

## B60A SERIES BRUSHLESS SERVO AMPLIFIERS

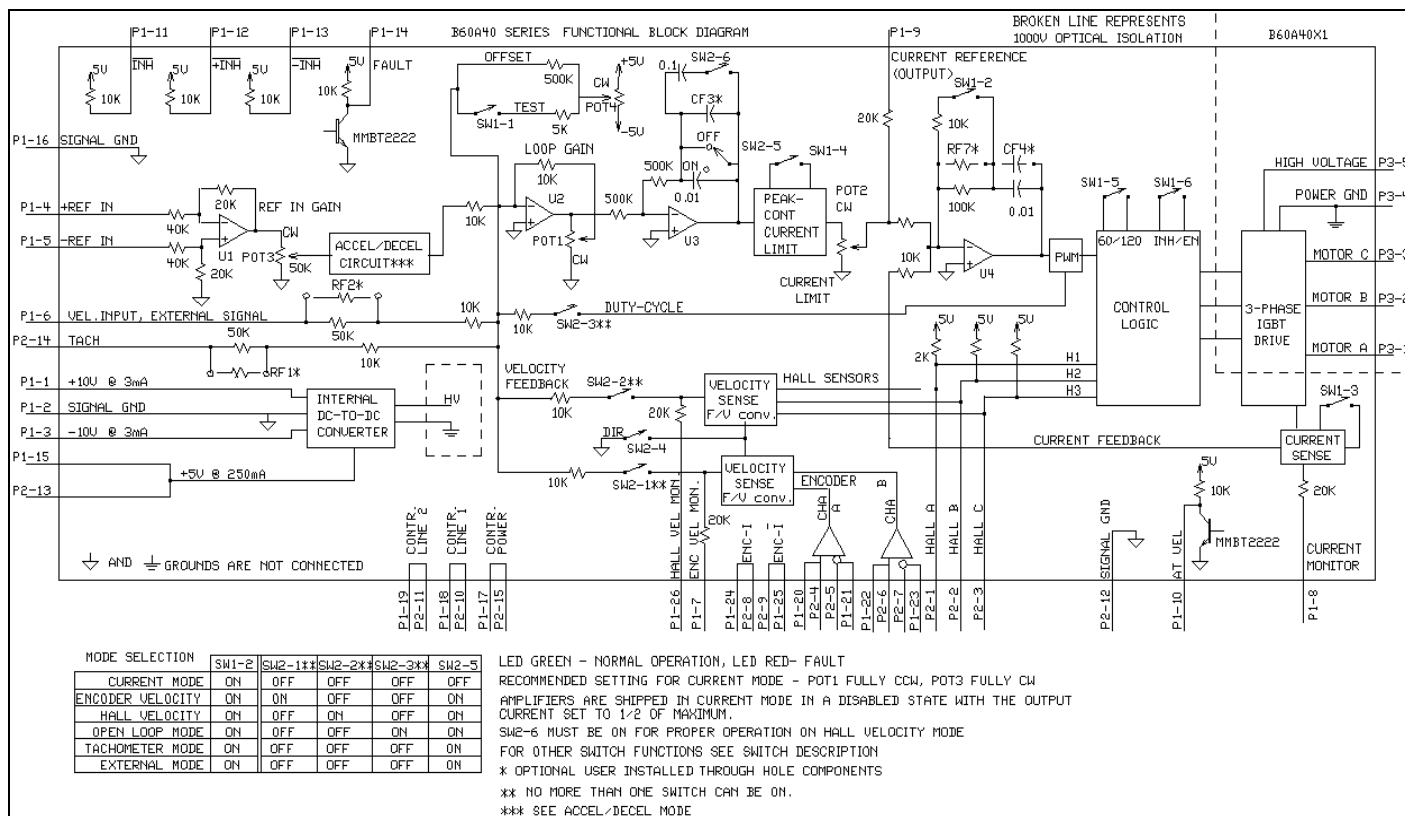
### Model: B60A40

**FEATURES:**

- Surface-mount technology
- Small size, low cost, ease of use
- Optical isolation, see block diagram
- Hall sensor commutation
- DIP switch selectable modes:  
current, open loop, tachometer, external velocity, Hall velocity and encoder velocity
- Encoder and Hall velocity monitors
- Four quadrant regenerative operation
- Agency Approvals:



**BLOCK DIAGRAM:**



**ADVANCED MOTION CONTROLS**  
 3805 Calle Tecate, Camarillo, CA 93012 Tel: (805) 389-1935, Fax: (805) 389-1165

**DESCRIPTION:** The B60A Series PWM servo amplifiers are designed to drive brushless DC motors at a high switching frequency. They are fully protected against over-voltage, under-voltage, over-current, over-heating and short-circuits. All models interface with digital controllers or can be used as stand-alone drives. They require only a single unregulated DC power supply. A single red/green LED indicates operating status. Loop gain, current limit, input gain and offset can be adjusted using 14-turn potentiometers. The offset adjusting potentiometer can also be used as an on-board input signal for testing purposes when SW1-1 (DIP-switch) is ON.

