PULNiX

TMC-73M / TMC-63M
MINIATURE CCD
COLOR CAMERA

OPERATIONS MANUAL

REV. 1, P/N 69-0017

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SECTION 1: OPERATION

1.1 OUTLINE

The TMC-73M (NTSC model) / TMC-63M (PAL model) is a super-miniature color video camera which uses a 1/3" high resolution solid state image sensor - the Charge Coupled Device (CCD). The CCD camera produces less geometrical distortion and has higher resistance to vibration and shock when compared with a camera using a pickup tube. These features make the camera suitable for both industrial and CCTV surveillance applications. It is also suitable as an input device in an image processing system since the TMC-73M offers superb color reproduction.

The TMC-73M series cameras feature separate outputs for Y/C output and standard VBS output.

All models have external access switches to select the white balance for outdoor(5600°K) and indoor (3200°K). The TMC-73M series uses complementary stripe color filters of Cy, Gr, Ye to generate all color variations. The complementary color system has the advantage of better sensitivity than the primary color system of R, G, B.

All models use CS-mount lenses and C-mount lenses with a adapter.

1.2 SPECIAL CHARACTERISTICS OF A CCD

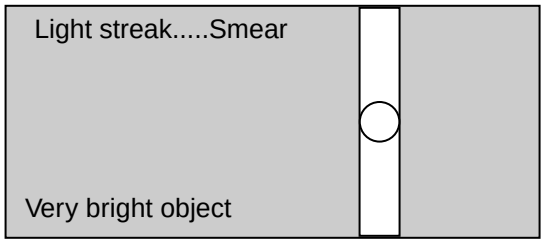
Smear phenomenon

This phenomenon occurs when shooting a very bright object (such as electronic light, fluorescent lamp, the sun or a strong reflection.) Due to the interline-transfer organization of the CCD image sensors (Refer to the "The Interline-transfer Organization of the CCD Image Sensors", Section 3.3), this phenomenon is caused by electronic charges generated beneath the photosensors by a light with a long wavelength, such as an infrared light.

NOTE: PULNiX color cameras contain a filter to minimize smear. Smear should only occur under extremely bright, and point light source conditions.

Patterned noise on the picture at high temperatures

Dark current (thermal noise) is inherent in semiconductors. At room temperature, the amount of dark current in all photosensors is very close. However, as the temperature rises, the amount of dark current increases. As a result, the relative difference between the dark current of each photosensor increases. This difference also causes the patterned noise on the picture.



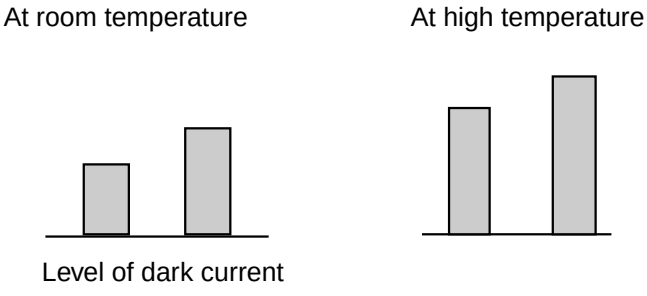
False signal

When vertical stripes or straight lines are shot, they may look wavy (Moire effect).

Blemish-free imagers

CCD photosensor elements generate electronic charges which ultimately produce horizontal and vertical rows in the CCD image sensor. Thus, any malfunctioning photosensor element could eventually cause a blemish on the monitor screen. However, the PULNiX TMC-73M/TMC-63M cameras all have blemish-free CCDs to avoid this problem.

Consult the specifications in "Comprehensive Specifications" for details on the blemishes of the TMC-73M/TMC-63M.



SECTION 2: COMPREHENSIVE SPECIFICATIONS

Model	TMC-73M (NTSC)	TMC-63M (PAL)
Imager	1/3" interline transfer CCD (4.8 x 3.6 mm)	
Pixel	768(H) x 494(V)	752(H) x 582(V)
Cell size	6.35µm(H) x 7.4µm(V)	6.5µm(H) x 6.25µm(V)
Color filter	Cy, Ye, Mg, G complementary color filter	
Scanning	2:1 interlaced, field mode scanning	
	525 lines, 59.94 Hz	625 lines, 50 Hz
Sync	Internal sync only	
	fH = 15.734 KHz fV = 59.94 Hz	fH = 15.625 KHz fV = 50.00 Hz
TV resolution	460(H) x 400(V) TV lines	450(H) x 450(V) TV lines
S/N ratio	50 dB (AGC off)	
Min. illumination	2 Lux F = 1.4 (AGC on)	
Video output	VBS = 1.0 Vp-p at 75 Ω (NTSC and PAL) Y (B/W) = 1.0 Vp-p with sync, Chroma = 285 mV at 75 Ω (Y/C or S-VHS)	
Color balance	Manual white balance with daylight and indoor switch External hue adjustment via serial data interface	
AGC	Max. 32 dB AGC, on-off jumper, manual gain control and ext. gain control	
Gamma	0.45	
Lens mount	CS-mount or C-mount with adapter	
Power req.	12 V DC, 200 mA	
Operating temp.	-10°C to +50°C	
Vibration & shock	Vibration: 7 G (11Hz to 200Hz), Shock: 70G	
Size (W X H X L)	40 dia x 78 mm 1.57" D x 3.07" L	
Weight	150 grams	
Power cable	12P-02 for NTSC/PAL and Y/C, KC-10 for NTSC/PAL only	
Power supply	12VDC, 300mA	
Auto iris connector	Internal wiring only for galvanometric iris drive and iris video output, Automatic electronic shutter built-in	
Functional options	Manual shutter, up to 16 fields integration output, external digital control for R-Y,B-Y hue, gain, iris level and chroma level	
Accessories	CS and C-mount mini lenses	

SECTION 3: THEORY OF OPERATION

3.1 OPERATION PRINCIPLES OF THE CCD

A CCD (Charge Coupled Device) consists of MOS (Metal Oxide-Silicon) capacitors arranged in a regular array. It performs three functions connected with handling electrical charges:

Photoelectric conversion (photo sensor)

Incandescent light generates electrical charges on the MOS capacitors, with the quantity of charge being proportional to the brightness.

Accumulation of electrical charges

When voltage is applied to the electrodes of the CCD, an electrical potential well is formed in the silicon layer. The electrical charge is accumulated in this well.

Transmission of electrical charge

When high voltage is applied to the electrodes, a deeper well is formed. When low voltage is applied, a shallower well is formed. In the CCD, this property is used to transmit electrical charge. When a high voltage is applied to the electrodes, a deep electric potential well is formed and electrical charge flows in from the neighboring wells. When this is repeated over and over among the regularly arranged electrodes, the electrical charge is transferred from one MOS capacitor to another. This is the principle of CCD electrical charge transmission.

