light into electric charges that correspond to the brightness. These converted electric charges are read from the photo sensors to the transfer block and then led sequentially to the output block. The transfer block has 506 vertical transfer blocks in the vertical direction of the screen, and one horizontal transfer block. The charges converted by the photo sensors are transferred to the vertical transfer blocks adjoining each photo sensor once every field, and these charges are then transferred sequentially to the horizontal transfer block. The horizontal transfer block sends the charges to the output block where they are converted to a voltage

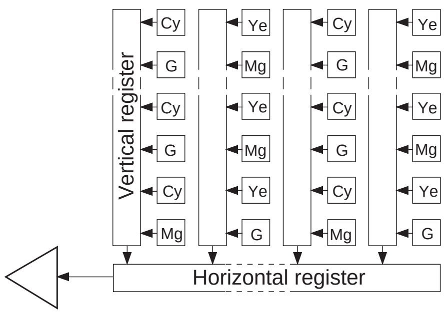


Fig. 9-1. CCD Image Sensor

The output signal from the CCD image sensor passes through a buffer and is then output from CCD OUT of the MUC. As this output signal is modulated by a clock of approximately 6.75MHz, the video signal is separated from this signal and sample-and-hold works to eliminate low frequency noise. The separated video signal passes through the AGC amplifier, is preblanked and clamped, and is then output from SHOUT. SHOUT is directly connected to SHIN, and the signal input from SHIN is A/D converted and processed as a digital signal.

The signal processing block first clamps the optical black to the reference, and then passes the signal through two 1H delay lines in order to achieve synchronization. (The current, 1H previous, and 2H previous lines are synchronized.)

Luminance (Y) signal processing mainly uses the 1H previous signal. The signal from the CCD image sensor has a chroma component, so this component is eliminated, gamma correction is applied, and setup, blanking and SYNC are added to create the Y signal.

Chroma signal processing uses the current and 2H previous signals added together and the 1H previous signal. These signals are phase separated, band limited, and then broken down into R, G and B using a matrix. The white balance of these R, G and B signals is controlled by the AWB controller and then gamma correction is performed to form the R-G and B-G signals. Next, the clock for these R-G and B-G signals is changed to 14.31818MHz (4Fsc), the hue and gain are controlled, blanking and burst signals are added, and the signals are modulated at 3.58MHz.

The Y and C signals are D/A converted and output from IOY and IOC as currents.

The MUC's internal timing generator generates the pulses necessary for driving the CCD image sensor and for signal processing. A built-in 27MHz (OSC) oscillation inverter is located between OSCI and OSCO, and an oscillation crystal vibrator, load capacitance and feedback resistance are connected to these pins to comprise the oscillation circuit. The 27MHz generated here is input to CK and used to generate the various pulses in sync with the HD and VD generated by the signal processing block. The MUC's internal signal processing block inputs the 13.5MHz (MCK = OSC/2) generated by the timing generator in order to generate the pulses required to create the NTSC video signal.

The electronic shutter is realized by controlling the accumulation time by superimposing the electric-charge sweep pulse SUBOUT (amplitude approximately 23V) onto the CCD image sensor substrate voltage (VSUB). The electric-charge sweep pulse SUBOUT is superimposed onto DC voltage DCOUT and then input to SUBIN. The electric-charge sweep pulse SUBOUT is output from the timing generator block in accordance with the shutter speed calculated by the MUC's internal AE controller.

The voltage (VSUB value) applied to SUBIN differs for each individual MUC, and must be adjusted in the range of +5 to +12.75V. This voltage is indicated in symbol form on the rear surface of the MUC. The MUC has a built-in DC amplifier between DCIN and DCOUT. DC voltage controlled in the range of approximately 0 to 5V is input from the EVR D/A to DCIN, and DCIN is adjusted to the indicated VSUB value.

9-2. EEPROM/EVR

The EVR generates various DC voltages such as the AGC control voltage used by the MUC and the VSUB voltage of the CCD image sensor.

The EEPROM stores the parameters needed for MUC operation.

9-3. VIDEO Output Block

The Y signal of the MUC passes through an LPF to eliminate the digital noise. The C signal is modulated by a rectangular wave and shaped into a sine wave. After that, the Y and C signals are mixed, the level is compensated and the impedance is converted to 75Ω by the video driver, and the signal is output.

9-4. Power Supply Block

Four power supplies: –8V, +3.3V, +5V and +15V are required to drive the MUC. The –8V and +15V supply voltages are created from the +5V by a DC/DC converter, and the +3.3V is created by the Pin 3 regulator.

10. Description of Functions

10-1. Operation During Power-on

Operation from the field after the power is turned on and clear is released is as follows.

Table 10-1. Operation During Power-on

Field	Operation	Description
1	Check for EEPROM presence.	
2	Check address 0 (h), then read data from the EEPROM to the buffer.	If the data is 9D (h), the EEPROM is valid and bytes 1 to 32 of the data are loaded to the buffer.
3	Read data from the EEPROM to the buffer.	Bytes 33 to 64 are loaded to the buffer.
4	Read data from the EEPROM to the buffer. Read the buffer data to the internal registers. Read the gain and hue for the 1st quadrant.	Bytes 65 to 96 are loaded to the buffer. The parameters for the internal controller are initialized by the EEPROM contents.
5	Read the gain and hue for the 2nd quadrant.	
6	Read the gain and hue for the 3rd quadrant.	
7	Read the gain and hue for the 4th quadrant. Start internal controller processing.	
8	Normal status	

10-2. AE

10-2-1. Operation

AE is performed by the electronic shutter and AGC control. First the AGC gain is set to the minimum limit and exposure control is performed with the electronic shutter. When exposure is insufficient even with the maximum exposure time, the AGC gain is controlled. When exposure is excessive, first the AGC gain is lowered. Then, if exposure is still excessive even at the minimum gain, the electronic shutter operates.

10-2-2. Flickerless Mode (Normally OFF)

Setting FLON (CAT8, byte 4, bit 0) to "1" results in flickerless mode.
In this mode, the electronic shutter speed is fixed to 1/100 s to reduce the flicker of fluorescent lights.
AE operation is performed by only AGC control.

10-2-3. Backlight Compensation (Normally ON)

Setting BLCOF (CAT8, byte 4, bit 1) to "1" deactivates the backlight compensation function. Backlight compensation is performed through a combination of the following two types.

10-2-4. Weighted Average Backlight Compensation

The screen is divided into five photometry windows and the integrated luminous intensity values for each window are multiplied by weighting values to obtain a weighted average. This method is suited for cases where the main subject is fixed within the screen.

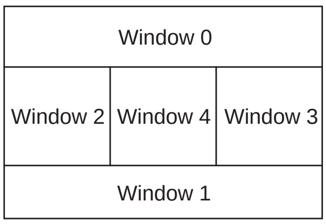


Fig. 10-1. AE Photometry Windows

10-2-5. Histogram Backlight Compensation (Normally OFF)

When the subject has only a slightly darker luminance than the overall screen, backlight compensation is performed through exposure compensation by applying the appropriate luminous intensity to the dark areas. This method is characterized by the fact that it is relatively unaffected by subject position movement, and is suited for cases where the main subject moves about actively within the screen. The backlight compensation level can be adjusted by [AE] BLC (SPEC code). Also, histogram backlight compensation operation can be turned on and off by [AE] HIST (SPEC code).

