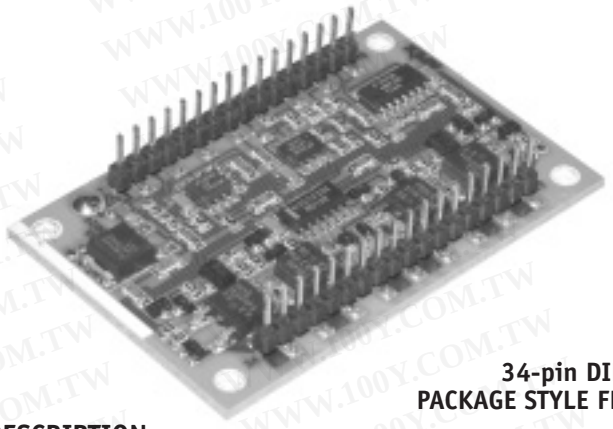
MSA66

FEATURES

- 10.8V to 80V Supply Voltage (7.5-16V VCC)
- 5A continuous output current
- 4-quadrant PWM
- Anti Shoot-Through Design
- 100% Duty Cycle from All Startup Conditions
- User Selectable PWM Frequency Up to 30 kHz Nominal
- Internal or External PWM Oscillator Operation
- Operation with single supply to 16V, Input Dynamic Range to -10V
- True Differential Analog Input
- User Available +5V regulator
- Logic Shut Down Mode Turns Off Power FETs
- Economical "Open Frame" Package

APPLICATIONS

- DC Brush Motor Control
- Reactive Loads
- Sub-woofer Driver



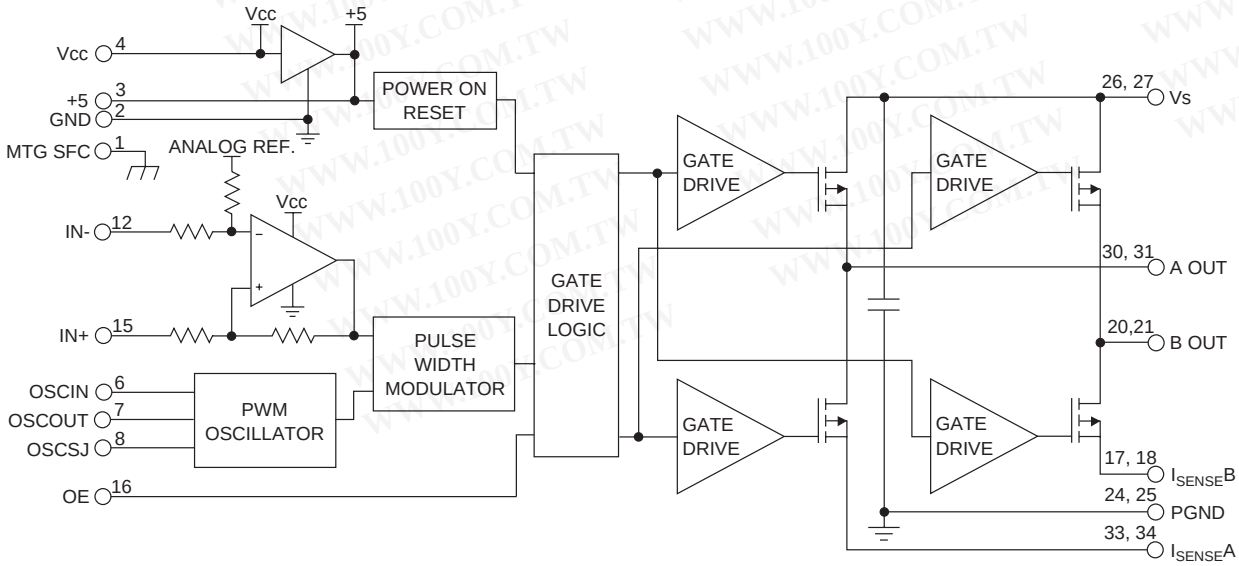
34-pin DIP
PACKAGE STYLE FD

DESCRIPTION

The MSA66 amplifier is a pulse width modulated amplifier that can deliver 400W continuously to a load. The full bridge output amplifier can be operated from a single power supply over a wide range of voltages, and if the voltage of the motor supply is within the V_{CC} rating, a common supply can be used for both motor supply and V_{CC}. The use of 4-quadrant PWM allows the amplifier to transition smoothly through 0 volts as is required for deceleration control and position control applications. The input amplifier is a true differential amplifier which allows operation with ground referenced inputs swinging from -10V to 10V, matching the output characteristics of many motor control chip-sets. Since the input is true differential, the MSA66 can be interfaced to single polarity input signals as well. Power FET source terminals are brought out for current sensing. One MSA66 can serve as the PWM oscillator for several others for synchronized PWM. See the section PWM Oscillator for details.