3.2 MECHANISM OF CCD ELECTRICAL CHARGE TRANSMISSION

The TMC-73M uses a 4-phase drive method CCD. For simplicity, a 2-phase drive method CCD is explained below.

Figure 1 shows an example of the changes which can occur in potential wells in successive time intervals.

At t1, the electrode voltages are fH1>fH2, so the potential wells are deeper toward the electrode at the higher voltage fH1. Electrical charge accumulates in these deep wells.

At t2, the clock voltages fH1 and fH2 are reversed; now the wells toward the electrode at voltage fH2 become deeper while those toward the electrode at fH1 become shallower. So the wells at fH2 are deeper than those at fH1 and the signal charge flows toward the deeper wells.

At t3, the electrode voltages have not changed since t2, so the signal charge flows into the wells toward the electrode at fH2. One transmission of electrical charge is completed. This action is repeated over and over to execute the horizontal transmissions.

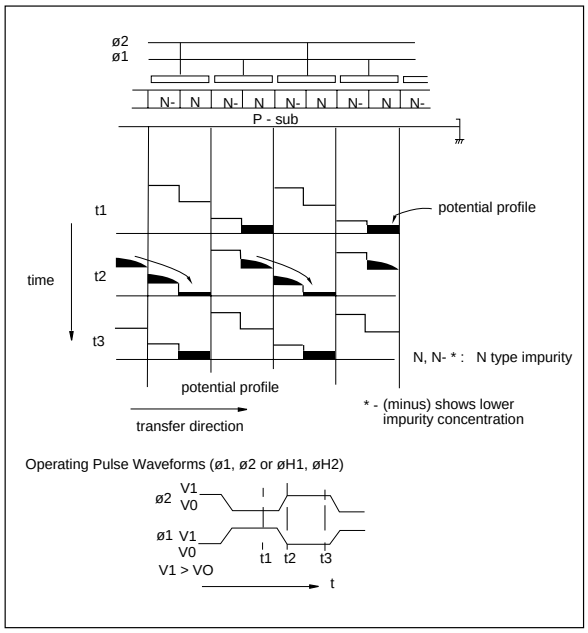


Figure 1

Vertical transfer

The vertical shift register transfers charges using a four-phase drive mode. Figure 2 shows an example of the changes which can occur in potential wells in successive time intervals. At tO, the electrode voltages are (V1 = V2)>(V3 = V4), so the potential wells are deeper toward the electrode at the higher voltages V1 and V2. Charges accumulate in these deep wells.

At t1, the electrode voltages are (V1 = V2 = V3)>(V4), so the charges accumulate in the wells toward the electrode at V1, V2 and V3.

At t2, the electrode voltages are (V2 = V3)>(V4 = V1), so the charges accumulate in the wells toward the electrode at V2 and V3. Electrode voltage states at t3 and after are shown below.

t3(V2 = V3 = V4)>(V1)
t4(V3 = V4)>(V1 = V2)
t5(V4>(V1 = V2 = V3)
t6(V4 = V1)>(V2 = V3)
t7(V4 = V1 = V2)>(V3)
t8(V1 = V2)>(V3 = V4) (Initial state)

These operations are repeated to execute the vertical transfer.

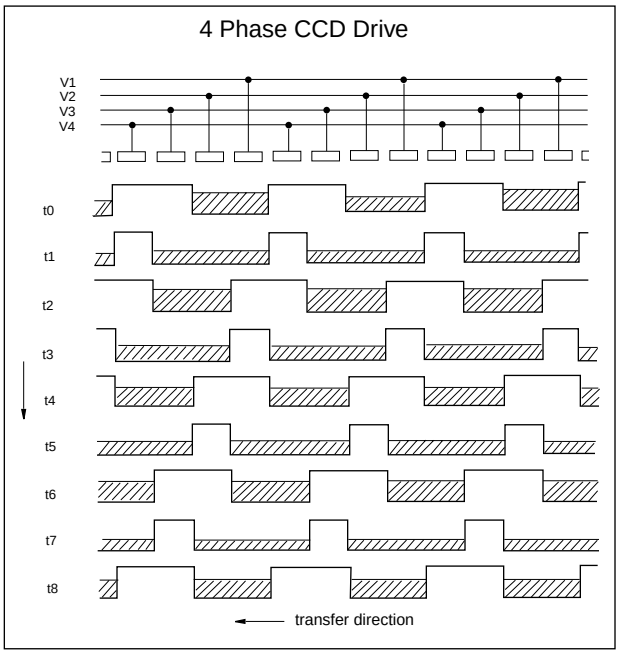
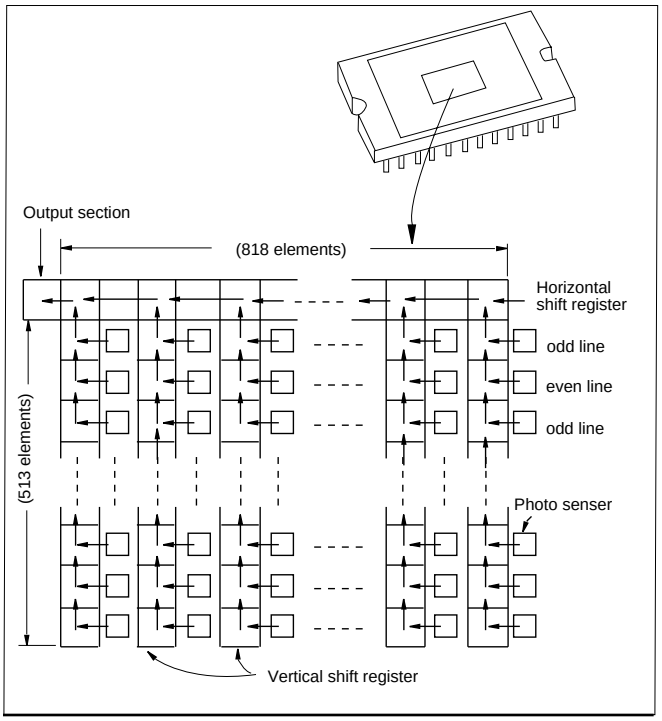


Figure 2

3.3 THE INTERLINE-TRANSFER ORGANIZATION OF THE CCD IMAGE SENSORS

The TMC-73M CCD video camera module adopts an interline-transfer organization in which the precisely aligned photosensor and vertical transmission section are arrayed interlinearly.

