

CCTV

(3)

CCTV

5

:

CCTV

CCTV

가

Vlado Damjanovski

“CCTV”

CCTV

.

가

.

가

.

CCD

,

Spec

.

가

,

가

,

)

.

CCTV

.

가

.

CCTV

가

.

“Camera”

“Camera obscura”

.

“Dark room()”

.

가

.

가

.

19

“ ”

,

.

Joseph Nicéphore Niépce

1826

“Camera obscura”

가

.

가

.

(viewfinder)

(eyepiece)

가

.

,

TV

“ ”

.

CCTV

가가

.

가

CCTV

.

()

()

TV

.

가

.

CCTV

5. CCTV

() 가 .
가
CCTV CCD 752 x 582 () , 100 ISO 25mm
8000 x 6000 () 가 . 120lpm
1997 가
CCD
RAM 가

Tube cameras

1931 1930 Vladimir(Vlado) Zworykin(1889-1982)
10



photo-effect (Target) (Photosensitivity)
가 .
CCTV 가 : Vidicon
Newvicon.
Vidicon Automatic target voltage control
Vidicon 가 CCD
Vidicon F1.4
5~10lux
Newvicon (1lx)
Vidicon Target CCTV
Newvicon 가 Vidicon 가
Newvicon 가

5. CCTV

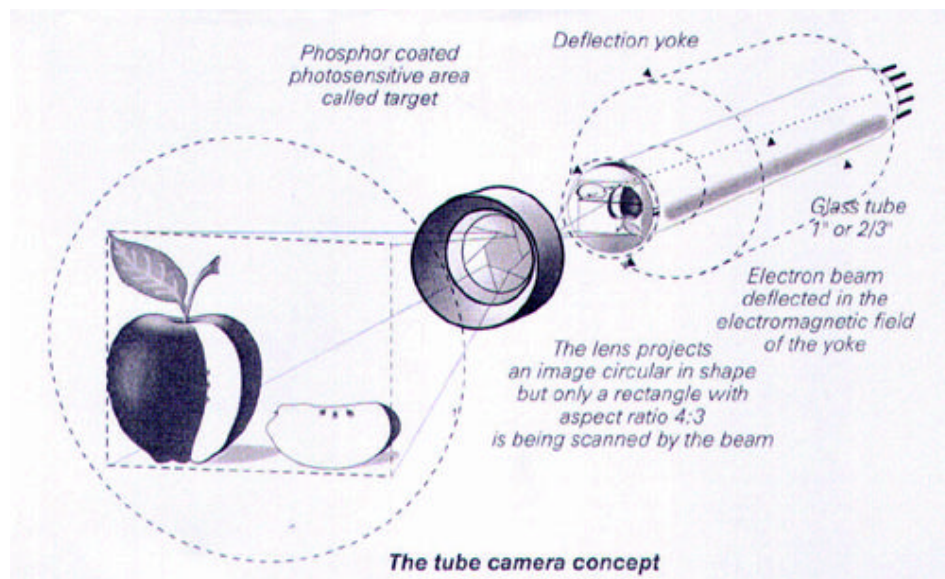


Photo-conductive
Photosensitivity Effect)

¹²A)

가

가

Composite Video Signal

가

가

"Dark current"

(electromagnetism)
EMF

가

가

Photosensitive
Flow가
Pico (PA=10⁻¹²)

가

(가)

가

가

CCD

Yoke

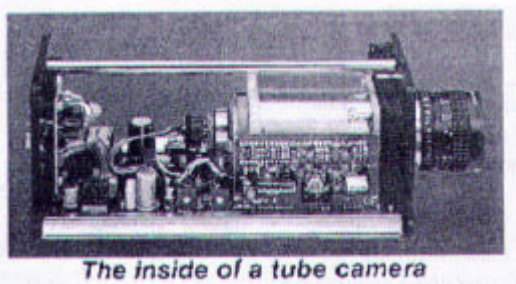
(precise alternating electromagnetic filed: EMF)
EMF가

EMF

(1,000V)

가

가



2

가

CCTV

CCTV

5. CCTV

가

CCD

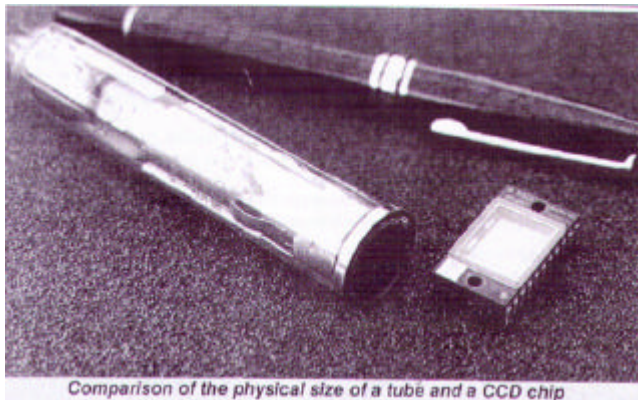
(

)

가

가

가



CCD

CCD

가

CCD

(

)

CCD

CCD

가

CCD Cameras

CCD "charge-coupled device"

1970

(PC)가

charge-coupled device



CCD가

CCD

CCD

CCD

가

(Shift register)

가

(

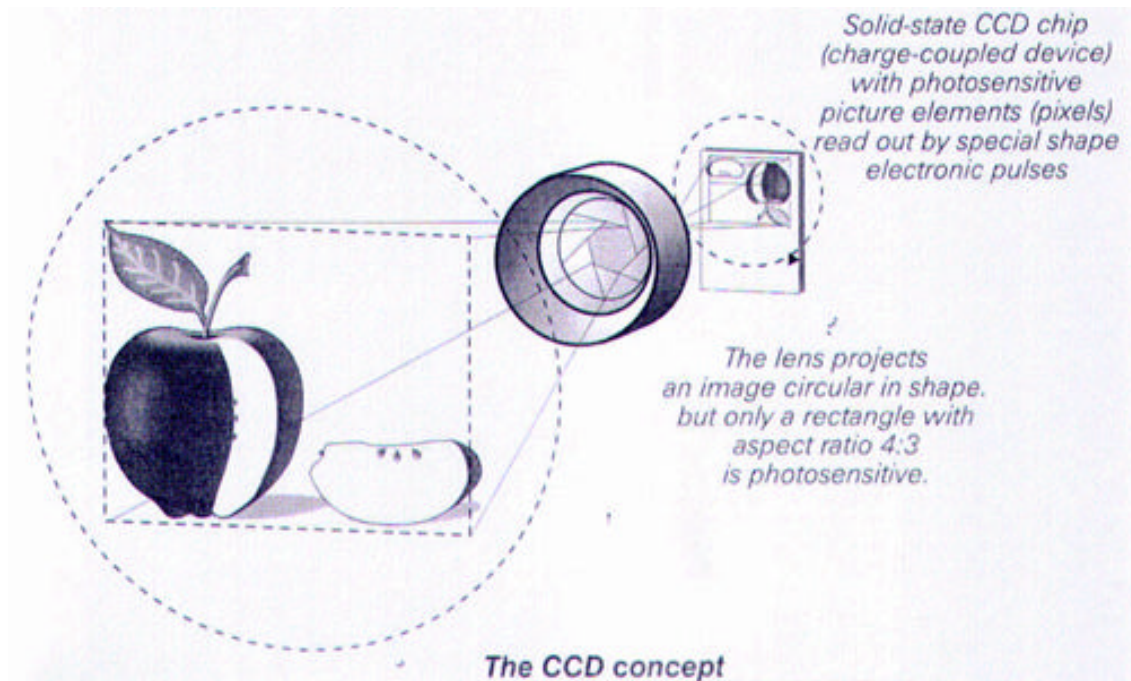
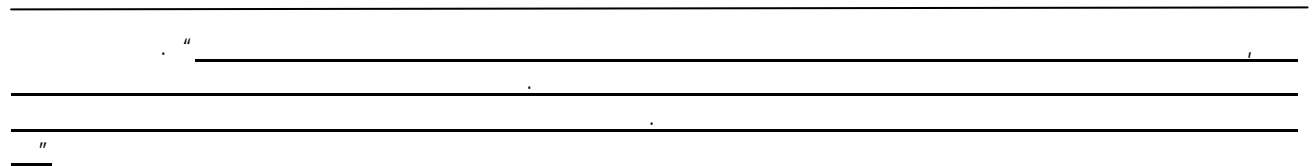
)

