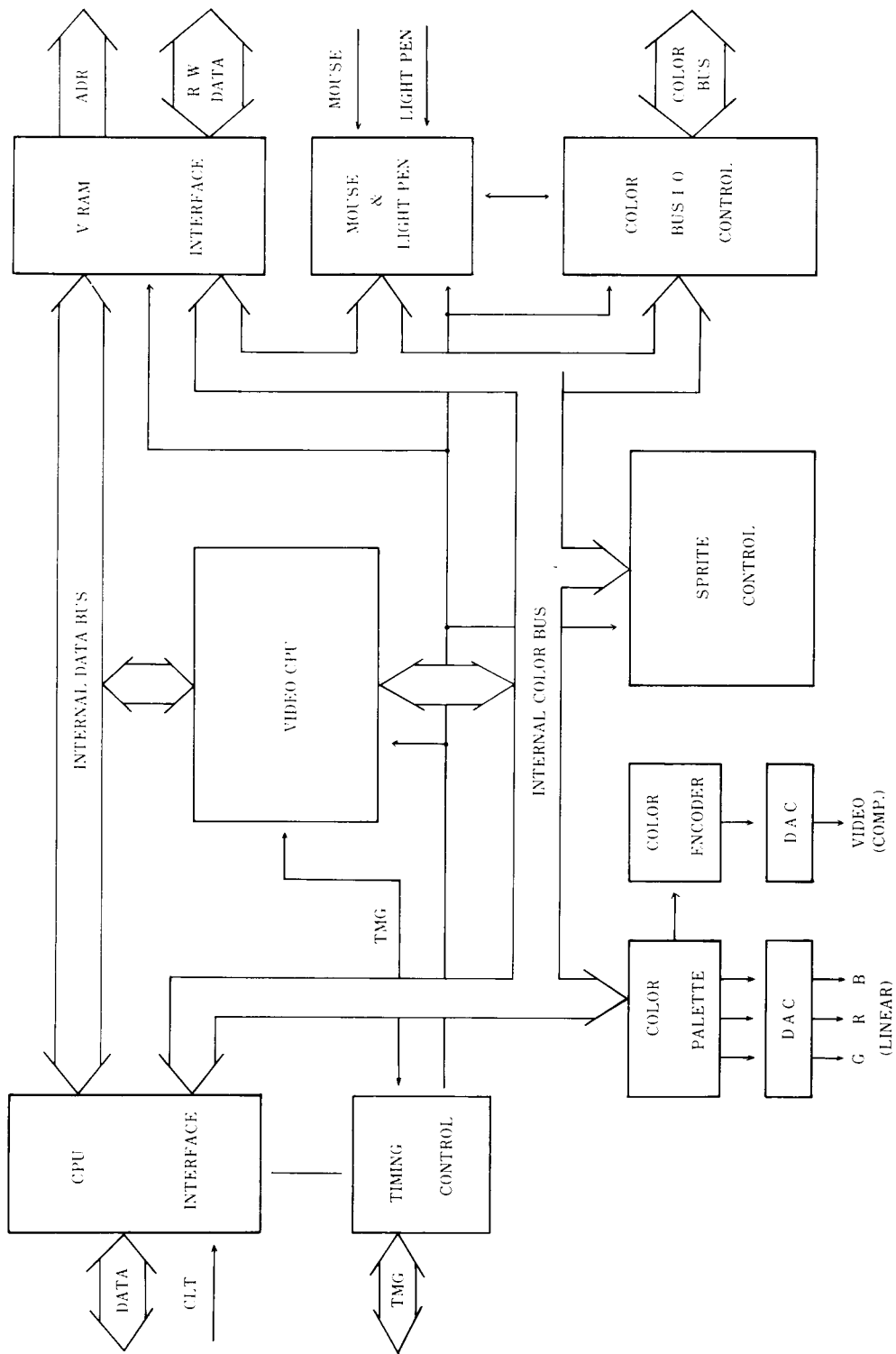# V9938

(MSX-VIDEO)

