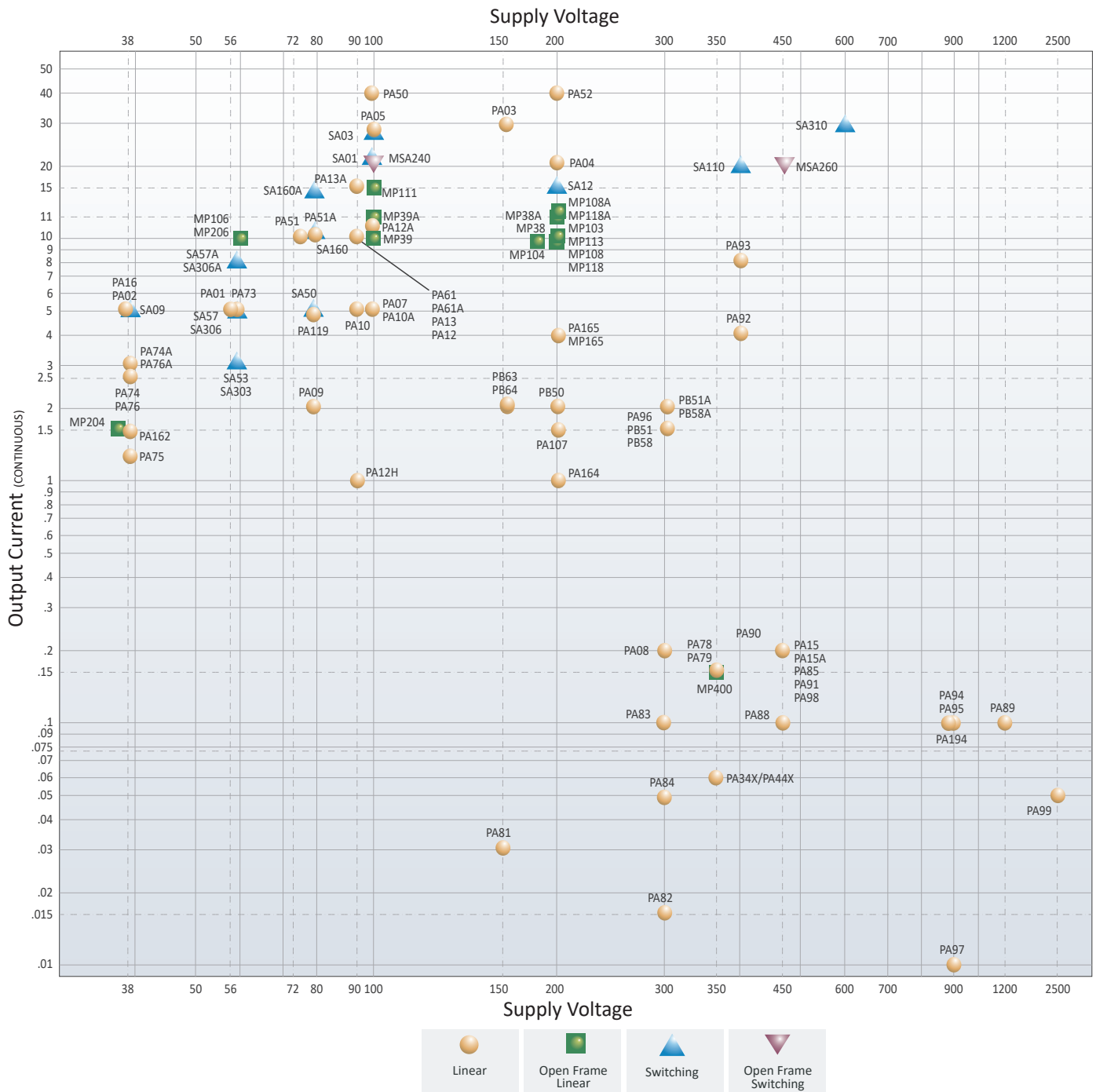


Product Selection Guide

APEX[®]
MICROTECHNOLOGY
PRECISION • POWER • ANALOG

Precision Power Analog

It's an exciting future for precision power analog! Apex Microtechnology is an industry leader for high-performance power operational amplifiers, pulse width modulation (PWM) amplifiers, and precision voltage references (VRE). Product form factors include monolithic ICs, board-level "open frame" modules, and traditional hybrid designs that can deliver up to 40 A of continuous output current and voltage supply operation ranging from 5 V to 2500 V. Target applications focus on the high power precision control of current, voltage and speed for the industrial, test and measurement, aerospace, defense, and medical markets.



