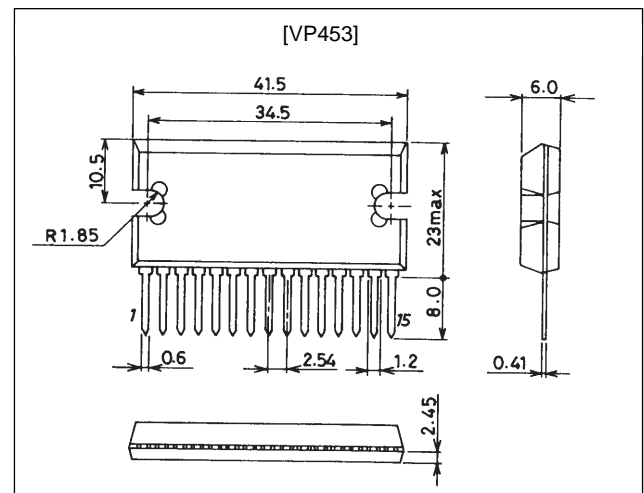


**VP453****CRT Display Video Output Amplifier****Features**

- Active load circuits
- Wide bandwidth and high output voltage. Optimal for use in  $f_H$  (horizontal deflection frequency) = 90 kHz class ultrahigh precision monitors.
- Single 15-pin SIP molded package houses three channels.

**Package Dimensions**unit: mm  
**2127A****Specifications****Absolute Maximum Ratings at  $T_a = 25^\circ\text{C}$** 

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC}$ max		90	V
Allowable power dissipation	$P_d$ max	With an ideal heat sink at $T_a = 25^\circ\text{C}$	25	W
Maximum junction temperature	$T_j$ max		150	$^\circ\text{C}$
Maximum case temperature	$T_c$ max		100	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-20 to +110	$^\circ\text{C}$

**Operating Conditions at  $T_a = 25^\circ\text{C}$** 

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	$V_{CC}$		80	V

**Electrical Characteristics at  $T_a = 25^\circ\text{C}$  (For a single channel, with  $R_{in} = 560 \Omega$ ,  $R_{ip} = 22 \Omega$ ,  $C_{ip} = 47 \text{ pF}$ )**

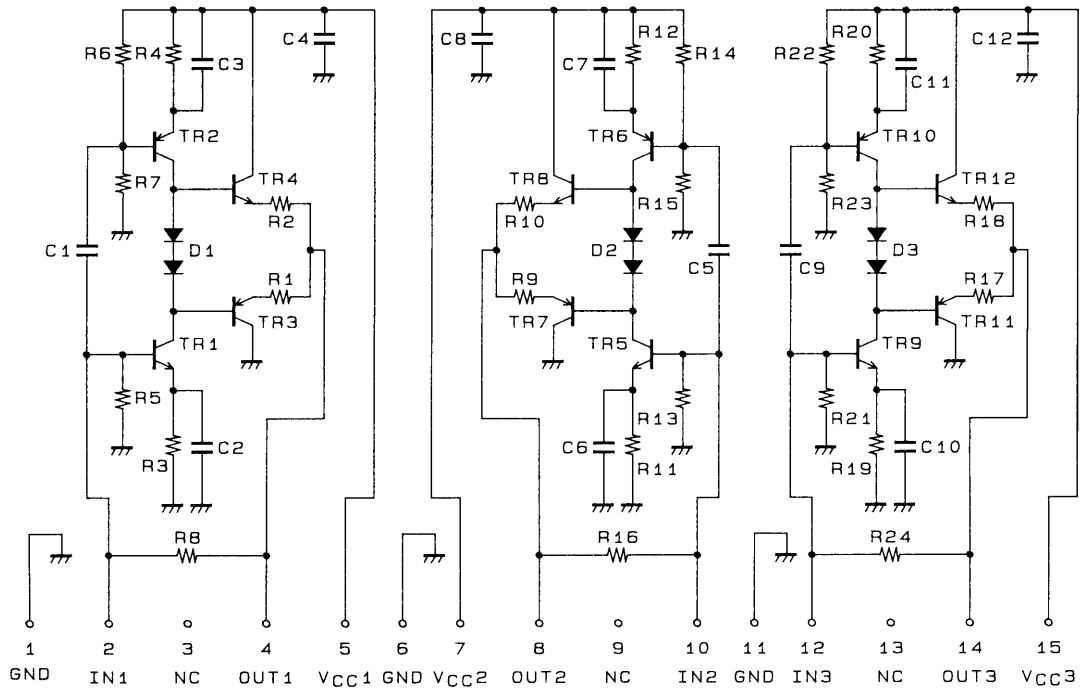
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Clock frequency bandwidth (-3 dB)	$f$ (clock)	$V_{CC} = 80 \text{ V}$ , $C_L = 10 \text{ pF}$		190		MHz
Frequency bandwidth (-3 dB)	$f_c$	$V_{IN}(\text{DC}) = 1.6 \text{ V}$ , $V_{OUT}(\text{p-p}) = 40 \text{ V}$		90		MHz
Pulse response	$t_r$	$V_{CC} = 80 \text{ V}$ , $C_L = 10 \text{ pF}$		4.0		ns
	$t_f$	$V_{IN}(\text{DC}) = 1.6 \text{ V}$ , $V_{OUT}(\text{p-p}) = 40 \text{ V}$		3.6		ns
Voltage gain	$V_G(\text{DC})$		11	13	15	Double
Current drain	$I_{CC}(1)$	$V_{CC} = 80 \text{ V}$ , $V_{IN}(\text{DC}) = 1.6 \text{ V}$ , $f = 10 \text{ MHz}$ clock, $C_L = 10 \text{ pF}$ , $V_{OUT}(\text{p-p}) = 40 \text{ V}$		35		mA
	$I_{CC}(2)$	$V_{CC} = 80 \text{ V}$ , $V_{IN}(\text{DC}) = 1.6 \text{ V}$ , $f = 100 \text{ MHz}$ clock, $C_L = 10 \text{ pF}$ , $V_{OUT}(\text{p-p}) = 40 \text{ V}$		77		mA