■ **GENERAL DESCRIPTION**

V9938 (MSX-VIDEO) is a video display processor (VPD) using an N-channel silicon gate MOS and a 64-pin shrink DIL plastic package. TMS9918A is software compatible.
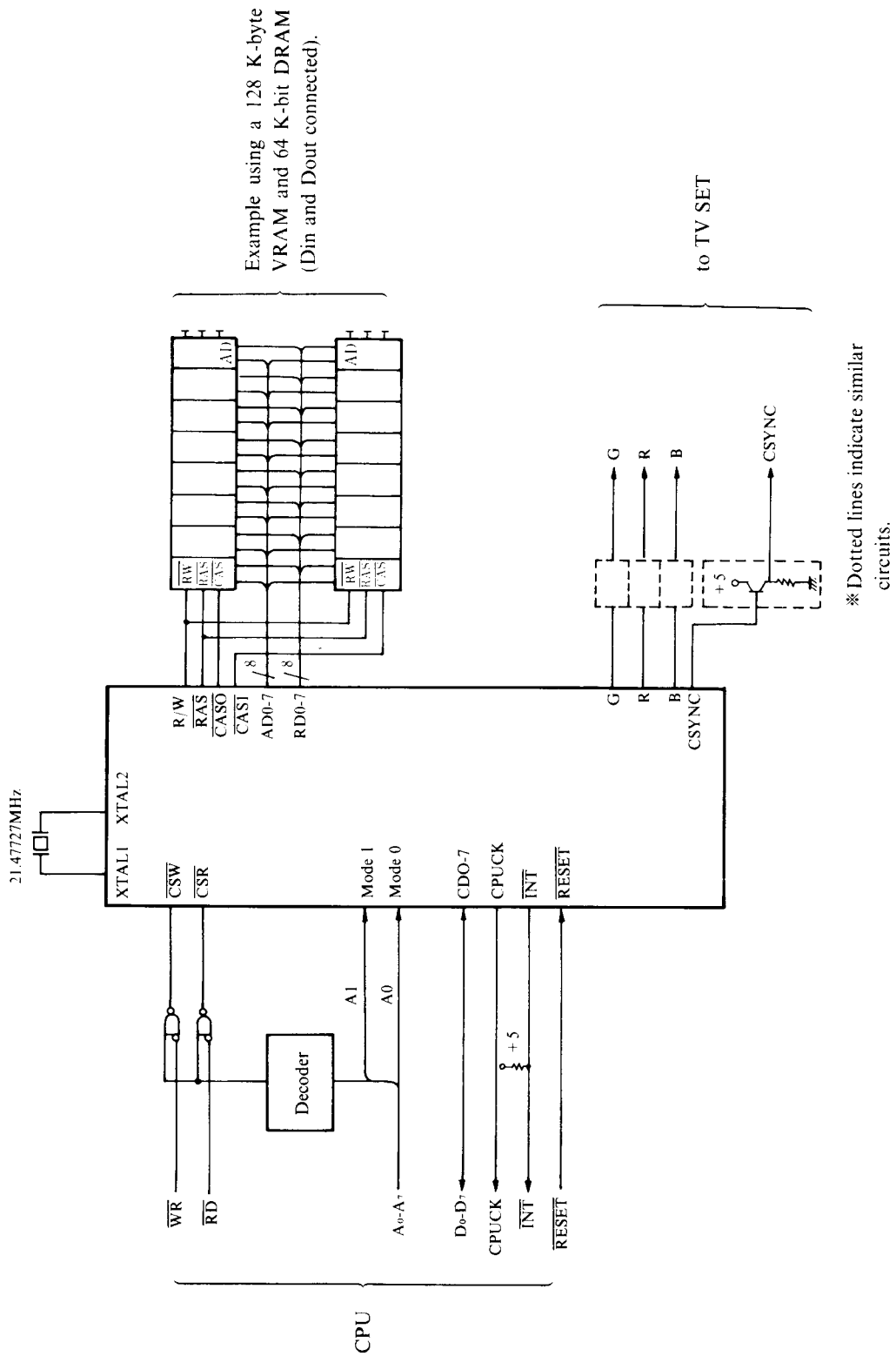
■ **FEATURES**