Copyright © 2020 Apex Microtechnology Inc.

Apex Microtechnology is an industry leader in high power analog components, designed to meet the performance and cost design targets of our customers' precision control applications. Apex Microtechnology is headquartered in Tucson, AZ, USA. Apex Microtechnology, Apex and Precision ICs are trademarks of Apex Microtechnology, Inc. All other corporate names noted herein may be trademarks of their respective holders.

HIGH CURRENT OPERATIONAL AMPLIFIERS

Model	Output Current <i>continuous (peak) (A)</i>	Supply Voltage <i>max (V)</i>	Slew Rate <i>typical (V/μs)</i>	Quiescent Current <i>max (mA)</i>	Power Dissipation <i>max (W)</i>	Package
PA50	40 (100)	100	50	36	400	12-pin MO-127 (CR)
PA52	40 (80)	200	50	36	400	12-pin MO-127 (CR)
PA03	30	150	8	300	500	12-pin MO-127 (CU)
PA05	30	100	100	120	250	12-pin MO-127 (CR)
PA04	20	200	50	90	200	12-pin MO-127 (CR)
MP111	15 (50)	100	130	157	170	34-pin Open Frame (FD)
MP206	15 (21) (x2 channels)	60	120	36	70 per channel	30-pin Open Frame (KP)
PA13A	15	90	4	50	135	12-pin PowerSIP (DP)
MP108A	11 (12)	200	170	65	100	34-pin Open Frame (FD)
MP38A	11 (25)	200	10	26	125	30-pin Open Frame (CL)
MP39A	11 (25)	100	10	26	125	30-pin Open Frame (CL)
MP103	10 (15) (x2 channels)	200	167	26	35 per channel	42-pin Open Frame (FC)
MP104	10 (12) (x2 channels)	180	50	26	100 per channel	42-pin Open Frame (KF)
MP106	10 (30)	60	50	36	130	42-pin Open Frame (FC)
MP108	10 (12)	200	170	65	100	34-pin Open Frame (FD)
MP118	10 (12)	200	65	30	100	34-pin Open Frame (FD)
MP38	10 (25)	200	10	26	125	30-pin Open Frame (CL)
MP39	10 (25)	100	10	26	125	30-pin Open Frame (CL)
PA12 (M)	10 (15)	90	4	50	125	8-pin TO-3 (CE)
PA12A	10 (15)	100	4	50	125	8-pin TO-3 (CE)
PA13	10 (15)	90	4	50	135	12-pin PowerSIP (DP)
PA51 (M)	10	72	2.6	10	97	8-pin TO-3 (CE)
PA51A	10	80	2.6	10	97	8-pin TO-3 (CE)
PA61 (M)	10	90	2.8	10	97	8-pin TO-3 (CE)
PA93	8 (14)	400	50	14	125	12-pin PowerSIP (DP)
PA01	5	56	2.6	50	67	8-pin TO-3 (CE)
PA02 (M)	5	38	20	40	48	8-pin TO-3 (CE)
PA07 (M)	5	100	5	30	67	8-pin TO-3 (CE)
PA10 (M)	5	90	3	30	67	8-pin TO-3 (CE)
PA119	5	80	900	120	75	8-pin TO-3 (CE)
PA16	5	38	20	40	62.5	12-pin PowerSIP (DP)
PA73 (M)	5	60	2.6	5	67	8-pin TO-3 (CE)
PA09 (M)	4.5 (5)	80	220	85	78	8-pin TO-3 (CE)
MP165	4 (10)	205	31	6	32	23-pin Open Frame (KL)
PA165	4 (10)	205	36	6	32	52-pin QFP Power Quad (PQ)
PA92	4 (7)	400	50	14	80	12-pin PowerSIP (DP)
PA74A	3 (x2 channels)	40	1.4	40	36 per channel/60	8-pin TO-3 (CE)
PA76A	3 (x2 channels)	40	1.4	40	36 per channel/60	8-pin TO-3 (CE)
PA74 (M)	2.5 (x2 channels)	40	1.4	40	36 per channel/60	8-pin TO-3 (CE)
PA76	2.5 (x2 channels)	40	1.4	40	36 per channel/60	8-pin TO-3 (CE)
PB50	2	200	100	25	35	8-pin TO-3 (CE)
PB51A	2	300	100	18	83	12-pin PowerSIP (DP)
PB58A	2	300	100	18	83	8-pin TO-3 (CE)
PB63	2 (x2 channels)	150	1000	46	45 per channel	12-pin PowerSIP (DP)
PB64	2 (x2 channels)	150	800	20	45 per channel	12-pin PowerSIP (DP)
MP204	1.5 (7.5) (x4 channels)	34	15	26	20 per channel	42-pin Open Frame (KK)
PA107	1.5 (5)	200	3000	56	62.5	12-pin PowerSIP (DP)
PA96	1.5	300	250	35	70	8-pin TO-3 (CE)
PB51	1.5	300	100	18	83	12-pin PowerSIP (DP)
PB58	1.5	300	100	18	83	8-pin TO-3 (CE)