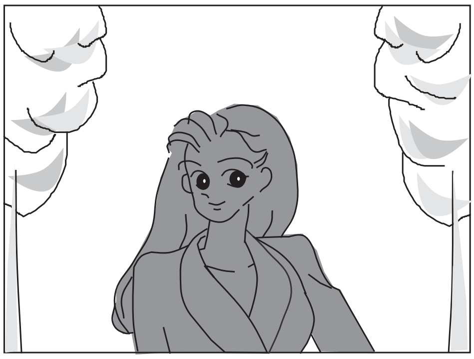


Fig. 10-2. Example of Backlight Subject

Note) Compensation may be insufficient when the background is extremely bright. Also, the backlight judgment may be difficult for some subjects with the result that AE operation appears to oscillate.

10-2-6. Parameter Reference (SPEC Codes)

Table 10-2. [AE] SPD

[AE] SPD	
Code	01 (h)
Description	Sets the AE response speed.
Setting range	00 to FF (h)
Recommended value	08 (h)
Remarks	01 (h): Maximum speed, FF (h): Minimum speed Setting to "00 (h)" may stop AE operation or result in misoperation.

Table 10-3. [AE] MAX

[AE] MAX	
Code	03 (h)
Description	Sets the AGC maximum gain during AE operation.
Setting range	00 to FF (h)
Recommended value	BB (h) (30dB)
Remarks	

Table 10-4. [AE] MIN

[AE] MIN	
Code	04 (h)
Description	Sets the AGC minimum gain during AE operation.
Setting range	00 to FF (h)
Recommended value	11 (h) (10dB)
Remarks	This is transition point where AE control shifts between the AGC control and electronic shutter control areas.

Table 10-5. [AE] LIM

[AE] LIM	
Code	05 (h)
Description	Sets the electronic shutter speed upper limit during AE operation.
Setting range	00 to 07 (h)
Recommended value	07 (h) (1/100,000s)
Remarks	See "Table 10-6".

Table 10-6. Correspondence Between [AE] LIM and Electronic Shutter Speed Upper Limit Value

[AE] LIM	Electronic shutter speed upper limit value [s]
0	1/500
1	1/1,000
2	1/2,000
3	1/5,000
4	1/10,000
5	1/20,000
6	1/50,000
7	1/100,000

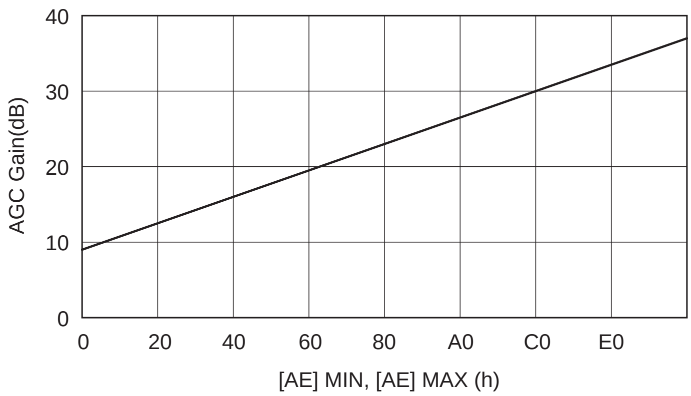


Fig. 10-3. Correspondence Between [AE] MIN, [AE] MAX and AGC Gain

Table 10-7. [AE] BLC

[AE] BLC	
Code	07 (h)
Description	Sets the effectiveness of histogram backlight compensation during AE operation.
Setting range	00 to FF (h)
Recommended value	0C (h) (0.75 times)
Remarks	

Table 10-8. [AE] HIST

[AE] HIST	
Code	08 (h)
Description	Turns on and off histogram backlight compensation during AE operation.
Setting range	00 to 01 (h)
Recommended value	01 (h) (OFF)
Remarks	Compensation can be turned on and off as follows. 00 (h): ON, 01 (h): OFF

10-3. AWB

10-3-1. Operation

Auto trace or all pull-in white balance can be selected by AWB2 (CAT8, byte 4, bit 6). (However, AWB1 and AWB3 = "0")

• **Auto trace**

Auto trace uses a feedback system. The color temperature range is limited by the pull-in window setting.

• **All pull-in**

Pull-in is performed at a faster operating speed than auto trace without pull-in window, response time or other limitations.

10-3-2. Pull-in Range

AWB sets a pull-in window that follows the black body radiation curve. The standard setting for the pull-in color temperature range (R-B axis direction) is approximately 2,500K to 9,500K. The pull-in color temperature ranges for each pull-in window are as shown in the table below.
The window is selected by [AWB] FRM (SPEC code) described hereafter.

Table 10-9. Pull-in Color Temperature Ranges for Different Pull-in Windows

Window	Minimum pull-in color temperature	Maximum pull-in color temperature
Standard window	approximately 2,500K	approximately 9,500K
Small window	approximately 2,800K	approximately 8,500K
Large window	approximately 2,400K	approximately 11,000K

When [AWB] FRM (SPEC code) is 12 (h), the window is canceled and pull-in operation is performed for any subject.

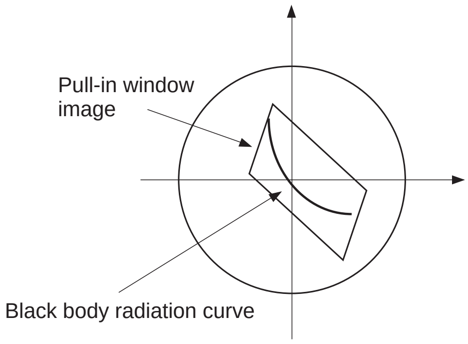


Fig.10-4. Pull-in Window Image

Note that the pull-in accuracy is approximately 4% or less with respect to the size of the burst flag.

10-3-3. Parameter Reference (SPEC Codes)

Table 10-10. [AWB] SPD

[AWB] SPD	
Code	11 (h)
Description	Sets the response speed.
Setting range	01 to 0E (h)
Recommended value	02(h)
Remarks	01 (h): Maximum speed, 0E (h): Minimum speed Setting "00 (h)" or higher than "0E (h)" stops AWB operation.

Table 10-11. [AWB] FRM

[AWB] FRM	
Code	12 (h)
Description	Selects the pull-in window.
Setting range	00 (h), 03 (h), 04 (h) or 12 (h)
Recommended value	00 (h) (standard window)
Remarks	00 (h): standard window, 03 (h): small window, 04 (h): large window, 12 (h): window canceled

Table 10-12. [AWB] RSFT, [AWB] BSFT

[AWB] RSFT, [AWB] BSFT	
Code	13 (h), 14 (h)
Description	Shift gain for manual mode
Setting range	00 to FF (h)
Recommended value	[AWB] RSFT: 03 (h), [AWB] BSFT: 02 (h)
Remarks	The same shift amount is applied to all manual modes. These parameters do not function in auto mode.

Table 10-13. [AWB] USRR, [AWB] USRB

[AWB] USRR, [AWB] USRB	
Code	15 (h), 16 (h)
Description	Adjustment gain for user mode
Setting range	00 to FF (h)
Recommended value	[AWB] USRR: 4C (h), [AWB] USRB: 58 (h)
Remarks	

Table 10-14. [AWB] PRER, [AWB] PREB

[AWB] PRER, [AWB] PREB	
Code	17 (h), 18 (h)
Description	Adjustment gain for pre-white balance
Setting range	00 to FF (h)
Recommended value	[AWB] PRER: 3A (h), [AWB] PREB: 90 (h)
Remarks	These determine the auto trace AWB start point. These parameters are valid after writing to the EEPROM and resetting.