**SPECIFICATIONS:**

	<b>MODEL</b>
<b>POWER STAGE SPECIFICATIONS</b>	<b>B60A40</b>
DC SUPPLY VOLTAGE	60 - 400 VDC
PEAK CURRENT (2 sec. max., internally limited)	± 60 A
MAXIMUM CONTINUOUS CURRENT (internally limited)	± 30 A
MINIMUM LOAD INDUCTANCE*	600 µH
SWITCHING FREQUENCY	15 kHz +/-15 %
HEATSINK (BASE) TEMPERATURE RANGE	0° to +65° C, disables if > 65° C
POWER DISSIPATION AT CONT. CURRENT	600 W
OVER-VOLTAGE SHUT-DOWN (self reset)	425 V nominal
BANDWIDTH (load dependent)	2.5 kHz

<b>MECHANICAL SPECIFICATIONS</b>	
POWER CONNECTOR: P3	Screw terminals
SIGNAL CONNECTORS: P1, P2 AMP 748390-6, AMP 748481-6	P1 is a 26 pin high density female D-sub connector and P2 is a 15 pin high density female D-sub connector.
SIZE	9.24 x 6.31 x 3.50 inches 234.7 x 160.2 x 88.9 mm
WEIGHT	5.64 lbs. 2.56 kg.

\* Low inductance motors require external inductors.

## PIN FUNCTIONS:

CONNECTOR	PIN	NAME	DESCRIPTION / NOTES	I/O
P1	1	+10V @ 3 mA	For customer use	O
	2	SIGNAL GND	Reference ground	SGND
	3	-10V @ 3 mA	For customer use	O
	4	+REF	Differential reference input, maximum $\pm 15V$ , 40K input resistance	I
	5	-REF		
	6	Velocity Input	Single ended reference input, external velocity signal, maximum $\pm 10V$ , 60K input resistance	I
	7	Encoder Velocity Monitor	1 V = 25 kHz Encoder Frequency	O
	8	Current Monitor	This output represents the actual motor current. Scaling: SW1-3 = OFF, 1 V = 4.5 A motor current SW1-3 = ON, 1 V = 9 A motor current	O
	9	Current Reference	This is the command signal to the internal current-loop. The maximum peak current rating of the amplifier always equals 7.25 V at this pin. SW1-3=ON, 7.25V = 60A; SW1-3=OFF, 7.25V = 30 A.	O
	10	AT VEL	Open Collector output. Internally pulled up to 5V thru 10K. This output is low, when the speed is within 10% of the commanded speed. See JF6 and JF7 information below.	O
	11	Inhibit/Enable	This TTL level input signal turns off all power devices of the "H" bridge when pulled to ground with SW1-6=ON. If SW1-6 = OFF pulling this pin to ground will enable the amplifier. This inhibit will cause a fault condition and a red LED.	I
	12	+Inhibit/Enable	If SW1-6=ON, pull P1-12 to ground to inhibit (+) amplifier output and P1-13 to inhibit (-) amplifier output. If SW1-6=OFF, pull P1-12 to ground to enable (+) amplifier output and P1-13 to enable (-) amplifier output. These inputs will NOT cause a fault condition or a red LED.	I
	13	-Inhibit/Enable		
	14	Fault (LED red)	This output activates during short circuit, over-voltage, under voltage, inhibit, over-temperature and power-on reset. A red LED also indicates a fault condition.	O
	15	+5V @ 250mA	For customer use. Note: the total current on P1-15 and P2-13 combined should not exceed 250 mA.	O
	16	SIGNAL GND	Reference ground	SGND
	17	Controller Power*	Connected to P2-15. For customer use	I
	18	Controller Line 1*	Connected to P2-10. For customer use	I
	19	Controller Line 2*	Connected to P2-11. For customer use	I
	20	Encoder Channel A+	Differential Encoder Output from P2-4	O
	21	Encoder Channel A-	Differential Encoder Output from P2-5	
	22	Encoder Channel B+	Differential Encoder Output from P2-6	O
	23	Encoder Channel B-	Differential Encoder Output from P2-7	
	24	Encoder Channel I+	Differential Encoder Output from P2-8	O
	25	Encoder Channel I-	Differential Encoder Output from P2-9	
	26	Hall Velocity Monitor	1V = 100 Hz Hall Sensor Frequency	O

NOTE: All circuits on connectors P1 and P2 are optically isolated form all circuits on connector P3.

