KOFORD
ENGINEERING, LLC

1.57 inch (40mm) Series

• High power density outer rotor sensorless design with built in internal fan for Industrial, military, and aerospace applications including blowers, pumps, and UAV's.

• Peak output of 900 watts and continuous power of 499 watts with no heatsinking and with a weight of only 203g for a power to weight ratio of 440 watts per kg.

• Up to 89% efficiency

• Up to 1,523 watts continuous power.

• Long life premium synthetic bearing lube with -73C to 149C temperature range

• Hi temp windings, epoxy magnets and silicone lead wires. Motor rated for continuous operation at 150°C.

• Characterized for operation at 12, 24, 36 and 48 volts

• Custom windings or modified shafts on request

• Matching drives available

Table of Contents

KOFORD ENGINEERING, LLC

1.57" (40mm) outer rotor Slotted Brushless motor

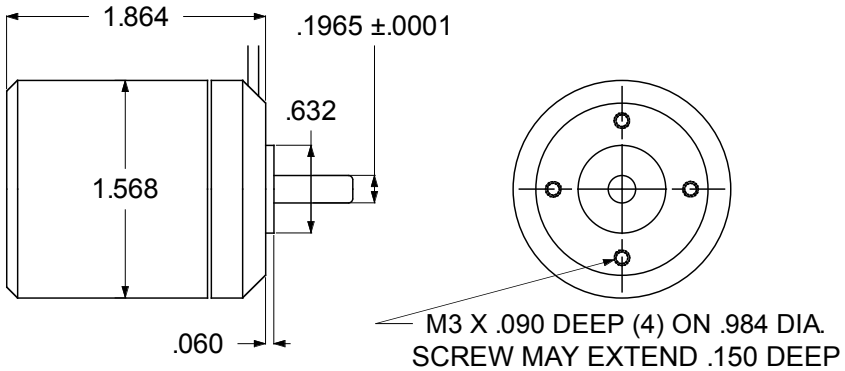
•2,076 to 8,352 rpm no load •Continuous power up to 499 watts •Peak power up to 900 watts

High power density outer rotor internal fan cooled sensorless 12 slot 14 pole slotted motor. The motor uses class 240°C insulation for ruggedness. 150°C Neo magnets are use along with stainless shaft, and high temp silicone insulated ultraflex lead wires. available. Custom windings or modified shafts can be provided

Motor Data

Nominal supply voltage	volts	12	24	36	48
No load speed	rpm±12%	3,100	6,200	9,300	12,400
Speed/torque slope	rpm/oz-in	.81	2.1	19	25
Peak efficiency	%	85	87	88	89
velocity constant	rpm/volt	258	258	258	258
Rated power	watts	91	235	373	499
Rated speed	rpm	2,414	5,139	7,971	10,826
Rated torque	oz-in	51	61.9	63.2	62.3
Rated current	amps	10	12	12	12.4
Peak output	watts	91	384	638	900
speed at peak output	rpm	2,414	3,817	6,882	8.988
torque at peak output	oz-in	51	135	125	135.4
current at peak output	amps	10.0	26.0	24.0	26.0
Km	oz-in/√w	12.3	12.3	12.3	12.3
Winding resistance#	ohm±15%	.180	.180	.180	.180
No load current	amp±50%	.38	.57	.74	.90
Velocity constant	rpm/volt±12%	258	258	258	258
Torque constant Kt	oz-in/amp	5.2	5.2	5.2	5.2
Winding inductance	mH	.09	.09	.09	.09

Ambient temperature range -73C to 149C
Weight 7 oz. (203 grams), maximum winding temp. 180C Rated power is for a 40°C ambient max., at elevated ambients the continuous motor power must be reduced. Contact factory for more informaiton. Data is for winding and magnet temperature of 20°C. For 12 amp drive peak power is imited by drive current limit. Phase leads are 18 AWG



Ordering Information: mail@koford.com • www.koford.com
Example: Part Number 40 S 258 A

