



## TPS4070

### FOUR CHANNEL BRIDGED OUTPUT POWER STAGE

Technical Information

Revision 1.0 – January 2004

#### GENERAL DESCRIPTION

The TPS4070 is a 4 channel bridged (16 power transistors) output power stage. The TPS4070 accepts 5V CMOS logic signals from a Class-T mixed signal processor to create a high fidelity 4 channel audio amplifier. The TPS4070 has been designed specifically for automotive head unit applications operating on a single 10-21V supply.

#### APPLICATIONS

- Automotive Head Units and Trunk Amplifiers
- DVD Receivers
- Multimedia Speaker Systems

#### BENEFITS

- 4-channel output stage – with integrated driver and FETs - in a single 32-pin SSIP package
- Low external component count
- Single-supply operation

#### FEATURES

- Four H-Bridge outputs
- High Efficiency
- High Power @20.0V
  - 70W<sub>sat. sq. wave</sub> @ 4Ω
- High Efficiency
  - 89% @ 25W 8Ω
  - 85% @ 50W 4Ω
- AM “Low EMI” mode with connection to appropriate Class-T controller
- Mute and Stand-By function
- Protection Modes:
  - Output Short to VPP and Ground
  - Output Short across Load
  - Load Dump Protection
  - Over-/Under-Voltage Protection
  - Over-current Protection
  - Over-temperature Protection
  - Fortuitous Open Ground



## Absolute Maximum Ratings (Notes 1, 2)

SYMBOL	PARAMETER	Value	UNITS
V <sub>PP</sub>	Supply Voltage (V <sub>PP</sub> )	26	V
V <sub>PP</sub> <sub>MAX</sub>	Peak Supply Voltage (t <sub>≤</sub> 50ms)	60	V
V <sub>IN</sub> <sub>RANGE</sub>	Voltage Range for Input Section Pins (Note 2) Inputs (Pins 1-11)	-0.3 to 5.3	V
T <sub>STORE</sub>	Storage Temperature Range	-55 to +150	°C
I <sub>R</sub>	Repetitive Peak Output Current	8	A
T <sub>J</sub>	Maximum Junction Temperature	150	°C
P <sub>D</sub>	Total Power Dissipation (T <sub>case</sub> = 70°C)	80	W
ESD	ESD Susceptibility - Human Body Model (Note 3)	2k	V
ESD	ESD Susceptibility – Machine Model (Note 4)	200	V

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.

See the table below for Operating Conditions.

Note 2: The input section pins (pins 1-11) should not be connected to voltages over 5.3V with respect to pins 13 and 14 (AGND). Please note that pin 12 is an output and can be damaged if a voltage is forced externally.

Note 3: Human body model, 100pF discharged through a 1.5KΩ resistor.

Note 4: Machine model, 220pF – 240pF discharged through all pins.

## Operating Conditions (Note 5)

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNITS
V <sub>PP</sub>	Supply Voltage (Note 5)	9.5	14.4	21	V
T <sub>A</sub>	Operating Free Air Temperature Range	-40	25	85	°C

Note 5: Recommended Operating Conditions indicate conditions for which the device is functional.

See Electrical Characteristics for guaranteed specific performance limits.

## Thermal Characteristics

SYMBOL	PARAMETER	Value	UNITS
θ <sub>JC</sub>	Junction-to-case Thermal Resistance	1.0	°C/W
θ <sub>JA</sub>	Junction-to-ambient Thermal Resistance (still air)	20	°C/W

**Electrical Characteristics** (Note 6)

$T_A = 25\text{ }^{\circ}\text{C}$ . Unless otherwise noted, the supply voltage is  $V_{PP}=14.4\text{V}$ . See Application/Test Circuit.