CCD

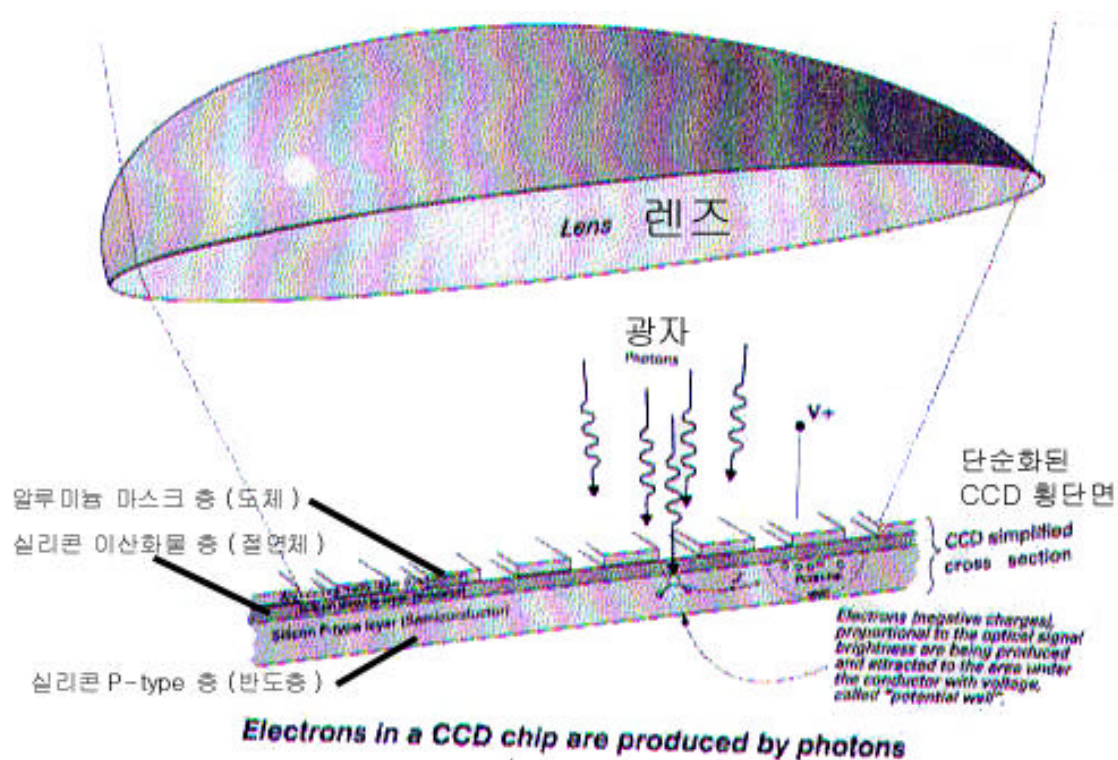
Gilbert Amelio

1874

5. CCTV



CCD (linear CCD: CCD) 2 (Array CCD: CCD)
가 가

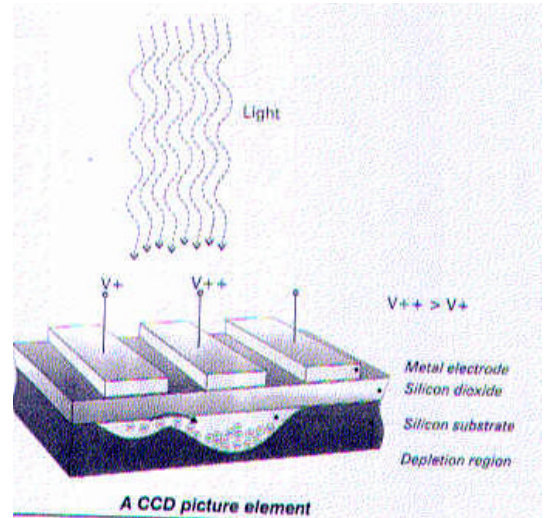


CCD

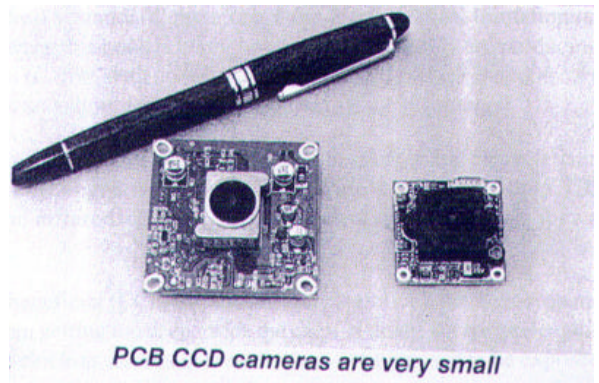
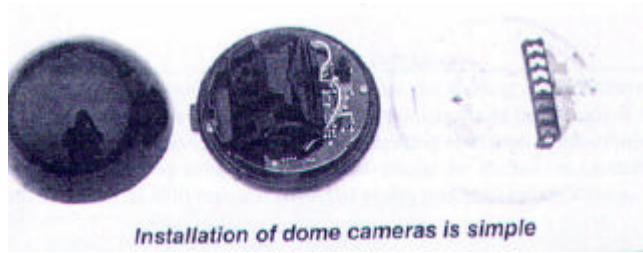
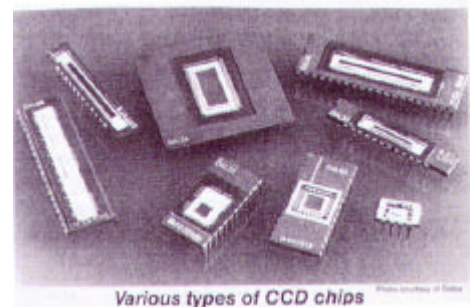
CCTV

5. CCTV

, () 가
 CCD
 , CCD
 ()
 : CCD ; OCR
 CCD ;
 CCD
 , CCD TV ()
 CCTV) CCD
 Tuber CCD ()
 가



. CCD
 Tube CCD
 - 0.1lx (B/W
 - 2
 - 가
 - EMF ; 가
 - (photo-effect)



가
 Tube
 2
 가
 2
 1/3"

CCTV

5. CCTV

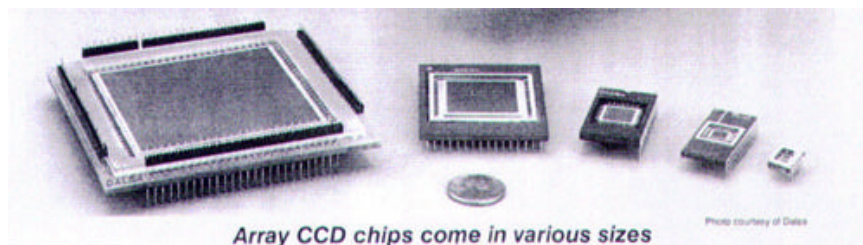
CCD

Vidicon Newvicon Tube CCD

100 ISO 가 200 ISO
100 ISO 4 가 400 ISO 1600 ISO

CCD 가
100 ISO F-16 1/125s
CCD , 1/50 CCIR F-1000 가 가
(AGC가 F-stops two) 가 1/50 1/125
(2.5 가)
2.5 F-stops 가 F-1000 F-400 가 (F-
number: 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32, 44, 64, 88, 128, 180, 250, 360, 500, 720, 1000, 1400
) F-16, 1/125 100 ISO 가 가
ISO Number가
F-16 F-40 9.5 가 $2^{9.5}=720$ ISO
CCD 100 ISO x 720 = 72,000ISO !

가 CCD 5000 ISO
()
CD 가
CCD ()



CCD (Array CCD chips)

가 TV ; (aspect ratio)
5120x5120 62mmx62mm
가 CCTV

CCD

(Photo-effect phenomenon)
CCD

CCD

" 가
가) (CCD
가



A CCTV camera CCD chip

5. CCTV

"Blooming Effect"

(Masked Area)가

Noise Smear가

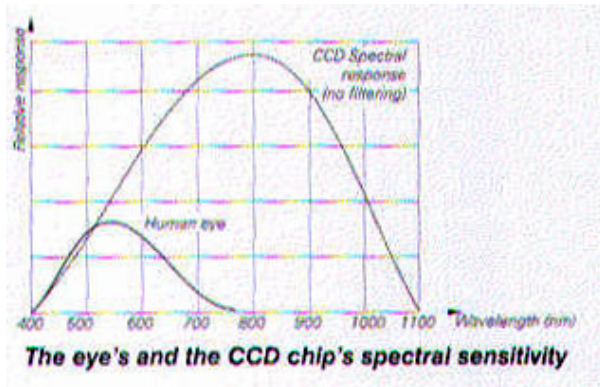
가

CCD

가
Plan-Parallel(?)
가

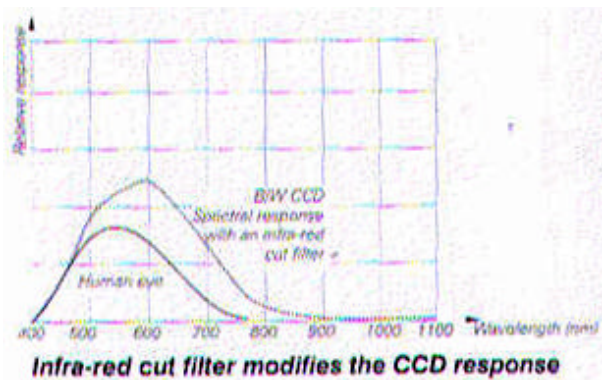
700nm

가



CCD

가



가 CCD

가

가

가

(?)