- 5V power supply
- Linear RGB and composite video output
- Built-in palette for displays in up to 512 colors.
- Maximum of 512 x 424 pixels and 16 colors.
- Bit mapped graphics
- A maximum of 256 colors can be displayed at the same time.
- 16 k-byte ～ 128 k-byte display memory
- 16K x 1b, 16K x 4b, 64K x 1b, 64K x 4b DRAMs can be used.
- 256 address, 4ms DRAM auto refresh.
- Expansion video memory can be connected.
- Built-in mouse and light pen interfaces.
- Eight sprites can be displayed for each horizontal line.
- Colors for sprites can be specified for each horizontal line.
- Area move, line, search and other commands.
- Logical operation function.
- Addresses can be specified by coordinates.
- External sync is possible.
- Superimpose is possible.
- Digitize is possible.
- Multi MSX-VIDEO configurations are possible.
- Additional external color palettes using the Color-Bus output.

━━━━━━NIPPON GAKKI CO., LTD.━━━━━━
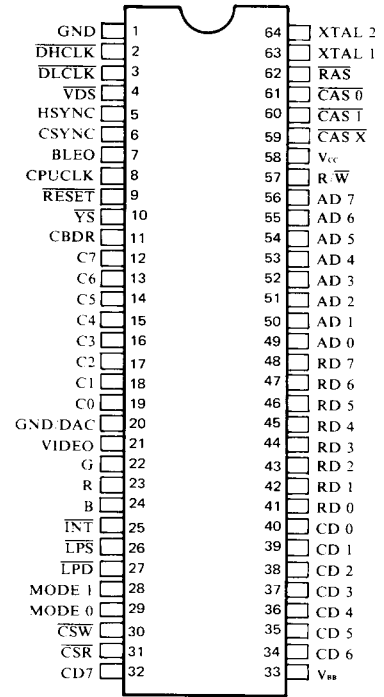
■ MSX-VIDEO BLOCK DIAGRAM

V9938

■ MSX-VIDEO CIRCUIT DIAGRAM

Example using a 128 K-byte VRAM and 64 K-bit DRAM (Din and Dout connected).

to TV SET

※ Dotted lines indicate similar circuits.

■ PIN LAYOUT AND FUNCTIONS

Pin Name	Pin No.	I/O	Function
CD0 LSB	40	I/O	CPU data bus
CD1	39	I/O	
CD2	38	I/O	
CD3	37	I/O	
CD4	36	I/O	
CD5	35	I/O	
CD6	34	I/O	
CD7 MSB	32	I/O	
MODE 0	29	I	CPU interface mode select
MODE 1	28	I	
$\overline{CSR}$	31	I	CPU-VDP read strobe
$\overline{CSW}$	30	I	CPU-VDP write strobe
RD0 LSB	41	I/O	VRAN data bus
RD1	42	I/O	
RD2	43	I/O	
RD3	44	I/O	
RD4	45	I/O	
RD5	46	I/O	
RD6	47	I/O	
RD7 MSB	48	I/O	
AD0 LSB	49	O	VRAM address bus
AD1	50	O	
AD2	51	O	
AD3	52	O	
AD4	53	O	
AD5	54	O	
AD6	55	O	
AD7 MSB	56	O	
$\overline{RAS}$	62	O	VRAM row address strobe
$\overline{CAS\ 0}$	61	O	VRAM column address strobe 0 (first half of VRAM)
$\overline{CAS\ 1}$	60	O	VRAM column address strobe 1 (last half of VRAM)
$\overline{CAS\ X}$	59	O	VRAM column address strobe X (for expansion VRAM)
$R/\overline{W}$	57	O	VRAM write strobe
$\overline{VDS}$	4	O	VRAM data select $\overline{VDS}$ = Low ; VRAM access for display data. $\overline{VDS}$ = High ; VRAM access for other than the above.
VIDEO	21	O	Composite video signal output
G	22	O	Linear RGB signal output
R	23	O	
B	24	O	
$\overline{YS}$	10	O	Signal for switching between VDP RGB output and external video signals. (For superimpose) $\overline{YS}$ = High ; VDP output is transparent $\overline{YS}$ = Low ; VDP output is not transparent
BLEO	7	O	Indicates No. 1 field/No. 2 field blanking for 3-value output. 　　Open drain output 　　High ; No. 2 field or active. 　　Middle ; No. 1 field or active. 　　Low ; Linear erase interval.