Motor type
Type S=sensorless H=120°halls
Winding number
Modifications A=none

Test Data
Total System Performance
40S258A with S12V10A Controller at 12 volts

Rpm	Torque Oz-in	Watts Out	Efficiency %	Amps
3100	0.0	512414.0	0.0	0.41
3026	5.1	11.4	67.6	1.40
2987	8.4	18.4	76.9	2.00
2917	13.5	29.2	81.2	3.00
2842	19.0	40.0	83.3	4.00
2769	24.2	49.6	82.6	5.00
2698	29.8	59.5	82.6	6.00
2628	34.8	67.8	80.7	7.00
2562	40.3	76.4	79.6	8.00
2487	45.8	84.4	78.1	9.00
2414	51.0	91.1	75.9	10.00

Dyno test results of a motor and drive combination with voltage held to 12v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Motor leads are full untrimmed length.

Test Data
Total System Performance
40S258A with S24V30A Controller at 24 volts

Rpm	Torque Oz-in	Watts Out	Efficiency %	Amps
6200	0.0	0.0	0.0	0.60
6023	8.7	38.6	70.0	2.30
5840	18.1	78.2	81.4	4.00
5658	29.2	122.1	84.8	6.00
5490	40.4	164.3	85.6	8.00
5327	51.2	201.7	84.0	10.00
5139	61.9	235.4	81.7	12.00
4964	72.7	267.2	79.5	14.00
4759	84.7	298.4	77.8	16.00
4629	94.7	324.6	75.1	18.00
4443	105.6	347.4	72.4	20.00
4313	116.3	371.3	70.3	22.00
4081	127.1	383.9	66.7	24.00
3817	134.9	381.1	61.1	26.00

Dyno test results of a motor and drive combination with voltage held to 12v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Motor leads are full untrimmed length.

Test Data
Total System Performance
40S258A with S36V30A Controller at 36 volts

Rpm	Torque Oz-in	Watts Out	Efficiency %	Amps
9300	0.0	0.0	0.0	0.77
8982	11.2	74.8	69.3	3.00
8835	16.8	110.2	76.5	4.00
8624	27.6	176.3	81.6	6.00
8410	39.0	242.8	84.3	8.00
8222	49.7	302.4	84.0	10.00
8029	61.1	362.9	84.0	12.00
7830	72.2	418.1	83.0	14.00
7651	82.6	467.8	81.2	16.00
7474	93.9	519.4	80.2	18.00
7276	104.7	563.8	78.3	20.00
7036	115.9	603.5	76.2	22.00
6882	125.4	638.6	73.9	24.00

Dyno test results of a motor and drive combination with voltage held to 36v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Motor leads are full untrimmed length.

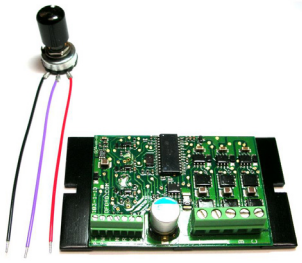
Test Data
Total System Performance
40S258A with S48V30A Controller at 48 volts

Rpm	Torque Oz-in	Watts Out	Efficiency %	Amps
12400	0.0	0.0	0.0	0.93
11888	15.2	133.7	69.6	4.00
11587	26.5	227.0	78.8	6.00
11339	37.6	315.5	82.2	8.00
11113	48.6	399.7	83.3	10.00
10869	59.8	481.3	83.6	12.00
10666	71.5	564.4	84.0	14.00
10422	82.3	634.8	82.7	16.00
10214	93.3	705.1	81.6	18.00
10021	104.1	771.9	80.4	20.00
9672	114.5	819.8	77.6	22.00
9524	124.4	876.8	76.1	24.00
8988	135.4	900.6	72.2	26.00

