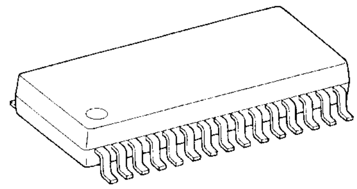
TOSHIBA Bipolar Linear IC Silicon Monolithic

TA84006F

Three-Phase Wave Motor Driver IC

The TA84006F is a three-phase wave motor driver IC. Used with a three-phase sensorless controller (TB6548F or TB6537P), the TA84006F can provide PWM sensorless drive for three-phase brushless motors.



SSOP30-P-375-1.00

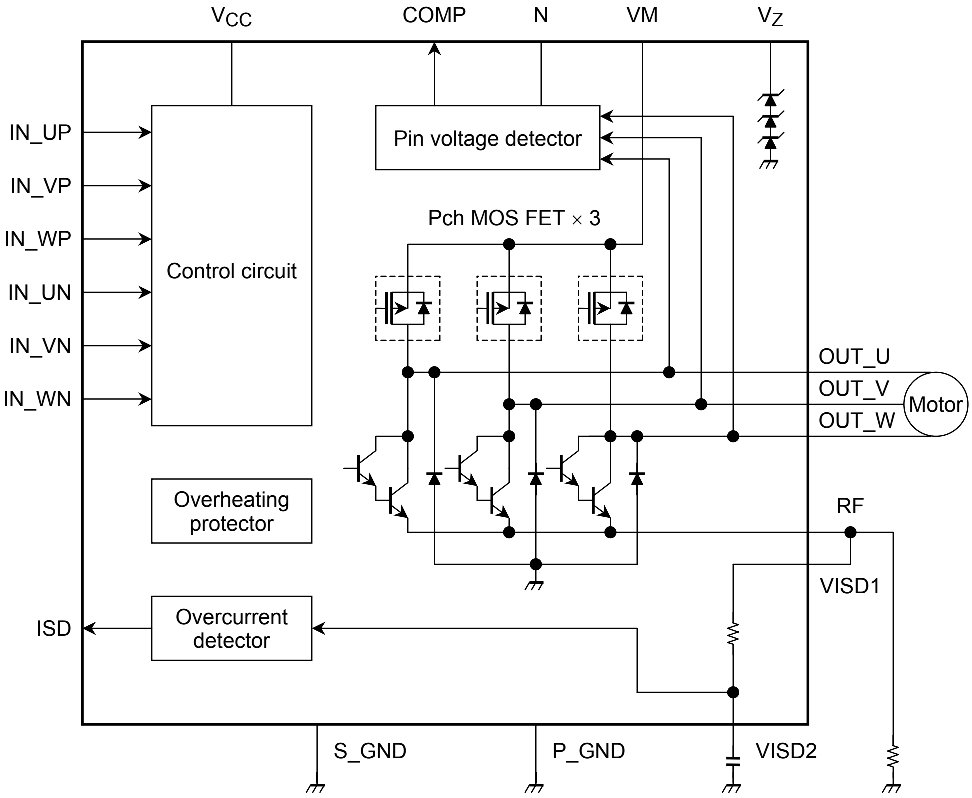
Weight: 0.63 g (typ.)

Features

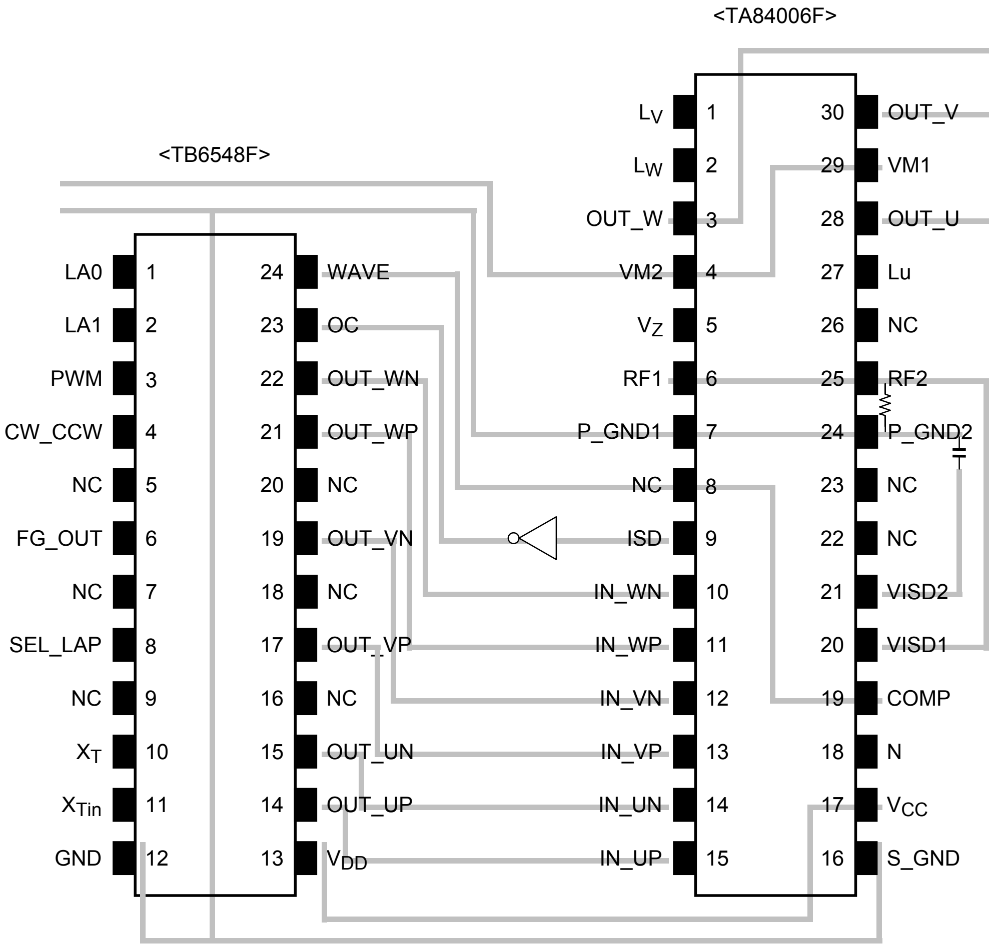
- Built-in voltage detector
- Overcurrent detector incorporated
- Overheating protector incorporated
- Multichip (MCH) structure
  Uses Pch MOS for the upper output power transistor
- Rated at 25 V/1.0 A
- Package: SSOP30-P-375-1.00

Note1: This product has a multichip (MCP) structure utilizing Pch MOS technology. Take care when handling because Pch MOS has low electrostatic resistance.