S/N

(IR Cut

CCD

IR

가

CCD

CCD

가

가

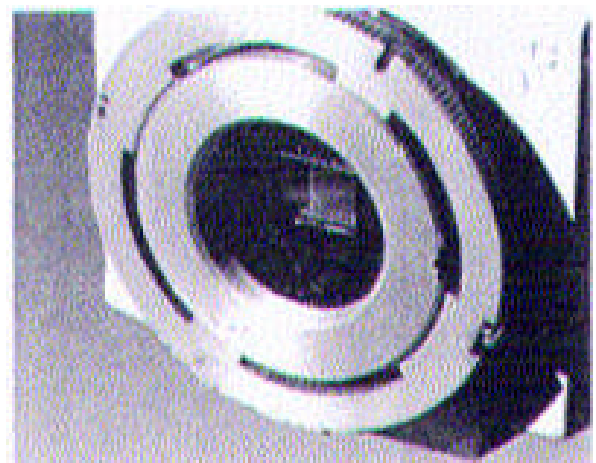
CCD 0.01 lx

가
0.1 lx

(0.3 ~ 0.5V)
2 lx

F1.4

가



The IR cut filter is a must for color CCD cameras

IR cut filter

CCD

CCTV

5. CCTV

CCD

CCTV Matrix(Array) CCD chips 가 .

1970 Frame Transfer (FT) CCD (Imaging Area) (Masked Area) .

CCIR 1/50s (EIA 1/50s)

Sync - (CCD) .

" "

?

가 ,

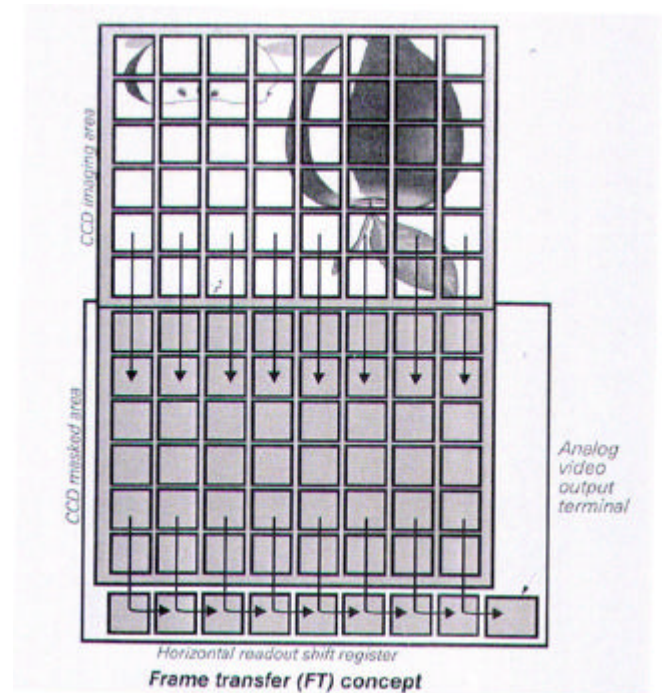
가

1/50s

TV ()

" Frame transfer" " Field transfer"

CCD



Newvicon CCD 가 Vidicon

Smearing , transfer가

가

가 가

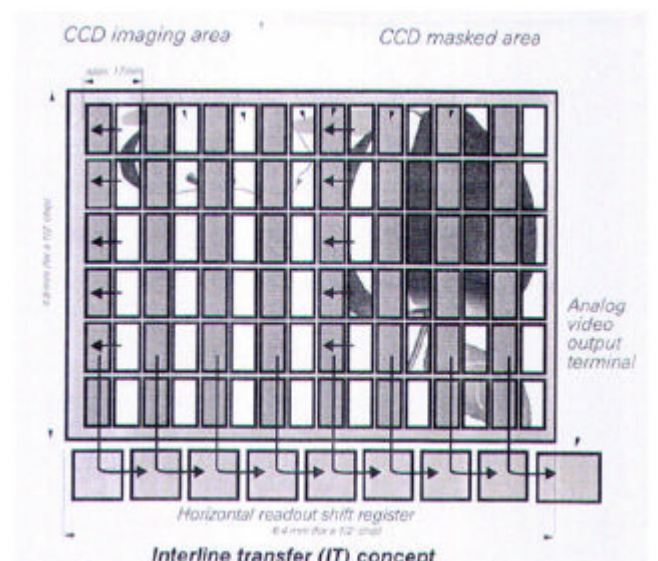
가

Interline Transfer(IT)

Sync Pulse

interline

, Smear



CCTV

5. CCTV

S/N 가

IT transfer

FT

가

CCD
1/50 (NTSC 1/60)
1Vpp

가

가

가

IT CCD
Iris) CCD-iris Electronic iris() 가 AI(Auto
MI(Manual Iris)

depth of field function()
가

The
(Smear)가 가

가 가

(1/60) 1/50
() 1/50 (EIA
1/60)

CCD

가

(Integration)
signal processing)

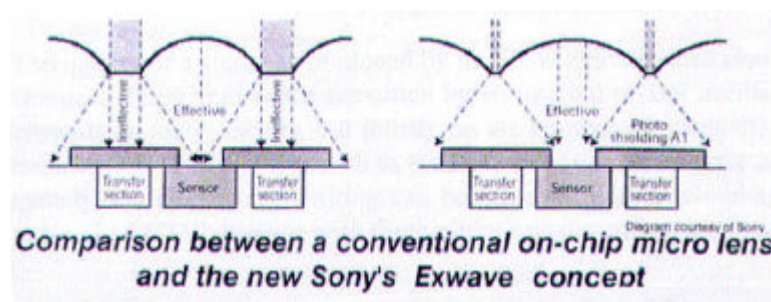
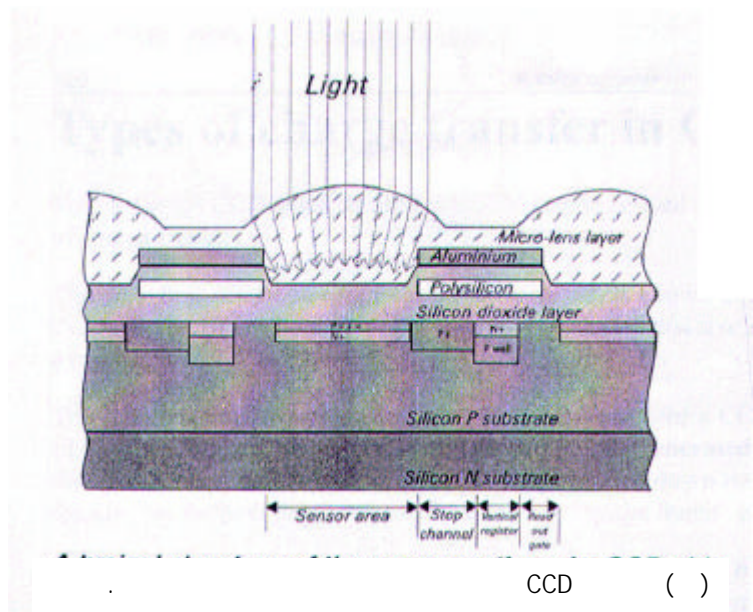
DSP(Digital

가

가

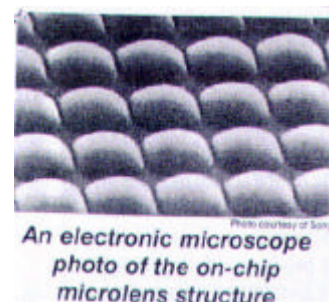
가 50 가 ()
(smoothness:?)
TL VCR(?)

(?)



On-chip

Exwave



On-chip

CCTV

5. CCTV

IT

()

가 CCTV 가 CCD IT

가

가 IT CCD ()
가 가

가
Transfer(IT) FIT CCD Frame Interline Transfer (FIT) Interline
Smear S/N

FIT (Smearing) S/N

가 가
S/N 가 가
TV Smear ()
(Electronic news gathering:ENG)