10-4. Suppress

The chroma signal and aperture correction suppress functions can be turned on and off under dim lighting conditions by SPRS (CAT8, byte 2, bit 1).

10-4-1. Chroma Suppress

This suppresses the chroma signal level in accordance with the AGC gain.

10-4-2. Aperture Correction Suppress

This suppresses the aperture correction level in accordance with the AGC gain.

10-5. Serial Communication

10-5-1. Interface Circuit

The MUC does not have a built-in RS232C level shift circuit, so a separate level shift circuit such as the MCB100EVB is required.

10-5-2. Communication Method

Communication is performed by the full-duplex start-stop sync method which conforms to RS232C. The communication speed is 9,600bps, and the communication settings are "data length: 8 bits, parity: none, start bit: one bit, stop bit: one bit, flow control: none".

10-5-3. Communication Timing

The MUC fetches data in 8-bit units at the timing determined by the communication speed from the fall of SI. The serial output is output in sync with the serial input. The communication data is LSB first.

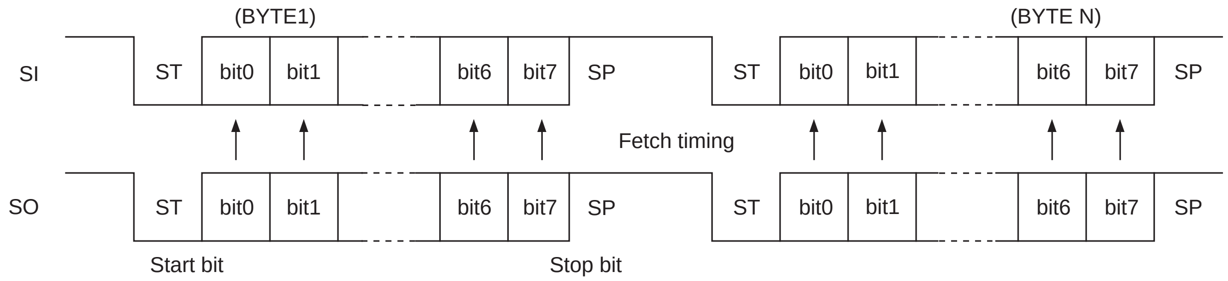


Fig. 10-5. Communication Timing

10-5-4. Communication Format

Data is sent in category units. The number of bytes to be transmitted is sent in the first byte, the category No. is sent in the second byte, and the data for each category is sent in the third and subsequent bytes. The first byte of the serial output is a flag indicating the status of the MUC's internal buffer. If the communication interval between category units is one field or more, there is no need to read this flag. When this flag is "1", the MUC's internal buffer is full and subsequent communication is ignored.

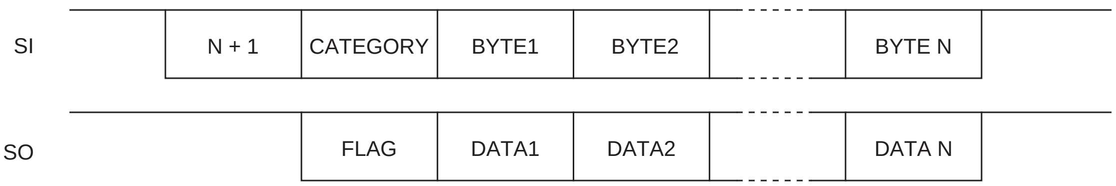


Fig. 10-6. Communication Format

10-5-5. Notes on Communication

Leave an interval of at least one field or more between different category data.

10-5-6. Serial Output Data Limitations

The MUC's internal output buffer has a capacity limit of 32 bytes. Therefore, serial output data for categories other than categories 5, 6 and 10 do not fit in the output buffer, so sometimes correct values may not be obtained. When serial output for categories other than categories 5, 6 and 10 must be obtained correctly, this data should be read out by the microcomputer in consideration of the communication prohibited interval.
The communication prohibited interval is the approximately 4H interval before the fall of SCSBUSY.
SCSBUSY is output from the VD pin when VDBUSY (CAT1, byte 13, bit 6) is "1".

10-6. List of Communication Parameters

Table 10-15. Category Codes

Category	Byte	Bit	Symbol	Description	Factory setting (H)	EEPROM address (H)
1	1	0 to 7		Fixed to "00h"	00	01
1	2	0 to 7		Fixed to "01h"	01	02
1	3	0 to 3	SETUP	Setup level 0 (0h) to 8.5 (Fh) IRE	0	03
1	3	4 to 7		Fixed to "6h"	6	03
1	4	0 to 3		Fixed to "Eh"	E	04
1	4	4 to 7	YDLY	Luminance signal delay adjustment OSC/2 clock (74.07ns) units	8	04
1	5	0 to 7		Fixed to "24h"	24	05
1	6	0 to 7		Fixed to "34h"	34	06
1	7	0 to 7		Fixed to "0Bh"	0B	07
1	8	0 to 7	RMATY	Matrix coefficient	2A	08
1	9	0 to 7	RMATC	Matrix coefficient	12	09
1	10	0 to 7	BMATY	Matrix coefficient	3E	0A
1	11	0 to 7	BMATC	Matrix coefficient	CA	0B
1	12	0 to 7		Fixed to "0Ch"	0C	0C
1	13	0 to 5		Fixed to "00h"	00	0D
1	13	6	VDBUSY	VD pin output signal switching 0: VD, 1: SCSBUSY	0	0D
1	13	7		Fixed to "0h"	0	0D
1	14	0 to 7		Fixed to "FFh"	FF	0E
2	1	0 to 7	YGAIN	Luminance signal gain	86	0F
2	2	0 to 7		Fixed to "AAh"	AA	10
2	3	0 to 7		Fixed to "26h"	26	11
2	4	0 to 7		Fixed to "A4h"	A4	12
2	5	0 to 7		Fixed to "04h"	04	13
2	6	0 to 7		Fixed to "FCh"	FC	14
2	7	0 to 3	RBQUAD	Linear matrix quadrant control bit 0: 1st, bit 1: 2nd, bit 2: 3rd, bit 3: 4th 0: Invalid, 1: Valid	—	—
2	7	4	CONGAIN	Linear matrix gain 0: Invalid, 1: Valid	—	—
2	7	5	CONHUE	Linear matrix hue 0: Invalid, 1: Valid	—	—
2	7	6 to 7		Dummy	—	—