Block Diagram



Pin Assignment



Pin Description

Pin No.	Pin Symbol	Pin Function	Remarks
1	L_V	V-phase output upper Pch gate pin	Leave open.
2	L_W	W-phase output upper Pch gate pin	Leave open.
3	OUT_W	W-phase output pin	Connects motor.
4	VM2	Motor drive power supply pin	Externally connects to VM1.
5	V_Z	Reference voltage pin	Used as VM drop circuit's reference voltage when VM (max) ≧ 22 V. Left open when VM (max) ≦ 22 V.
6	RF1	Output current detection pin	Externally connected to RF2. (Connect a detection resistor between this pin and GND.)
7	P_GND1	Power GND pin	Externally connects to P_GND2.
8	NC	Not connected	—
9	ISD	Overcurrent detection output pin	Inputs the inversion of ISD pin output to TB6548F's (or TB6537P/F's) OC pin.
10	IN_WN	W-phase upper drive input pin	Connects to TB6548F's (or TB6537P/F's) OUT_WN pin; incorporates pull-down resistor.
11	IN_WP	W-phase lower drive input pin	Connects to TB6548F's (or TB6537P/F's) OUT_WP pin; incorporates pull-up resistor.
12	IN_VN	V-phase upper drive input pin	Connects to TB6548F's (or TB6537P/F's) OUT_VN pin; incorporates pull-down resistor.
13	IN_VP	V-phase lower drive input pin	Connects to TB6548F's (or TB6537P/F's) OUT_VP pin; incorporates pull-up resistor.
14	IN_UN	U-phase upper drive input pin	Connects to TB6548F's (or TB6537P/F's) OUT_UN pin; incorporates pull-down resistor.
15	IN_UP	U-phase lower drive input pin	Connects to TB6548F's (or TB6537P/F's) OUT_UP pin; incorporates pull-up resistor.
16	S_GND	Signal GND pin	—
17	V_{CC}	Control power supply pin	$V_{CC\ (opr)}$ = 4.5 to 5.5 V
18	N	Mid-point pin	Mid-point potential confirmation pin; left open
19	COMP	Location detection signal output pin	Connects to TB6548F's (or TB6537P/F's) WAVE pin.
20	VISD1	Overcurrent detection input pin 1	Externally connects to RF2 pin.
21	VISD2	Overcurrent detection input pin 2	Connect a capacitor between this pin and GND. Internal resistor and capacitor used to reduce noise.
22	NC	Not connected	—
23	NC	Not connected	—
24	P_GND2	Power GND pin	Externally connects to P_GND1 pin.
25	RF2	Output current detection pin	Externally connects to RF1 pin. Connect a detection resistor between this pin and GND.
26	NC	Not connected	—
27	Lu	U-phase upper output Pch gate pin	Leave open.
28	OUT_U	U-phase output pin	Connects motor.
29	VM1	Motor drive power supply pin	Externally connects to VM2 pin.
30	OUT_V	V-phase output pin	Connects the motor.

Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Motor power supply voltage	VM	25	V
Control power supply voltage	V_{CC}	7	V
Output current	I_O	1.0	A/phase
Input voltage	V_{IN}	GND − 0.3 ~V_{CC} + 0.3 V	V
Power dissipation	Pd	1.1 (Note2)	W
		1.4 (Note3)	
Operating temperature	T_{opr}	−30~85	°C
Storage temperature	T_{stg}	−55~150	°C

Note2: Standalone

Note3: When mounted on PCB (50 × 50 × 1.6 mm, Cu 30%)

Recommended Operating Conditions (Ta = −30~85°C)

Characteristics	Symbol	Test Circuit	Test Conditions	Min	Typ.	Max	Unit
Control power supply voltage	V_{CC}	—	—	4.5	5.0	5.5	V
Motor power supply voltage	VM	—	—	10	20	22	V
Output current	I_O	—	—	—	—	0.5	A
Input voltage	V_{IN}	—	—	GND	—	V_{CC}	V
Chopping frequency	fchop	—	—	15	20	50	kHz
Vz current	I_Z	—	—	—	—	1.0	mA

Electrical Characteristics (Ta = 25°C, V_{CC} = 5 V, VM = 20 V)

Characteristics	Symbol	Test Circuit	Test Conditions	Min	Typ.	Max	Unit
Input voltage	V_{IN} (H)	1	IN_UP, IN_VP, IV_WP IN_UN, IN_VN, IN_WN	2.5	—	5.0	V
	V_{IN} (L)	1	—	GND	—	0.8	
Input current	I_{IN1} (H)	2	V_{IN} = 5 V, IN_UP, IN_VP, IN_WP	—	—	20	μA
	I_{IN2} (H)	2	V_{IN} = 5V, IN_UN, IN_VN, IN_WN	300	450	600	
	I_{IN1} (L)	2	V_{IN} = GND, IN_UN, IN_VN, IN_WN	—	—	1	
	I_{IN2} (L)	2	V_{IN} = GND, IN_UP, IN_VP, IN_WP	300	450	600	
Power supply current	$I_{CC}1$	3	Upper phase 1 ON, lower phase 1 ON, output open	—	8.0	13.0	mA
	$I_{CC}2$	3	Upper phase 2 ON, synchronous regeneration mode, output open	—	7.0	12.0	
	$I_{CC}3$	3	All phases OFF, output open	—	6.0	11.0	
	IM1	3	Upper phase 1 ON, lower phase 1 ON, output open	—	2.0	3.5	
	IM2	3	Upper phase 2 ON, synchronous regeneration mode, output open	—	2.0	3.5	
	IM3	3	All phases OFF, output open	—	1.8	3.2	
Lower output saturation voltage	VSAT	4	I_O = 0.5 A	—	1.0	1.5	V
Upper output ON resistance	Ron	5	I_O = ±0.5 A, bi-directional	—	0.65	1.0	Ω
Lower diode forward voltage	V_F (L)	6	I_F = 0.5 A	—	1.2	1.6	V
Upper diode forward voltage	V_F (H)	7	I_F = 0.5 A	—	0.9	1.4	V
Mid-point voltage	VN	8	VM = 20 V VRF = 0 V	9.88	10.4	10.92	V
Pin voltage detection level	VCMP	9	VM = 20 V VRF = 0 V	9.88	10.4	10.92	V
Pin voltage detection output voltage	VOL (CMP)	9	I_{OL} = 1 mA	GND	—	0.5	V
	ROH (CMP)	9	—	7	10	13	kΩ
Overcurrent detection level	VRF	10	—	0.45	0.5	0.55	V
Overcurrent detection output voltage	VOH (ISD)	10	I_{OH} = 0.1 mA	4.5	—	5.0	V
	VOL (ISD)	10	I_{OL} = 0.1 mA	GND	—	0.5	V
Reference voltage	V_Z	11	I_Z = 0.5 mA, T_j = 25°C	20.9	22.0	23.1	V
TSD temperature	TSD	—	T_j	—	165	—	°C
TSD hysteresis width	ΔT	—	—	—	30	—	°C
Output leakage current	I_L (H)	12	Pch MOS	—	0	100	μA
	I_L (L)	13	—	—	0	50	