A horizontal shift register links up with the vertical transmission section. Light variations are sensed by the photosensors which generate electronic charges proportional to the light intensity. The generated charges are fed into the vertical shift registers all at once. The charges are then transferred from the vertical transmission section to the horizontal shift registers successively and finally reach the output amplifier to be read out successively.



3.4 INSTRUCTIONS FOR POWERING THE TMC-73M/TMC-63M

Connectors

The TMC-73M requires 12 V DC (200mA). Power is obtained through the 12-pin connector located at the rear of the camera. PULNiX offers a 4-conductor power cable with mating connector (model# C-10). For Y/C output, use a 12-pin connector to supply power.

Optional output

Each pin has to be designated for various options such as Y/C output, integration control, etc. The customer will be required to assign option numbers.

Warning

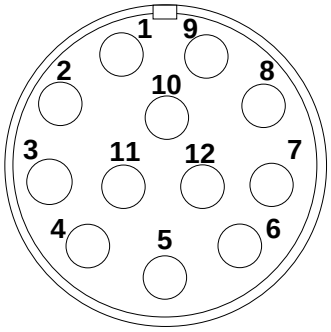
The TMC-73M must use either the 12P Series or C-10 cable. When applying power to the camera, make sure that none of the exposed leads on the multiple conductor cable are touching. This may cause damage to the camera. Besides the power connector, there is a standard BNC video connector on the rear of the camera.

3.4.1 12-PIN CONNECTOR AND POWER CABLES

12-Pin Connector

TMC-73M/TMC-63M	12P-02 Cable
1. GND	Gray
2. +12V DC In	Yellow
3. GND	Red Shield
4. Video Out (VBS)	Red Coax Signal
5. GND	Orange Shield
6. Auto/Man	Orange Coax Signal
7. Chroma	Black Coax Signal
8. GND	White Shield
9. Y (B/W)	White Coax Signal
10. D0	Brown
11. D1	Blue
12. D2	Black Shield

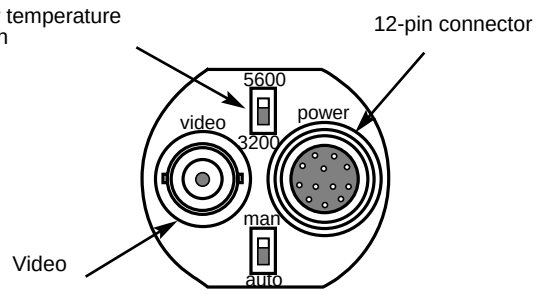
12-Pin Figure Power Connector



12P Series cables available:

12P-02 2 meters
12P-05 5 meters
12P-10 10 meters
12P-15 15 meters
12P-25 25 meters
12P-X Custom length
12P-02 8-conductor cable for RGB
12P-02MF RGB separator cable (for use with CCA-7 Signal Separator only)

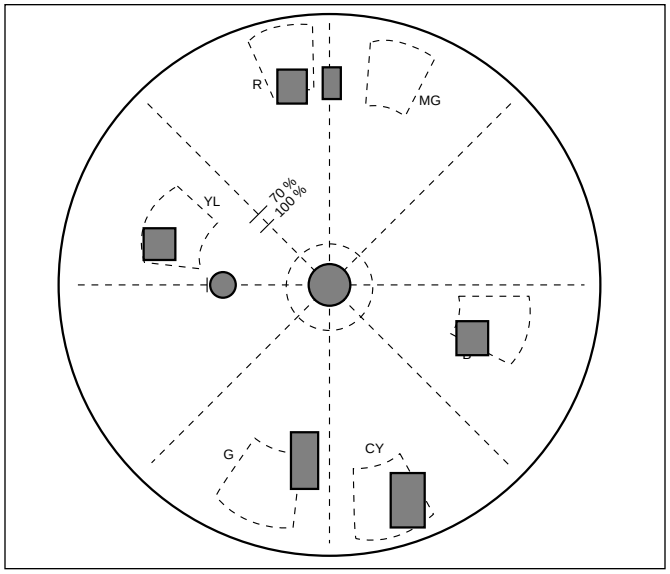
3.4.2 BACK PANEL ASSEMBLY



Back Panel Assembly

3.4.3 COLOR BALANCE ADJUSTMENT

The TMC-73M/TMC-63M cameras feature an advanced color balancing system which is set to out-door condition and indoor condition as factory set. External digital control is capable to set internal D/A converter for R-Y, B-Y Hue and chroma level adjust-ment.



3.4.4 AUTO SHUTTER AND AUTO IRIS OUTPUT

The TMC-73M has a built-in autoshutter control which works as electronic iris so that standard fixed or manual iris lens can be used.

The TMC-73M has auto iris output pads located on the PWB1. optional output from special connector may be obtained from PULNIX. The lens mount of the camera is a standard CS-mount or C-mount with a adapter, and most standard 1/2" auto iris lenses may be used with the TMC-73M/TMC-63M.

D0, D1, D2 are used for manual shutter speed control.
.

Warning:
Do not unplug the auto iris lens from the camera while the camera is powered. This may damage the lens.

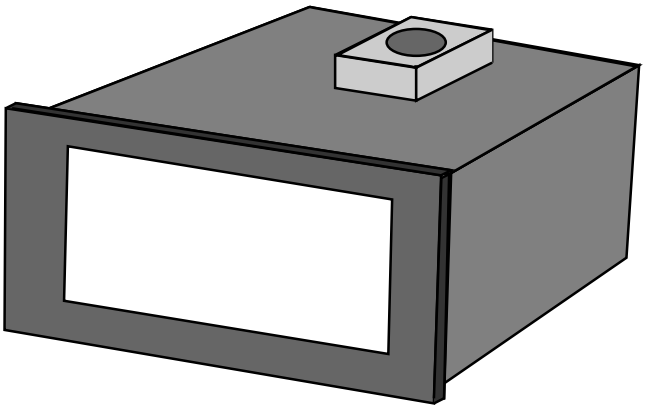
SPEED CONTROL

	0	1	2	3	4	5	6	7
D0	L	H	L	H	L	H	L	H
D1	L	L	H	H	L	L	H	H
D2	L	L	L	L	H	H	H	H
Shutter speed	1/60	1/125	1/250	1/500	1/1000	1/2000	1/4000	1/10000
Integ-ration (option)	2FLD	4FLD	6FLD	8FLD	10FLD	12FLD	14FLD	16FLD

