

**VPS13**

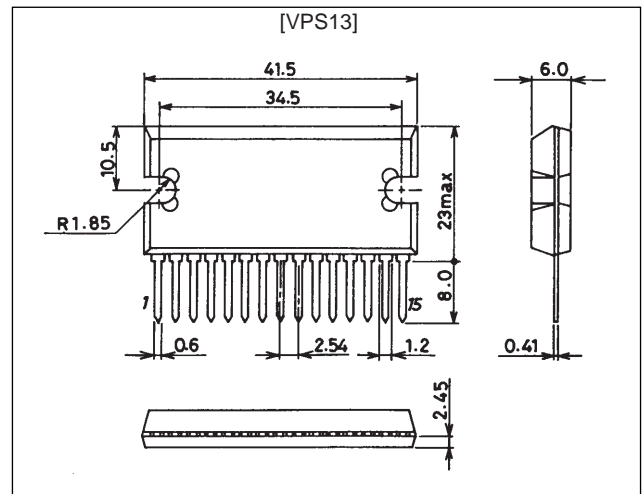
CRT Display Video Output Amplifier, High-Voltage/Wideband Amplifier

Features

- High output voltage and wide bandwidth; optimal for use in f_H (horizontal deflection frequency) = 100 kHz class monitors.
($f = 130$ MHz -3 dB at $V_{OUT} = 40$ V_{p-p})
- SIP molded 15-pin package houses three amplifier 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
	V_{BB} max		15	V
Allowable power dissipation	P_d max	With an ideal heat sink at $T_c = 25^\circ\text{C}$	30	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
	V_{BB}		10	V

Electrical Characteristics at $T_a = 25^\circ\text{C}$ (for a single channel)

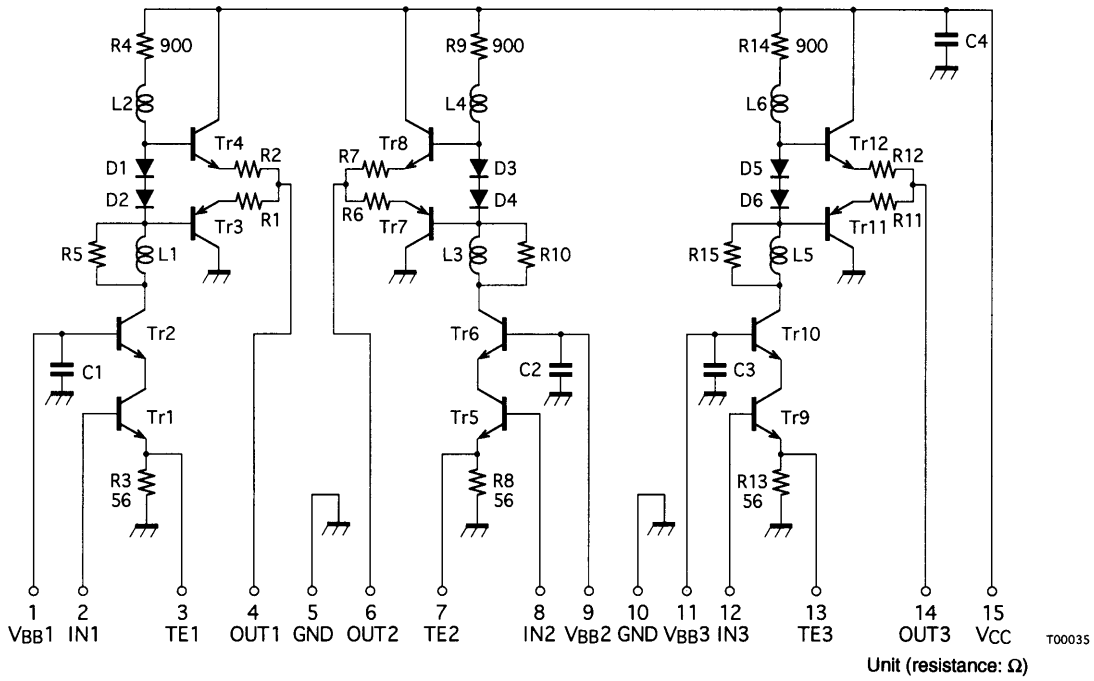
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Frequency band (-3 dB)	f_c	$V_{CC} = 80$ V, $V_{BB} = 10$ V, $C_L = 10$ pF V_{IN} (DC) = 3.2 V, V_{OUT} (p-p) = 40 V		130		MHz
Impulse response	t_r	$V_{CC} = 80$ V, $V_{BB} = 10$ V, $C_L = 10$ pF		3.5		ns
	t_f	V_{IN} (DC) = 3.2 V, V_{OUT} (p-p) = 40 V		2.9		ns
Voltage gain	VG (DC)		13	15	17	double
Current drain	$I_{CC}(1)$	$V_{CC} = 80$ V, $V_{BB} = 10$ V, V_{IN} (DC) = 2.9 V, $f = 10$ MHz clock, $C_L = 10$ pF, V_{OUT} (p-p) = 40 V		47		mA
	$I_{CC}(2)$	$V_{CC} = 80$ V, $V_{BB} = 10$ V, V_{IN} (DC) = 2.9 V, $f = 130$ MHz clock, $C_L = 10$ pF, V_{OUT} (p-p) = 40 V		85		mA