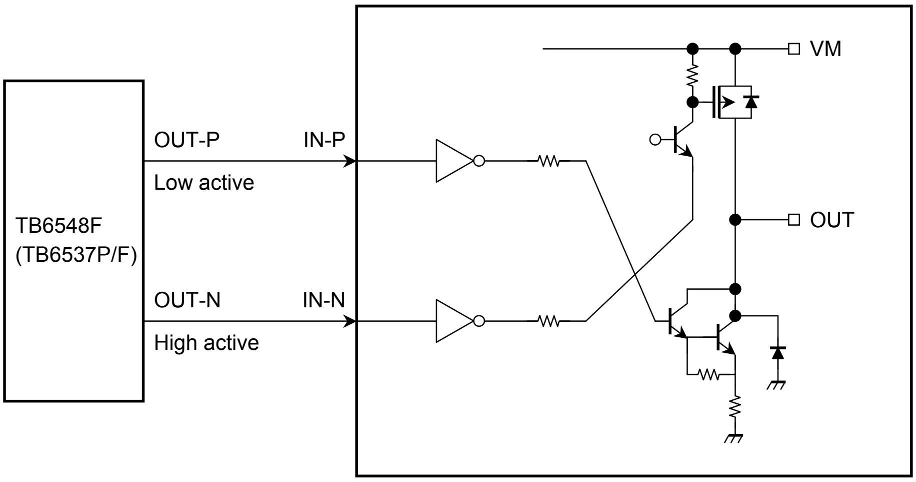
Functions

Input		Output		
IN-P	IN-N	Upper Power Transistor	Lower Power Transistor	
High	High	ON	OFF	High
Low	High	ON	ON	Prohibit Mode (Note4)
High	Low	OFF	OFF	High impedance
Low	Low	OFF	ON	Low

Connecting TB6548F (or TB6537P/F) to TA84006F allows electric motors to be controlled by PWM.

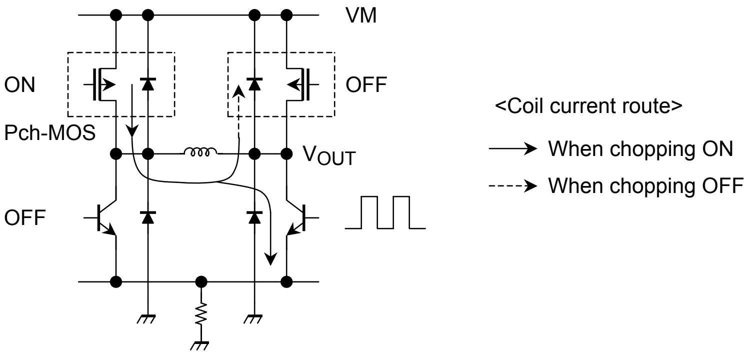
Note4: In Prohibit Mode, the output power transistor goes into vertical ON mode and through current may damage the circuit. Do not use TA84006F in this mode.
When TA84006F is connected to TB6548F or TB6537P/F, this mode does not occur but can be triggered by input noise during standalone testing.

<Schematic>



<Lower PWM>

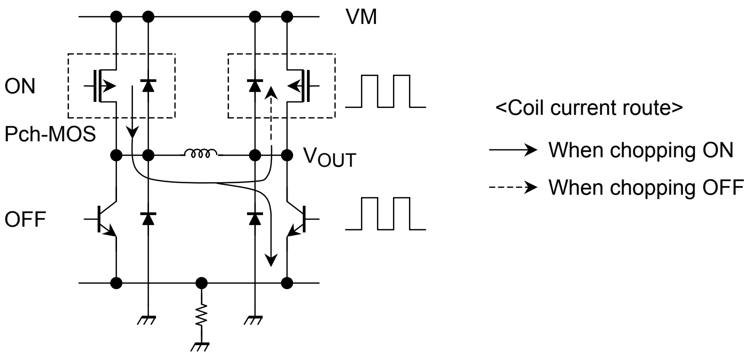
Connecting TA84006F to TB6537P/F controls lower PWM.
At chopping ON, the diagonally output power transistors are ON.
At chopping OFF, the lower transistor is OFF, regenerating the motor current via the upper diode (incorporates Pch MOS).