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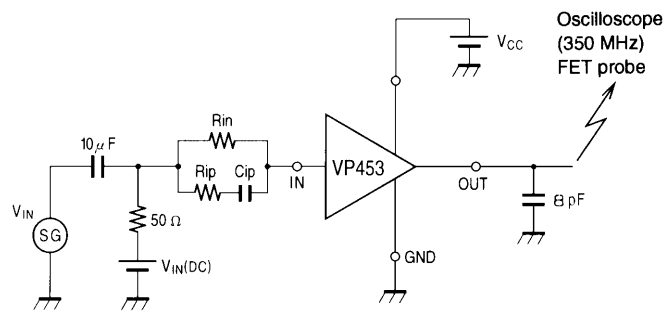
VP453

Internal Equivalent Circuit

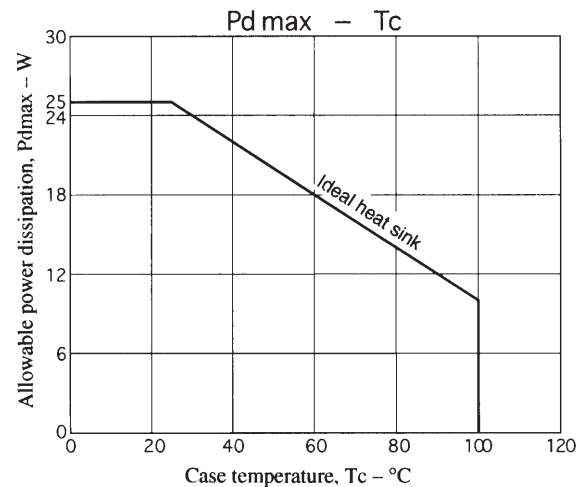
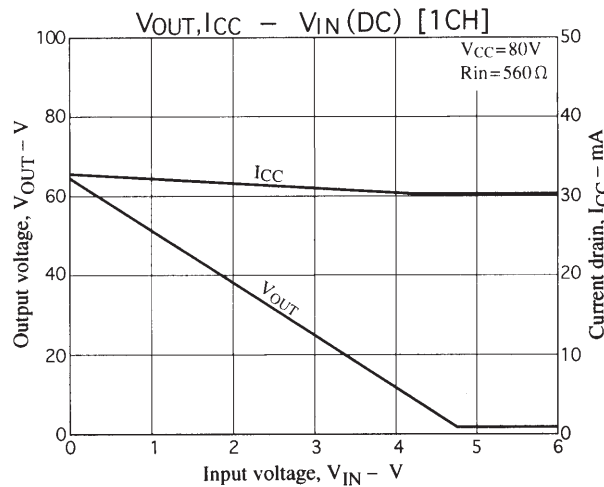
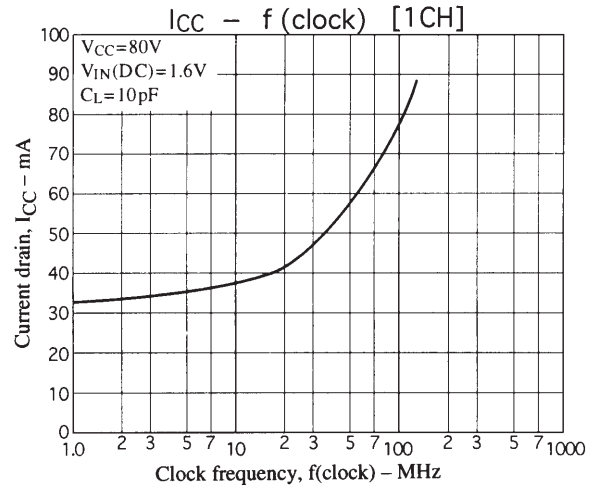
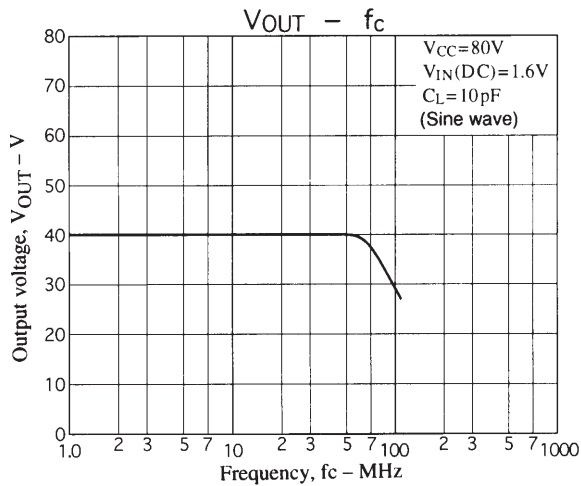