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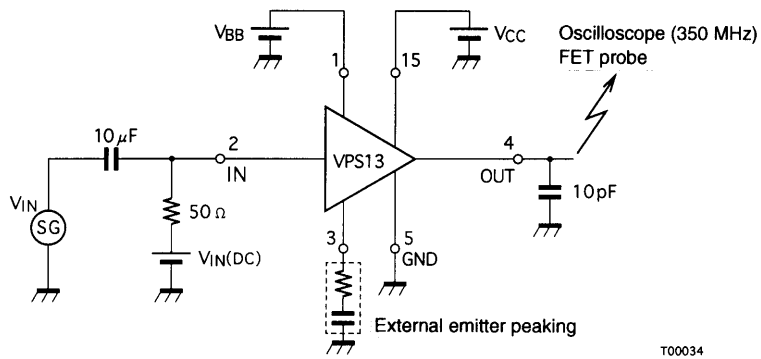
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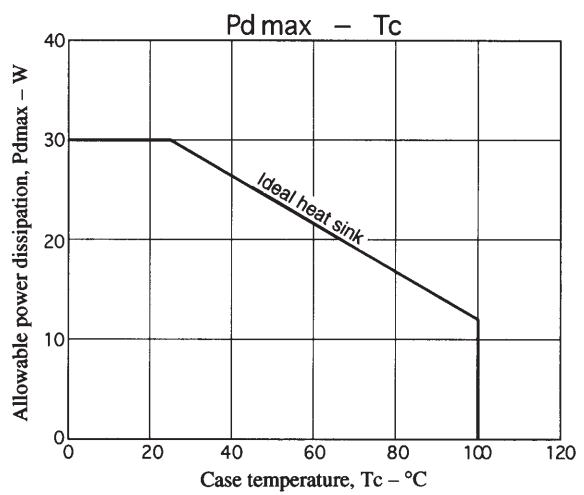
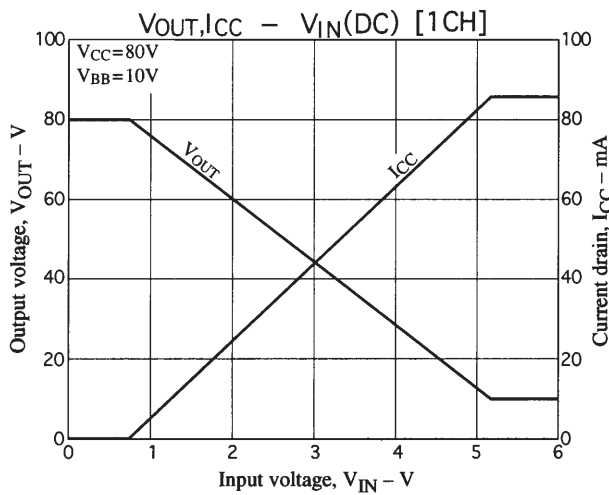
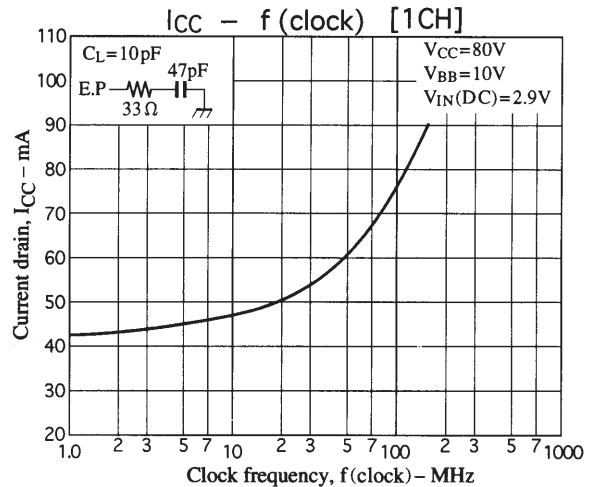
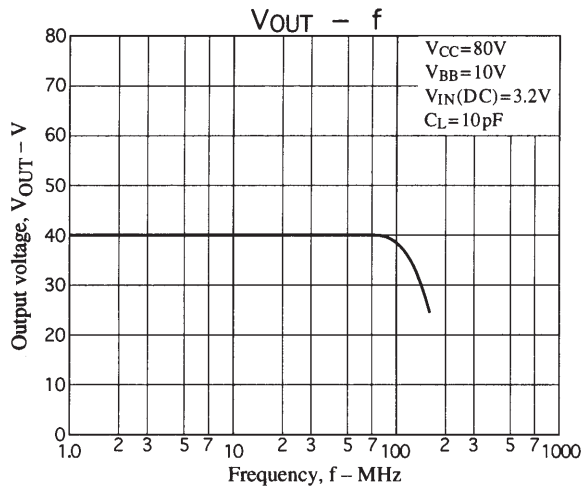
VPS13