<Synchronous rectification PWM>

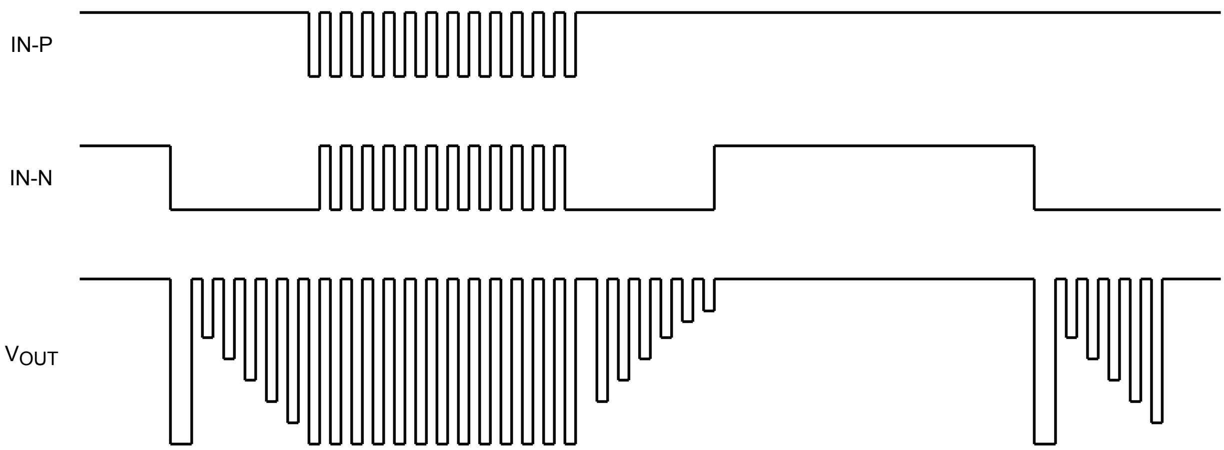
Connecting TA84006F to TB6548F controls synchronous rectification PWM.

At chopping OFF, power dissipation is reduced by operating the Pch MOS in reverse and regenerating the motor's current.



<Timing Chart>

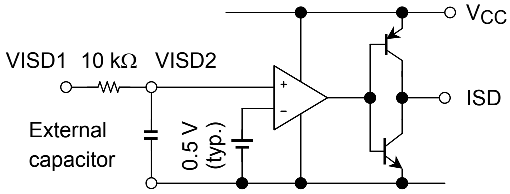
When controlling synchronous rectification PWM



Equivalent Circuit

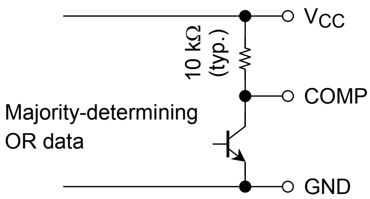
<Overcurrent detector (RF, VISD, ISD) >

- Input to the VISD1 pin the voltage generated at the overcurrent detection resistor RF connected to the RF pin.)
- At chopping ON, voltage spikes at the RF pin as a result of the Pch MOS output capacitance. To cancel the spike, externally connect a capacitor to the VISD2 pin. (10 kΩ resistor built-in)
- If the VISD2 pin voltage exceeds the internal reference voltage (VRF = 0.5 V), the overcurrent detection output ISD pin goes Low.
  Inputting the inversion of ISD pin output to the TB6537P/F or TB6548F OC pin limits the PWM ON time and the current at the ISD output rising edge.



<Pin voltage detector (COMP) >

- The pin voltage detector outputs the result of ORing the output pin voltages and the virtual mid-point N voltage to determine the majority.
  (If at least two phases of the three-phase output are larger than the mid-point potential, the detector outputs “Low”. Conversely, if at least two phases are smaller than the mid-point potential, the circuit outputs “High”.)



- Regarding the virtual mid-point potential VN used as the reference for the pin voltage detection circuit as half the voltage applied to the motor,

  $VN = [\ (VM - Ron\ (upper)\ {*}I_O) - (V_{sat}\ (lower) + VRF)\ ]/2 + V_{sat} + VRF$

  $\quad = [VM - VRF + V_{sat}\ (lower) - Ron\ (upper)\ {*}I_O]/2 + VRF$

  Here, considering that: $V_{sat}\ (lower) - Ron\ (upper)\ {*}I_O \simeq V_F$,

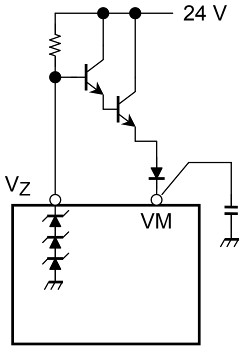
  setting is: $VN = [VM - VRF + V_F]/2 + VRF$

<Overheating protector>

- Automatic restoration TSD (ON) = 165°C TSD (OFF) = 135°C
- Temperature hysteresis supported TSD (HYS) = 30°C

<Example of 24 V support>

- Incorporate a Zener diode and make external connections shown in the diagram below, and design the device so that the voltage applied to the VM is clamped at 22 V below the maximum operating power supply voltage.
- A capacitor is needed to control the effect of the counter electromotive force.
  Verification is particularly necessary when the motor current is large at startup or at shut down (output OFF).



V_Z pin fluctuation width

20.9 V to 23.1 V

Because of the temperature characteristics (3.5 × 3 mV/°C), at an ambient temperature of 85°C:

V_Z (max) = 23.1 + (85 − 25) × 3.5 × 3 mV

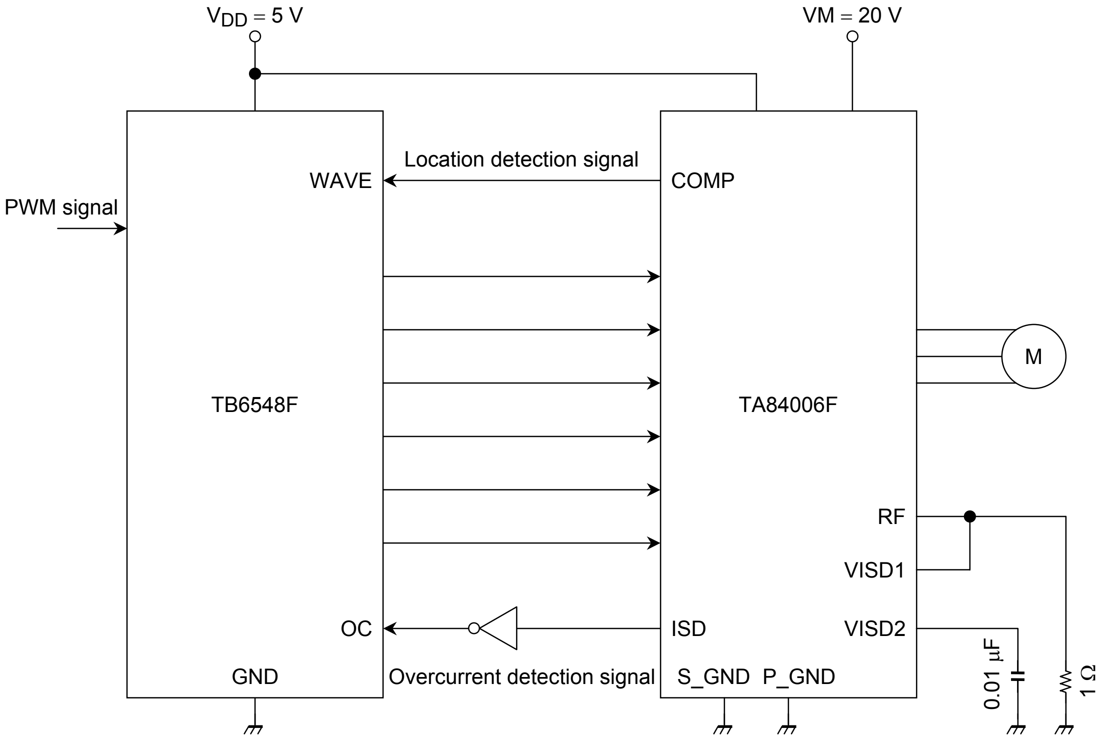
= 23.73 V

By taking the measures in the diagram at right to bring the voltage down to 22 V:

V_Z (max) = 23.73 − (0.7 − 2 mV × (85 − 25)) × 3

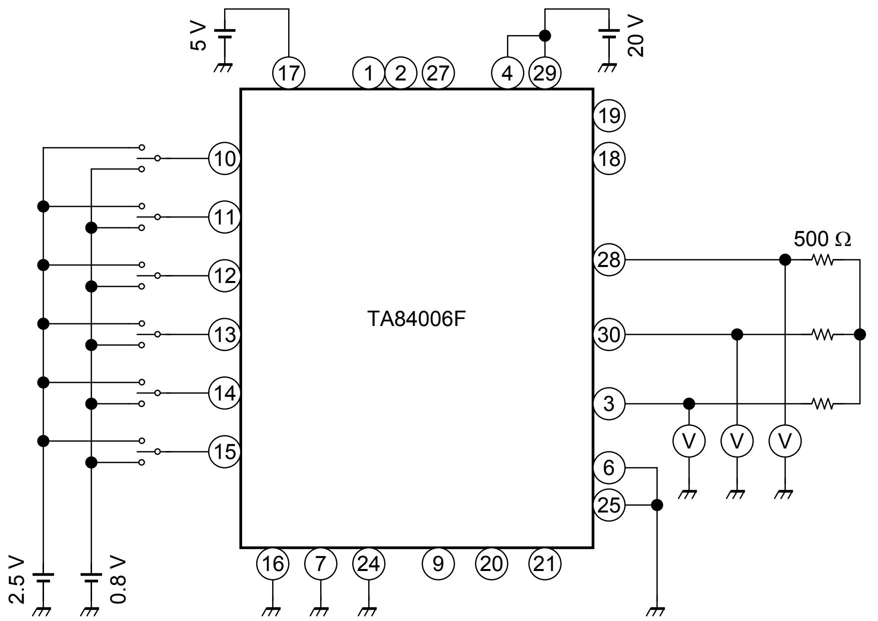
= 21.99 V

Example of Application Circuit



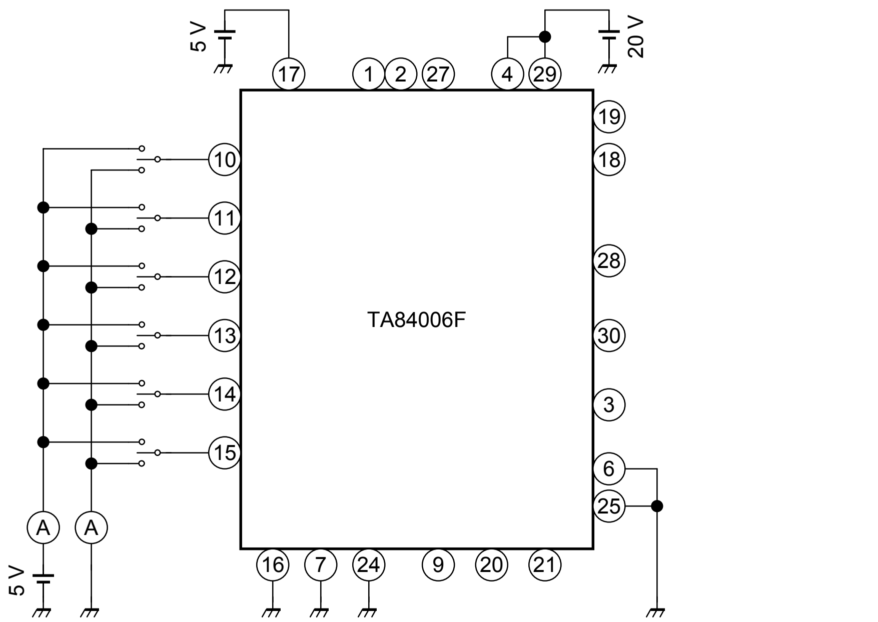
Note5: A short circuit between the outputs, or between output and supply or ground may damage the device. Periferal parts may also be dameged by overvoltage and overcurrent. Design the output lines, V_{CC}, V_S, and GND lines so that short circuits do not occur.
Also be careful not to insert the IC in the wrong direction because this could destroy the IC.