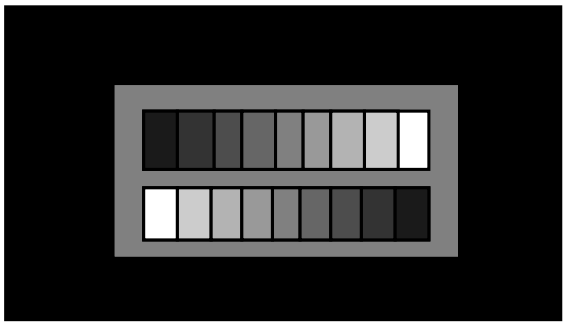
SECTION 4 : ALIGNMENT AND ADJUSTMENT

4.1 EQUIPMENT

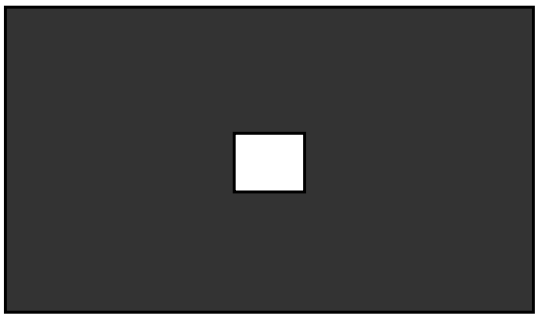
1. Light source for test chart.
   Pattern Box PTB-100 (90-130V)
   PTB-220 (190-240V)



2. For video level and gamma adjustment.

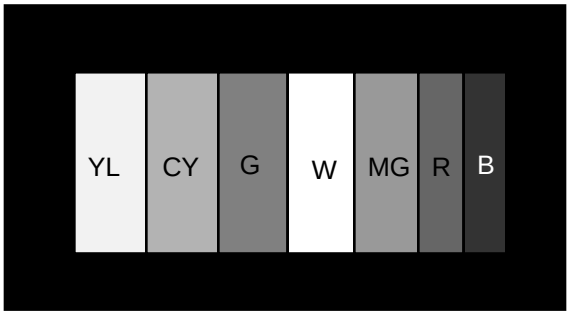


Grayscale Chart



White Window Chart

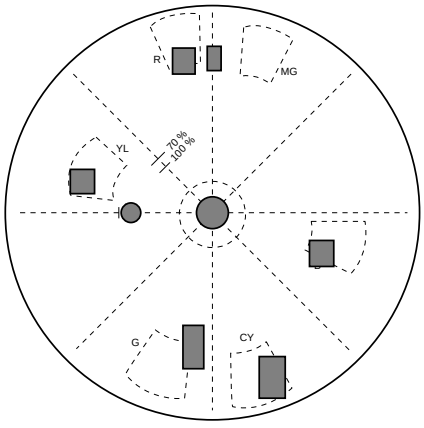
3. For color adjustment.
   (Use color bar chart)



Color Bar Chart

4. For signal adjustment.
   Vectorscope
   Waveform monitor
   Oscilloscope

5. Standard Pattern Frame



4.2 PREPARATION

4.2.1 BACK FOCUS ADJUSTMENT (ONLY FOR OPTIONAL REQUIREMENT)

Subject: Resolution chart

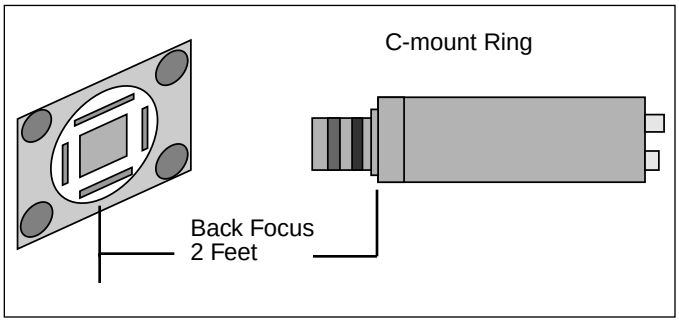
1. Mount the manual lens (i.e. Cosmicar 25mm, F=1.4).

2. Open the lens iris completely and set lens focal length to minimum for the lens used (e.g. 2 ft.).

3. If image is not focused properly, set back focus as follows.

4. Unscrew the M2x3 hex screw on the Front Panel until the focus ring is loose.

5. Adjust the silver back focus ring until the image is focused.
6. Repeat steps 4 and 5 if needed.



4.3 TMC-73M ADJUSTMENT PROCEDURES

4.3.1 PRESET

Preset each potentiometer as follows:

PWB1

VR101	Y level	= 2.5 V
VR102	SH level	= 1.7 V
W101	TMC-73M...Open, TMC-63M...Short	
W102	TMC-73M...Short, TMC-63M...Open	
W103	TMC-73M...Open, TMC-63M...Short	
W104	TMC-73M...Open, TMC-63M...Short	

PWB2

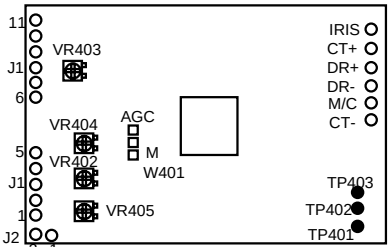
W201	TMC-73M...N, TMC-63M...P
W202	Open
W203	NTSC...Open, PAL...Short
W204	NTSC...Open, PAL... Short
W205	Right side (VD)

PWB3

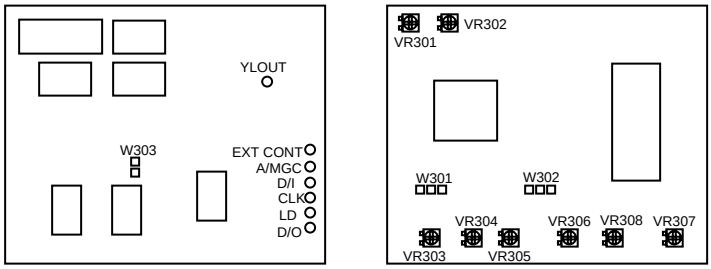
VR301	B-Y GAIN	= 2.4 V
VR302	R-Y GAIN	= 3.2 V
VR303	R cont 3200	= 3.8V
VR304	R cont 5600	= 4.0 V
VR305	B cont 3200	= 4.0 V
VR306	B cont 5600	= 3.4V
VR307	R-Y Hue	= 3.5 V
VR308	B-Y Hue	= 3.0 V
W301, W302	Set to 3200°K	
W303	Open (AGC on)	

PWB4

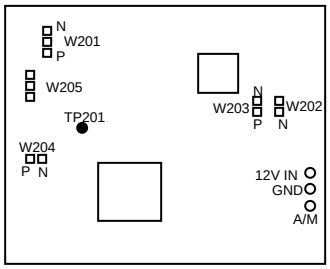
VR401	MGC	= 2.5 V
VR402	AGC MAX	= 3.0 V
VR403	AGC	= 2.0 V
VR404	Vsub	See Vsub voltage
VR405	IRIS level	= 2.0 V
W401	Keep open. Use MGC/AGC selection	
W402	NTSC... Open, PAL...Short	



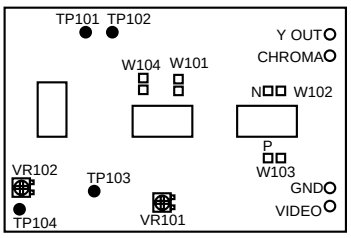
PWB4



PWB3



PWB2



PWB1

4.3.2 FUNCTION TEST

With above settings, the camera will output a good picture and you can proceed to the fine tuning process.