SYMBOL	PARAMETER	Conditions	MIN.	TYP.	MAX.	UNITS
$I_{STBY}$	Stand-By Current	$V_{SLEEPB} < 0.15\text{V}$			0.1	mA
$V_{IL}$	Stand-By On Threshold Voltage	SLEEPB Low (amp off)			0.6	V
$V_{IH}$	Stand-By Off Threshold Voltage	SLEEPB High (amp on)	2.3			V
$V_{IL}$	Mute-On Threshold Voltage	MUTE Low			1	V
$V_{IH}$	Mute-Off Threshold Voltage	MUTE High	2.3			V
$V_{IL}$	Yn/YnB Low Threshold Voltage				0.6	V
$V_{IH}$	Yn/YnB High Threshold Voltage		2.3			V
$V_{OH}$	Fault Reporting Logic Output High Voltage	Open Drain Output	3.5			V
$V_{OL}$	Fault Reporting Logic Output Low Voltage	$R_{FAULT} = 51\text{K}\Omega$			1	V
$V_{IH}$	AM Mode On Threshold Voltage		2.3			V
$V_{IL}$	AM Mode Off Threshold Voltage				1	V
$I_{AM}$	AM Mode Pin Input Current				1	$\mu\text{A}$

Note 6: Minimum and maximum limits are guaranteed but may not be 100% tested.

**Performance Characteristics** (Note 6)

$T_A = 25\text{ }^{\circ}\text{C}$ . Unless otherwise noted,  $R_L = 4\Omega$ . Measurement Bandwidth = 20kHz. All specifications shown are applicable only when the TPS4070 is used in conjunction with the TCA4000 Class-T Controller. See Application/Test Circuit.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
$P_{OUT}$	Output Power (Continuous power/ channel)	$V_{PP}=20\text{V}$ saturated sq. wave	65	72		W
		$V_{PP}=20\text{V}$ THD+N=10%		50		W
		$V_{PP}=20\text{V}$ THD+N=1%		39		W
		$V_{PP}=16\text{V}$ saturated sq. wave		48		W
		$V_{PP}=16\text{V}$ THD+N=10%		33		W
		$V_{PP}=16\text{V}$ THD+N=1%		26		W
		$V_{PP}=14.4\text{V}$ saturated sq. wave	35	39		W
		$V_{PP}=14.4\text{V}$ THD+N=10%		27		W
		$V_{PP}=14.4\text{V}$ THD+N=1%		21		W
$\eta$	Power Efficiency	$V_{PP}=20.0\text{V}$ , 4 x 70W sat sq wave		85		%

**AM Mode** (Note 6)

$T_A = 25\text{ }^{\circ}\text{C}$ . Unless otherwise noted, the supply voltage is  $V_{PP}=14.4\text{V}$ ,  $R_L = 4\Omega$ . Measurement Bandwidth = 20kHz. See Application/Test Circuit.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
$I_{OCD}$	Over-current detect		5.5			A
$P_{out}$	Output Power (Note 7)	$V_{PP}=16\text{V}$ , THD+N=10%		20		W
		$V_{PP}=14.4\text{V}$ , THD+N=10%	13	16		W

Note 7: The TPS4070 heat sinking in AM Mode must be increased (as compared to Class-T mode) to sustain the typical output numbers. This is due to the lower efficiency of Class B output stage operation.

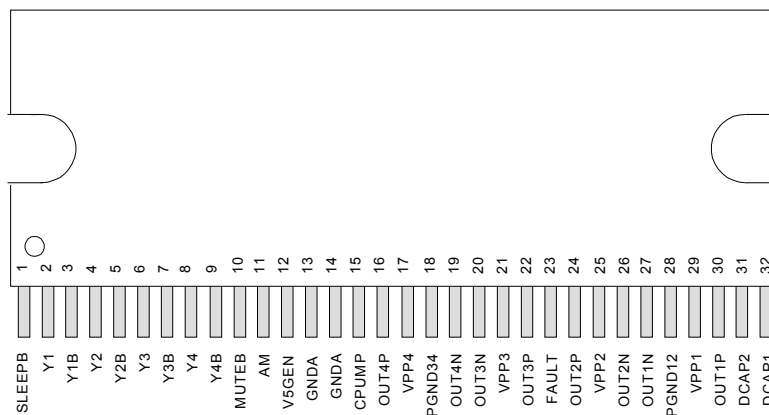
**Protection Circuits** (Note 5)

$T_A = 25\text{ }^{\circ}\text{C}$ . Unless otherwise noted, the supply voltage is  $V_{PP}=14.4\text{V}$ .