Pin diagram (64-pin package):

Left side (pins 1–32):

```
GND        1
DHCLK      2
DLCLK      3
VDS        4
HSYNC      5
CSYNC      6
BLEO       7
CPUCLK     8
RESET      9
YS        10
CBDR      11
C7        12
C6        13
C5        14
C4        15
C3        16
C2        17
C1        18
C0        19
GND DAC   20
VIDEO     21
G         22
R         23
B         24
INT       25
LPS       26
LPD       27
MODE 1    28
MODE 0    29
CSW       30
CSR       31
CD7       32
```

Right side (pins 64–33):

```
64  XTAL 2
63  XTAL 1
62  RAS
61  CAS 0
60  CAS 1
59  CAS X
58  Vcc
57  R/W
56  AD 7
55  AD 6
54  AD 5
53  AD 4
52  AD 3
51  AD 2
50  AD 1
49  AD 0
48  RD 7
47  RD 6
46  RD 5
45  RD 4
44  RD 3
43  RD 2
42  RD 1
41  RD 0
40  CD 0
39  CD 1
38  CD 2
37  CD 3
36  CD 4
35  CD 5
34  CD 6
33  Vss
```

Pin Name	Pin No.	I/O	Function
HSYNC	5	I/O	High order level (High ~ Middle) output for 3-value logic. Lower order level (Middle ~ Low) input. High ; No HSYNC timing or color burst timing. Middle; HSYNC or no color burst timing. Low : HSYNC input.
CSYNC	6	I/O	Composite sync output in high order level for 3-value logic. Lower order level is VSYNC input.
CBDR	11	O	This pin shows the direction of the color bus. High ; color bus is input Low ; color bus is output
C0 LSB	19	I/O	Color bus
C1	18	I/O	Color code is normally output, used as input port for digitize. The 4 high
C2	17	I/O	order bits are used for mouse input when a mouse is used.
C3	16	I/O	
C4	15	I/O	C4 = XA
C5	14	I/O	C5 = XB
C6	13	I/O	C6 = YA
C7 MSB	12	I/O	C7 = YB
$\overline{\text{LPS}}$	26	I	Light pen SW input. Mouse SW input when a mouse is used. Low ; SW ON High ; SW OFF
$\overline{\text{LPD}}$	27	I	Light pen light detection input. Mouse SW input when a mouse is used. Low ; light detection or SW ON. High ; other than the above.
$\overline{\text{DHCLK}}$	2	O	Dot clock output for high resolution. Approx. 10.74 MHz, open drain output.
$\overline{\text{DLCLK}}$	3	I/O	Dot clock output for low resolution. Approx. 5.37 MHz, open drain output. Input is also possible using the mode register, used for multi VDP.
XTAL 1	63	I	This pin is used for XTAL connection. Also used for input when using an externally generated clock.
XTAL 2	64	I	
CPUCLK	8	O	Outputs 1/6 the XTAL frequency.
$\overline{\text{INT}}$	25	O	CPU interrupt output, open drain output. Low ; generates interrupts.
$\overline{\text{RESET}}$	9	I	Resets all circuits in the VDP.
Vcc	58	I	5V power supply
GND	1	I	Ground 0 V
GND DAC	20	I	Ground 0 V
V$_{BB}$	33	O	Baseboard voltage

