Ordering number : EN5331

Wideband Output Module (video pack)

# VP513

## CRT Display Video Output Amplifier: High-Voltage, Wideband Amplification

## Features

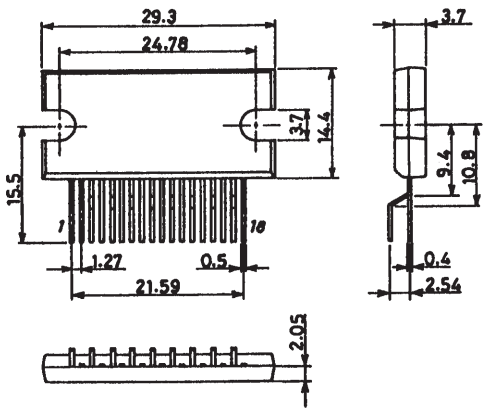
- Low power dissipation class A amp: 6.5W with 25 MHz (clock)
- Bandwidth f (–3 dB) = 70 MHz
- Pulse response (tr, tf)
  tr = 5.8 ns (typ) and tf = 5.0 ns (typ)
  at 40 Vp-p swing
- Plastic mold package for excellent reliability

## Package Dimensions

unit: mm

**2117**

[VP513]




## Specifications

### Absolute Maximum Ratings at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Maximum supply voltage | $V_{CC}$ max | | 90 | V |
| | $V_{BB}$ max | | 15 | V |
| Allowable power dissipation | Pd max | At Tc = 25°C with an ideal heat sink | 25 | W |
| Junction temperature | Tj max | | 150 | °C |
| Case temperature | Tc max | | 100 | °C |
| Storage temperature | Tstg | | –20 to +110 | °C |

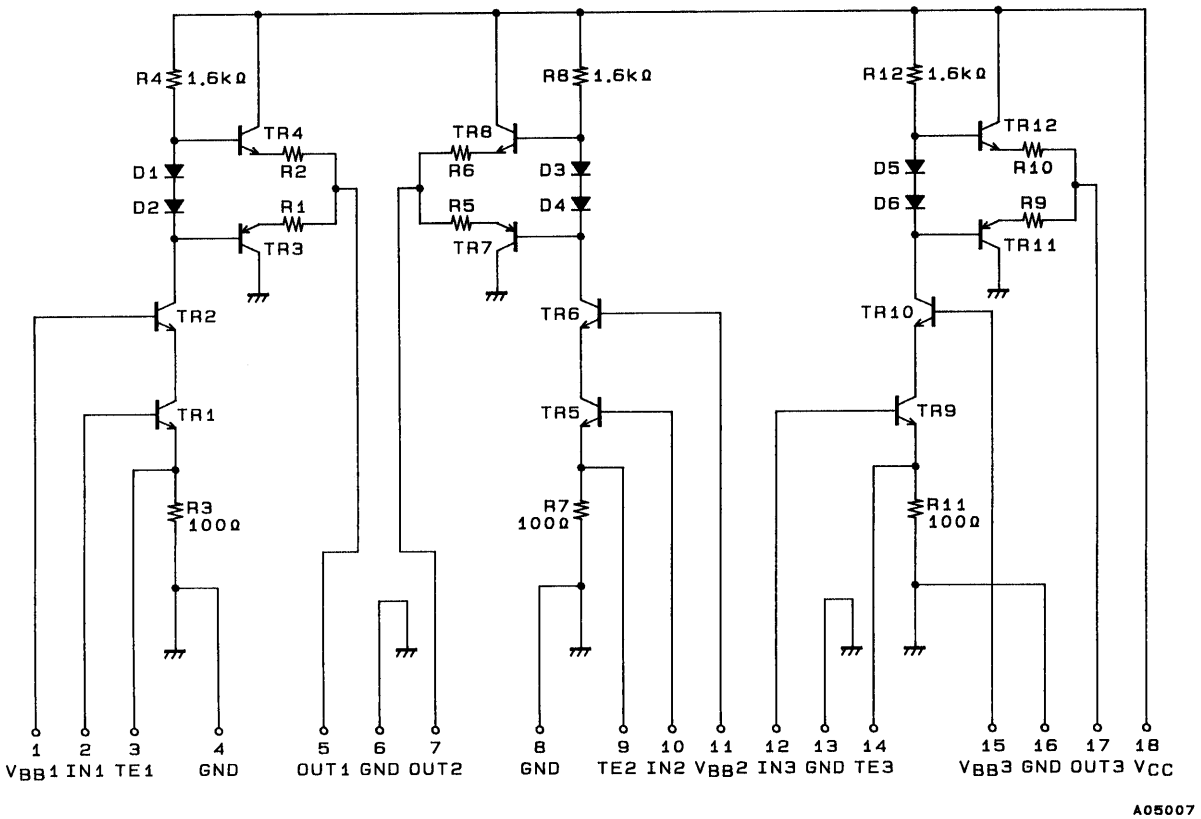
### Operating Conditions at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Recommended supply voltage I | $V_{CC}$ | | 70 | V |
| | $V_{BB}$ | | 10 | V |
| Recommended supply voltage II | $V_{CC}$ | | 80 | V |
| | $V_{BB}$ | | 10 | V |