Test Circuit 1: V_{IN} (H), V_{IN} (L)

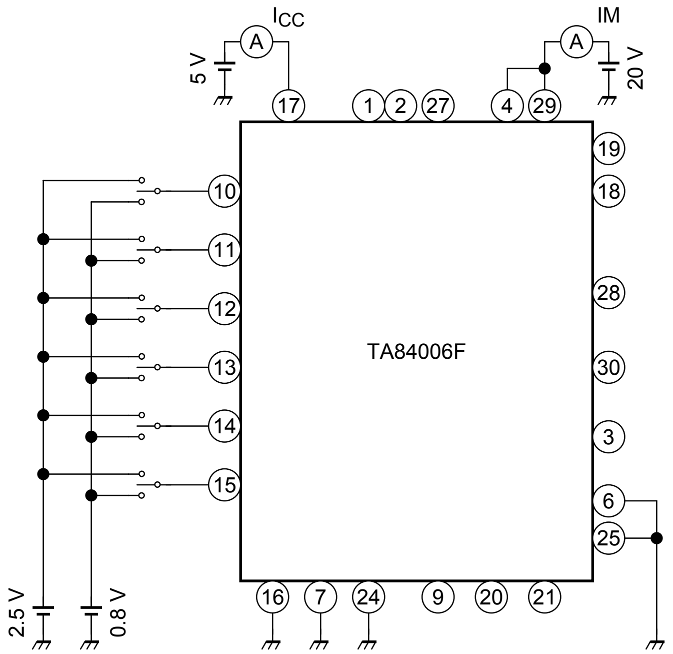


Input V_{IN} = 0.8 V/2.5 V, measure the output voltage, and test the function.

Test Circuit 2: I_{IN} (H), I_{IN} (L)

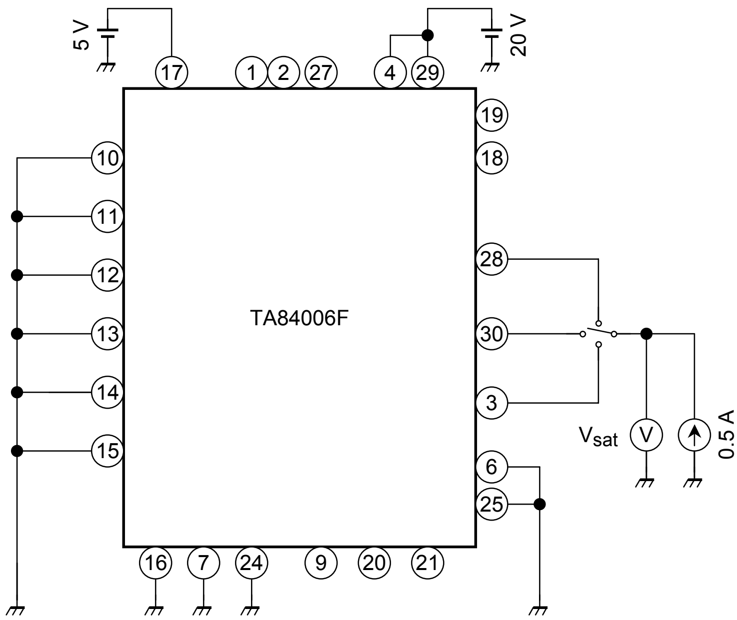


Test Circuit 3: $I_{CC}1$, $I_{CC}2$, $I_{CC}3$, IM1, IM2, IM3

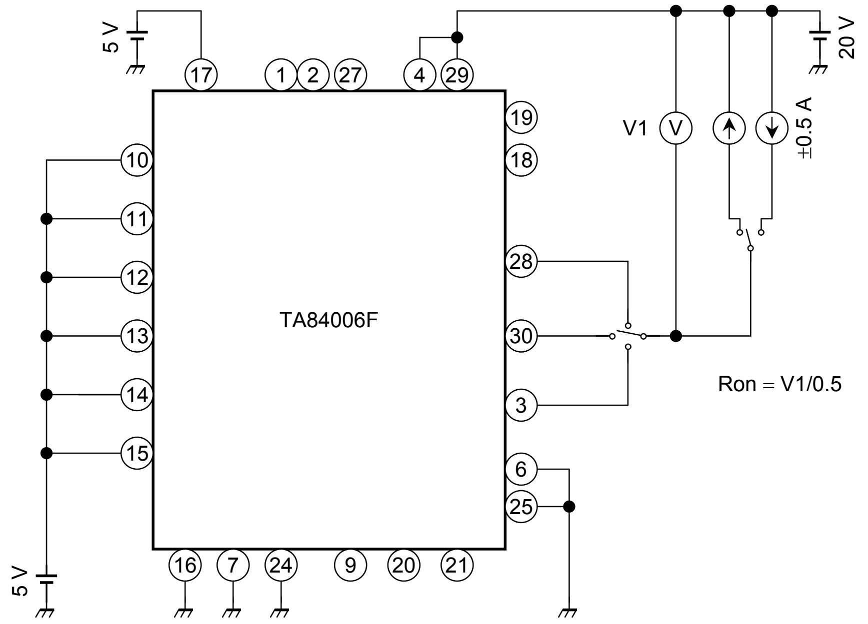


$I_{CC}1$, IM1: Upper phase 1 ON, lower phase 1 ON (eg, U-phase: H; V-phase: L; W-phase: Z)
$I_{CC}2$, IM2: Upper phase 1 ON, synchronous regeneration mode (eg, U-phase: H; V-phase: H; W-phase: Z)
$I_{CC}3$, IM3: All phases OFF