Category	Byte	Bit	Symbol	Description	Factory setting (H)	EEPROM address (H)
2	8	0 to 7	RYGAIN	Linear matrix coefficient	Adjustment value	4F, 51, 53, 55
2	9	0 to 7	BYGAIN	Linear matrix coefficient	Adjustment value	50, 52, 54, 56
2	10	0 to 7	RYHUE	Linear matrix coefficient	Adjustment value	57, 59, 5B, 5D
2	11	0 to 7	BYHUE	Linear matrix coefficient	Adjustment value	58, 5A, 5C, 5E
3	1	0 to 7		Fixed to "00h"	00	15
3	2	0 to 7		Fixed to "00h"	00	16
3	3	0 to 7		Fixed to "00h"	00	17
3	4	0 to 7	SHOFST	Sample-and-hold output offset	3D	18
3	5	0 to 7		Fixed to "89h"	89	19
3	6	0 to 7		Fixed to "00h"	00	1A
3	7	0 to 7		Fixed to "00h"	00	1B
4	1	0 to 7	VREFY	VREFY adjustment	Adjustment value	1C
4	2	0 to 7	VREFC	VREFC adjustment	Adjustment value	1D
4	3	0 to 7	VSUB	VSUB adjustment	Adjustment value	1E
4	4	0 to 7		Fixed to "80h"	80	1F
5	1	0 to 7	AGCCONT	Gain control	1E	20
5	2	0 to 7		Fixed to "FFh"	FF	21
5	3	0	SHTSPDM	Shutter speed (lower 1 bit, MSB)	—	—
5	3	1	SHTHL	Electronic shutter high speed/ low speed switching 0: High speed, 1: Low speed	—	—
5	3	2	SHTON	Electronic shutter ON/OFF 0: OFF, 1: ON	—	—
5	3	3 to 7		Fixed to "10h"	—	—
5	4	0 to 7	SHTSPDL	Shutter speed (upper 8 bits)	—	—
5	5	0 to 7		Fixed to "00h"	—	—
5	6	0 to 7		Fixed to "00h"	—	—
5	7	0 to 7		Fixed to "00h"	—	—
6	1	0 to 7	WBR	White balance control	3A	22
6	2	0 to 7	WBG	White balance control	26	23
6	3	0 to 7	WBB	White balance control	48	24
6	4	0 to 7		Fixed to "D0h"	—	—
6	5	0 to 7		Fixed to "04h"	—	—
7	1	0 to 7		Fixed to "00h"	00	25
7	2	0 to 7		Fixed to "14h"	14	26
7	3	0 to 7		Fixed to "05h"	05	27
7	4	0 to 7		Fixed to "55h"	55	28

<table>
<tr><th>Category</th><th>Byte</th><th>Bit</th><th>Symbol</th><th colspan="2">Description</th><th>Factory setting (H)</th><th>EEPROM address (H)</th></tr>
<tr><td>7</td><td>5</td><td>0 to 7</td><td></td><td colspan="2">Fixed to "74h"</td><td>74</td><td>29</td></tr>
<tr><td>8</td><td>1</td><td>0 to 2</td><td></td><td colspan="2">Fixed to "0h"</td><td>—</td><td></td></tr>
<tr><td>8</td><td>1</td><td>3</td><td>AWB</td><td colspan="2">AWB control
0: ON, 1: OFF</td><td>—</td><td></td></tr>
<tr><td>8</td><td>1</td><td>4 to 6</td><td>AEADJUST</td><td colspan="2">AE adjustment mode switching
0h: OFF, 3h: ON</td><td>—</td><td></td></tr>
<tr><td>8</td><td>1</td><td>7</td><td>AE</td><td colspan="2">AE control
0: ON, 1: OFF</td><td>—</td><td></td></tr>
<tr><td>8</td><td>2</td><td>0</td><td>MCR</td><td colspan="2">Microcontroller control
0: ON, 1: OFF</td><td>—</td><td></td></tr>
<tr><td>8</td><td>2</td><td>1</td><td>SPRS</td><td colspan="2">Suppress control
0: ON, 1: OFF</td><td>—</td><td></td></tr>
<tr><td>8</td><td>2</td><td>2</td><td></td><td colspan="2">Fixed to "0h"</td><td>—</td><td></td></tr>
<tr><td>8</td><td>2</td><td>3</td><td>SW</td><td colspan="2">Serial communication based
AE/AWB mode switching
0: Invalid, 1: Valid</td><td>—</td><td></td></tr>
<tr><td>8</td><td>2</td><td>4 to 7</td><td></td><td colspan="2">Fixed to "0h"</td><td>—</td><td></td></tr>
<tr><td>8</td><td>3</td><td>0 to 7</td><td></td><td colspan="2">Fixed to "00h"</td><td>—</td><td></td></tr>
<tr><td>8</td><td>4</td><td>0</td><td>FLON</td><td colspan="2">Flickerless ON/OFF
0: OFF. 1: ON</td><td>—</td><td></td></tr>
<tr><td>8</td><td>4</td><td>1</td><td>BLCOF</td><td colspan="2">Backlight compensation ON/OFF
0: ON, 1: OFF</td><td>—</td><td></td></tr>
<tr><td>8</td><td>4</td><td>2 to 4</td><td></td><td colspan="2">Fixed to "0h"</td><td>—</td><td></td></tr>
<tr><td rowspan="2">8</td><td rowspan="2">4</td><td rowspan="2">5</td><td></td><td colspan="2">AWB mode setting</td><td>—</td><td></td></tr>
<tr><td>AWB1</td><td>0: Auto</td><td>1: Manual</td><td>—</td><td></td></tr>
<tr><td>8</td><td>4</td><td>6</td><td>AWB2</td><td rowspan="2">(AWB2, AWB3):
(0, 0): ATW
(0, 1): Pre WB
(1, 0): Pull-in
(1, 1): Hold</td><td rowspan="2">(AWB2, AWB3):
(0, 0): Indoor
(0, 1): Fluorescence
(1, 0): User
(1, 1): Outdoor</td><td>—</td><td></td></tr>
<tr><td>8</td><td>4</td><td>7</td><td>AWB3</td><td>—</td><td></td></tr>
<tr><td>8</td><td>5</td><td>0</td><td>E2WR</td><td colspan="2">EEPROM write control
0: OFF, 1: Write</td><td>—</td><td></td></tr>
<tr><td>8</td><td>5</td><td>1</td><td>E2WEN</td><td colspan="2">EEPROM WRITE ENABLE send
0: OFF, 1: Send</td><td>—</td><td></td></tr>
<tr><td>8</td><td>5</td><td>2</td><td></td><td colspan="2">Dummy</td><td>—</td><td></td></tr>
<tr><td>8</td><td>5</td><td>3</td><td>E2RSW</td><td colspan="2">EEPROM read control
0: OFF, 1: ON</td><td>—</td><td></td></tr>
<tr><td>8</td><td>5</td><td>4</td><td>E2RAL1</td><td colspan="2">EEPROM read range specification
0: OFF, 1: Select</td><td>—</td><td></td></tr>
<tr><td>8</td><td>5</td><td>5</td><td>E2RAL2</td><td colspan="2">EEPROM read range specification
0: OFF, 1: Select</td><td>—</td><td></td></tr>
</table>