\* No connection internal to the amplifier. See block diagram.

**PIN FUNCTIONS:**

CONNECTOR	PIN	NAME	DESCRIPTION / NOTES	I/O
P2	1	HALL 1	Hall sensor inputs, internal 2K pull-up, logic levels: maximum low level input is 1.5 VDC, minimum high level input is 3.5 VDC	I
	2	HALL 2		
	3	HALL 3		
	4	Encoder Channel A+	Differential Encoder Input, channel A	I
	5	Encoder Channel A-		
	6	Encoder Channel B+	Differential Encoder Input, channel B	I
	7	Encoder Channel B-		
	8	Encoder Channel I+	Differential Encoder Input, index mark (Not Required)	I
	9	Encoder Channel I-		
	10	Controller Line 1*	Connected to P1-18. For customer use.	O
	11	Controller Line 2*	Connected to P1-19. For customer use.	O
	12	Signal GND	Reference ground	SGND
	13	+5V @ 250 mA	For customer use. Note: the total current on P1-15 and P2-13 combined should not exceed 250 mA.	O
	14	TACH	Tachometer Input, 60 K $\Omega$ input resistance, $\pm$ 60 V max.	I
	15	Controller power*	Connected to P1-17. For customer use.	O
P3	1	MOTOR A	Motor phase A connection	O
	2	MOTOR B	Motor phase B connection	O
	3	MOTOR C	Motor phase C connection	O
	4	POWER GND	Power ground	PGND
	5	HIGH VOLTAGE	DC power input	I

NOTE: All circuits on connectors P1 and P2 are optically isolated form all circuits on connector P3.

\* No connection internal to the amplifier. See block diagram.

**SWITCH FUNCTIONS:****BANK 1**

SWITCH	FUNCTION DESCRIPTION	SETTING	
		ON	OFF
1-1	Test / Offset controls the sensitivity of the "offset" pot. This is used as an on-board reference signal in test mode.	Test	Offset
1-2	Current loop gain	Decrease	Increase
1-3	Current scaling. When OFF, this increases the sensitivity of the current sense thus reducing both peak and continuous current limit by 50%.	100%	50%
1-4	Continuous current reduction	Continuous / peak current limit ratio is 50%	Continuous / peak current limit ratio is 25%
1-5	60/120 degree commutation phasing	120 degree phasing	60 degree phasing
1-6	INHIBIT/ENABLE	P1-11, 12, 13 : INHIBIT	P1-11, 12, 13 : ENABLE

Units are shipped set for ½ current output via SW1-3=off and in the disabled state via SW1-6=off.

**BANK 2**

SWITCH	FUNCTION DESCRIPTION	SETTING	
		ON	OFF
2-1 †	Encoder Velocity feedback. This connects the internally generated velocity signal from the encoder.	Encoder velocity feedback enabled.	Encoder velocity feedback disabled.
2-2 †	Hall Velocity feedback. This connects the internally generated velocity signal from the Hall sensors.	Hall sensor velocity feedback enabled.	Hall sensor velocity feedback disabled.
2-3 †	Duty Cycle feedback. This connects the internally generated velocity signal from the output stage.	Duty cycle feedback enabled.	Duty cycle feedback disabled.
2-4	Velocity Feedback Polarity	Toggles the polarity of the velocity feedback signal (Encoder or Hall velocity mode only).	
2-5	Loop integrator. This capacitor normally ensures "error-free" operation in velocity mode by reducing the error signal (output of summing amplifier) to zero.	Enables the velocity / voltage loop integrator capacitor.	Disables the velocity / voltage loop integrator capacitor.
2-6	Integrator capacitor. This adjusts the value of the integrator capacitor in the velocity mode.	Increase	Decrease

† Important Note: Amplifier will not operate properly with more than one switch ON due to multiple feedback signals. See block diagram.