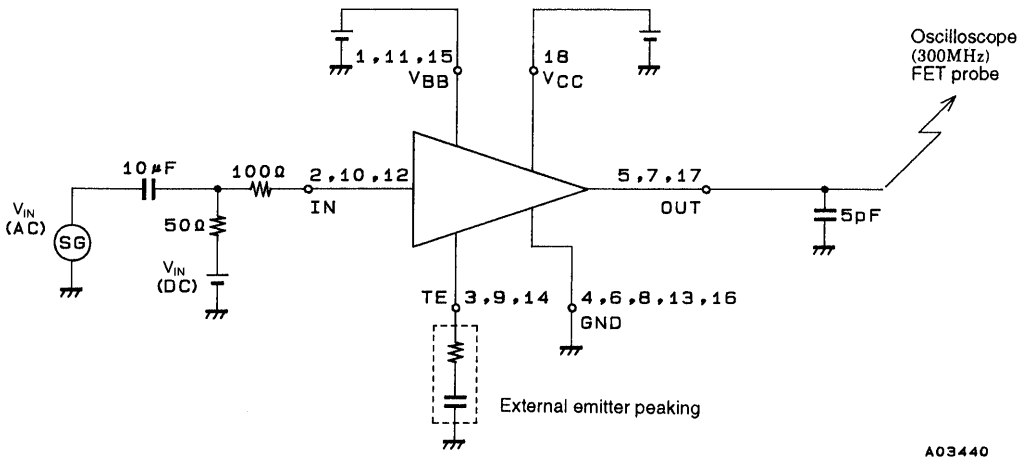
## Electrical Characteristics at Ta = 25°C