CCTV

TV

CCD

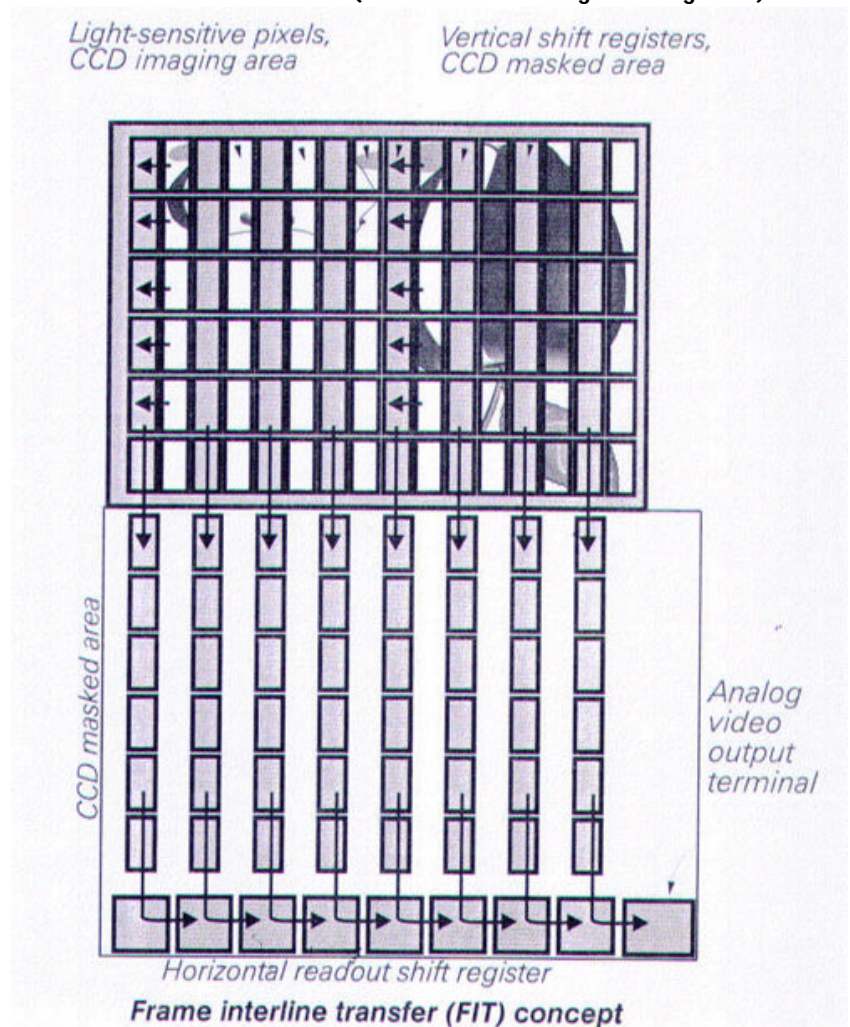
CCD

가

가

CCD

가



. Frame Interline Transfer (FIT) concept

CCTV

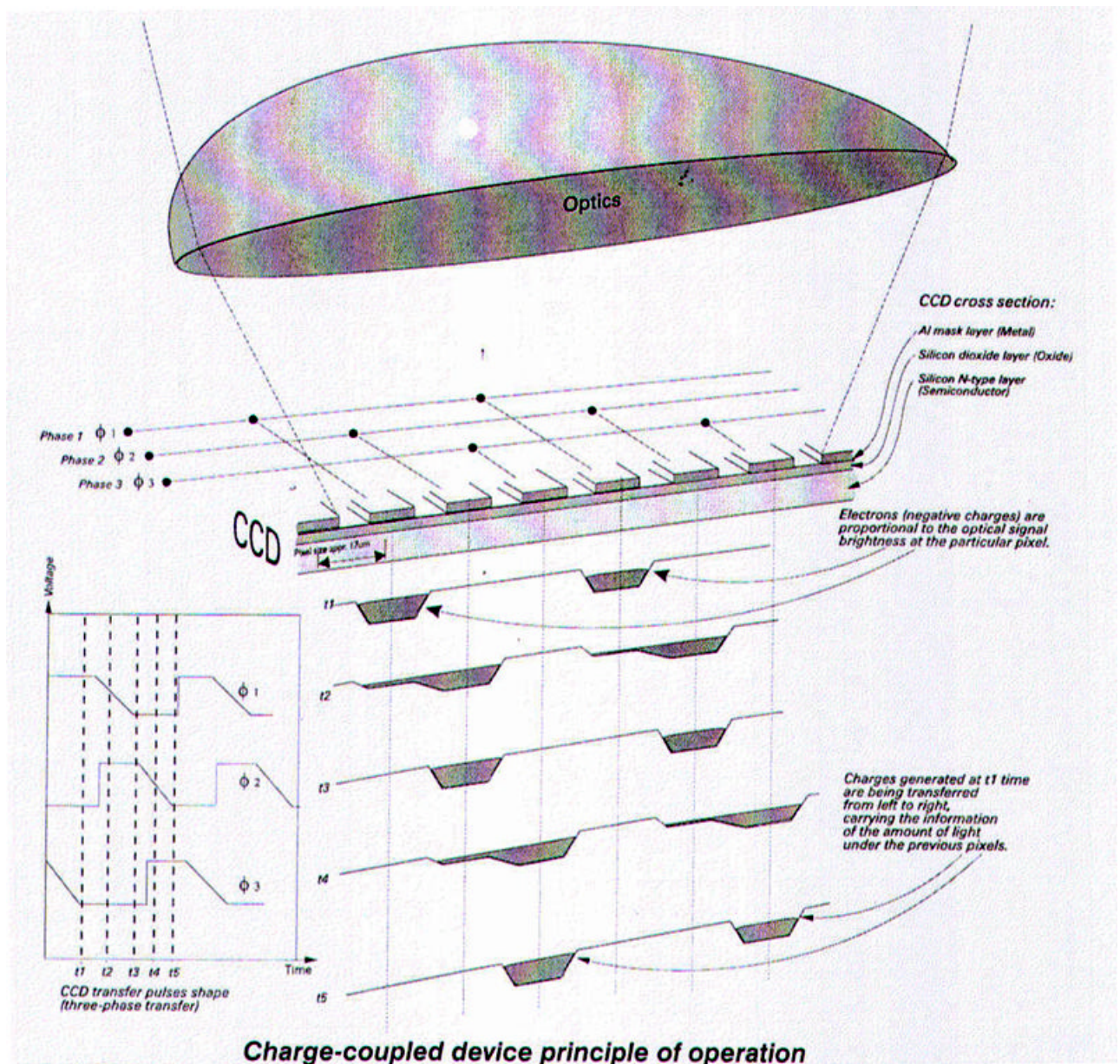
5. CCTV

CCD

(Pulses used in CCD for transferring charges)

CCD

CCD 가 (Shifting) Phase() (FT, IT FIT) (Elementary Shifting) 2
 , 3 4 CCTV 3
 가 가

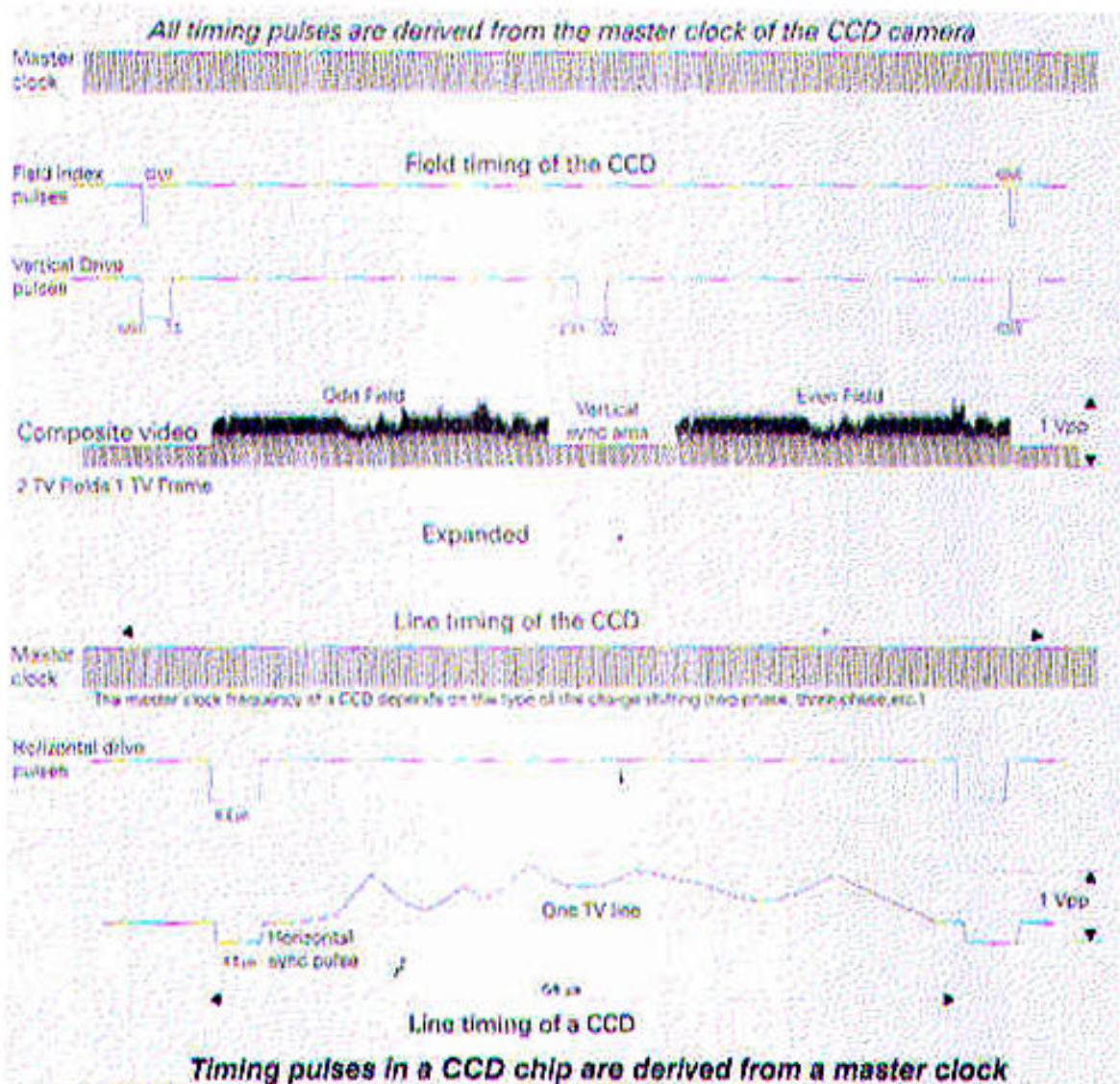


CCD

가 (Master Frequency) 1, 2, 3 가 () 3 0-5Vdc CCTV 가

5. CCTV

가



CCD

(Master Clock)

CCD

CCD (CCD chip as a Sampler)