... continued on next page

(M) = Available in military grade, please refer to apexanalog.com for more information.

HIGH CURRENT OPERATIONAL AMPLIFIERS (CONT.)

Model	Output Current continuous (peak) (A)	Supply Voltage max (V)	Slew Rate typical (V/ μ s)	Quiescent Current max (mA)	Power Dissipation max (W)	Package
PA75	1.25 (1.5) (x2 channels)	40	1.4	10	19.5 per channel/28.6	7-pin TO-220 (CX) 7-pin D2PAK (CC)
PA162	1 (1.5) (x4 channels)	40	1.4	50	15 per channel/45	20-pin PSOP (DK)
PA164	1 (4)	205	36	6	28	52-pin QFP Power Quad (PQ)

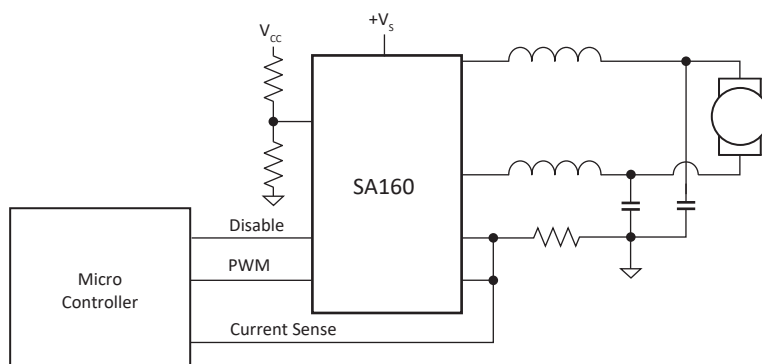
HIGH CURRENT PWM AMPLIFIERS

Model	Output Current continuous (peak) (A)	Phases / Channels	Supply Voltage max (V)	Switching Frequency max (kHz)	Power Delivery max (W)	Power Dissipation max (W)	Package
SA310 	30 (80)	3	600	400	18000	111	16-pin MO-127 (KR)
SA03	30 (40)	2	100	23	3000	300	12-pin MO-127 (CR)
SA110A 	28 (40)	1	400	400	11200	178	12-pin PowerSIP (DP)
MSA260	20 (30)	2	450	50	9000	250	58-pin Open Frame (KC)
SA110 	20 (40)	1	400	400	8000	178	12-pin PowerSIP (DP)
SA01	20 (30)	2	100	48.7	2000	185	10-pin PowerDIP (DE)
MSA240	20 (30)	2	100	50	2000	250	58-pin Open Frame (KC)
SA12	15 (20)	2	200	200	3000	250	12-pin MO-127 (CR)
SA160A	14 (20)	2	80	250	1120	156	12-pin PowerSIP (DP)
SA160	10 (15)	2	80	250	800	156	12-pin PowerSIP (DP)
SA306	8 (17)	3	60	300	480	100	44-pin HSOP (HR)
SA57	8 (17)	2	60	300	480	100	44-pin HSOP (HU)
SA50	5 (7)	2	80	50	400	72	8-pin TO-3 (CE)
SA09	5 (7.5)	2	40	500	200	80	18-pin DIP (EL)
SA303	3 (10)	3	60	300	180	100	44-pin HSOP (HU)
SA53	3 (10)	2	60	300	180	100	44-pin HSOP (HU)