The FD package, a modular 34-pin DIP, is constructed of surface mount components on a dielectrically isolated aluminum substrate. See the FD package outline for details.

EQUIVALENT SCHEMATIC

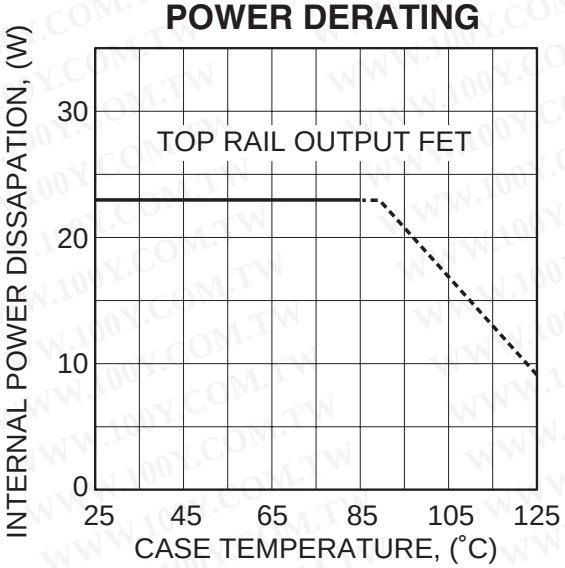


ABSOLUTE MAXIMUM RATINGS		
	SUPPLY VOLTAGE, V_S	80V
	SIGNAL SUPPLY, V_{CC}	16V
	OUTPUT CURRENT, continuous	5A
	INPUT VOLTAGE	-10V to V_{CC} + 10V
	TEMPERATURE, pin solder, 10s	300˚C.
	TEMPERATURE, junction1	150˚C
	TEMPERATURE RANGE, storage	-40 to 105˚C
	OPERATING TEMPERATURE, mounting surface	-40 to 85˚C

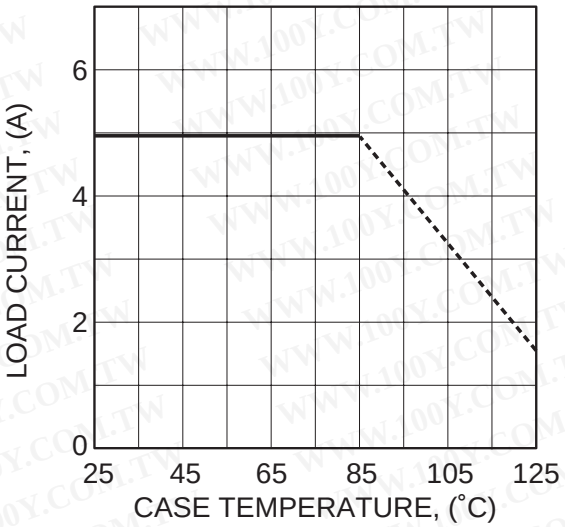
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
GENERAL	25˚C mounting surface temperature				
OVERALL GAIN	Set by internal resistors		0.095V_S		V/V
SWITCHING FREQENCY	No external capacitor	25	30	35	kHz
EFFICIENCY[2]	80V, 5A, 35 kHz, 1 mHy load inductance, 15V V_{CC},	90			%
THERMAL RESISTANCE JUNCTION TO CASE	Full temperature range, each FET		2.65		˚C/W
INPUT					
DIFFERENTIAL INPUT RESISTANCE	Set by internal resistors		150		KΩ
COMMON MODE INPUT RESISTANCE	Set by internal resistors		45		KΩ
INPUT COMMON MODE VOLTAGE RANGE		-10		V_{CC} +10	V
COMMON MODE REJECTION RATIO			36		db
DIFFERENTIAL OFFSET			25	400	mV
LOGIC					
VI_L				0.8	V
VI_H		2.0			V
R_{IN} to Ground			51		KΩ
OUTPUT					
TOP RAIL R_{ON}[3]			0.2	0.38[3]	Ω
BOTTOM RAIL R_{ON}[3]			0.1	0.29[3]	Ω
TOTAL R_{ON}[3]			0.3	0.67[3]	Ω
CONTINUOUS LOAD CURRENT				5	A
PEAK LOAD CURRENT				10	A
DISSIPATION[2]	V_S = 80V, V_{CC} = 15V, L = 1mHy, pwm f = 35 kHz, I(+5) = 400mA				
Single FET				23	W
MSA66	Includes 400mA user current from +5			55.4	W
POWER SUPPLY					
V_S		10.8		80	V
V_{CC}		7.5		16	V
+5 Output to user		4.75	5.0	5.25	V
V_S Current	Continuous current			5	A
V_{CC} Current[4]			100	500	mA
+5 Current	Available to user	400			mA

NOTES:
1. Long term operation at the maximum junction temperature will result in reduced product life. Derate internal power dissipation to achieve high MTTF.
2. Power dissipation caused by 400 mA from +5 is included; use this power for sizing heat sink.
3. This rating at 150°C junction temperature.
4. Maximum value includes 400mA supplied to external loads by +5V regulator.