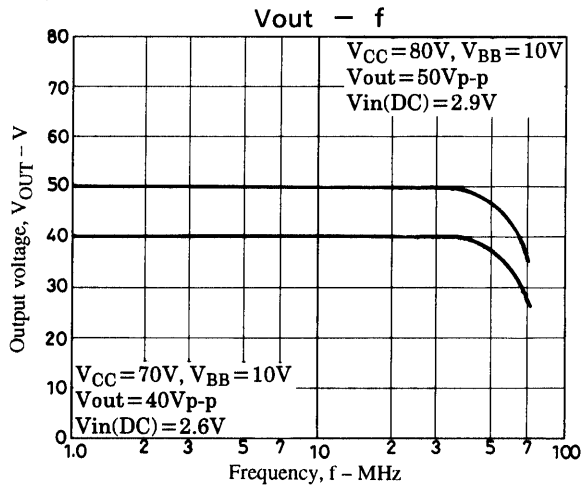
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Bandwidth I (–3 dB) | fc | $V_{CC}$ = 70 V, $V_{BB}$ = 10 V, $C_L$ = 5 pF, $V_{IN}$ (DC) = 2.6 V, $V_{OUT}$ (p-p) = 40 V | | 70 | | MHz |
| Bandwidth II (–3 dB) | fc | $V_{CC}$ = 80 V, $V_{BB}$ = 10 V, $C_L$ = 5 pF, $V_{IN}$ (DC) = 2.9 V, $V_{OUT}$ (p-p) = 50 V | | 65 | | MHz |
| Pulse response characteristics | tr | $V_{CC}$ = 80 V, $V_{BB}$ = 10 V, $C_L$ = 5 pF, $V_{IN}$ (DC) = 2.9 V, $V_{OUT}$ (p-p) = 40 V | | 5.8 | | ns |
| | tf | | | 5.0 | | ns |
| Voltage gain | $G_V$ (DC) | | 13 | 15 | 17 | |
| Current drain I | $I_{CC}1$ | $V_{CC}$ = 70 V, $V_{BB}$ = 10 V, $V_{IN}$ (DC) = 2.6 V, f = 10 MHz clock, $C_L$ = 5 pF, $V_{OUT}$ (p-p) = 40 V | | 25 | | mA |
| | $I_{CC}2$ | $V_{CC}$ = 70 V, $V_{BB}$ = 10 V, $V_{IN}$ (DC) = 2.6 V, f = 70 MHz clock, $C_L$ = 5 pF, $V_{OUT}$ (p-p) = 40 V | | 40 | | mA |
| Current drain II | $I_{CC}1$ | $V_{CC}$ = 80 V, $V_{BB}$ = 10 V, $V_{IN}$ (DC) = 2.9 V, f = 10 MHz clock, $C_L$ = 5 pF, $V_{OUT}$ (p-p) = 50 V | | 30 | | mA |
| | $I_{CC}2$ | $V_{CC}$ = 80 V, $V_{BB}$ = 10 V, $V_{IN}$ (DC) = 2.9 V, f = 70 MHz clock, $C_L$ = 5 pF, $V_{OUT}$ (p-p) = 50 V | | 47 | | mA |