4.3.3 WHITE BALANCE

Equipment: Color bar chart (3200°K),
Vector scope, Wave form monitor.
Set AGC and White balance selection to Manual side (short to GND).
Set to auto-shutter off(PWB2, A/M to GND).
Use standard lens (Calibrated) and set the iris to F=8.
For 5600°K, use blue conversion filter.

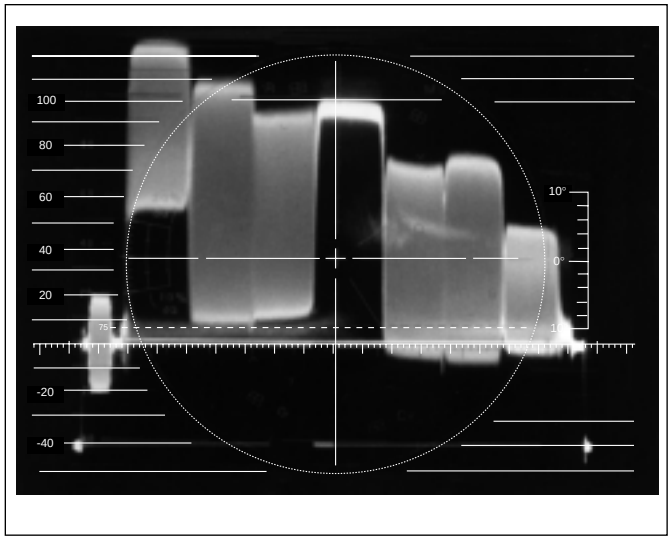
Burst level
Confirm that burst level on Vector scope is on the 75 % line.

R gain, B gain
Confirm that the white spot on Vector scope is in the center after adjusting white balance.

C1 gain
Confirm that each color dot on the Vector scope combines into one spot.

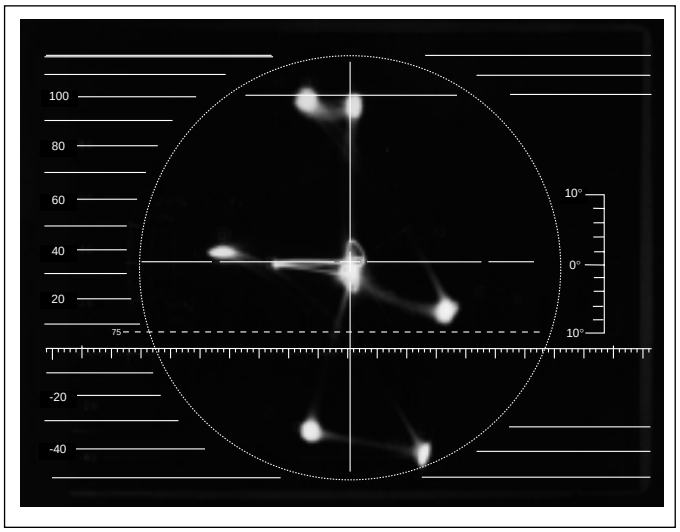
4.3.4 Y LEVEL, SETUP LEVEL

Use Waveform monitor.
Observe the waveform and adjust VR101 to set the white level to 95 IRE.
Put lens cap on and confirm that setup (Pedestal level) is 7, 5 IRE.



4.3.5 R-Y GAIN, B-Y GAIN, R-Y HUE, B-Y HUE

Use Vector scope.
Adjust VR302 (R-Y gain), VR301 (B-Y gain), VR307(R-Y Hue), VR308(B-Y Hue) to set each vector as shown below:



4.3.6 WHITE BALANCE

Adjust VR303 (R cont) and VR305 (B cont) to set the vector scope white center for 3200°K.
Change jumpers W301 and 302 to 5600°K side.
Adjust VR304 and VR306 with color temperature conversion filter to set white center.

4.3.7 AGC

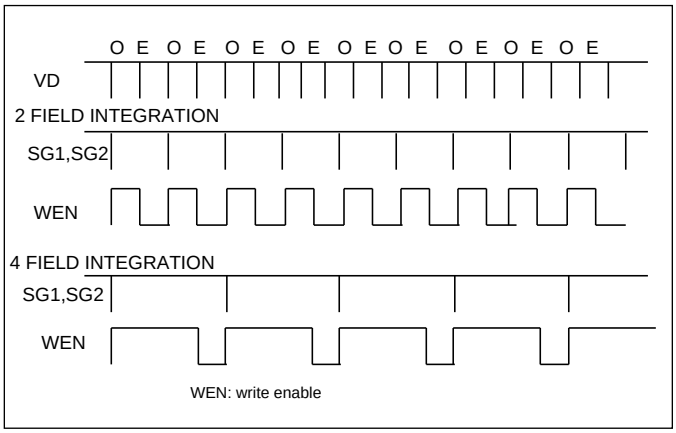
Select MGC/AGC to AGC side (open).
Adjust lens to see if AGC is functioning.
Observe the AGC threshold level and adjust AGC potentiometer if necessary.

4.3.8 SHUTTER CONTROL AND INTEGRATION CONTROL

Auto-shutter mode (electronic iris)
Set A/M selection to auto mode (Open) and check the electronic iris change. Adjust VR102 to select the best lighting condition if the preset is not adequate.

Manual shutter control
Select A/M to manual mode (short to GND).
If external control is required,it is necessary to wire D0, D1, D2 inputs.
The shutter speed is programmed by selecting D0, D1, D2.

Integration mode (Optional)
This integration is synchronous and the interval of the integration is programmed by selecting D0, D1, D2.
Select SMD1 open and SMD2 low (GND).
Pin #3 WEN can be used as picture grabbing timing.