CCTV

CCD

(Pixel) 2

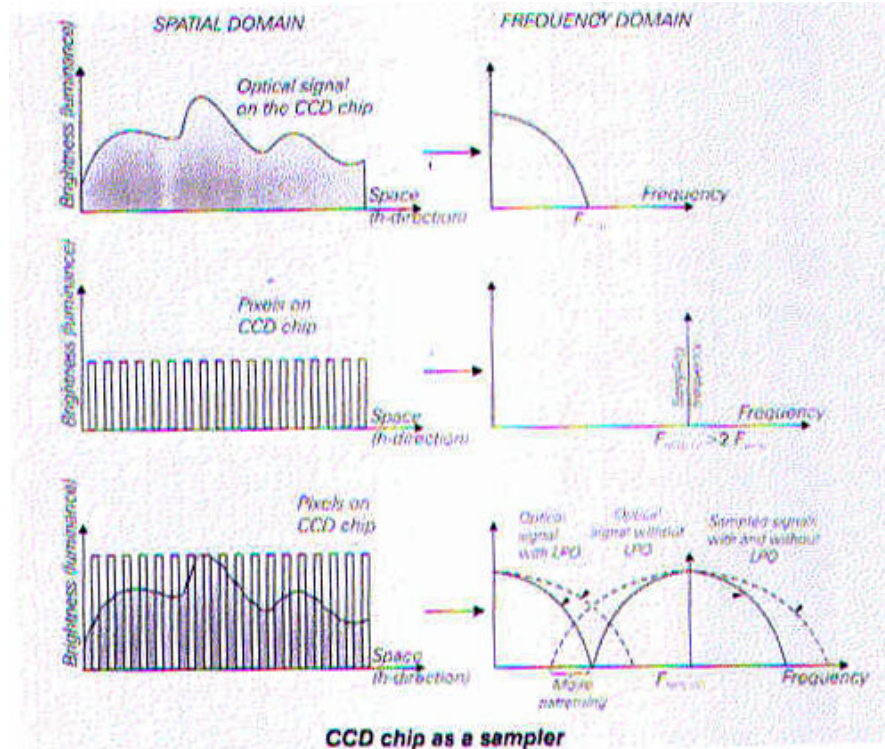
CCD
, MTF

가

CCTV

5. CCTV

Non-Continuity) (beam) CCD Tube TV TV (Line
가 가 가 TV



CCD

가

가

To some, Nyquist

가

가

, 1928

가

CD-

가

Nyquist

, CCD

Moire

(fold-over)

가

F_{max}

가

Nyquist

$F_{nyquist}$

Amplitude

Sideband

가 CCD

가 $F_{nyquist}$

() Side Band 가

($F_{nyquist}/2 - F_{max}$)

Low-pass optical(LPO)
birefringent quartz plates

CCD

Detail

5. CCTV

(Correlated Double Samples: CDS)

CCD 가 . 가

CCD

Processing) CCD (CDS) (Signal Sampling

CDS , CCD CCD

(diffusion) CCD diffusion On-chip

Reference reset signal()가 가 가

CDS - 가

가 CDS 가 CCD

TV



5. CCTV

가

가

가

(?)

attribute

Smear, Gamma

50

가

S/N

3dB

Gamma

가

•

•

•

• S/N

•

가

Gamma

Dark Current,

Spectral response, OLPF(optical low pass filtering), AGC

dB

(Sensitivity)

TV

CCTV

1Vpp(1 V peak-to-peak)

3200°K

(Iris opening) , 2000lx

90%

F-Stop,

가

(?)

EIA

700mV가

20mV

Gamma

0.45

25mm~50mm

가

AGC가

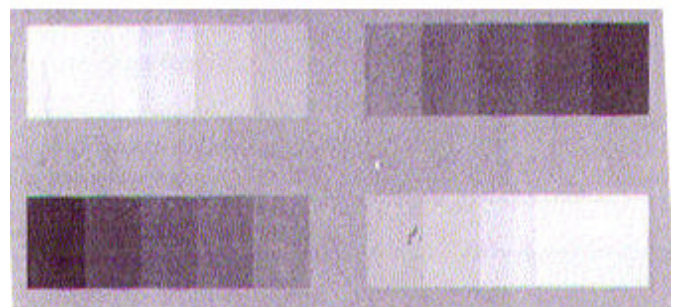
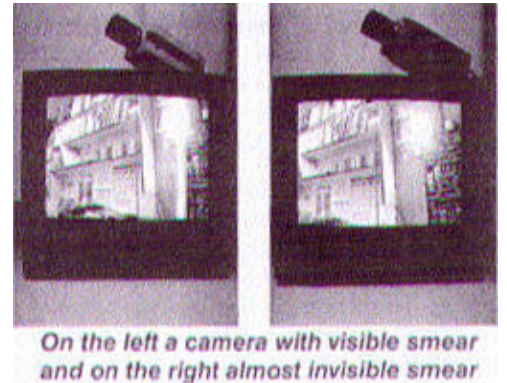
The Gray Scale Test Chart

F/5.6

가 700mV

F/4

가



CCTV

5. CCTV

(Minimum illumination)

CCTV 가 가 lux 가 가 가 .

가 가 30%(700mV) , 50%

가 10%

0.1lx." : " F/1.4 80%

AGC 10%(70mV)

(, () AGC가 가 F1.4 0.01lx Spec 가 가) F/1.4 0.1lx Spec (AGC 50% 가

CCD

(가) F-stop

가 CCD ()

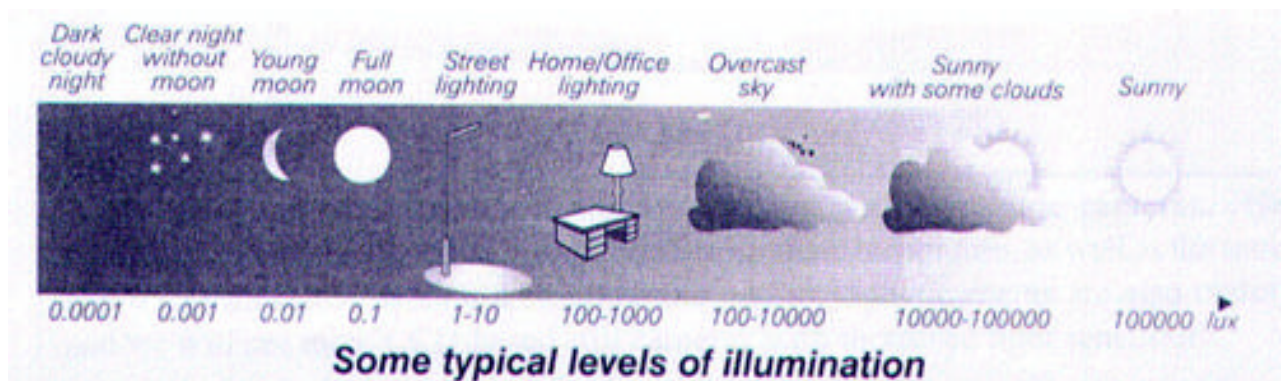
CCD

(10 (lux). F1.4 75% 1lx CCD 0.1lx

Spec

B/W CCD 가

CCD (Cut filter) CCD



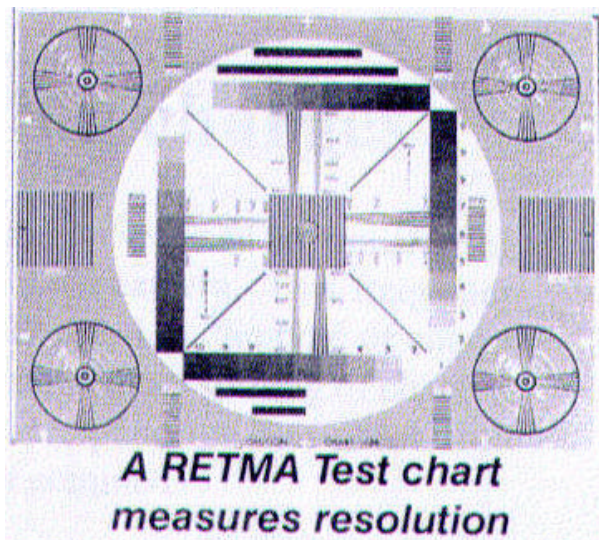
5. CCTV

CCTV	(Sharing)	CCD (sub-pixel)
B/W	B/W 1/3	
3	CCD 가 B/W	가
(monochrome)	가	CCD IR cut filter
가		가

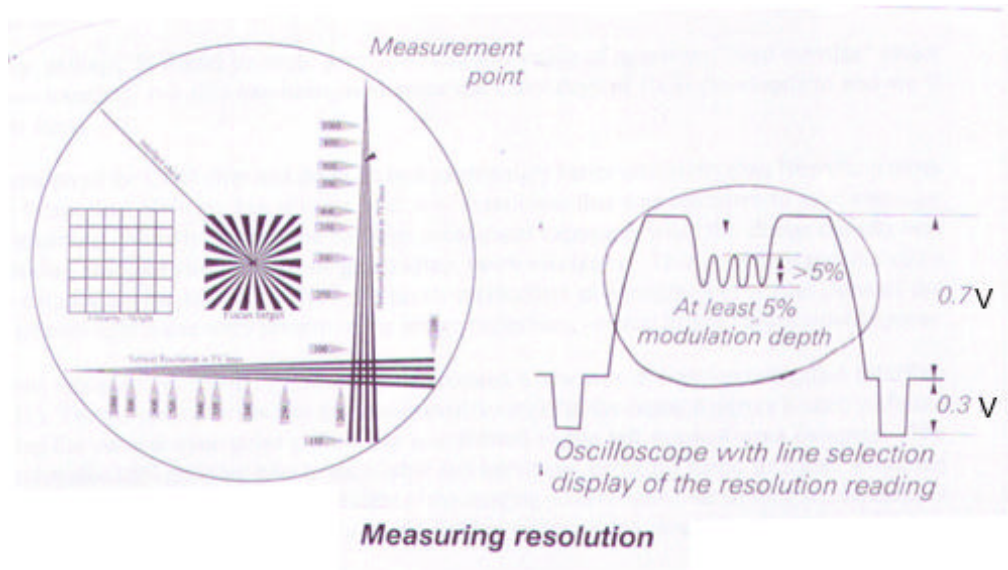
(Camera resolution)