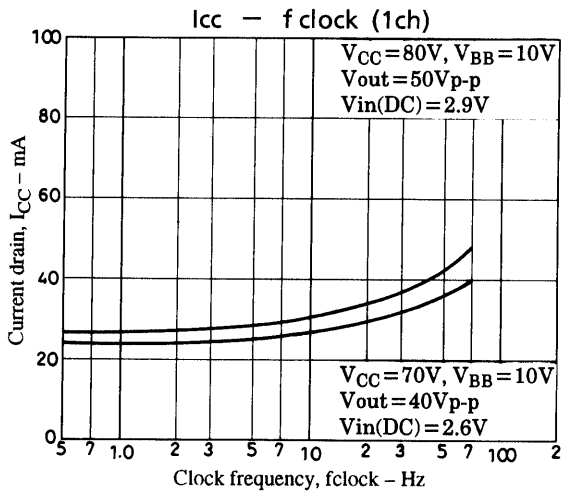
## Internal Equivalent Circuit

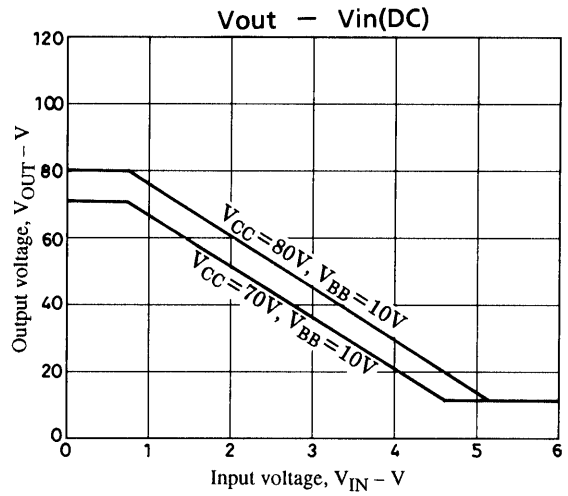


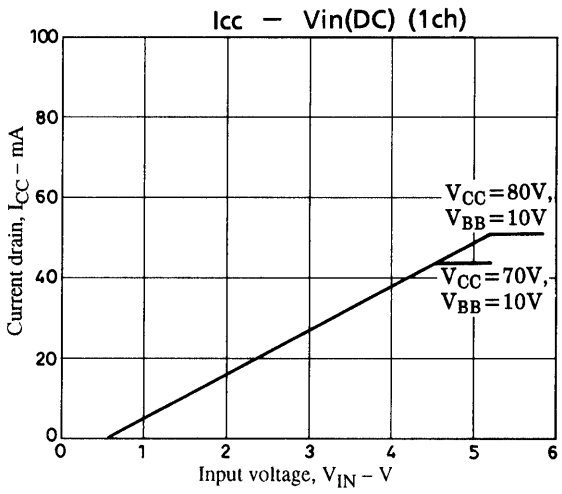
## Test Circuit

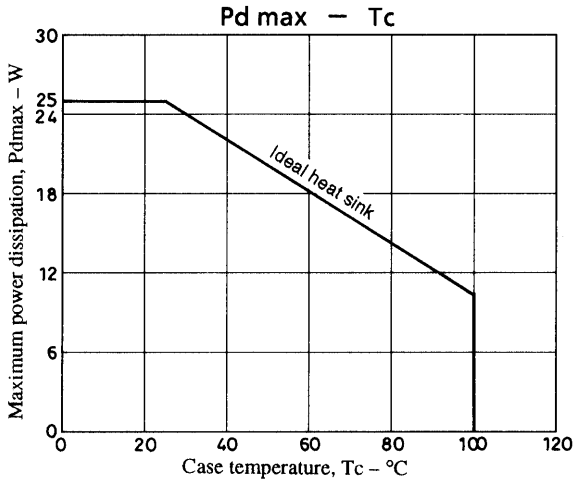


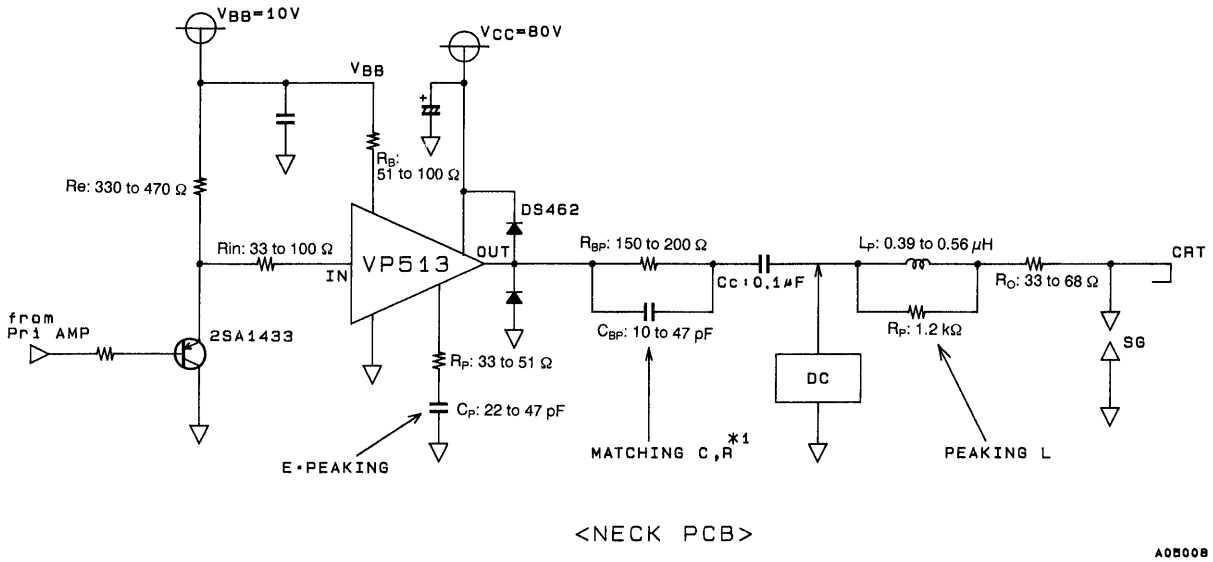





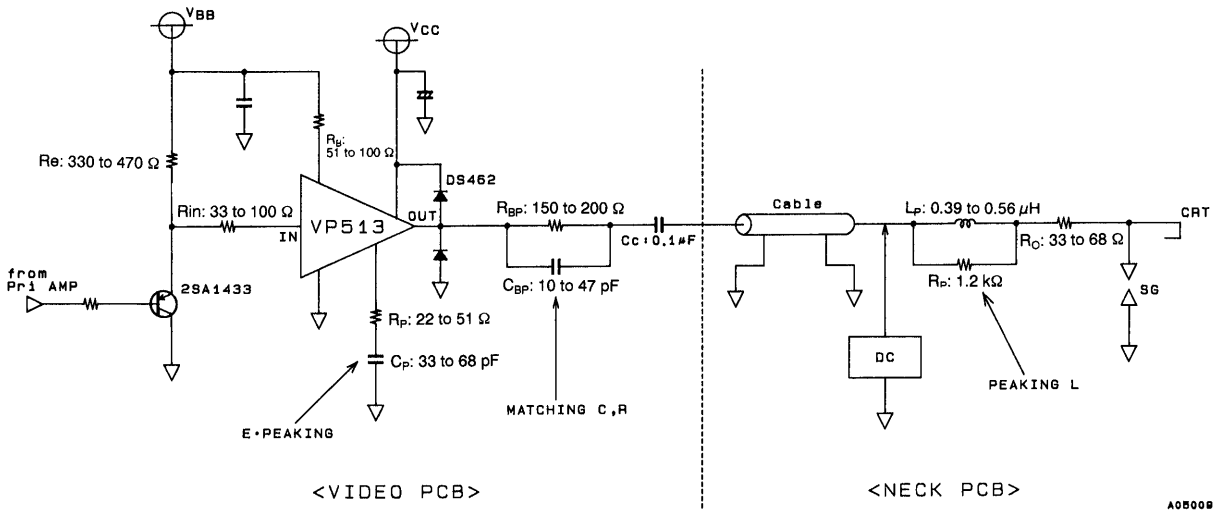

## Application Circuit Examples

1. CRT neck mounted circuit




Note: 1. The matching RC circuit is used to match the IC internal impedance with the impedance of the load. In neck mounted applications, this circuit can be removed if the total load capacitance, $C_L$, is no more than 10 pF.

2. Cable transmission (separated boards)



## Thermal Design for the VP513

Since the VP513 includes three channels, we first consider a single channel. The chip temperature of each transistor under actual operating conditions is determined using the following formula.