Speed control

	0	1	2	3	4	5	6	7
D0	L	H	L	H	L	H	L	H
D1	L	L	H	H	L	L	H	H
D2	L	L	L	L	H	H	H	H
Shutter speed	1/60	1/125	1/250	1/500	1/1000	1/2000	1/4000	1/10000
Integ-ration (option)	2FLD	4FLD	6FLD	8FLD	10FLD	12FLD	14FLD	16FLD

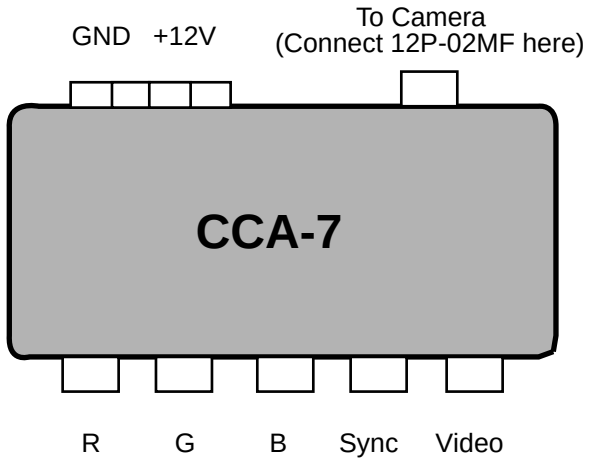
Continuous shutter
By applying a negative going TTL pulse to pin #6 TRIG input, the TMC-73M can operate with continuous shutter speed change. The input pulse must move within a field timing and the shutter speed is between the pulse edge and SG1, SG2. In order to activate this function, D0, D1, D2 must all be low (GND). Unless the TRIG pulse is applied, CCD charges are kept discharging and when the pulse is input, the discharge stops and integration starts up to the transfer gate timing (SG1, SG2).

External Digital Control
The TMC-73M has built-in digital communication and D/A converter which can take serial data input and provide various function controls.
The standard functions are;
Manual gain control
Iris level control for galvanometric iris lens
Chroma level adjustment
R-Y hue, B-Y hue control
12 bit of serial data controls 8 bit of data and 4 bit of address data. The D/A output is controlled as increment of 5/256 V (= 0.02V) to maximum 5.0 V.
See the data input format section.

SECTION 5: RGB OPERATION (Option)

5.1 CCA-7 RGB "BREAKOUT" MODULE

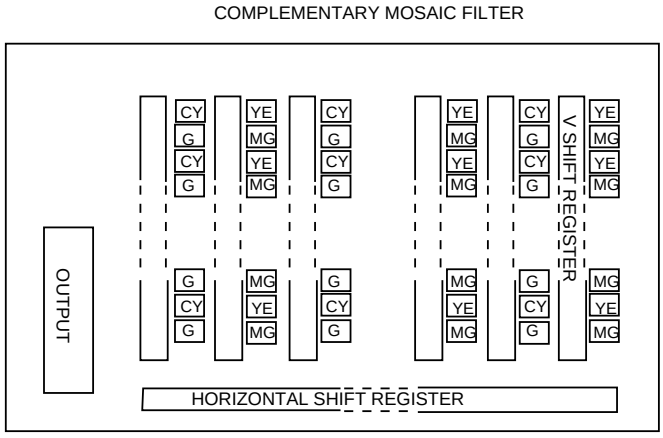
CCA-7 is a compact device designed to accept camera outputs via the 12P-02MF (2 - meter) cable from the camera, and then output the signals (R, G, B, Sync, and Video) via standard BNC connectors. It also accepts 12V DC input via a terminal for power.



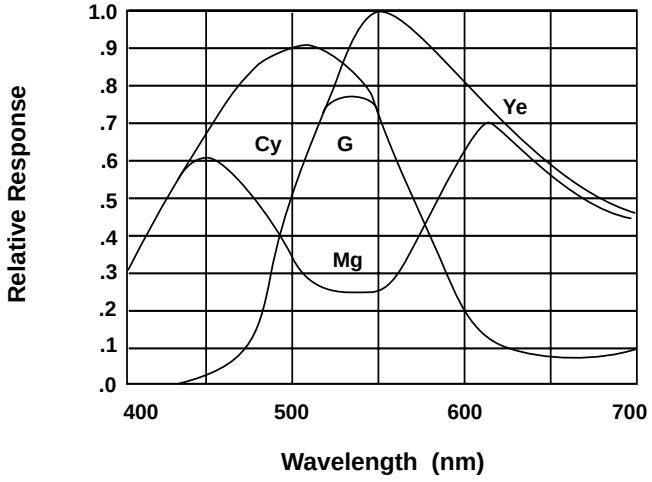
Note: RGB option is only available when TMC-73M is modified for use with CCA-7. Contact PULNiX for further assistance.