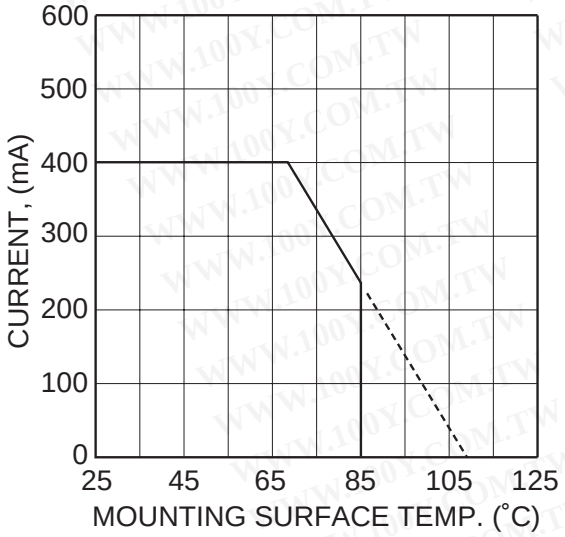
POWER DERATING



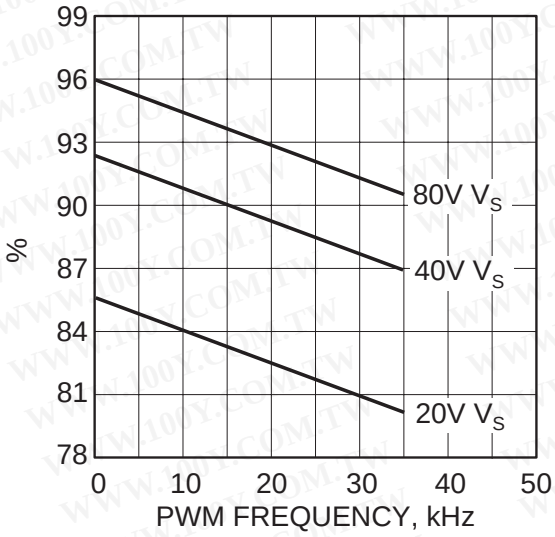
CONTINUOUS LOAD CURRENT



+5 OUTPUT CURRENT



EFFICIENCY @ 5A OUTPUT



I/O	Signal	Description	Pin Numbers
I	V_S	Unregulated high current motor supply voltage	26, 27
I	Pgnd	Return line for the high motor current supply voltage	24, 25
I	V_{CC}	Control circuit power	4
I	Ground	Signal/logic ground	2
O	+5	Regulated Logic Supply	3
O	Mtg Sfc	Connects mounting surface to a pin	1
O	A Out	Half bridge output for driving motor coil	30, 31
O	B Out	Half bridge output for driving motor coil	20, 21
I/O	$I_{SENSE}A$	Source of the N-rail FET in half bridge A	33, 34
I/O	$I_{SENSE}B$	Source of the N-rail FET in half bridge B	17, 18
I	OE	Logic input, a 1 enables the MSA66 which is otherwise tri-state.	16
I	OSC IN	Input to PWM comparators	8
O	OSC OUT	Output of PWM integrating amplifier, this output must be connected to OSC IN to form the PWM oscillator.	9
I/O	OSC SJ	Summing junction of PWM integrating amplifier. A capacitor may be placed between OSC OUT and OSC SJ to lower the PWM frequency.	10
I	IN-	Input to differential amplifier	14
I	IN+	Input to differential amplifier	15

GENERAL

Please read Application Note 1, “General Operating Considerations” and Application Note 30, “PWM Basics” for helpful information on power supplies, heat-sinking, bypassing, grounding and mounting. Visit www.apexmicrotech.com for design tools that help automate pwm filter design and heat-sink selection. The Application Notes and Technical Seminar sections contain a wealth of information on specific types of applications. Information on package outlines, heat-sinks, mounting hardware and other accessories are located in the Packages and Accessories section. Evaluation kits are available for most Apex product models; consult the Evaluation Kit section for details.

GROUNDING

Switching amplifiers are notorious for noise problems caused by improper grounding and power supply filtering. In the MSA66 Apex has taken design steps to minimize these problems; however thought and care should be used in power supply and ground wiring and filtering. Refer to Application Note1 "General Operating Considerations" and Application Note 30 "PWM Basics" for helpful information regarding power supplies, heat sinking, and grounding.