■ ELECTRICAL CHARACTERISTICS

1. Maximum Ratings

Symbol	Item	Rating	Unit
Vcc	Power supply voltage	$-0.5 \sim +7.0$	V
Vin	Input voltage	$-0.5 \sim +7.0$	V
Ts	Storage temperature	$-50 \sim +125$	°C
To	Operating temperature	$0 \sim +70$	°C

2. Recommended Operating Conditions

Symbol	Item	Minimum	Reference	Maximum	Unit
Vcc	Power supply voltage	4.75	5.00	5.25	V
Vss	Power supply voltage		0		V
TA	Operating ambient temperature	0		70	°C
VIL 1	Low level input voltage (group 1)	-0.3		0.8	V
VIL 2	Low level input voltage (group 2)	-0.3		0.8	V
VIL 3	External clock low level input voltage (group 3)	-0.3		0.8	V
VIH 1	High level input voltage (group 1)	2.2		Vcc	V
VIH 2	High level input voltage (group 2)	2.2		Vcc	V
VIH 3	External clock high level input voltage (group 3)	3.5		Vcc	V

Note: Group 1 $\overline{\text{CSR}}$, RDO-7, CO-7, $\overline{\text{LPS}}$, $\overline{\text{LPD}}$, $\overline{\text{RESET}}$, $\overline{\text{DLCLK}}$
       Group 2   CDO-7, MODE 0, MODE 1, $\overline{\text{CSW}}$
       Group 3   XTAL 1, XTAL 2

3. AC Characteristics

Symbol	Item	Condition	Minimum	Reference	Maximum	Unit
VOL 4	Low level output voltage (group 4)	IOL = 1.6mA			0.4	V
VOL 5	Low level output voltage (group 5)	IOL = 1.6mA			0.4	V
VOL 6	Low level output voltage (group 6)	IOL = 10mA			0.4	V
VOL 7	Low level output voltage (group 7)	IOL = 1.6mA			0.4	V
VOH 4	High level output voltage (group 4)	IOH = 100μA	2.4			V
VOH 5	High level output voltage (group 5)	IOH = 60μA	2.7			V
ILI	In-put leak current				10	μA
ILO	Output leak current (when floating)				25	μA
Icc	Current consumption				230	mA

Note: Group 4   CDO-7, RDO-7, ADO-7, $\overline{\text{VDS}}$, CBDR, CPUCLK, CO-7
       Group 5 $\overline{\text{RAS}}$, $\overline{\text{CAS 0}}$, $\overline{\text{CAS 1}}$, $\overline{\text{CASX}}$, R/$\overline{\text{W}}$
       Group 6 $\overline{\text{DLCLK}}$, $\overline{\text{DHCLK}}$
       Group 7 $\overline{\text{INT}}$