Brushed DC Motor Driver

SA160

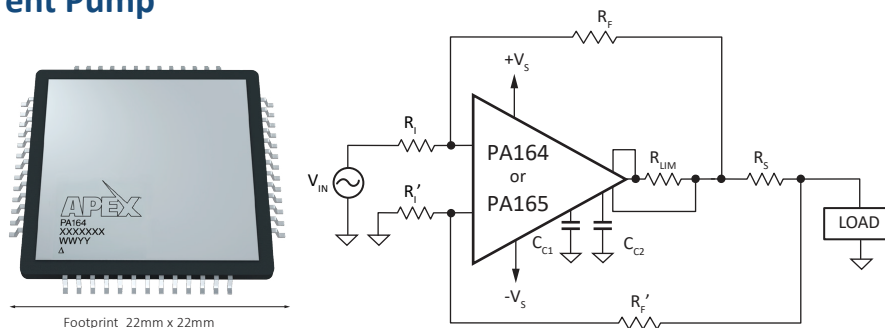
PWM Amplifier
15 A Peak, 80 V
12-pin PowerSIP Package



Compact Howland Current Pump for Grounded Loads

PA164/PA165

Power Amplifier
200 V, 1 A or 4 A continuous
52-pin QFP style package



HIGH SPEED OPERATIONAL AMPLIFIERS

Model	Slew Rate typical (V/μs)	Supply Voltage max (V)	Output Current continuous (peak) (A)	Quiescent Current max (mA)	Power Dissipation max (W)	Package
PA107	3000	200	1.5 (5)	56	62.5	12-pin PowerSIP (DP)
PA194	2100	900	0.1 (0.2)	4	30	8-pin PowerSIP (GN)
PB63	1000	150	2 (x2 channels)	46	45 per channel	12-pin PowerSIP (DP)
PA85 (M)	1000	450	0.2	25	30	8-pin TO-3 (CE)
PA98	1000	450	0.2	25	30	12-pin PowerSIP (DP)
PA119	900	80	5	120	75	8-pin TO-3 (CE)
PB64	800	150	2 (x2 channels)	20	45 per channel	12-pin PowerSIP (DP)
PA94	700	900	0.1 (0.2)	24	30	8-pin PowerSIP (DQ)
MP400	350	350	0.15 (0.2)	2.5	14.2	42-pin Open Frame (FC)
PA78	350	350	0.15 (0.2)	2.5	14	20-pin PSOP (DK)
PA79	350	350	0.15 (0.2) (x2 channels)	2.5	14 per channel/26	20-pin PSOP (DK)
PA90	300	400	0.2 (0.35)	14	30	12-pin PowerSIP (DP)
PA91	300	450	0.2 (0.35)	14	30	12-pin PowerSIP (DP)
PA96	250	300	1.5	35	70	8-pin TO-3 (CE)
PA09 (M)	220	80	4.5 (5)	85	78	8-pin TO-3 (CE)
PA84 (M)	200	300	0.04 (0.05)	7.5	17.5	8-pin TO-3 (CE)
MP108A	170	200	11 (12)	65	100	34-pin Open Frame (FD)
MP108	170	200	10 (12)	65	100	34-pin Open Frame (FD)
MP103	167	200	10 (15) (x2 channels)	26	35 per channel	42-pin Open Frame (FC)
MP111	130	100	15 (50)	157	170	34-pin Open Frame (FD)
MP206	120	60	15 (21) (x2 channels)	36	70 per channel	30-pin Open Frame (KP)