Vertical resolution()	가
CCIR/PAL 625	EIA/NTSC 525
()	가
가 (vertical sync pulse), equalization lines()	
CCIR/PAL 575	EIA/NTSC 470
가 0.7 Kell factor()	가 400TV 가
() 5 "General characteristic of TV systems"	"Resolution" .)
가 330 TV EIA/NTSC	

(Horizontal resolution)	가
가 600 TV	가 CCD
CCD 75%	CCD 4:3
가 0.75 3/4	가
REMITA	가 TV .(?)
가 75	가 EIA
(underscan: 가	(?) 가
)	



5. CCTV



가 가 가 가 (F-stop, 5.6 8)
(AGC, Gamma, CCD-iris)

TV line
(Oscilloscope)가
가 (0.7V) 5%
()

가
가



CCTV Test Chart

가 50
가 10%
(CCTV) CCD B/W 가
B/W 가
TV 3 가 3
1" 1000 TV 가

CCTV

5. CCTV

S/N (Signal/Noise ratio)

S/N 가 (Noise) CCD 가 S/N 가 AGC 가

S/N (decibel) dB (logarithm) 3 (?) 가 dBmV dB 1μV 1mV dBμV

$S/N = 20 \log(V_s/V_n)$ (39) 가 Where(?): V_s V_n 가

$S/N = 10 \log (P_1/P_2)$ 10 20

CCTV 가 () dB 3dB 가 41% (100% 가) 3dB

DB(ratio)	0	0.1	0.2	0.3	1	2	3	10	20	30	60
V/C	1	1.012	1.023	1.035	1.122	1.259	1.413	3.162	10	31.62	1000
Power	1	1.023	1.047	1.072	1.259	1.585	1.995	10	100	1000	1,000,000

) CCD S/N

CCTV

5. CCTV

The diagram illustrates the test setup for measuring the video noise level of a CCD camera. It shows the signal flow from input sources through various processing stages to the final measurement point.

- Input Sources:** TV, S/N, 10kHz, and 5MHz signals are provided as inputs.
- Signal Processing:** The signals pass through a series of components:
 - A gain stage (\times) followed by an RMS calculation.
 - A Video Insertion test signal (VITS) source.
 - A gamma correction stage (γ).
 - An AGC (Automatic Gain Control) stage.
 - A CCD-iris stage.
 - A BLC (Black Level Compensation) stage.
- Measurement:** The output signal is measured using a video noise meter, which provides a reading in dB.
- Test Conditions:** The test is conducted at 100kHz and 5MHz frequencies.
- Results:** The measured video noise level is 48dB.
- Additional Information:** The test is performed using a CCTV CCD camera, and the results are compared against a reference value of 51dB.

CCD (Dynamic range of a CCD chip)

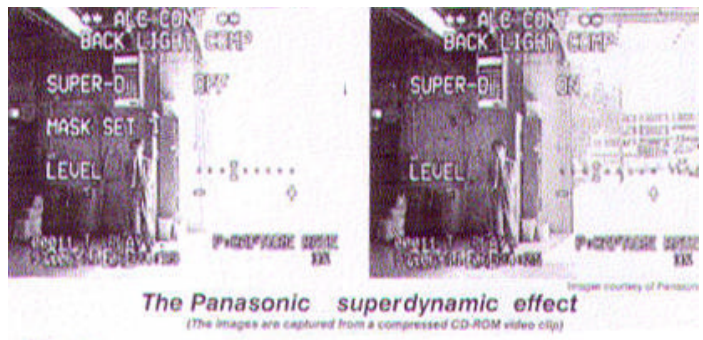
DR(Dynamic range:) CCD Spec . ,

CCD DR() RMS(root-mean-square:) 가
() DR S/N 가 ,
dB DR LOG가 ,
CCD 가
CCD RMS
1000 DR CCD
1000,000 가
CCD 가 AGC, Auto iris lens CCD-iris 가
Auto iris CCD
CCD-iris (CCIR/PAL
1/50 , EIA/NTSC 1/60 .)
CCD (PAL: 1/50 NTSC: 1/60) BLOOMING 가
(pixel)
Anti-blooming
CCD Anti-
blooming (Shift register)가
(DR)

CCTV

5. CCTV

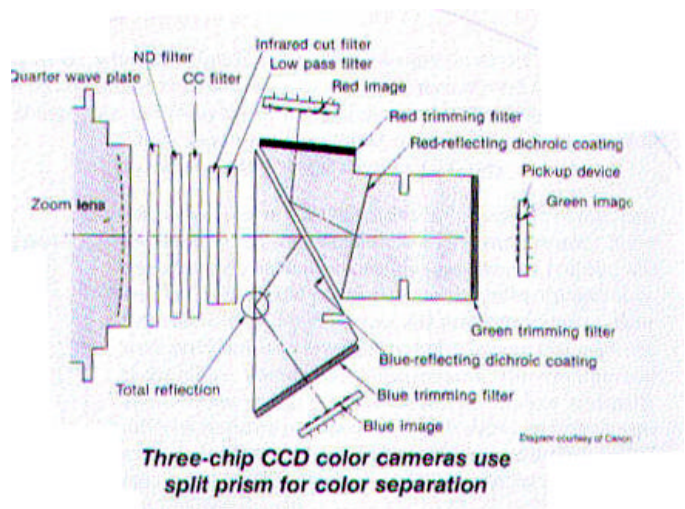
AGC	White peak reference point	
	White peak 가	
Plettac	Peak light blanking()	
Panasonic NTSC: 1/60)	CCD 가	(PAL: 1/50
	1/1000	
	(Panasonic	
) 40	가	
(DR)		
CCD	S/N	Dynamic Range()
		DR
-50	가 가	CCD head가
	(?)	CCD 가
CCTV	가	
	가	



Superdynamic Effect

Color CCD Cameras.

	(,)	가
(R,G,B)	가	
" 가 "	가	
가	가	
TV	3	CCD
가	RGB	
	(Optical split-prism:)	CCD
	3	CCD
	split-prism	



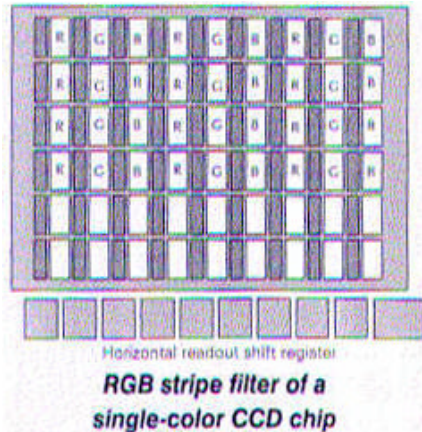
CCTV

5. CCTV

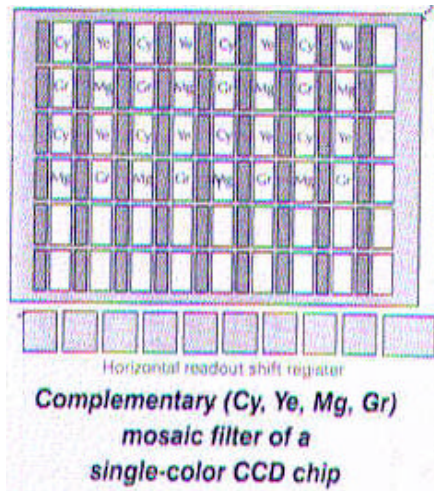
Split -prism

3-

CCTV



CCD RGB



CCD (Cy, Ye, Mg, Gr)

가 CCTV

가

Color filter array(CFA)

CCD

Y

$V=R-Y$ $U=B-Y$

CCD

가

(?) CFA

CCTV

CVBS

: Luminance(Y),
(U=B-Y)

Quadrature()
RGB

CCD

- RGB Stripe

(stripe)

- Complementary colors mosaic filter ()
CCD

Yellow Green()
Cyan(), Magenta()

CCD

가

50%

RGB

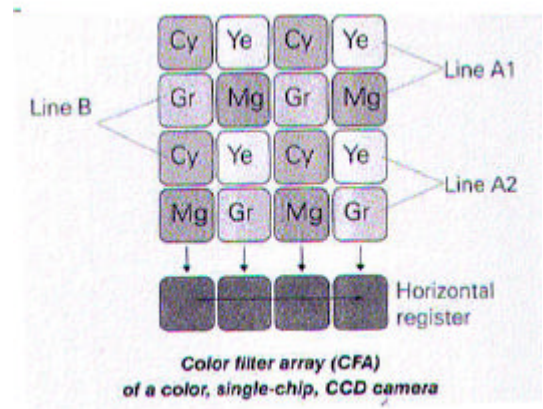
CCD

RGB

(Cy, Mg, Ye Gr)

가

65%



, CCD

CFA (Color filter array)

CCTV

5. CCTV

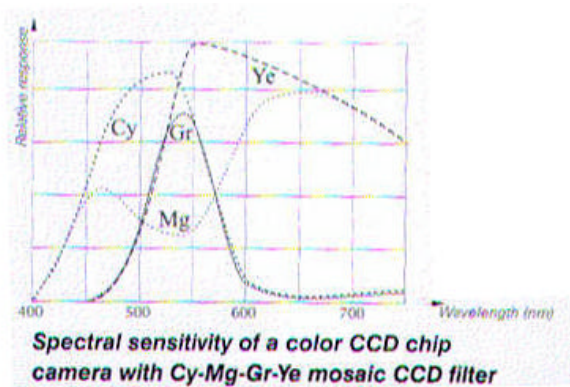
CFA

CFA

Shift register

(Gr+Cy), (Mg+Ye), (Gr+Cy), (Gr+Cy)
3

가 : (Y), (R-Y), (B-Y).