4. Composite Video Signal Output Level

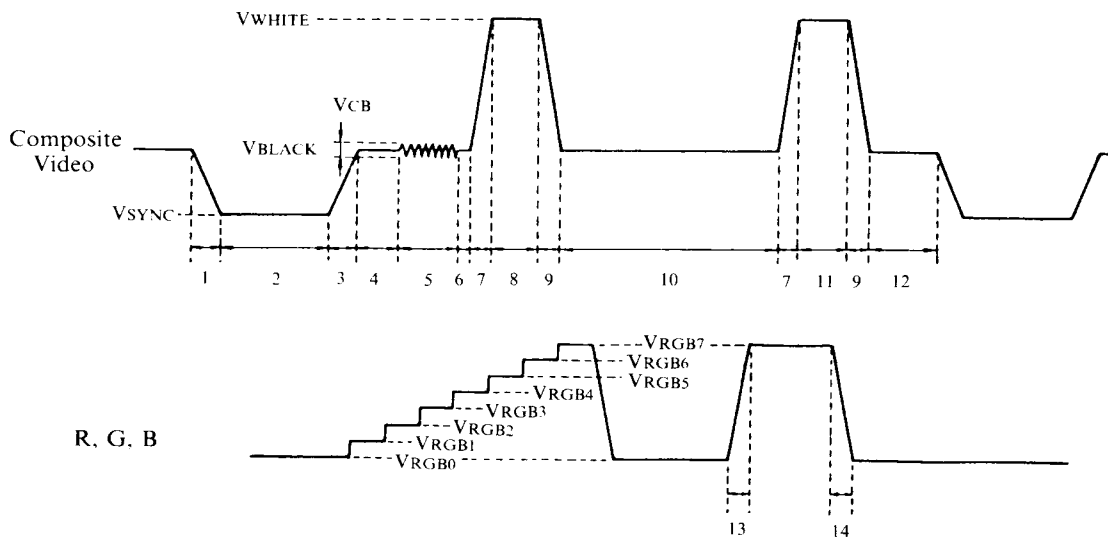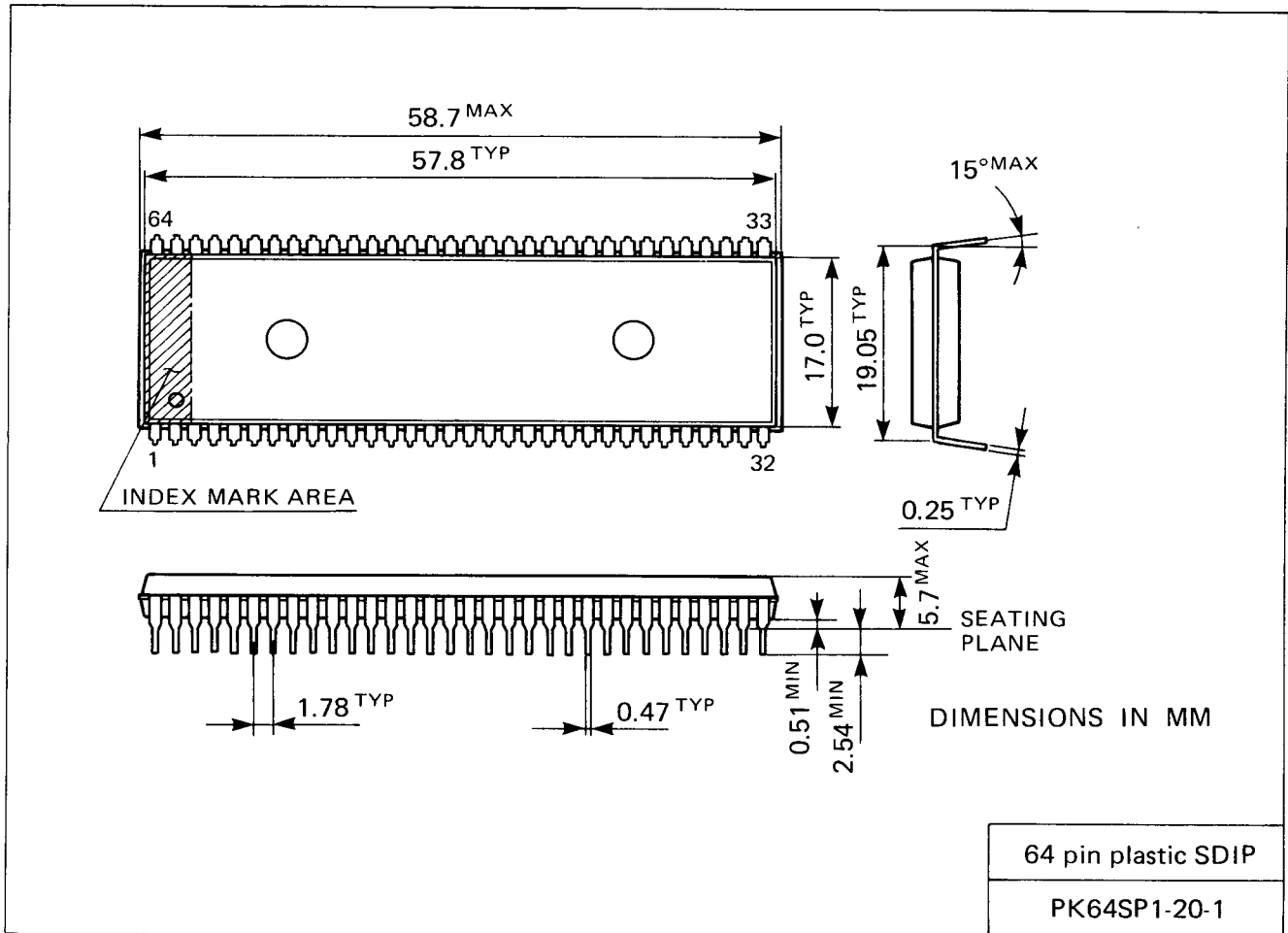| Symbol	Item	Measurement Conditions	Minimum	Reference	Maximum	Unit
VWHITE	White level output voltage		2.20	2.60	3.00	V
VWHITE(B/W)	White level output voltage (monochrome mode)		2.50	2.80	3.20	V
VBLACK	Black level output voltage		1.80	2.20	2.50	V
VSYNC	Sync level output voltage	RL = 470Ω	1.60	2.00	2.30	V
VCB	Color burst amplitude		0.16	0.22	0.28	V
VP-P	White level, sync level potential differential.		0.40	0.60	0.75	V
VP-P(B/W)	White level, sync level potential differential (monochrome mode)		0.60	0.80	0.95	V