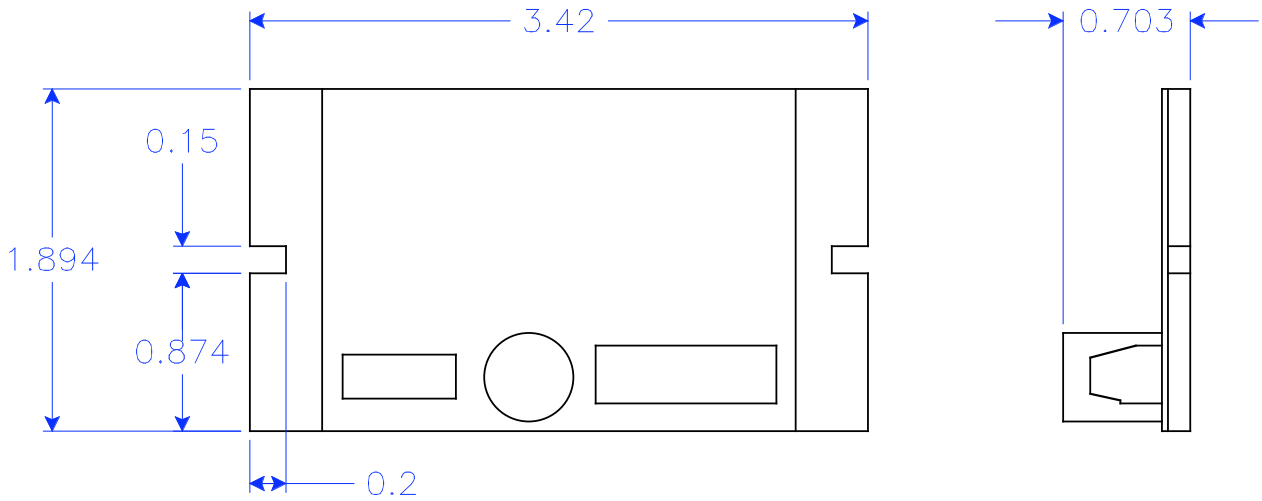
Dyno test results of a motor and drive combination with voltage held to 48v at input of drive using remote voltage sense on the power supply. Winding temperature is held below 40C by running test quickly and/or allowing motor to cool between tests. Test were conducted at room temperature. Motor leads are full untrimmed length.

KOFORD ENGINEERING, LLC

S12V10A digital sensorless motor driver 10A 10-12V



Ultra high efficiency miniature sensorless digital drive with 37kHz pwm frequency, designed for speed input from a pot, or form a 0-5V analog signal or an equivelant 5 volt pwm signal from a microcontroller. In the case of the pwm input the frequency should be above 8kHz to allow the drive to filter out the AC component of the signal. Between 0 and .5 volts the motor is off, the speed ramps to the maximum value as the input is increased from .5v to 4.5 volts. Between 4.5 and 5.0 volts the motor runs at full speed. The speed input should not exceed 5.0 volts. The drive has a sophisticated start up which will start higher inertia loads than is typical for sensorless drives. Once power supply, motor and speed pot are connected, the motor can be operated without the need for any adjustments, set up or programing. If reversible operation is required a SPDT switch can be added between DR and P- or a 0 or 5 volt signal from a microcontroller to DR can be used. If the switch is open the motor will run in the clockwise direction, if the switch is closed the motor will run in the counterclockwise direction. The Tach output is referenced to P-, and is a 5 volt square wave at 3 pulses per revolution per magnet pole pair (21 kHz=1,000 rpm). The EN input will turn off the motor if pulled to ground. To apply brake connect BRK to P+ with a swich, or use an external 5v signal connected between BRK and BG. The CV-1 braking module should be used when braking if the drive is used with a power supply instead of a battery. The drive can be custom programed for your specific application, for example to run at a fixed speed when power or the enable is applied.



Terminal block positions (motor lead hook up for Koford motors).

P+=connect to one side of pot (5.0v) (red)
PW=connect to pot wiper (center terminal) (purple)
P-=connect to other side of pot (ground) (black)
EN=unconnected or 5v to run, 0v to turn motor off
DR=leave unconnected for forward direction, hook to P- for reverse
BK=unconnected or 0v=off, 5v=on

TC=tach/encoder output 3 pulses per revolution per magnet pole pair (21 kHz=1,000 rpm)
-=Connect to black (-) lead of power supply
+=Connect to red (+) lead of power supply
A=blue motor wire
B=white motor wire
C=brown motor wire

Ordering information:

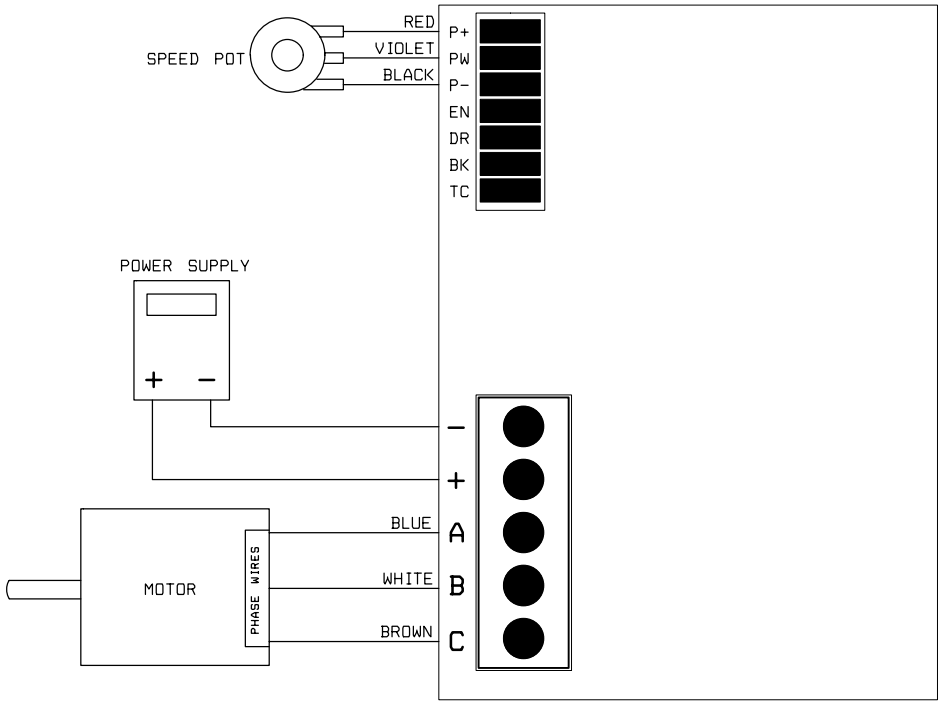
please send the order to: mail@koford.com

Part number:

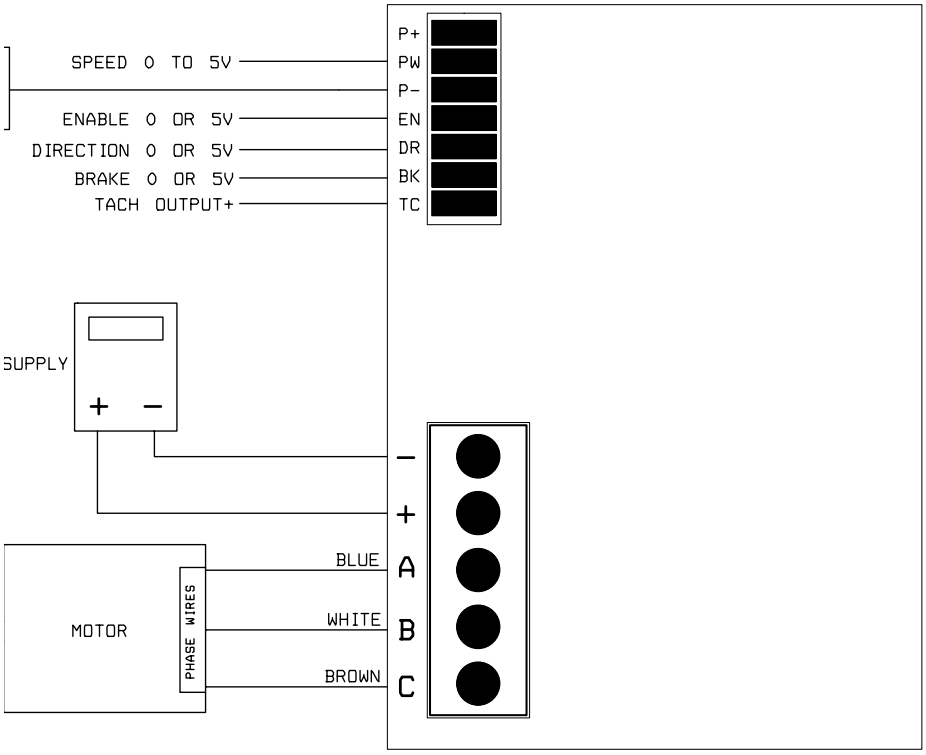
S12V10A-40A closed loop speed control drive 3,100rpm