SECTION 6: IMAGER COLOR FILTERS

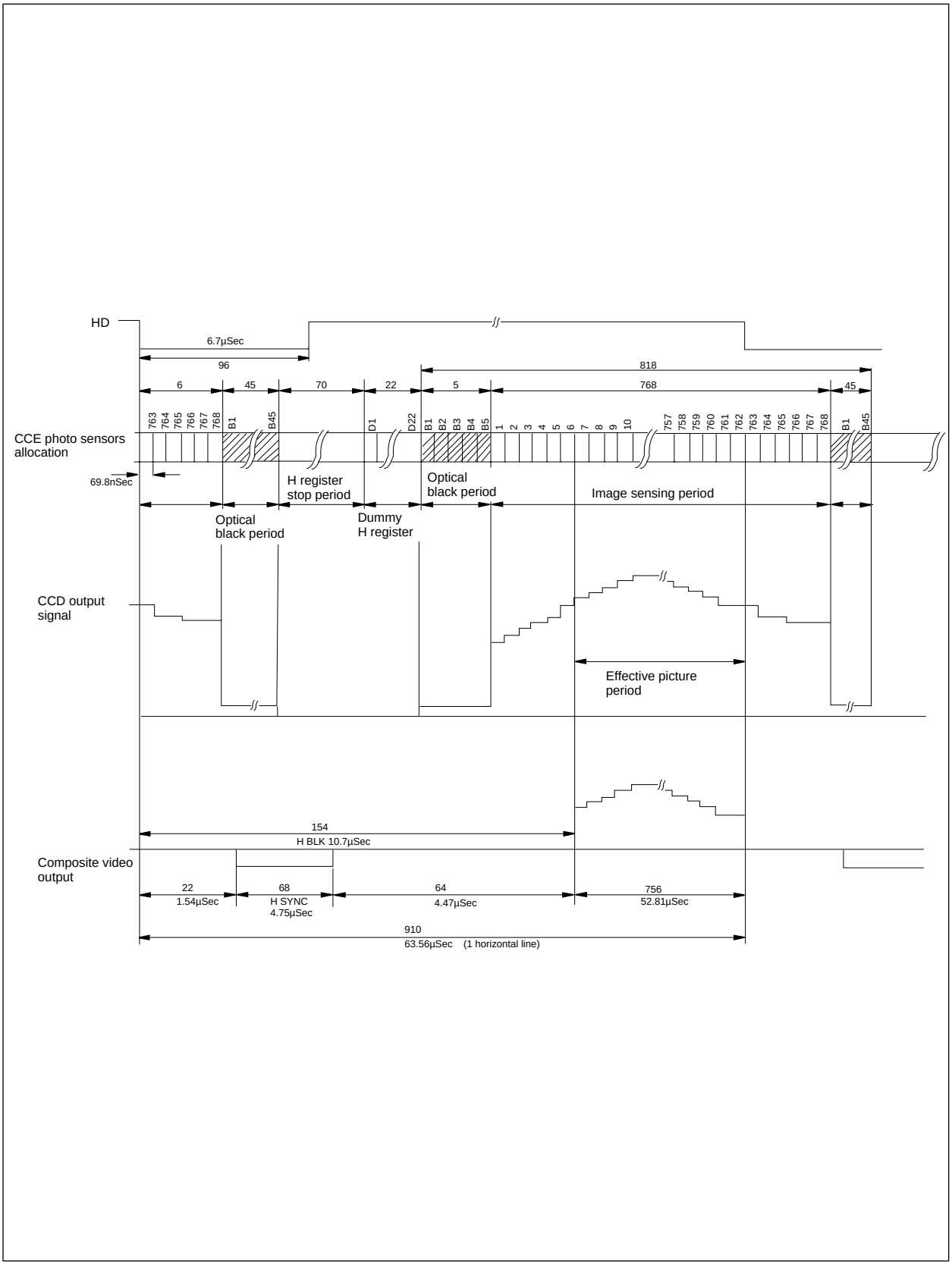
6.1 DIAGRAM OF COMPLEMENTARY STRIPE FILTER