Category	Byte	Bit	Symbol	Description	Factory setting (H)	EEPROM address (H)
8	5	6	E2RAL3	EEPROM read range specification 0: OFF, 1: Select	—	
8	5	7	E2RAL4	EEPROM read range specification 0: OFF, 1: Select	—	
8	6	0 to 7	E2CODE	EEPROM control code	—	
8	7	0 to 7	E2ADRS	EEPROM address	—	
8	8	0 to 7	E2DATA	EEPROM data	—	
8	9	0 to 7	SPCODE	SPEC code	—	
8	10	0 to 7	SPCDAT	SPEC data	—	
8	11	0 to 7		Fixed to "00h"	—	
9	1	0 to 7		Fixed to "00h"	00	2A
9	2	0 to 7		Fixed to "00h"	00	2B
9	3	0 to 7		Fixed to "02h"	02	2C
9	4	0 to 7		Fixed to "00h"	00	2D
9	5	0 to 7		Fixed to "80h"	80	2E
10	1	0 to 7		Fixed to "00h"	—	
10	2	0 to 7		Fixed to "00h"	—	
10	3	0 to 7		Fixed to "00h"	—	
10	4	0	PGON	Pattern generator ON/OFF 0: OFF, 1: ON	—	
10	4	1		Fixed to "1h"	—	
10	4	2		Fixed to "0h"	—	
10	4	3		Fixed to "1h"	—	
10	4	4	PGCOLSEL	Color bar/monochrome switching 0: Color bar, 1: Monochrome	—	
10	4	5 to 7	PGCOL	Color specification 0h: OFF, 1h: Blue, 2h: Red, 3h: Magenta, 4h: Green, 5h: Cyan, 6h: Yellow, 7h: White	—	
10	5	0	PGHV	Horizontal/vertical switching 0: H, 1: V	—	
10	5	1	PGRSTR	Raster specification 0: OFF, 1: ON	—	
10	5	2 to 3	PGPTSL	Pattern switching 0h: OFF, 1h: ramp, 2h: impulse, 3h: invert impulse	—	
10	5	4		Fixed to "1h"	—	
10	5	5		Fixed to "0h"	—	
10	5	6 to 7		Fixed to "2h"	—	

Category	Byte	Bit	Symbol	Description	Factory setting (H)	EEPROM address (H)
10	6	0 to 7		Fixed to "00h"	—	
10	7	0 to 7		Fixed to "00h"	—	
10	8	0 to 7		Fixed to "00h"	—	
10	9	0 to 7		Fixed to "00h"	—	

10-7. List of SPEC Codes (See the respective functions for a detailed description.)

Table 10-16. SPEC Codes

Code (H)	Symbol	Description	Factory setting (H)	EEPROM address (H)
01	[AE] SPD	AE response speed	08	2F
02		Fixed to "04h"	04	30
03	[AE] MAX	AE maximum gain	BB	31
04	[AE] MIN	AE minimum gain	Adjustment value	32
05	[AE] LIM	AE shutter speed upper limit	07	33
06		Fixed to "EEh"	EE	34
07	[AE] BLC	Backlight compensation control	0C	35
08	[AE] HIST	Histogram backlight compensation control	01	36
09		Fixed to "01h"	01	37
0A		Fixed to "01h"	01	38
0B		Fixed to "03h"	03	39
0C		Fixed to "03h"	03	3A
11	[AWB] SPD	AWB response speed	01	35
12	[AWB] FRM	AWB detection window setting	12	36
13	[AWB] RSFT	Manual mode shift amount setting	03	37
14	[AWB] BSFT	Manual mode shift amount setting	02	38
15	[AWB] USRR	User mode setting	4C	39
16	[AWB] USRB	User mode setting	58	3A
17	[AWB] PRER	Pre-white balance	Adjustment value	41
18	[AWB] PREB	Pre-white balance	Adjustment value	42
21		Fixed to "08h"	08	43
22		Fixed to "05h"	05	44
23		Fixed to "05h"	05	45
24		Fixed to "04h"	04	46
25		Fixed to "07h"	07	47
31		Fixed to "52h"	52	48
32		Fixed to "80h"	80	49
33		Fixed to "8Ah"	8A	4A
34		Fixed to "3Dh"	3D	4B
35		Fixed to "80h"	80	4C
36		Fixed to "00h"	00	4D

10-8. Communication with the EEPROM

10-8-1. Communication Timing

Communication to peripheral ICs is performed every field in the order of MUC internal → EVR → EEPROM. EEPROM communication is performed only when the "write enable" or "write" commands are sent.

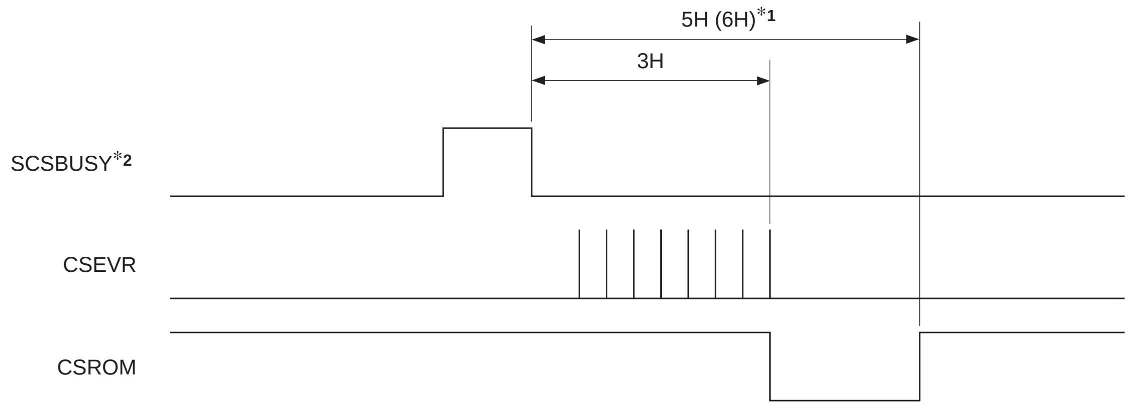


Fig. 10-7. Communication Timing with Peripheral ICs 1

*1 When the "write enable" command is sent. Values in parentheses are for when the "write" command is sent.
*2 Data is output from the VD pin when VDBUSY (CAT1, byte 13, bit 6) is "1".

When the "read" command is sent, 32 bytes of data are read continuously from the EEPROM during one field. At this time, communication is not performed with the MUC's internal circuits and the EVR.

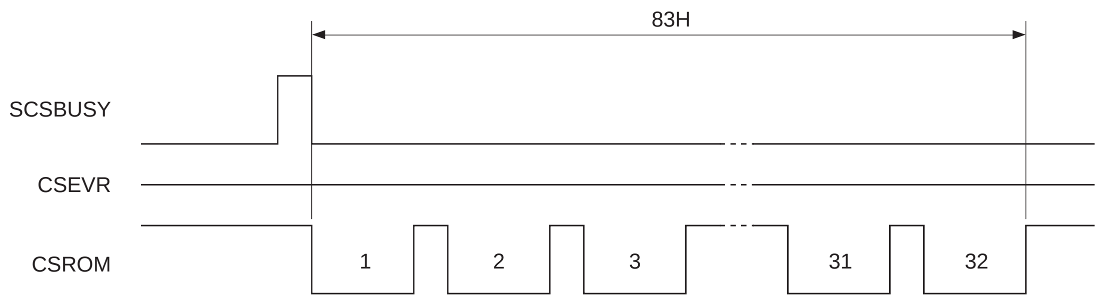


Fig. 10-8. Communication Timing with Peripheral ICs 2

10-8-2. Communication Parameters

The communication settings are performed by bytes 5, 6, 7 and 8 of category 8. The EEPROM allows two bytes of data to be written per address, but the MUC uses only the first byte of data. Therefore, when writing data, write the same data in both the first and second bytes.