* Reference values are indicated by Vcc = 5.00V, TA = 25 °C.

5. RGB Output Level

Symbol	Item	Measurement Conditions	Minimum	Reference	Maximum	Unit
VRGB 7	R, G, B maximum output voltage	RL = 470Ω	2.5	2.8	3.2	V
VRGB 0	R, G, B minimum output voltage (black level)		1.7	2.0	2.4	V
VP-P	R, G, B VRGB7-VRGB0 potential differential.		0.65	0.8	1.00	V
DRGB	R, G, B VP-P deviation				5.0	%

* Reference values are indicated by Vcc = 5.00V, TA = 25 °C.

6. Sync Signal Output Level

Symbol	Item	Measurement Conditions	Minimum	Reference	Maximum	Unit
VTLVH 1	3-value output high level BLEO		4.5		Vcc	V
VTLVM 1	3-value output intermediate level BLEO	RL = 1KΩ	2.5		3.5	V
VTLVL 1	3-value output low level BLEO	RL = 1KΩ			0.4	V
VTLVH 2	3-value output high level HSYNC, CSYNC	No load	4.5		Vcc	V
VTLVM 2	3-value output intermediate level HSYNC, CSYNC		2.7		3.7	V
VTLVL 2	3-value output low level HSYNC, CSYNC				0.8	V
VYH	$\overline{Ys}$ output high level	IOH = 100µA	2.4			V
VYL	$\overline{Ys}$ output low level	IOL = 1.6mA			0.4	V
ITLVH	High level input current HSYNC, CSYNC	VI + 0.4V			−4.0	mA
ITLVL	Intermediate level input current HSYNC, CSYNC	VI = 0.4V			−2.0	mA

■ PACKAGE DIMENSIONAL DIAGRAM

58.7 MAX
57.8 TYP
64
33
15°MAX
17.0 TYP
19.05 TYP
1
32
INDEX MARK AREA
0.25 TYP
5.7 MAX
SEATING PLANE
1.78 TYP
0.47 TYP
0.51 MIN
2.54 MIN
DIMENSIONS IN MM

64 pin plastic SDIP
PK64SP1-20-1

The specifications of this product are subject to improvement changes without prior notice.

── AGENCY ──