6.2 SPECTRAL RESPONSE WITH COMPLEMENTARY MOSAIC FILTER



SECTION 7: TIMING CHART FOR TMC-73M/TMC-63M



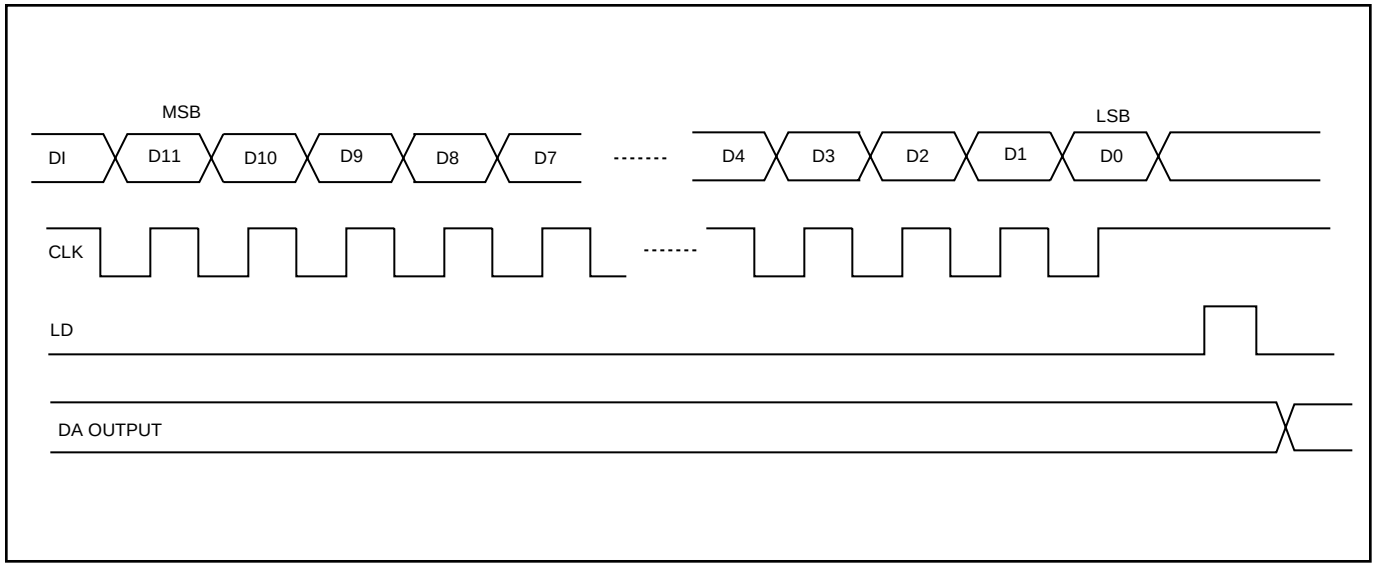
SECTION 8: SERIAL DATA INPUT FORMAT

LSB MSB

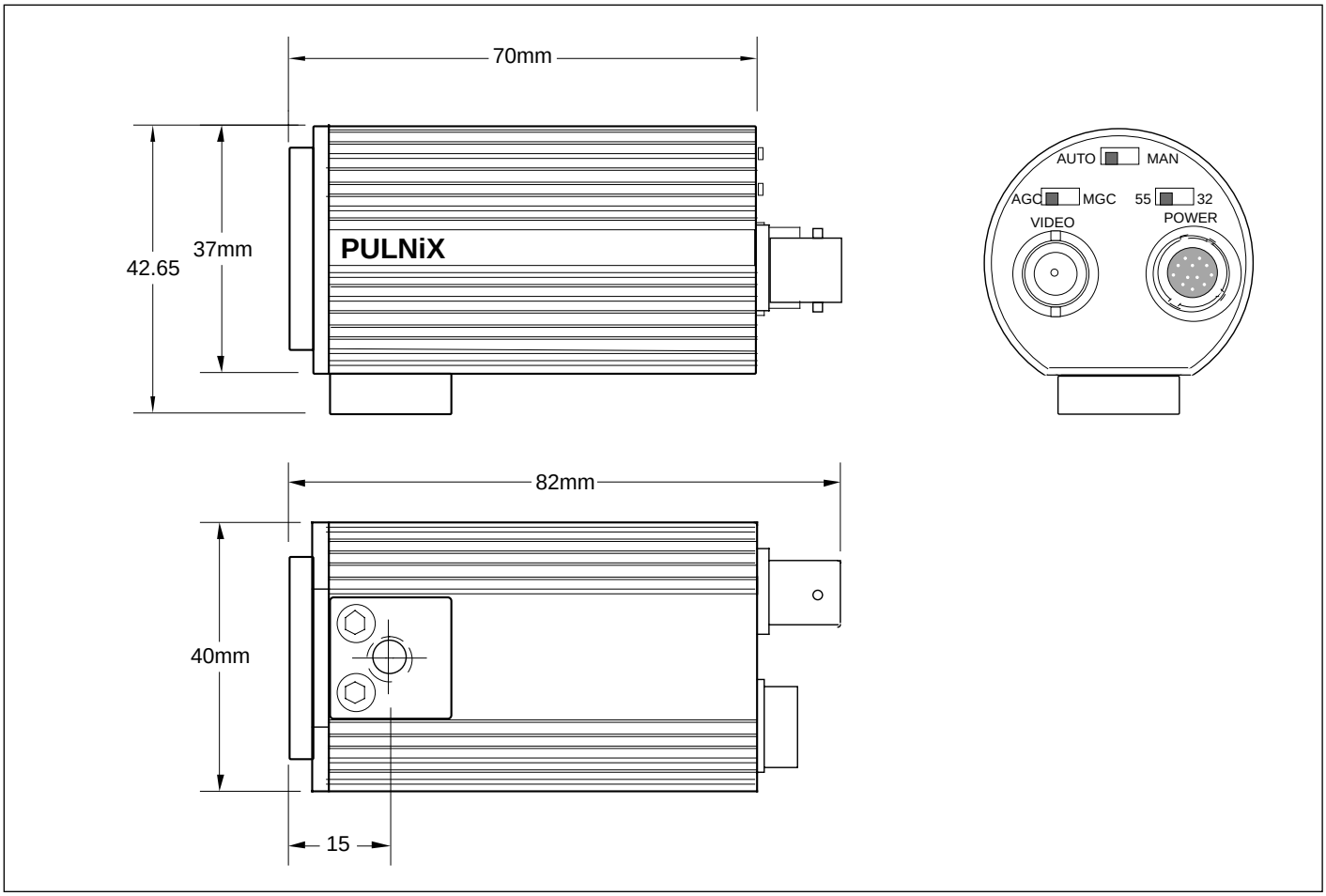
D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	
←		D/A OUTPUT					→	←	ADDRESS DATA		→	
0	0	0	0	0	0	0	0	(5/256) X 1 = 0.02 V				
1	0	0	0	0	0	0	0	(5/256) X 2 = 0.04 V				
0	1	0	0	0	0	0	0	(5/256) X 3 = 0.06 V				
				⋮								
0	1	1	1	1	1	1	1	(5/256) x 255 = 4.98 v				
1	1	1	1	1	1	1	1	(5/256) x 256 = 5.00 v				

ADDRESS

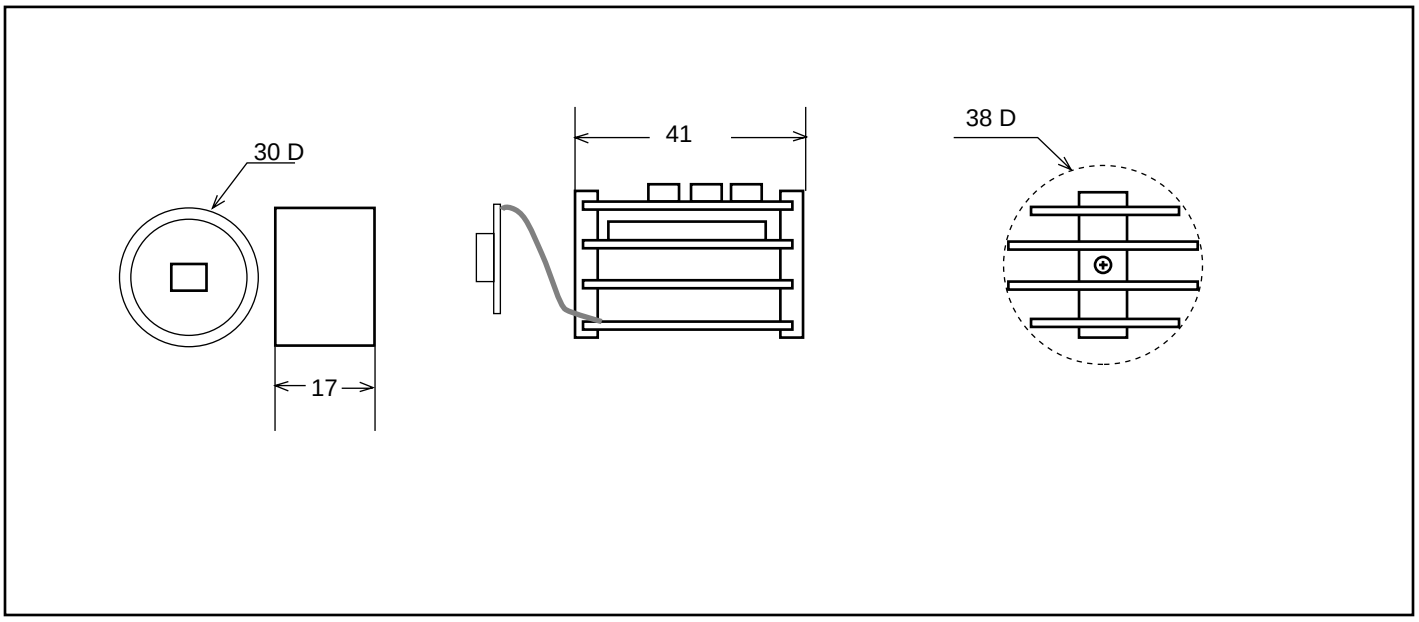
D8	D9	D10	D11		
0	0	0	0	Do not care	
0	0	0	1	A01 = Manual gain control	6dB at <1.5V, 32dB* at .4.3 V
0	0	1	0	A02 = Iris level control	Close at TBD, open at TBD
0	0	1	1	A03 = Chroma level	1.6 at <1.8 V, 1.0 at >4.5 v
0	1	0	0	A04 = R-Y Hue	0.02 v ..Hue off, other rotates hue
0	1	1	0	A05 = B-Y Hue	"
Others				Do not care	



SECTION 9: MECHANICAL DRAWINGS
9.1 STANDARD CONFIGURATIONS



9.2 OEM INTERNAL ASSEMBLY (Flex-Rigid board structure)



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WARRANTY

All our solid-state cameras have a full three year warranty. If any such product proves defective during this warranty period, Pulnix America, Inc. will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product. This warranty shall not apply to any damage, defect or failure caused by improper use or inadequate maintenance and use.

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