Cy-Mg-Gr-Ye CCD CCD Spectral

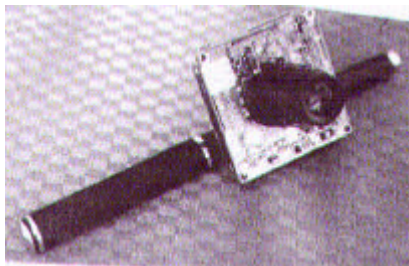
$$Y = 1/2[(Gr+Cy) + (Mg+Ye)] = 1/2(2B+3G+2R) \quad (41)$$

CCD

$$\text{LineA1} \\ R-Y = [(Mg+Ye) - (Gr+Cy)] = (2R-Gr) \quad (42)$$

$$\text{LineA2} \\ B-Y = [(Gr+Ye) - (Mg+Cy)] = (2B-Gr) \quad (43)$$

가 PAL(NTSC)



PCB

White Balance

CCD 가 (Automatic White Balance(AWB) 가 Through-the-lens automatic white balance(TTL-AWB) 가

CCTV

5. CCTV

가 CCD

가

가 CCD White Balance AWB Reset 가

MWB () 가 AWB 가 Manual white balance(MWB) 가 : (Indoor) (outdoor).
2800° K~3200° K 5600° K~6500° K 가

가 가 (Balance)
가 , Quad
가

AWB Automatic tracking white balance(ATWB) 가
() PTZ camera
. Pan Tilt Head CCTV

가 Panning() 가 ATWB 가
ATWB

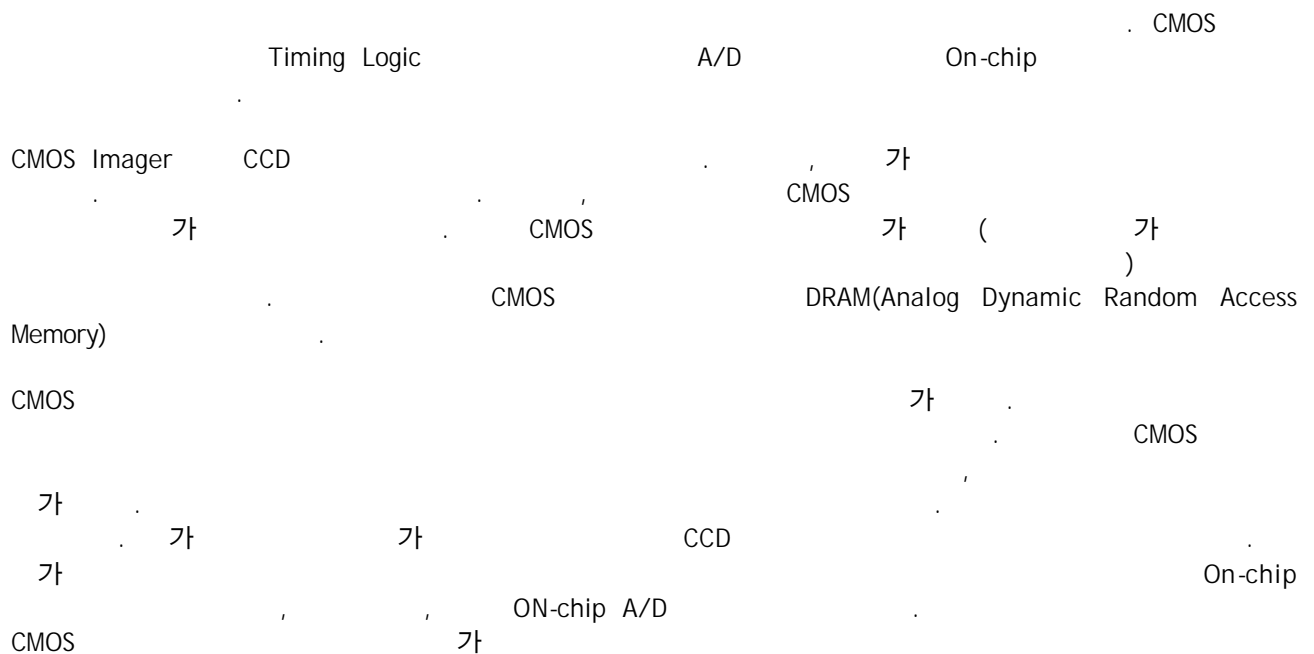
CRT 6500° K
(9300 ° K) (5600 ° K) 가

CMOS cameras

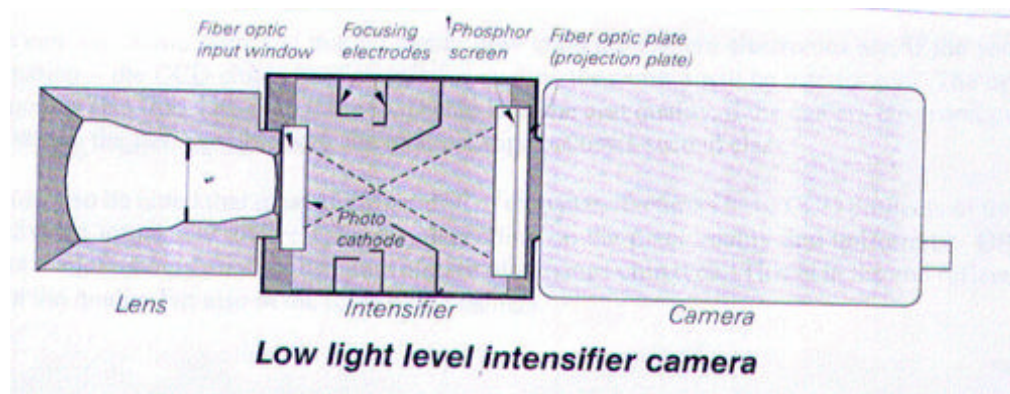
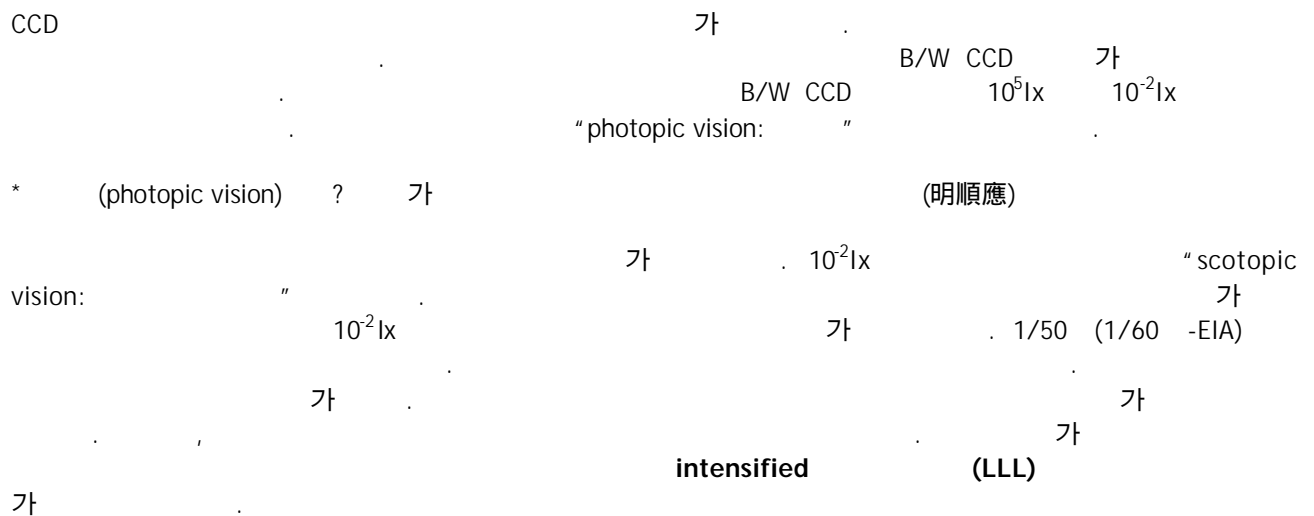
A photograph showing a small, black, hexagonal single-chip color CMOS camera module next to a US penny for scale. The camera is very small, highlighting the miniaturization of VLSI technology.