**POTENTIOMETER FUNCTIONS:**

POTENTIOMETER	DESCRIPTION	TURNING CW
Pot 1	Loop gain adjustment in open loop & velocity modes. Turn this pot fully ccw in current mode.	Increases loop gain
Pot 2	Current limit. This potentiometer adjusts both the continuous and peak current limit while maintaining a selected ratio (50%).	Increases current limit
Pot 3	Reference in gain. This potentiometer adjusts the ratio between input signal and output variables (voltage, current, and velocity).	Increases reference input gain
Pot 4	Test / Offset. Used to adjust any imbalance in the input signal or in the amplifier. When SW1-1 (DIP switch) is ON, the sensitivity of this pot is greatly increased allowing it to be used as an on-board signal source for testing purposes. See section "G".	N/A

**TEST POINTS FOR POTENTIOMETERS:** See section "G".

**OPERATING MODE SELECTION:**

The following operating modes can be selected by setting the DIP-switches according to the chart in the functional block diagram:

- Current mode
- Open loop mode
- Tachometer mode
- External velocity mode
- HALL velocity mode
- Encoder velocity mode

See section G for more information.

**ADJUSTABLE ACCEL/DECEL RATE**

The B60A series has built-in acceleration and deceleration when in Hall velocity or Encoder velocity modes. To enable Accel/Decel and the AT VEL output (P1-10), set the jumpers according to the tables.

ACCEL/DECEL	JF8	JF9
Enabled	Not installed	Installed
Disabled	Installed	Not installed

MODE	JF6*	JF7*
HALL Velocity	Not installed	Installed
Encoder Velocity	Installed	Not installed

\*Based on the mode of operation, JF6 and JF7 must be configured as shown above for proper operation of the AT VEL (P1-10) function.

JF6-JF9 are jumper locations on the PCB. These jumper locations are silk-screened on the PCB for easy identification.

The acceleration and deceleration rates can be set independently using through-hole resistors at locations RF3, RF4, RF5 and RF6 (see table below). The rates are based on + or – 10 Volts to the Reference inputs. The “Time” listed in the table below is the time it takes to reach the 10-Volt input. The ramping rates are linear with respect to time. For example, if the input were only 5 Volts, the time to ramp to this voltage would be half the time to ramp to 10 Volts. These locations are silk-screened on the PCB for easy identification.

Time (Seconds)	Acceleration		Deceleration	
	RF3 (Ohms)	RF4 (Ohms)	RF6 (Ohms)	RF5 (Ohms)
1	50K	50K	50K	50K
2	50K	20K	50K	20K
3*	10K	10K	10K	10K
4	500K	20K	500K	20K
5	50K	5K	50K	5K
6	500K	10K	500K	10K
7	50K	2K	50K	2K
8	50K	1K	50K	1K
9	20K	0.1K	20K	0.1K
10	100K	0.1K	100K	0.1K

\* = Default setting

**APPLICATION NOTE:** For proper operation, P1-6, and P2-14 must be connected to the signal ground if they are not being used.

**SET-UP:** See section "G" for engineering and installation notes.

#### CURRENT LIMIT ADJUSTMENTS:

These amplifiers feature separate peak and continuous current limit adjustments. The current limit adjustment Pot 2 adjusts both peak and continuous current limit at the same time. Pot 2 has 12 active turns and one inactive turn on each end and is approximately linear. Thus, to adjust the current limit turn the potentiometer counter-clockwise to zero, then turn clockwise to the appropriate value. In many applications it is sufficient to use only the DIP-switches for current limit adjustments. SW1-3 reduces both peak and continuous current limit by 50% when OFF. SW1-4 reduces only the continuous current limit by 50% when OFF:

SW1-4	CONTINUOUS / PEAK CURRENT LIMIT RATIO
ON	50%
OFF	25%

P1-9 is the input to the internal current amplifier power stage. Since the output current is proportional to P1-9, the adjusted current limit can easily be observed at this pin without connecting the motor. Note that a command signal must be applied to the reference inputs to obtain a reading on P1-9. The maximum peak current value equals 7.25 V at this pin and the maximum continuous current value equals 3.63 V at this pin. If SW3=ON, peak rated amplifier current = 7.25 V. If SW3=OFF, ½ peak rated amplifier current = 7.25 V. Example: using the B60A40 with SW3=ON, 60A=7.25V and with SW3=OFF, 30A=7.25V.

The actual output current can be monitored at pin P1-8.

**ORDERING INFORMATION:**

Model: B60A40X

X indicates the current revision letter.