HIGH VOLTAGE OPERATIONAL AMPLIFIERS

Model	Supply Voltage max (V)	Output Current continuous (peak) (A)	Slew Rate typical (V/μs)	Quiescent Current max (mA)	Power Dissipation max (W)	Package
PA99	2500	0.05 (0.07)	30	4	37	12-pin PowerDIP (CW)
PA89	1200	0.075 (0.1)	16	6	40	12-pin MO-127 (DC)
PA194	900	0.1 (0.2)	2100	4	30	8-pin PowerSIP (GN)
PA94	900	0.1 (0.2)	700	24	30	8-pin PowerSIP (DQ)
PA95	900	0.1 (0.2)	30	2.2	30	8-pin PowerSIP (DQ)
PA97	900	0.01 (0.015)	8	1	5	7-pin SIP (DR)
PA15 (PA15A)	450	0.2	20 (30)	3	30	10-pin PowerSIP (FL/FU)
PA85 (M)	450	0.2	1000	25	30	8-pin TO-3 (CE)
PA98	450	0.2	1000	25	30	12-pin PowerSIP (DP)
PA91	450	0.2 (0.35)	300	14	30	12-pin PowerSIP (DP)
PA88	450	0.1	30	2	15	8-pin TO-3 (CE)
PA90	400	0.2 (0.35)	300	14	30	12-pin PowerSIP (DP)
PA93	400	8 (14)	50	14	125	12-pin PowerSIP (DP)
PA92	400	4 (7)	50	14	80	12-pin PowerSIP (DP)
MP400	350	0.15 (0.2)	350	2.5	14.2	42-pin Open Frame (FC)
PA78	350	0.15 (0.2)	350	2.5	14	20-pin PSOP (DK)
PA79	350	0.15 (0.2) (x2 channels)	350	2.5	14 per channel/26	20-pin PSOP (DK)
PA340 CC-style	350	0.06 (0.12)	32	2.5	14	7-pin D2PAK (CC)
PA341 CE-style	350	0.06 (0.12)	32	2.5	12	8-pin TO-3 (CE)
PA441/PA341 DF-style	350	0.06 (0.12)	32	2.5	12	24-pin PSOP (DF)
PA441/PA341 DW-style	350	0.06 (0.12)	32	2.5	9	10-pin PowerSIP (DW)
PA443/PA343 DF-style	350	0.06 (0.12) (x2 channels)	32	2.5	12 per channel/24	24-pin PSOP (DF)
PA96	300	1.5	250	35	70	8-pin TO-3 (CE)
PA84 (M)	300	0.04 (0.05)	200	7.5	17.5	8-pin TO-3 (CE)

... continued on next page

(M) = Available in military grade, please refer to apexanalog.com for more information.

HIGH VOLTAGE OPERATIONAL AMPLIFIER (CONT.)