Byte 5

Table 10-17. Byte 5 Parameters

Bit	Parameter	Function
0	E2WR	Writes the byte 8 data at the byte 7 address.
1	E2WEN	Sends the write enable command.
3	E2RSW	Outputs the read EEPROM data as serial output.
4	E2RAL1	Reads the 32 bytes of data from addresses 00 (h) to 1F (h).
5	E2RAL2	Reads the 32 bytes of data from addresses 20 (h) to 3F (h).
6	E2RAL3	Reads the 32 bytes of data from addresses 40 (h) to 5F (h).
7	E2RAL4	Reads the 32 bytes of data from addresses 60 (h) to 7F (h).

Note) With the exception of bit 3 "E2RSW", do not set two or more bits to "1" at the same time.

Byte 6 E2CODE (8 bits)

These are the EEPROM operation commands.

Table 10-18. EEPROM Commands

Code	Command
A8 (h)	Read
A4 (h)	Write
A3 (h)	Write enable
A0 (h)	Write prohibited

Byte 7 E2ADRS (7 bits)

This specifies the EEPROM address to which the data is written.

Byte 8 E2DATA (7 bits)

This is the data written to the EEPROM.

10-8-3. Data Read

The EEPROM data can be read in 32-byte units as the serial output data for MUC categories 5, 6 and 10. Perform the following settings and read the EEPROM data.

Table 10-19. Data Read Settings

Byte	Bit	Parameter	Setting value	Comment
5	3	E2RSW	1	
5	4	E2RAL1	*	When reading the data from addresses 00 (h) to 1F (h).
5	5	E2RAL2	*	When reading the data from addresses 20 (h) to 3F (h).
5	6	E2RAL3	*	When reading the data from addresses 40 (h) to 5F (h).
5	7	E2RAL4	*	When reading the data from addresses 60 (h) to 7F (h).
6	—	E2CODE	A8 (h)	Read command
7	—	E2ADRS	—	The address is automatically set by the MUC.
8	—	E2DATA	—	

Note) Set one of these bits to "1".

Data is read from the EEPROM from the field two after the above settings are sent. If the E2RALn setting is left as "1", data is read each field. To stop reading data, set E2RALn to "0".
Be sure to stop the EEPROM read communication before reading the read EEPROM data from the serial output. The data read from the EEPROM is output as normal serial output (categories 5, 6 and 10) while E2RSW is "1".
The relationship between the EEPROM address and the serial output categories and bytes is as shown in the table below.

Table 10-20. Relationship Between EEPROM Address and Serial Output

Read command	CAT5, bytes 1 to 18	CAT6, bytes 1 to 11	CAT10, bytes 1 to 3
E2RAL1 = "1"	00 (h) to 11 (h)	12 (h) to 1C (h)	1D (h) to 1F (h)
E2RAL2 = "1"	20 (h) to 31 (h)	32 (h) to 3C (h)	3D (h) to 3F (h)
E2RAL3 = "1"	40 (h) to 51 (h)	52 (h) to 5C (h)	5D (h) to 5F (h)
E2RAL4 = "1"	60 (h) to 71 (h)	72 (h) to 7C (h)	7D (h) to 7F (h)

Set E2RSW to "0" after the EEPROM data has been read. Otherwise, AE and AWB do not operate properly as evaluation values cannot be obtained.
If the screen becomes disturbed after data has been read, perform the following settings before reading data. These settings should be canceled after the data has been read.

Table 10-21. Settings During EEPROM Read

Parameter	Value
MCR (CAT8, byte 2, bit 0)	0
SPRS (CAT8, byte 2, bit 1)	1
SW (CAT8, byte 2, bit 3)	1

10-8-4. Write Preparations

The initial status for the EEPROM after power-on is the write prohibited status in order to protect the data. Therefore, the write enable command must be sent before writing data. The write enable command remains valid until the power is turned off or the write prohibited command is sent. Perform the following settings to send the write enable command.

Table 10-22. EEPROM Write Enable Settings

Byte	Bit	Parameter	Setting value	Comment
5	1	E2WEN	1	
6	—	E2CODE	A3 (h)	Write enable
7	—	E2ADRS	—	
8	—	E2DATA	—	

The command is sent to the EEPROM at the field two after the above settings are made. When E2WEN is "1", the write enable command is sent every field. To stop sending the write enable command, set E2WEN to "0".

10-8-5. Write

Perform the following settings to write data to the EEPROM.

Table 10-23. EEPROM Write Settings

Byte	Bit	Parameter	Setting value	Comment
5	0	E2WR	1	
6	—	E2CODE	A4 (h)	Write
7	—	E2ADRS		Sets the EEPROM address.
8	—	E2DATA		Data written to the byte 7 address.

Data is written to the EEPROM at the field two after the above settings are sent. One byte of data can be written per field. When E2WEN is "1", data is written every field. To stop writing data, set E2WEN to "0".

10-8-6. Write Prohibited

After data has been written, send the write prohibited command in order to protect the data. Perform the following settings to send the write prohibited command.

Table 10-24. EEPROM Write Prohibited Settings

Byte	Bit	Parameter	Setting value	Comment
5	1	E2WEN	1	
6	—	E2CODE	A0 (h)	Write prohibited
7	—	E2ADRS	—	
8	—	E2DATA	—	

The command is sent to the EEPROM at the field two after the above settings are sent. When E2WEN is "1", the write prohibited command is sent every field. To stop sending the write prohibited command, set E2WEN to "0".

11. Adjustment Items

11-1. Prepared Equipment and Connections

Color monitor, stabilized power supply (+5V), oscilloscope, vector scope, digital voltmeter, pattern box (3200K), color bar chart, color temperature conversion filter, ND filter, personal computer (OS: Windows95), RS232C extension cable, MCB100EVB and MUC control program

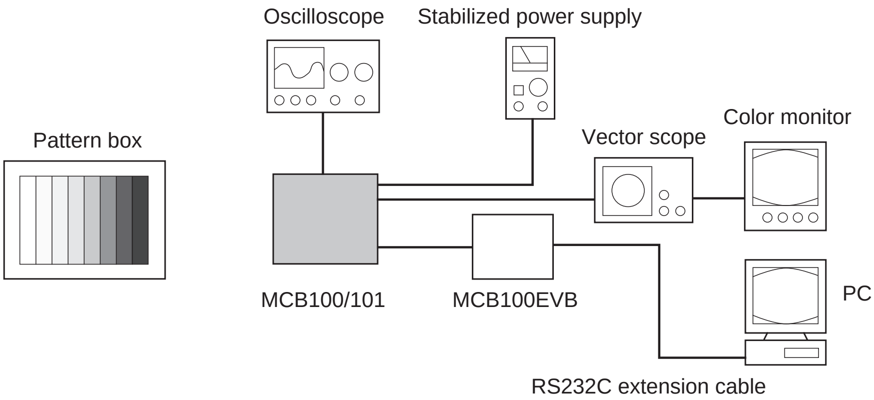


Fig. 11-1. Connection Diagram

11-2. VSUB Adjustment

Adjust the VSUB voltage to the voltage value prescribed for each individual MUC. The VSUB voltage value is indicated in symbol form on the rear surface of the MUC.