The high power ground for the amplifier is not electrically connected to the signal ground; this allows a tree grounding system to be used. Signal and power must be kept within 0.5V of each other to insure adequate gate drive to the output FETS. Using a tree grounding system to avoid low frequency ground loops, or tying signal ground to power ground at the MSA66 both work as far as the MSA66 is concerned; system considerations will determine which system is best. Doing both at the same time often creates ground loop noise problems.

The mounting surface is dc connected to pin 1, and is connected to pin 2 through a 1uF ceramic capacitor. MSA66's have operated satisfactorily with pin 1 and the heatsink floating; with the heatsink grounded through wiring, and with the heatsink dc connected by a short jumper from pin 1 to pin 2. System considerations will determine the approach.

BYPASSING

All power supply terminals are bypassed internally with a 0.1µf capacitor. An additional switching regulator grade electrolytic capacitor should be installed between V_S and P_{GND}. In order to keep EMI to a minimum a 50µf or greater capacitor is recommended, and it should be mounted as close to the MSA66 terminals as possible.

PWM OSCILLATOR

The internal PWM oscillator may be used in generating PWM in the MSA66. This oscillator is a hysteresis oscillator formed from an active integrator and a comparator. To complete the oscillator circuit the feedback path for this oscillator must be closed by connecting OSC OUT, pin 9, to OSC IN, pin 8.

This oscillator has a nominal frequency of 30kHz with a tolerance of ±5 kHz. The frequency can be lowered by adding a capacitor, $C_{EXTERNAL}$ from OSC OUT, pin 9, to OSC SJ, pin 10. The nominal frequency can be determined by using the following formula:

$$F=30kHz\ (1000pf/(1000pf+C_{EXTERNAL})) \pm 17\%$$

EXTERNAL PWM

Alternatively a triangle wave from an external source may be used in generating PWM. In this case pins 8 and 9 are not connected; the external triangle wave must have a negative level of 0.5V, a positive level of 4.5V, and a frequency of 35 kHz or less.

The oscillator of one MSA66 may serve as the “external source” for up to 10 others. This operation requires that the OSC OUT, pin 9, of one MSA66 be connected to OSC IN, pin 8, of itself and to OSC IN, pin 8, of all of the MSA66s being clocked.

OUTPUT ENABLE

The MSA66 must be enabled by putting OE to 1. Otherwise all power FETs are turned off. Only gate drive is affected, the Pulse Width Modulator continues to operate when OE is at 0.

AMPLIFIER OPERATION

The MSA66 generates a differential output voltage of $2(V_S - V_{DS\ ON})$ for a 20V input swing. Thus the differential gain is:

$$A = (V_S - V_{DS\ ON}) /10$$

For example, at 5A with V_S = 80V the gain is calculated as:

$$A= (80V - (5A*(0.205\Omega + 0.105\Omega)))/10$$

The input amplifier is designed to operate with either IN1 or IN2 10V below ground or above V_{CC}. At the sacrifice of gain and equivalent offset this can extended to greater voltage by adding a resistor to each input. A 75k 1% resistor will halve the gain and double the offset, but allow operation to 20V below ground or above V_{CC}.

The differential structure of the MSA66 allows operation single ended input referenced to any voltage within the dynamic range. Either input can serve as the reference input.

CURRENT SENSE

There are no current limit or current sensing circuits in the MSA66. However, the source terminals of the N-rail power FETs are brought out separate from power ground, which allows inserting resistors for current sensing by external circuits.

CURRENT SENSE OPTIONS

If a voltage proportional to the coil current, including polarity, is required; then a separate sense resistor should be used to sense the current from each half bridge. These resistors should then be connected to a true differential amplifier to produce this voltage. This technique is suitable for transconductance drive to a motor.

A magnitude of current signal may be obtained by tying the sources together and using a common sense resistor. The voltage at this resistor, with suitable scaling, may be fed to a comparator which can disable the output by setting OE to 0. Setting OE to 0 immediately turns off all power FETs, which are not turned on until the first rising edge of the PWM clock after OE has returned to 1. This implements a current limit circuit.

The same sense circuit can be used to implement an electronic circuit breaker latching the OE input to 0 with an external latch. Normal operation will not resume until this latch is reset.

When two sense resistors are used both transconductance operation and current limit may be obtained by using a differential amplifier for analog current feedback and a summing amplifier to drive the comparator. Alternatively the differential amplifier output may be full wave rectified to obtain the magnitude of current signal.

STARTUP CONDITIONS

No special startup conditions are required. The MSA66 can transition from shutdown to 100% duty cycle under all conditions.

There is approximately a 100µs delay after +5V has stabilized until operation starts.

+5V SUPPLY

An internal regulator provides +5V±5%. This +5V regulator supplies about 100mA to internal circuits: 400 mA is available for external use.

Some internal precision circuits as well as logic use this 5V supply; therefore the user must take reasonable precaution to avoid corrupting the supply.