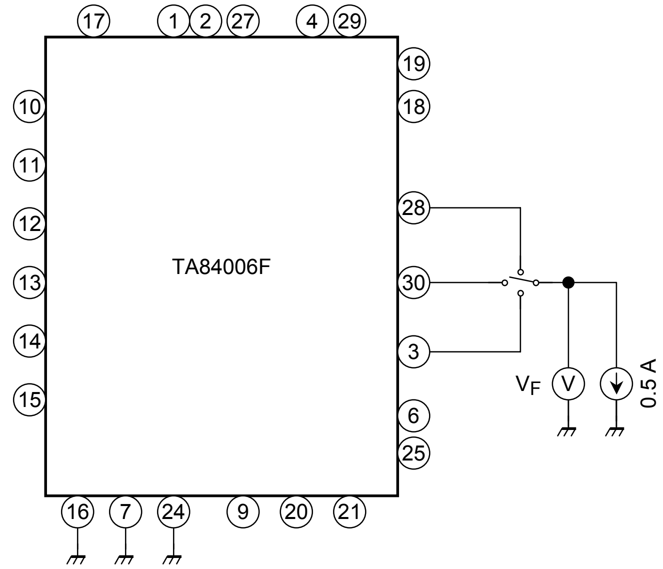
Test Circuit 4: V_{sat}



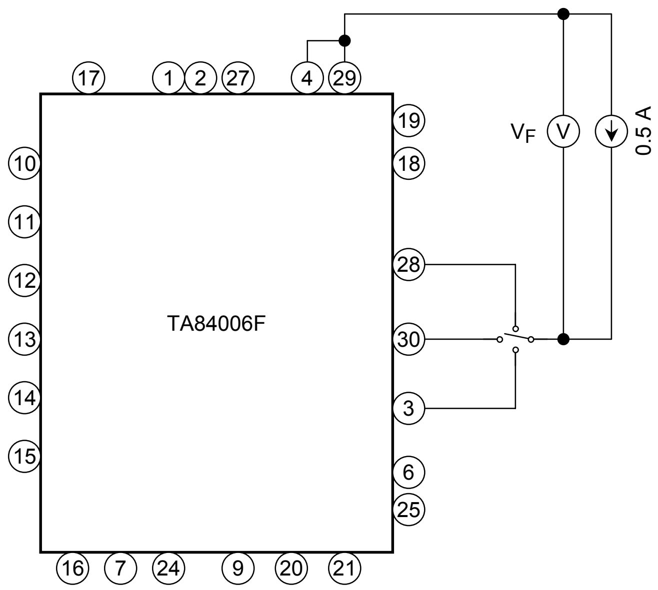
Test Circuit 5: Ron



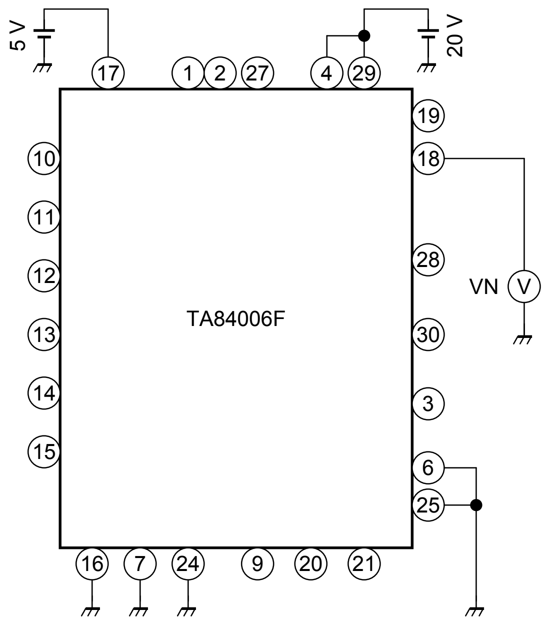
Test Circuit 6: V_F (L)



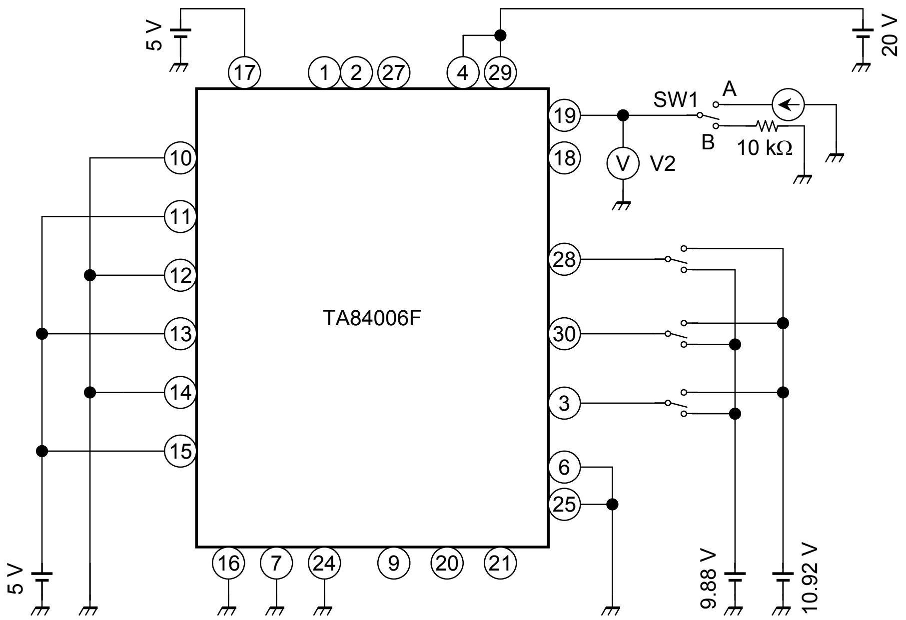
Test Circuit 7: V_F (H)



Test Circuit 8: VN



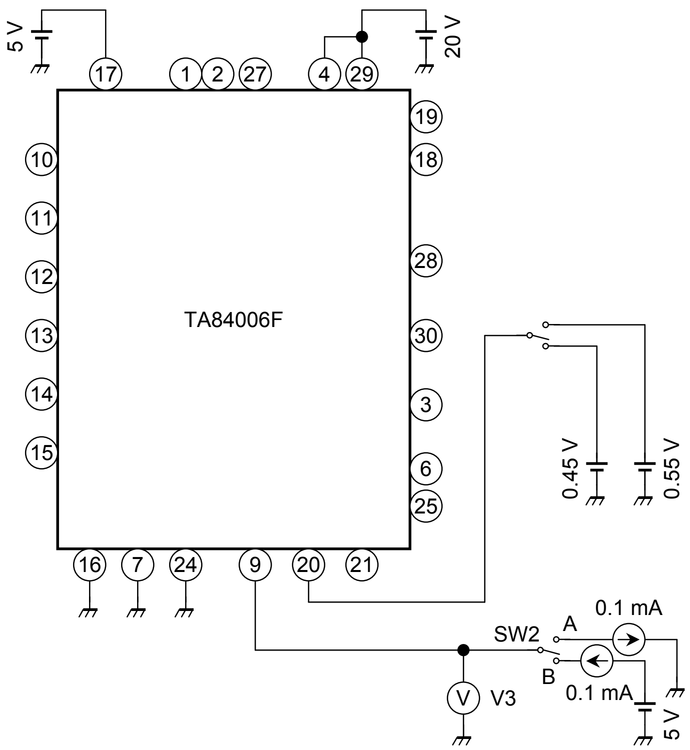
Test Circuit 9: VCMP, VOL (CMP), ROH (CMP)



(1) Where output phase 2 is High (10.92 V) and phase 1 is Low (= 9.88 V), set SW1 = A and measure V2 = VOL (CMP).