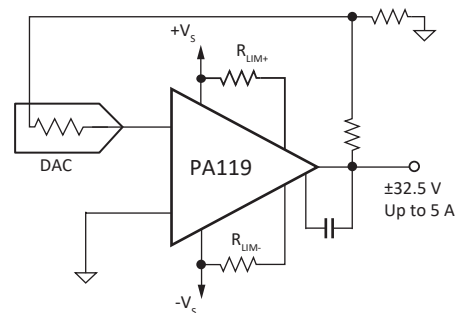
Model	Supply Voltage max (V)	Output Current continuous (peak) (A)	Slew Rate typical (V/ μ s)	Quiescent Current max (mA)	Power Dissipation max (W)	Package
PB51A	300	2	100	18	83	12-pin PowerSIP (DP)
PB58A	300	2	100	18	83	8-pin TO-3 (CE)
PB51	300	1.5	100	18	83	12-pin PowerSIP (DP)
PB58	300	1.5	100	18	83	8-pin TO-3 (CE)
PA08 (M)	300	0.15 (0.2)	30	8.5	17.5	8-pin TO-3 (CE)
PA83 (M)	300	0.075 (0.1)	30	8.5	17.5	8-pin TO-3 (CE)
PA82	300	0.015 (0.025)	20	8.5	11.5	8-pin TO-3 (CE)
PA165	205	4 (10)	36	6	32	52-pin QFP Power Quad (PQ)
PA164	205	1 (4)	36	6	28	52-pin QFP Power Quad (PQ)
MP165	205	4 (10)	31	6	32	23-pin Open Frame (KL)
PA107	200	1.5 (5)	3000	56	62.5	12-pin PowerSIP (DP)
MP108A	200	11 (12)	170	65	100	34-pin Open Frame (FD)
MP108	200	10 (12)	170	65	100	34-pin Open Frame (FD)
MP103	200	10 (15) (x2 channels)	167	26	35 per channel	42-pin Open Frame (FC)
PB50	200	2	100	25	35	8-pin TO-3 (CE)
MP118	200	10 (12)	65	30	100	34-pin Open Frame (FD)
PA52	200	40 (80)	50	36	400	12-pin MO-127 (CR)
PA04	200	20	50	90	200	12-pin MO-127 (CR)
MP38A	200	11 (25)	10	26	125	30-pin Open Frame (CL)
MP38	200	10 (25)	10	26	125	30-pin Open Frame (CL)
MP104	180	10 (12) (x2 channels)	50	26	100 per channel	42-pin Open Frame (KF)
PB63	150	2 (x2 channels)	1000	46	45 per channel	12-pin PowerSIP (DP)
PB64	150	2 (x2 channels)	800	20	45 per channel	12-pin PowerSIP (DP)
PA81	150	0.03 (0.5)	20	8.5	11.5	8-pin TO-3 (CE)
PA03	150	30	8	300	500	12-pin MO-127 (CU)

(M) = Available in military grade, please refer to apexanalog.com for more information.

Fast Power Driver with Current Output DAC

PA119

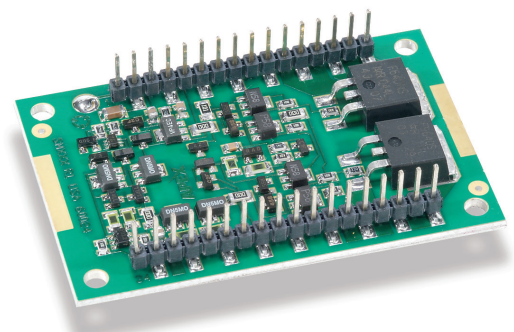
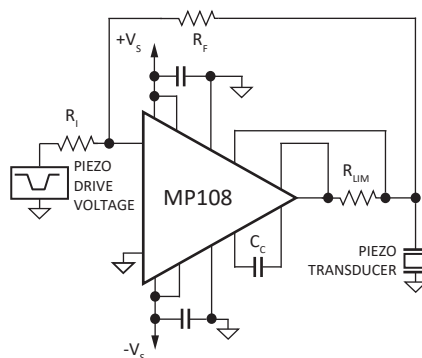
Power Amplifier
80 V, 900 V/ μ s
8-Pin TO-3 Package