Internal Equivalent Circuit



Test Circuit (for a single channel)





Thermal Design

Since the VPS13 includes three channels as shown in the circuit diagram on page 2, we first consider a single channel. The chip temperature of each transistor under actual operating conditions is determined using the following formula.

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

$\theta_{j-c} (T_{ri})$: Thermal resistance of an individual transistor

$P_c(T_{ri})$: Collector loss for an individual transistor

ΔT_c : Case temperature rise

T_a : Ambient temperature

The $\theta_{j-c} (T_{ri})$ for each chip is: $\theta_{j-c} (Tr1) = 35^\circ\text{C/W}$

$$\theta_{j-c} (Tr2) \text{ to } (Tr4) = 30^\circ\text{C/W} \dots\dots\dots(2)$$

Although the loss for each transistor in a video pack varies with frequency and is not uniform, if we assume the maximum operating frequency, $f = 130 \text{ MHz}$ (clock), then the chip with the largest loss will be transistor 3 ($Tr3$) of the emitter-follower stage. From the P_d-f (clock) figure we see that loss will be 22% of the total loss for a single channel:

$$P_c (\text{emitter-follower stage})_{(f=130 \text{ MHz})} = P_d (1ch)_{(f=130 \text{ MHz})} \times 0.22 \text{ [W]} \quad (3)$$

Here, we must select a heat sink with a capacity θ_h such that the T_j of these transistors does not exceed 150°C . Equation (4) below gives the relationship between θ_h and ΔT_c .