Subject	—
Measurement point	SUBIN pin of MUC
Measurement equipment	Digital voltmeter
Adjustment data	VSUB (CAT4, byte 3)
EEPROM address	1Eh
Standard value	

11-3. SYNC Level Adjustment

Subject	—
Measurement point	VIDEO OUT
Measurement equipment	Oscilloscope
Adjustment data	VREFY (CAT4, byte 1)
EEPROM address	1Ch
Standard value	40 IRE

11-4. BURST Level Adjustment

Subject	—
Measurement point	VIDEO OUT
Measurement equipment	Oscilloscope
Adjustment data	VREFC (CAT4, byte 2)
EEPROM address	1Dh
Standard value	40 IRE

11-5. SETUP Level Adjustment

Subject	—
Measurement point	VIDEO OUT
Measurement equipment	Oscilloscope
Adjustment data	SETUP (CAT1, byte 3, bits 0 to 3)
EEPROM address	03h
Standard value	5 IRE

11-6. Minimum Gain Adjustment

This system has a SHOUT dynamic range of 2Vp-p = 250%. Therefore, video output of 100 IRE is obtained with a SHOUT of 800mVp-p. The standard CCDOUT value is set at 250mVp-p in order to absorb the AGC gain variance, and the AGC gain (min.) should be set so that SHOUT is 800mVp-p at this time.

Subject	Color bar chart
Measurement point	CCDOUT and SHOUT pins of MUC
Measurement equipment	Oscilloscope, ND filter
Adjustment data	[AE] MIN (SPEC code 04h)
EEPROM address	32h
Standard value	SHOUT = 800mVp-p at CCDOUT = 250mVp-p

1. Set AEADJUST (CAT8, byte 1, bits 4 to 7) to "3(h)" to enter adjustment mode.
2. Adjust the luminous intensity using ND filters, etc., so that the video signal portion of CCDOUT is 250mVp-p.
3. Adjust [AE] MIN (SPEC code) so that SHOUT is 800mVp-p.
4. Once the adjustment value has been determined, write it to the EEPROM.

11-7. Pre-White Balance Adjustment

Pre-white balance consists of aligning the AWB start point. The pre-white balance alignment procedures are as follows, and the new settings are reflected the next time the system is booted.

Subject	White margin
Measurement point	VIDEO OUT
Measurement equipment	Vector scope, color temperature conversion filter
Adjustment data	[AWB] PRER, [AWB] PREB (SPEC codes 17h, 18h)
EEPROM address	41h, 42h
Standard value	Adjust so that the bright spot is in the center of the vector scope.

1. Image a light source of the reference color temperature onto the entire screen.
2. Set [AWB] RSFT and [AWB] BSFT (SPEC codes) to 0 (h).
3. Enter user mode (AWB1 = "1", AWB2 = "1", AWB3 = "0").
4. Adjust [AWB] USRR and [AWB] USRB (SPEC codes) to align the start point with white (the center of the vector scope).
5. Set the [AWB] USRR and [AWB] USRB values at that point to [AWB] PRER and [AWB] PREB (SPEC codes).
6. Return [AWB] RSFT, [AWB] BSFT, [AWB] USRR and [AWB] USRB to their recommended values (03 (h), 02 (h), 4C (h) and 58 (h), respectively).
7. Write the values to the EEPROM.

When the system is booted following this operation, AWB operates from the condition where the white balance is aligned with the reference light source. Note that if values that deviate greatly from the black body radiation curve are written to [AWB] PRER and [AWB] PREB, AWB may not activate.

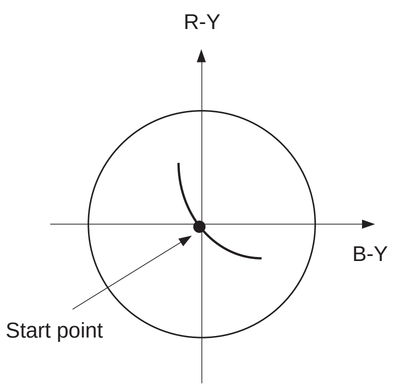


Fig. 11-2. Pre-White Balance

11-8. Color Reproducibility Adjustment

The MUC can set the hue and gain parameters for the R-Y and B-Y data independently in four quadrants on the R-G and B-G axes before conversion to R-Y and B-Y format.

Subject	Color bar chart
Measurement point	VIDEO OUT
Measurement equipment	Vector scope
Adjustment data	RYGAIN, BYGAIN, RYHUE, BYHUE (CAT2, bytes 8 to 11)
EEPROM address	4Fh to 5Eh
Standard value	Adjust so that the bright spots of all colors are contained in the reproduction window of each color.

1. Select the quadrants you wish to adjust.
   Select the quadrants where you wish to change the hue and gain using RBQUAD (CAT2, byte 7, bits 0 to 3).
   Setting a bit to "1" selects the corresponding quadrant. (Multiple quadrants can be selected.)
   CAT2, byte 7, bit 0 → 1st quadrant selected
   CAT2, byte 7, bit 1 → 2nd quadrant selected
   CAT2, byte 7, bit 2 → 3rd quadrant selected
   CAT2, byte 7, bit 3 → 4th quadrant selected

2. Select hue and gain control.
   Set CONGAIN (CAT2, byte 7, bit 4) to "1" to enable gain control.
   Set CONHUE (CAT2, byte 7, bit 5) to "1" to enable hue control.

3. Adjust the hue and gain of the selected quadrants using the following parameters.
   RYGAIN (CAT2, byte 8, bits 0 to 7) → R-Y gain adjustment
   BYGAIN (CAT2, byte 9, bits 0 to 7) → B-Y gain adjustment
   RYHUE (CAT2, byte 10, bits 0 to 7) → R-Y hue adjustment
   BYHUE (CAT2, byte 11, bits 0 to 7) → B-Y hue adjustment

When setting the parameters independently for each quadrant, repeat the operations above for each field. Thus, four fields are required when setting each of the four quadrants independently.

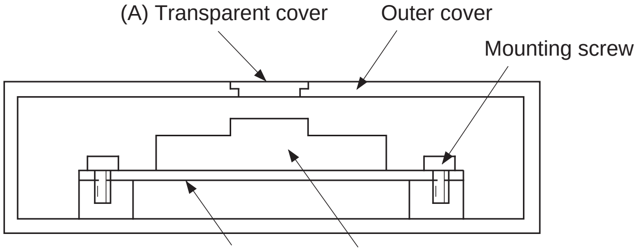
Set the matrix constants as follows.

RMATY = 2A (h)
RMATC = 12 (h)
BMATY = 3E (h)
BMATC = CA (h)

Notes on Handling

This product is designed for installation inside electronic equipment. Therefore, care should be taken to ensure a safe design in consideration of the following items.