(2) Where output phase 1 is High (10.92 V) and phase 2 is Low (9.88 V), set SW1 = B and confirm that 5 V × 10 kΩ/(10 kΩ + 13 kΩ) < V2 < 5 V × 10 kΩ/(10 kΩ + 7 kΩ).

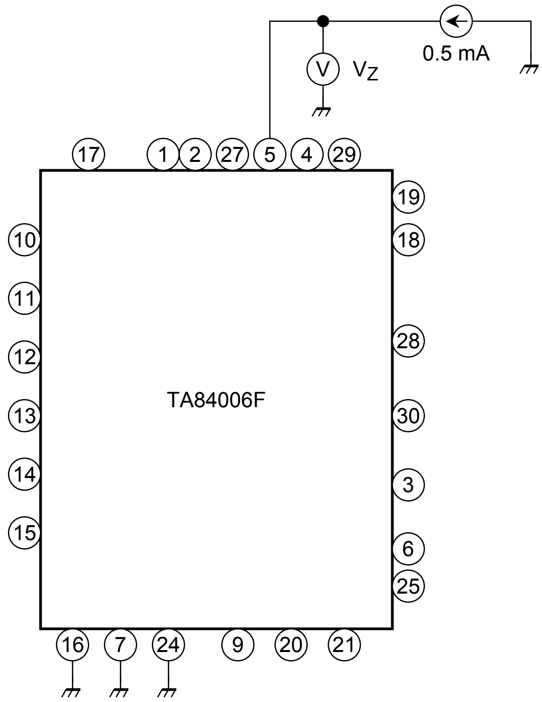
Test Circuit 10: VRF, VOH (ISD), VOL (ISD)



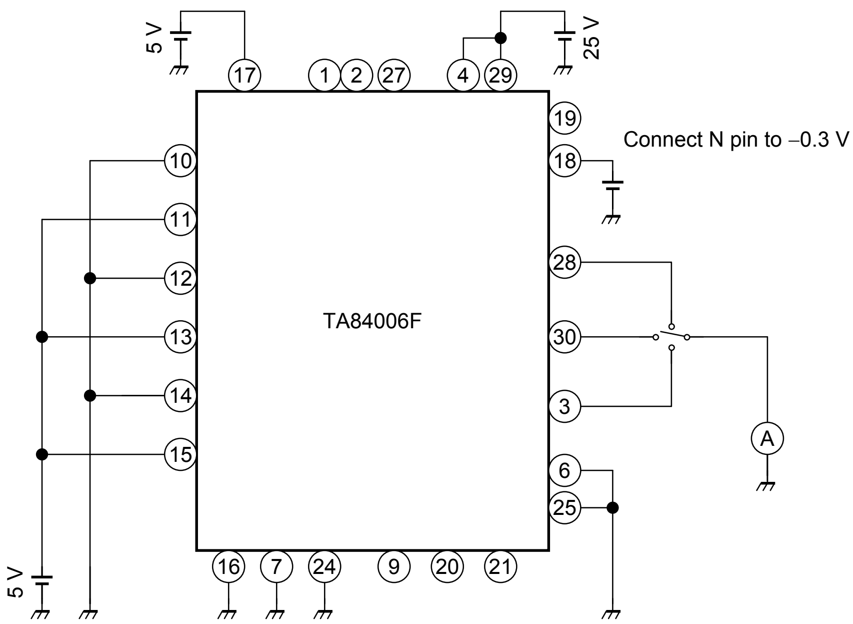
(1) Where VISD = 0.55 V, set SW2 = A and measure V3 = VOH (ISD).

(2) Where VISD = 0.45 V, set SW2 = B and measure V3 = VOL (ISD).

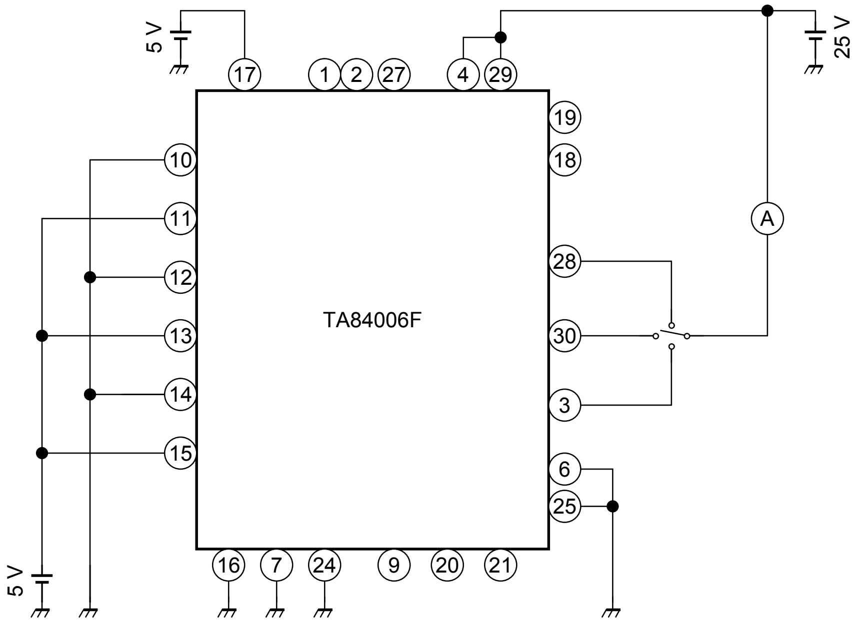
Test Circuit 11: V_Z



Test Circuit 12: I_L (H)



Test Circuit Test Circuit 13: I_L (L)



Package Dimensions

Weight: 0.63 g (typ.)

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