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
$OV_{ON}$	Over-voltage Threshold	Over-voltage turn on (amp muted)	23.0	24.0	26.0	V
$OV_{OFF}$	Over-voltage Reset	Over-voltage turn off (mute off)	22.0	22.5		V
$UV_{OFF}$	Under-voltage Reset	Under-voltage turn off (mute off)		9.5	10.0	V
$UV_{ON}$	Under-voltage Threshold	Under-voltage turn on (amp muted)	7.8	8.1	8.6	V
$OT_{ON}$	Over-Temperature Threshold	Over-temperature turn on (amp muted)	150	160	170	$^{\circ}\text{C}$
$OT_{OFF}$	Over-Temperature Reset	Over-temperature turn off (mute off)	120	130	140	$^{\circ}\text{C}$
$I_{OC}$	Over-Current Detect	Cycle in/out of mute mode every 600ms	5.5	7.0		A
$VP_{MAX}$	Load Dump Voltage Withstand	Test conditions, $t_r > 2.5\text{ms}$ , $t_{pulse} < 50\text{ms}$	60			V

**TPS4070 Pinout**

32-pin SSIP Package  
(Top View)

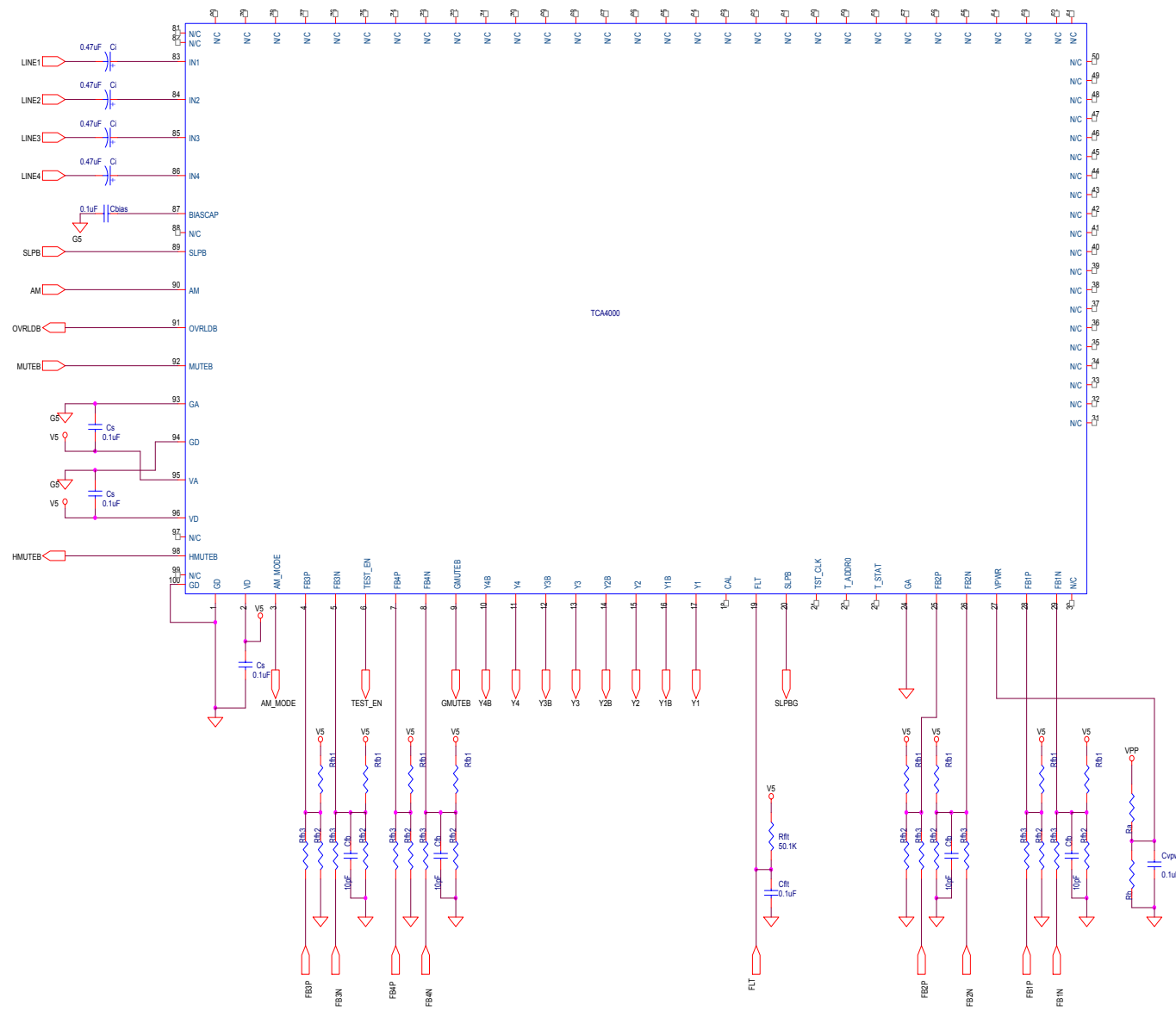


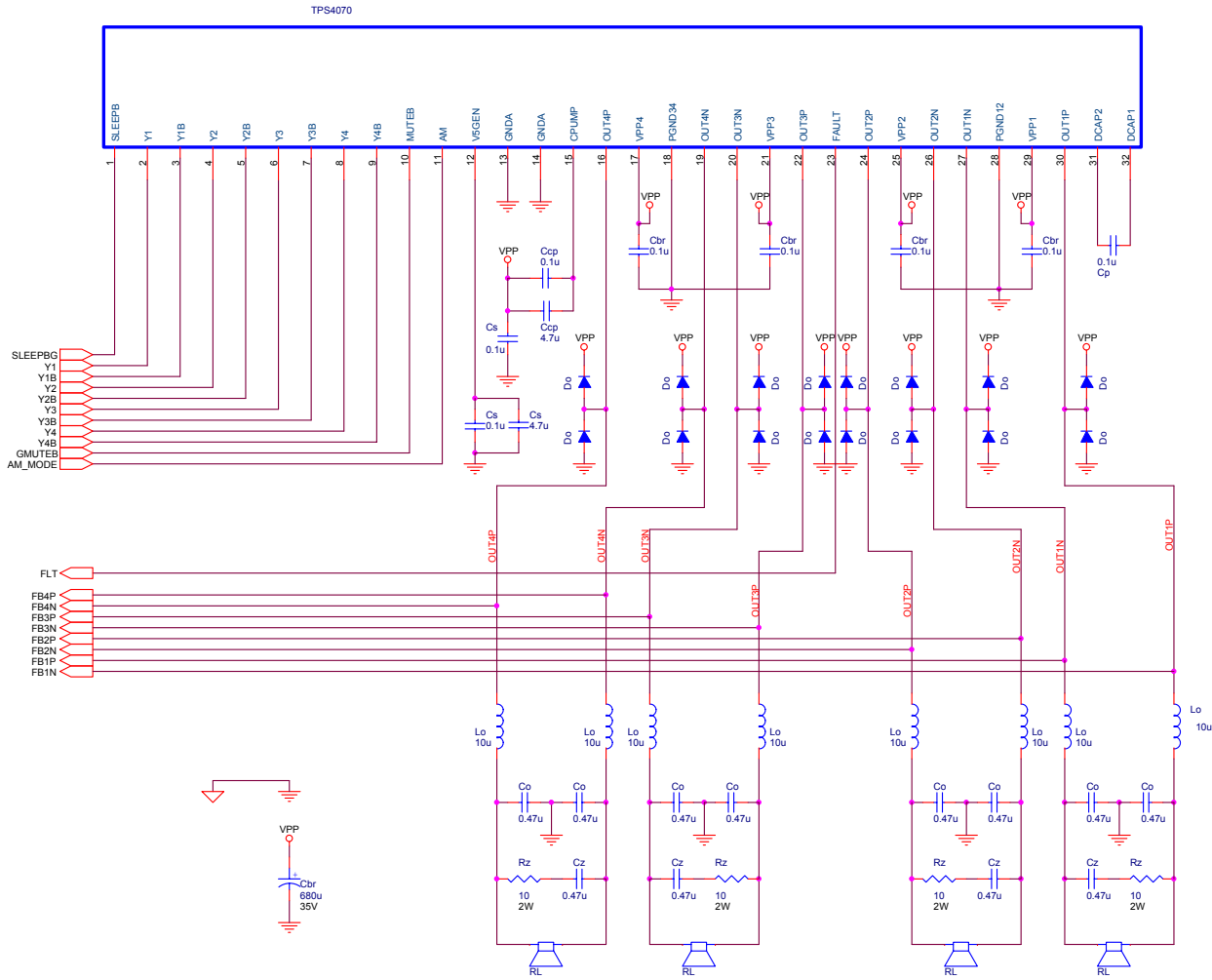
Note: The heat slug of the TPS4070 is connected to PGND.