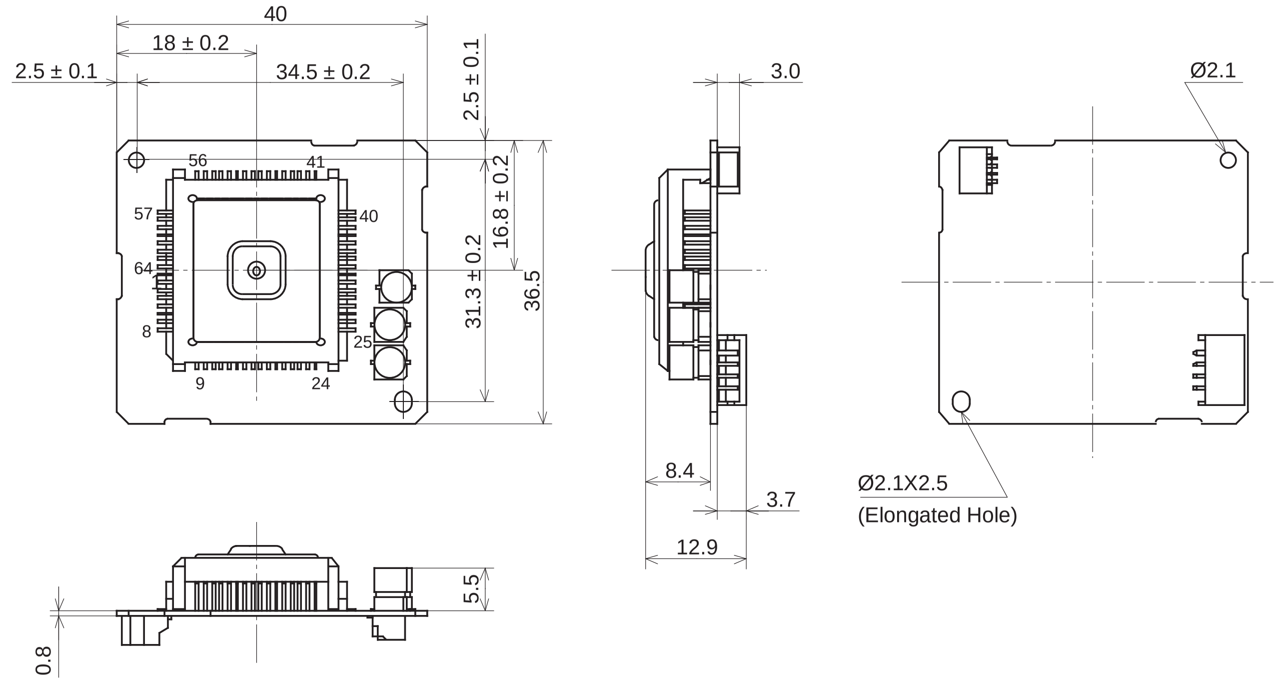
1. Operating temperature
   Make sure that the temperature inside the equipment does not exceed the operating temperature.
2. CCD light resistance
   Imaging highly luminous subjects such as the sun for short periods, or fixed imaging of even relatively low luminosity subjects for extended periods will discolor the on-chip color filters of the CCD.
   Avoid use under these conditions, as the on-chip color filters cannot be guaranteed against discoloration occurring under these circumstances.
   Be sure to check the operating environment beforehand and to take appropriate protective measures.
3. Mounting method
   The MCB100/101 does not have a dustproof or waterproof structure.
   In particular, it may not be possible to remove dust or dirt entering the optical aperture, so attaching a transparent cover in the manner of (A) in the figure below is recommended.



4. Preventing damage from electrostatic discharge
   The ICs mounted on the MCB100/101 are easily damaged by static electricity.
   Therefore, be sure to take the following protective measures and to handle the MUC in the same manner as a semiconductor device in order to prevent electrostatic discharge.
   a) Either handle bare handed or use non-chargeable gloves, clothes or material. Also use conductive shoes.
   b) When handling directly use an earth band.
   c) Install a conductive mat on the floor or working table to prevent the generation of static electricity.
   d) Ionized air is recommended for discharge when handling the MCB100/101.
5. Storage and operating environment cautions
   Avoid storage or use under harsh environments subject to high temperatures, high humidity, dust, etc., or where water or humidity may cause condensation.
6. Mechanical strength
   The MCB100/101 is a precision optical part, so care should be taken not to apply excessive mechanical shocks or force.
7. Socket insertion and removal
   The mechanical strength of the MUC insertion/removal socket is guaranteed for up to five vertical insertions and removals. Therefore, repeated insertion and removal should be avoided as much as possible.
8. Modifications
   Do not modify the MCB100/101, as it cannot be guaranteed in these cases.
9. Safety standards
   The MCB100/101 is a partially fabricated item, and as such safety standards are not prescribed.
   Users should ensure that finished products using the MCB100/101 conform to applicable safety standards.

Package Outline Unit: mm

MCB100

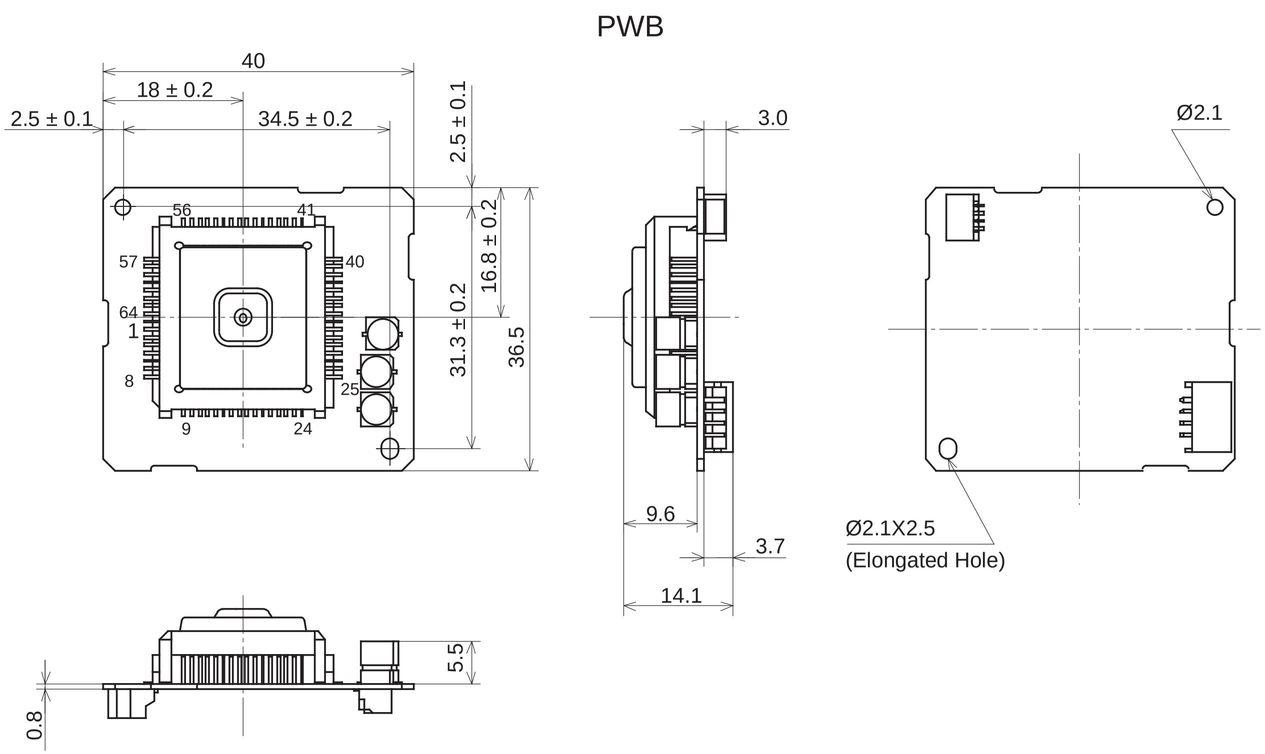


PACKAGE STRUCTURE (HYBRID IC)

Printed Wiring Boad MATERIAL	Glass fiber / Epoxy (FR-4)
I/O	CONNECTOR
MASS	12.07g

Package Outline Unit: mm

MCB101



PACKAGE STRUCTURE (HYBRID IC)

Printed Wiring Boad MATERIAL	Glass fiber / Epoxy (FR-4)
I/O	CONNECTOR
MASS	12.07g