A05906

Test Circuit (for a single channel)



T00037



**Thermal Design**

Thermal design requires that the two conditions  $T_j(\text{max}) \leq 150^\circ\text{C}$  and  $T_c \leq 100^\circ\text{C}$  be met.

(a) Concerning  $T_j(\text{max})$ , the chip temperature  $T_j$  for each transistor is given by equation (1).

$$T_j = (T_{ri}) = \theta_{j-c} (T_{ri}) \times P_C (T_{ri}) + \Delta T_c + T_a \text{ (}^\circ\text{C)} \dots\dots\dots(1)$$

$\theta_{j-c} (T_{ri})$ : The thermal resistance of each transistor chip itself

$P_C (T_{ri})$ : The collector loss for each transistor

$\Delta T_c$ : Increase in the case temperature

$T_a$ : Ambient temperature

$\theta_{j-c} (T_{ri})$  for each chip will be:

$$\theta_{j-c} (T_{r1}) \text{ to } (T_{r4}) = 35^\circ\text{C/W} \dots\dots\dots(2)$$

The loss in transistors in a video pack varies with frequency. The loss increases with the frequency.

For example, if the maximum frequency will be 120 MHz (clock), then the transistors with the largest losses will be transistors 3 and 4 in the emitter-follower (EF) stage. From the  $P_d - f(\text{clock})$  figure, we see that that loss will be 25% of the total for a single channel. That is:

$$P_C (\text{EF stage})_{f=120\text{ MHz}} = P_d (1\text{ch})_{f=120\text{ MHz}} \times 0.25 \text{ [W]} \dots\dots\dots(3)$$

The thermal design must assure that  $T_j$  does not exceed  $150^\circ\text{C}$  at this time.

(b) Concerning  $T_c(\text{max})$ , the relationship between  $\theta_h$  and  $\Delta T_c$  is:

$$\Delta T_c = P_d (\text{total}) \times \theta_h \dots\dots\dots(4)$$

Taking the increase due to  $T_a$  into account, the condition the thermal design must meet becomes  $T_c = \Delta T_c + T_a < 100^\circ\text{C}$ .

Next we design thermal conditions for the VP453 that meet the conditions in sections (a) and (b) above.

**Sample Thermal Design for the VP453**

Conditions: For an  $f_H = 95$  kHz class monitor,  $f_V = 120$  MHz (clock).

$V_{CC} = 80$  V,  $V_{OUT} = 40$  Vp-p ( $C_L = 10$  pF)

Here we consider the case where such a monitor is to be operated at ambient temperatures up to  $T_a = 60^\circ\text{C}$  and at a maximum frequency of  $f = 100$  MHz (clock).