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

The required θ_h is calculated using this equation and equation (1).

VPS13 Thermal Design Example

Conditions: Using an $f_H = 100$ kHz class monitor, $f_V = 130$ MHz (clock)

$$V_{CC} = 80 \text{ V}, V_{BB} = 10 \text{ V}, V_{OUT} = 40 \text{ V}_{p-p} (C_L = 10 \text{ pF})$$

Here we consider the case where this class of monitor is operated up to $T_a = 60^\circ\text{C}$ at a maximum clock frequency of $f = 130$ MHz.

As mentioned previously, the chip with the largest loss is transistor 3 (Tr3) of the emitter-follower stage. Determining that value gives:

$$P_c (\text{emitter-follower stage}) = 6.8 \times 0.22 \approx 1.5 \text{ [W]} \dots\dots\dots(5)$$

Now, determine ΔT_j by substituting the value for θ_{j-c} in equation (5).

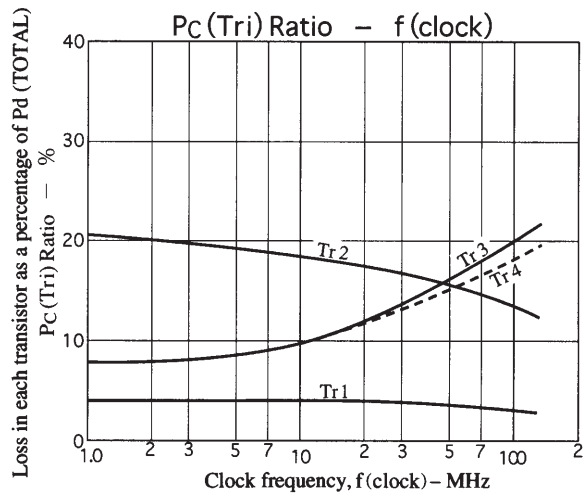
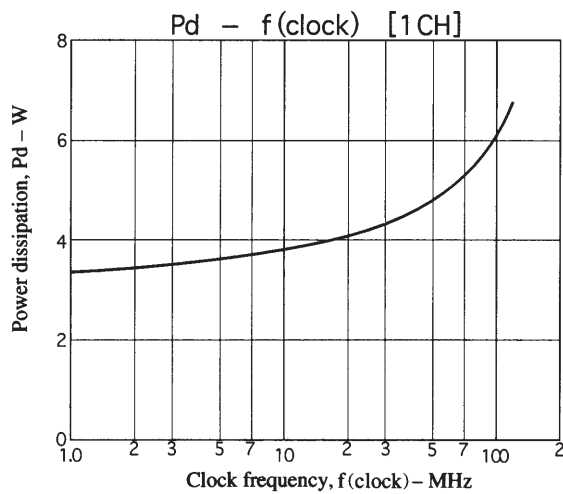
$$\Delta T_j = 1.5 \times 30 = 45 \text{ [}^\circ\text{C]}$$

Here, $\Delta T_j < 50^\circ\text{C}$, and we need only consider cases where $T_c < 100^\circ\text{C}$. Therefore, we must design a θ_h for the heat sink such that the $T_c < 100^\circ\text{C}$ condition holds when three channels are operating at maximum levels, i.e., $P_d(\text{TOTAL}) = P_d(\text{one channel}) \times 3$.

ΔT_c will be $100 - 60 = 40^\circ\text{C}$, and therefore:

$$\theta_h = \Delta T_c \div P_d (\text{TOTAL}) = 40 \div (6.8 \times 3) = 2.0, \text{ i.e. } \theta_h = 2.0 \text{ }^\circ\text{C/W}$$

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 and the above data into account is also required.



V_{CC} (V)	V_{BB} (V)	V_{OUT} (V)	V_O (center)
80	10	40	45

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