$Tj = (Tri) = \theta j\text{-}c\ (Tri) \times Pc\ (Tri) + \Delta Tc + Ta\ [°C]$ ..... (1)

- $\theta j\text{-}c\ (Tri)$: Thermal resistance of an individual transistor
- $Pc\ (Tri)$: Collector loss for an individual transistor
- $\Delta Tc$: Case temperature rise
- $Ta$: Ambient temperature

The $\theta j\text{-}c(Tri)$ for each chip is:

$\theta j\text{-}c\ (Tr1) = 45°C/W / \theta j\text{-}c\ (Tr2)$ to $(Tr4) = 35°C/W$ ..... (2)

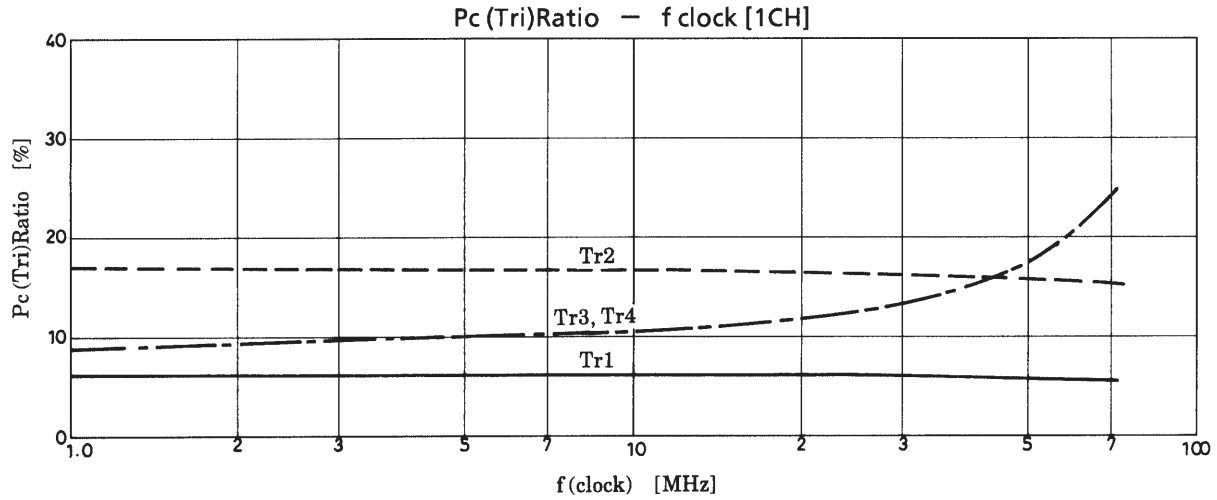
Although the loss for each transistor in a Video Pack varies with frequency and is not uniform, if we assume that the maximum operating frequency, f = 70 MHz (clock), then the chips with the largest loss will be transistors 3 and 4 (Tr3 and Tr4) and that loss will be about 1/4 of the total loss.Thus from the Pd for a single channel we have:

$Pc\ (Tr3)\ 70\ MHz = Pd\ (1CH)\ 70\ MHz \times 1/4$ ..... (3)

Here, we must select a heat sink with a capacity $\theta h$ such that the Tj of these transistors does not exceed 150°C. Equation (4) below gives the relationship between $\theta h$ and $\Delta Tc$.

$\Delta Tc = Pd\ (TOTAL) \times \theta h$ ..... (4)

The required $\theta h$ is calculated using this equation and equation (1).



## VP513 Thermal Design Example

Conditions: Using an $f_H$ = 64 kHz class monitor, fv = 70 MHz (clock)

$V_{CC}$ = 80 V, $V_{BB}$ = 10 V, $V_{OUT}$ = 50 Vp-p ($C_L$ = 10 pF)

Since this class of monitor can be operated up to Ta = 60°C, here we consider the case where the maximum clock frequency is 70 MHz.
As mentioned previously, the chips with the largest loss are transistors Tr3 and Tr4. Determining those values gives:

$$Pc\ (Tr3) = 3.7 \times 0.25 = 0.93\ [W] \quad \ldots\ldots (5)$$

We determine ΔTj by substituting the value for θj-c in equation (5).

$$\Delta Tj = 0.93 \times 35 = 32.6\ [°C] \quad \ldots\ldots (6)$$

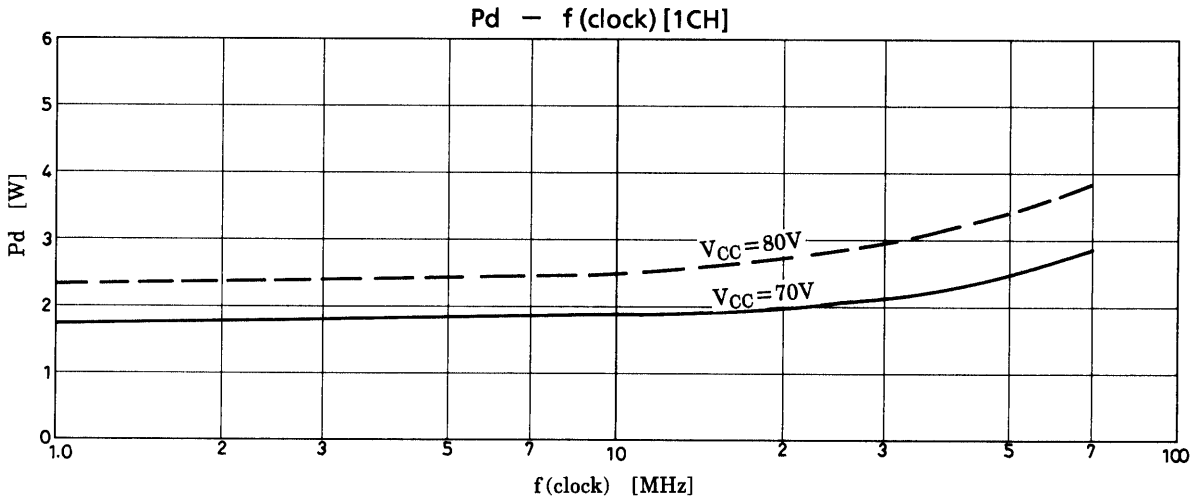
Here, Tc(max) (measured at the back surface) will be under 100°C, and the value in item (6) above shows that it suffices to focus on Tc(max) < 100°C in the thermal design to fulfill the Tj(max) < 150°C and Tc(max) < 100°C conditions.