**TYPICAL SYSTEM WIRING:** See section "G".

**MATING CONNECTORS:**

Manufacturer: AMP® (Tel: 1-800-522-6752)

Part numbers:

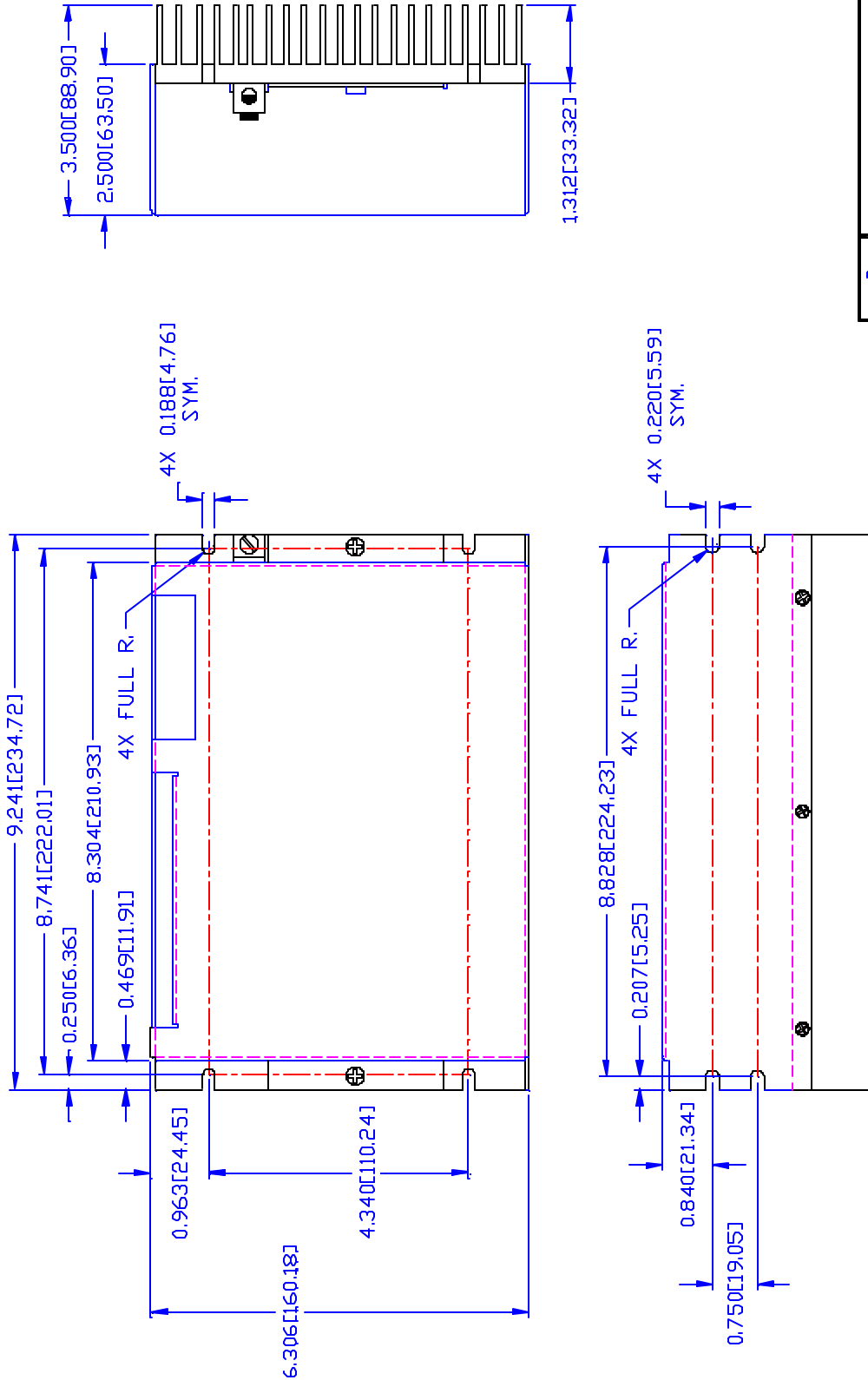
15 Pin plug	748364-1
26 Pin plug	748365-1

Pins	748333-2
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Shell Kit (plastic with metal coating)

15 Pin	748677-1
26 Pin	748677-2





BACKSIDE VIEW

NOTE: DIMENSIONS IN [ ] ARE IN MM.

B	CHANGE ADDRESS ON TITLE BLOCK	02/13/02	RB
A	DIM IS E500 WAS E374	02/18/99	RB
REV	DESCRIPTION	DATE	BY

**ADVANCED**  
**MOTION CONTROLS**  
 FVM SERVO AMPLIFIERS  
 3805 Calle Tecate, Concord, CA 93012

TITLE  
 MOUNTING DIMENSIONS, S60A40

SIZE DWG. NO. MDS60A

SCALE: FULL

SHT. 1 OF 1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	
TOLERANCES .XX ± .010 .XXX ± .005 DO NOT SCALE DRAWING	
DRAWN BY:	R. BAUTISTA
CHECK BY:	
DESIGN APPROVED:	
DATE:	11/09/98
DATE:	
DATE:	
DATE:	
USED ON	
S60A SERIES	
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