Piezo Transducer Drive

MP108

Power Amplifier
200 V, 170 V/ μ s
Open Frame Package



HIGH VOLTAGE PWM AMPLIFIERS

Model	Supply Voltage max (V)	Phases / Channels	Output Current continuous (peak) (A)	Switching Frequency max (kHz)	Power Delivery max (W)	Power Dissipation max (W)	Package
SA310 	600	3	30 (80)	400	18000	111	16-pin MO-127 (KR)
MSA260	450	2	20 (30)	50	9000	250	58-pin Open Frame (KC)
SA110A 	400	1	28 (40)	400	11200	178	12-pin PowerSIP (DP)
SA110 	400	1	20 (40)	400	8000	178	12-pin PowerSIP (DP)
SA12	200	2	15 (20)	200	3000	250	12-pin MO-127 (CR)
SA03	100	2	30 (40)	23	3000	300	12-pin MO-127 (CR)
SA01	100	2	20 (30)	48.7	2000	185	10-pin PowerDIP (DE)
MSA240	100	2	20 (30)	50	2000	250	58-pin Open Frame (KC)
SA160A	80	2	14 (20)	250	1120	156	12-pin PowerSIP (DP)
SA160	80	2	10 (15)	250	800	156	12-pin PowerSIP (DP)
SA50	80	2	5 (7)	50	400	72	8-pin TO-3 (CE)

PRECISION VOLTAGE REFERENCES

Model	Output (V)	Initial Error ($\pm$ mV)	TempCo (ppm/ $^{\circ}$ C)	Noise (μ Vp-p)	Package	Feature
VRE102	$\pm$ 10	1.0	1.09	6	DIP14 (HC)	Dual, High Temp Range
VRE104	4.5	0.8	1.48	3	DIP14 (HC)	Dual, High Temp Range
VRE107M	$\pm$ 5	0.9	1.33	3	DIP14 (HC)	High Rel Military, Dual, High Temp Range
VRE204M	4.5	0.8	1.48	3	LCC20 (HD)	Small Pkg, High Rel Military
VRE205	5	0.8	1.33	3	LCC20 (HD)	Small Pkg, High Rel Military
VRE210	10	0.5	1.11	6	LCC20 (HD)	Small Pkg, High Temp Range
VRE302	2.5	0.4	1.0	1.5	DIP8 (KD), SMT8 (GD)	Low Cost
VRE304	4.5	0.9	2.0	3	SMT8 (GD)	Low Cost
VRE305	5	0.5	0.6	3	DIP8 (KD), SMT8 (GD)	Low Cost
VRE306	6	0.6	0.6	4	SMT8 (GD)	Low Cost
VRE310	10	1.0	0.6	6	DIP8 (KD), SMT8 (GD)	Low Cost
VRE410	$\pm$ 10	1.6	1.0	6	SMT14 (GE)	Dual, Low Cost
VRE3025	2.5	0.25	0.6	1.5	DIP8 (KD), SMT8 (GF)	+10V Supply
VRE3050	5	0.5	0.6	3	SMT8 (GF)	+10V Supply

SINE WAVE REFERENCES

Model	Sine Wave Output (Vrms)	Initial Error ($\pm$ mV)	Temperature Coefficient (ppm/ $^{\circ}$ C)	Distortion (%THD)	Package
SWR200	7.071	0.5	20	0.1	DIP14 (HC)

POWER DESIGN SOFTWARE TOOL

Need help with selecting the best product that suits your application needs or with resolving key design challenges and calculations associated with your power analog circuit?

Apex's Power Design software tool helps automate many of the calculations required when working with high power linear and PWM amplifiers. It has multiple modules that provide the ability to plot load-lines and current limits directly onto the Safe Operating Area to ensure circuit stability; calculate internal power dissipation and heatsink requirements; dynamically select a part and assist with other key tasks involved with designing high power analog circuits.

https://www.apexanalog.com/support/power_design_tool.html

POWER DESIGN 

APEX[®]
MICROTECHNOLOGY
PRECISION • POWER • ANALOG

5980 N Shannon Road
Tucson, AZ 85741 USA
Phone: +1 (520) 690-8600
Fax: +1 (520) 888-3329

For Technical Support:

Call Toll Free +1 (800) 546-2739
in the U.S. and Canada
Fax: +1 (520) 888-7003
email: apex.support@apexanalog.com

For Customer Service:

Call Toll Free +1 (800) 862-1032
in the U.S. and Canada
Fax: +1 (520) 888-3329
email: custserv@apexanalog.com

Please visit www.apexanalog.com for a current listing of authorized distributors and sales representatives.

apexanalog.com

MARCH 2020