Therefore, a heat sink that maintains the Tc < 100°C condition will have the following thermal resistance:

$$\theta h = \Delta Tc \div Pd\ (TOTAL) = (Tc - Ta) \div [Pd\ (1CH) \times 3]$$
$$= 40 \div (3.7 \times 3) = 3.6°C/W$$

Thus the thermal resistance in this case is θh = 3.6 °C/W.

In actual practice, the ambient temperature and operating conditions will allow a heat sink smaller than that indicated by this calculation to be used. Therefore, design optimization taking the actual conditions into account is also required.




## Surge Protection

Surge protection is required when this device is connected to a CRT. This product requires the same protection as earlier products.

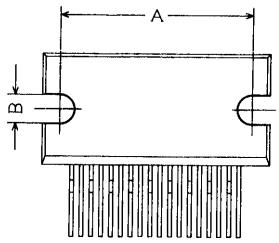
1. Termination spark gap
2. Surge suppression resistor (Recommended value: 33 to 68 Ω)
3. Surge suppression diode (Installed in the vicinity of the IC output pin.)

Note: Caution: The value of surge suppression resistors must be determined taking both the stipulated discharge test and the required frequency bandwidth into account.

## Application Notes

Mounting notes:
Since the specified heat sink is required to operate a mounted Video Pack, we recommend the following mounting technique. (See the thermal design item for details on the required heat sink.) In particular, since the package used for this product is even more compact than that used in the earlier VPS series, the following points require special care. (These are recommendations.)

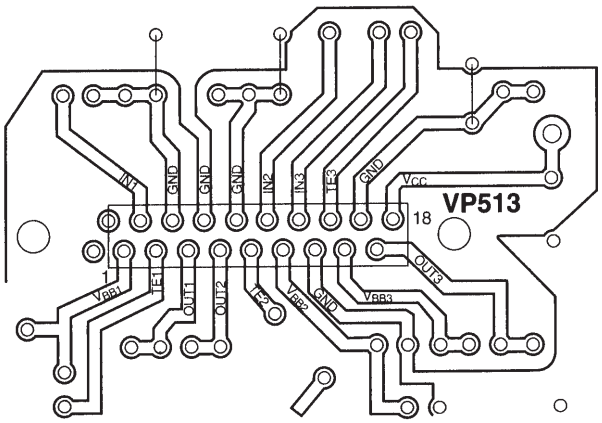
1. A tightening torque of between 0.39 and 0.88 N·m is recommended.
2. The bolt hole spacing in the heat sink should match that of the IC. In particular, the bolt hole spacing should be pulled in to be as close as possible, within the range that mounting is possible, to the dimensions A and B in the package dimensions drawing, as shown below.




3. Use either the truss screws (truss bolts) or binding screws stipulated in the JIS standards as the mounting bolts. Also, use washers to protect the IC case.
4. Foreign matter, such as machining chips, must not be left trapped between the IC case and the heat sink. If grease is applied to the junction surface, be sure to apply the grease evenly.
5. Solder the IC leads to the printed circuit board after mounting the heat sink to the IC.

Note: The heat sink is absolutely required to operate this Video Pack. Never, in any situation, apply power to a Video Pack as an independent device. The Video Pack may be destroyed.

Peripheral wiring and ground leading:
The VP513 supports standard lead forming to a zigzag 2.54 mm pitch. Also, the pin layout is standardized to the I/O and power supply line arrangement shown below.




**IC Surrounding Pin Layout (Top view)**

Note: Design applications that use two-sided printed circuit boards or similar technologies so that input and output lines do not cross. Crossed lines can lead to increased crosstalk. Also, lines should be kept as short as possible, and the ground plane should be made as wide as possible. These layout design principles will minimize bandwidth degradation and oscillation.

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