As mentioned previously, the chips with the maximum loss will be transistors 3 and 4 in the emitter-follower stage. Equation (5) follows from deriving that value from the figure below and equation (3).

$$P_C(\text{Tr3, 4})_{f=120\text{ MHz}} = 6.9 \times 0.25 \approx 1.72 \text{ [W]} \dots\dots\dots(5)$$

However, the actual usage conditions include a blanking period. If we calculate the power during this period approximately at a 1-MHz power ratio, from  $P_d - f(\text{clock})$  and  $P_C(\text{Tri})\text{Ratio} - f(\text{clock})$  figures, we see that  $P_C(\text{BLK})$  for transistors 3 and 4 will be:

$$P_C \text{ BLK}(\text{Tr3, 4}) = 2.6 \times 0.08 = 0.21 \text{ [W]} \dots\dots\dots (6)$$

If the blanking period is 20% of the total, from the data of equation (5) and formula (6) we see that the loss in transistors 3 and 4 will be:

$$P_C(\text{Tr3, 4}) = P_C(\text{Tr3, 4})_{f=120\text{ MHz}} \times 0.8 + P_C \text{ BLK}(\text{Tr3, 4}) \times 0.2 \approx 1.42 \text{ [W]} \dots(7)$$

Next, applying the value of  $\theta_{j-c}$  to equation (7), shows  $\Delta T_j$  to be:

$$\Delta T_j = 1.42 \times 35 \approx 50 \text{ [}^\circ\text{C]}$$

Since  $\Delta T_j \leq 50^\circ\text{C}$ , it suffices to only consider the  $T_c \leq 100^\circ\text{C}$  condition in the thermal design. That is, in the thermal design we design  $\theta_h$  so that  $T_c$  will be under  $100^\circ\text{C}$  when  $P_d(\text{total}) = P_d(1\text{ch}) \times 3$  for the time when all three channels are operating at their maximum levels.

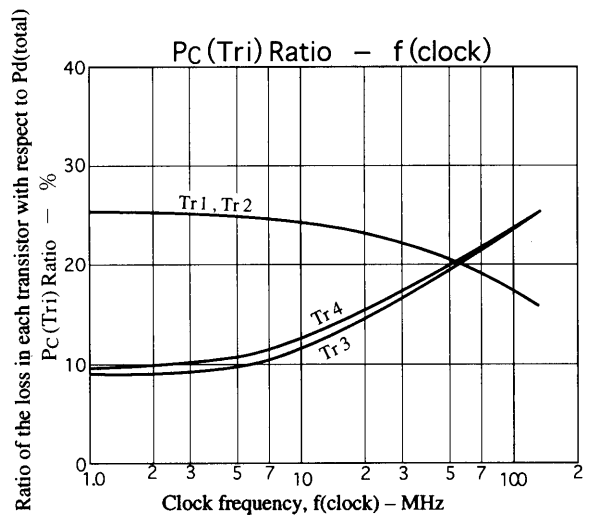
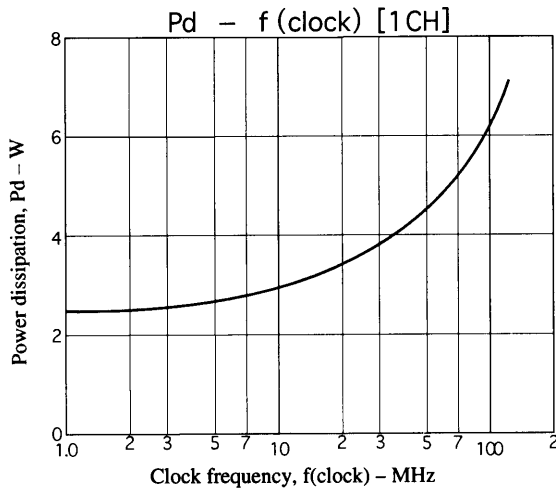
$$\Delta T_c \text{ will be: } \Delta T_c = 100 - 60 = 40^\circ\text{C}$$

$$\theta_h = \Delta T_c \div P_d(\text{total}) = 40 \div \{(6.9 \times 0.8 + 3.5 \times 0.2) \times 3\} = 2.1$$

Thus:

$$\theta_h = 2.1^\circ\text{C/W}$$

In actual use, due to the actual ambient temperature, the operating conditions, and other factors, it will be possible to use a heat sink smaller than the one required by the above design. Users should design an optimal heat sink using the data presented above and their actual conditions.



$V_{CC}$ (V)	$V_{OUT}$ (V)	$V_O$ (center)
80	40	40

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