CCTV

5. CCTV



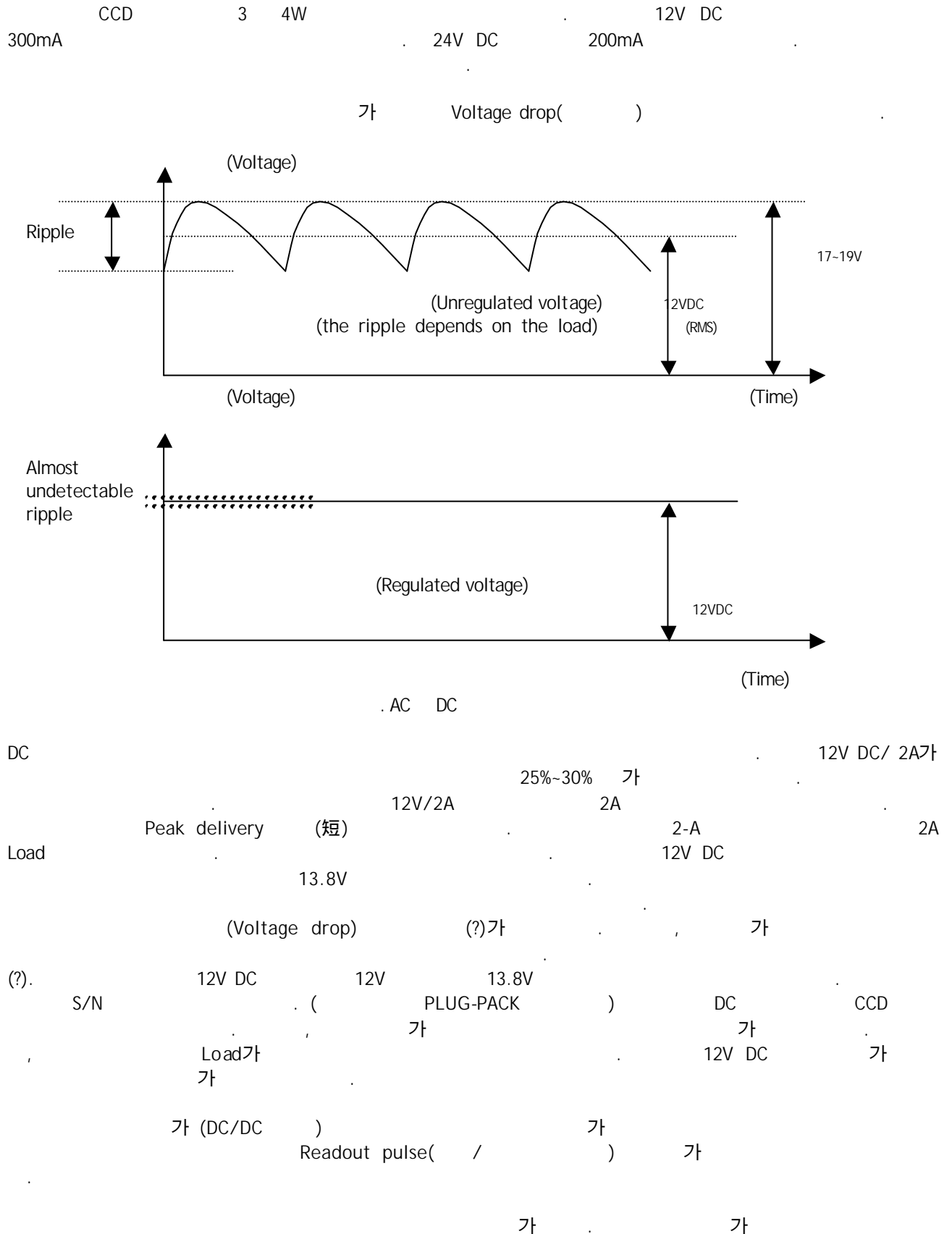
Special low light intensified cameras



(Low light level intensifier camera)

5. CCTV

(Camera power supplies and copper conductors)



5. CCTV

(voltage drops)

가

AWG	#24(0.22mm ²)	#22(0.33mm ²)	#20(0.52mm ²)	#18(0.83mm ²)
Ohm/m	0.078	0.050	0.030	0.018
Ohm/ft	0.257	0.165	0.099	0.059
(A)	1.5	2.0	3.0	6.0

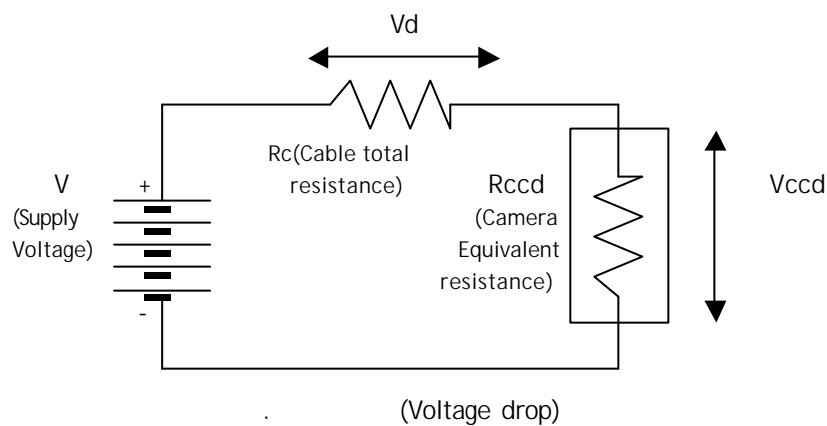
DC

12V DC

 $P = V \cdot I$

가

가



AWG	가 (No./diam.in mm)	Copper Area(mm ²)	(Ohm/km)
10	65/0.30	4.59	4.0
12	41/0.30	2.90	6.0
14	26/0.30	1.84	9.4
14	50/0.25	2.45	7.0
16	7/0.50	1.37	13.0
16	16/0.30	1.13	15.3
16	30/0.25	1.47	12.0
17	32/0.20	1.00	20.0
18	16/0.25	0.78	23.5
18	24/0.20	0.75	26.0
19	1/0.90	0.65	27.0
20	1/0.80	0.50	35.0
20	7/0.30	0.49	35.0
20	9/0.30	0.64	28.0
20	10/0.25	0.49	35.0
20	16/0.20	0.50	39.0
21	1/0.70	0.40	46.0
21	14/0.20	0.44	44.0
22	1/0.64	0.32	54.8
22	7/0.25	0.34	54.5
24	1/0.50	0.20	89.2
24	7/0.20	0.22	84.3
26	1/0.40	0.13	136.0
26	7/0.16	0.14	139.4
28	7/0.127	0.08	221.5

CCTV

5. CCTV

가 (;transformer) 24V AC 25%-30%

AC (24V AC 가) 2

가 가 가

AC (200~300mA). 24V AC (UPS: uninterruptible Power Supplies)가 Step-sinewave UPS가 가

UPS가 CCTV 가

가 12V DC figure-8

AWG(American wire Gauge)

가 figure-8 14/0.20 가

가 mm 14 x (0.1)² x

3.14=0.44mm² 1 figure-8 0.04ohm 14/0.20

Specification 8ohm/ 100m DC loop (loop 2 x 100m).

300mm 12V DC

Ohm

가 12V CCD 250mA

12V/0.25A = 48 ohm .(?)

300m 14/0.20 24ohm loop 가 72ohm 가

12V Rc Rccd

4V Vd

(Voltage divider) : (波形)

4V 16V

((Plus pack)) 가

(4V 가) 9V

13V DC/DC

9V 가

가 24/0.20 15 ohm loop 가

2.8V 가

가 loop 가

가 10V 16VDC 가 (PSU: Power Supply Unit) 가 가

가 24V AC RMS(Root Mean Square)

5. CCTV

가 .

Ohm 가 AC DC 24V AC

RMS , 24 x 1.41 = 33.84Vzp(volts zero-to-peak) . 가 24V AC

12V DC Ohm

), 24V AC (110V 240V AC

) AC 가

가 ,

가

가 , mm²

가 AWG 가

V - (V - phase adjustment)

AC Line-lock 가 LOCK(?) 가 가

120° ()

) 가

Lin-lock 0 가 V- 가 V-

Oscilloscope가 가 V- 가 V-

AC 가 Line-Lock Locking

(Camera checklist)

- 가 (PTZ) Setup
- Auto Iris Plug. 가 AI 가 가 가
 - AI Pin-Wiring DC 가
 - 가 가 (Back-focus) DC 가
 - length viewfinder, 가 CCD C-mount Focal-CS-mount
 - 가
 - Focus ring 가 가
 - Auto Iris 가 ALC
 - (가) 가
 - (가) 가 1/4"
 - 가 10 15mm
 - / 가
 - (MOD: Minimum Object Distance)
 - 10mm 가 ID Set() (?)
 - Auto Iris CCD iris가 , CCD iris Iris
 - (?) Iris lens Auto Iris CCD-iris
 - Set
 - 가 VCR
 - CCD Smear , Voltage drop()
 - 24V AC 가 가 가 V-phase
 - 가 (White-balance)
 - 가 AWB(Automatic white balance) ATWB(Automatic tracking white balance)
 - ATW가
 - DSP(Digital Signal Processing) (parameters)