## TPS4070 Pinout

PIN	NAME/FUNCTION	TYPE	DESCRIPTION
1	SLEEPB	INPUT (L)	Logic input, ACTIVE LOW. Setting SLEEP to low puts the TPS4070 in sleep mode. Input range is 0 to 5V with 3.3V compliant inputs.
2, 4, 6, 8	Y1, Y2, Y3, Y4	INPUT (L)	Non-inverted switching modulator inputs.
3, 5, 7, 9	Y1B, Y2B, Y3B, Y4B	INPUT (L)	Inverted switching modulator inputs.
10	MUTEB	INPUT (L)	Logic Input, ACTIVE LOW. Setting MUTE to low puts the device in mute mode. Typically driven by external power supply or microcontroller. Input range is 0 to 5V with 3.3V compliant inputs.
11	AM	INPUT (L)	Logic input, ACTIVE HIGH. Enables Analog Mode operation. Typically driven by Tripath controller. Input range is 0 to 5V with 3.3V compliant inputs.
12	5VGEN	OUTPUT	On chip 5V regulator bypass capacitor connection
12	HMUTEB	OUTPUT (L)	Logic output, ACTIVE LOW. HMUTEB low indicates TPS4070 is in mute mode
13, 14	GNDA	GROUND	Analog ground
15	CPUMP		Charge pump output capacitor
16	OUT4P	OUTPUT	Positive Output Channel 4
17	VPP4	POWER	Positive Supply Voltage Channel 4
18	PGND34	GND	Power Ground for Outputs 3 and 4
19	OUT4N	OUTPUT	Negative Output Channel 4
20	OUT3N	OUTPUT	Negative Output Channel 3
21	VPP3	POWER	Positive Supply Voltage Channel 3
22	OUT3P	OUTPUT	Positive Output Channel 3
23	FAULT	OUTPUT (L)	Open Drain Logic Output, ACTIVE HIGH. FAULT high indicates fault condition.
24	OUT2P	OUTPUT	Positive Output Channel 2
25	VPP2	POWER	Positive Supply Voltage Channel 2
26	OUT2N	OUTPUT	Negative Output Channel 2
27	OUT1N	OUTPUT	Negative Output Channel 1
28	PGND12	GND	Power Ground for Outputs 1 and 2
29	VPP1	POWER	Positive Supply Voltage Channel 1
30	OUT1P	OUTPUT	Positive Output Channel 1
31	DCAP2	OUTPUT	Charge pump switching capacitor connection
32	DCAP1	OUTPUT	Charge pump switching capacitor connection

## Application/Test Circuit





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## Contact Information

### **TRIPATH TECHNOLOGY, INC**

2560 Orchard Parkway, San Jose, CA 95131

408.750.3000 - P

408.750.3001 - F

For more Sales Information, please visit us @ [www.tripath.com/contact.htm](http://www.tripath.com/contact.htm)

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