P1 speed pot with knob and leads

Stand alone operation with speed pot, motor direction can be reversed by switching Blue and White leads



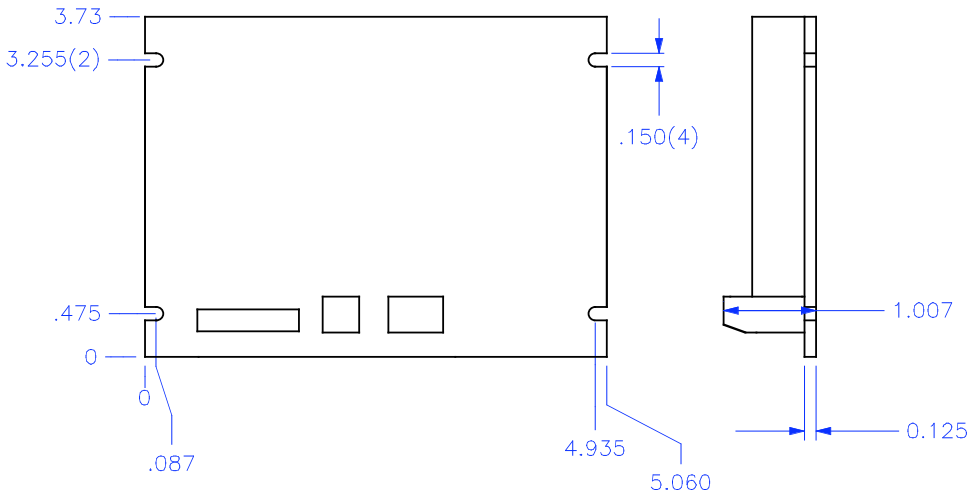
External control



KOFORD ENGINEERING, LLC

S24V30A digital sensorless motor driver 30A 10-32V

Ultra high efficiency miniature sensorless digital drive with 37kHz pwm frequency, designed for speed input from a pot, or form a 0-5V analog signal or an equivelant 5 volt pwm signal from a microcontroller. In the case of the pwm input the frequency should be above 8kHz to allow the drive to filter out the AC component of the signal. Between 0 and .5 volts the motor is off, the speed ramps to the maximum value as the input is increased from .5v to 4.5 volts. Between 4.5 and 5.0 volts the motor runs at full speed. The speed input should not exceed 5.0 volts. The drive has a sophisticated start up which will start higher inertia loads than is typical for sensorless drives. Once power supply, motor and speed pot are connected, the motor can be operated without the need for any adjustments, set up or programing. If reversible operation is required a SPDT switch can be added between DR and P- or a 0 or 5 volt signal from a microcontroller to DR can be used. If the switch is open the motor will run in the clockwise direction, if the switch is closed the motor will run in the counterclockwise direction. The Tach output is referenced to P-, and is a 5 volt square wave at 3 pulses per revolution per magnet pole pair (21 kHz=1,000 rpm). The EN input will turn off the motor if pulled to ground. To apply brake connect BRK to P+ with a swich, or use an external 5v signal connected between BRK and BG. The CV-3 braking module should be used when braking if the drive is used with a power supply instead of a battery. The drive can be custom programed for your specific application, for example to run at a fixed speed when power or the enable is applied.



Terminal block positions (motor lead hook up for Koford motors).

P+=connect to one side of pot (5.0v) (red)
PW=connect to pot wiper (center terminal) (purple)
P-=connect to other side of pot (ground) (black)
EN=unconnected or 5v to run, 0v to turn motor off
DR=leave unconnected for forward direction, hook to P- for reverse
BK=unconnected or 0v=off, 5v=on

TC=tach/encoder output 3 pulses per revolution per magnet pole pair (21 kHz=1,000 rpm)
-=Connect to black (-) lead of power supply
+=Connect to red (+) lead of power supply
A=blue motor wire
B=white motor wire
C=brown motor wire

Ordering information:

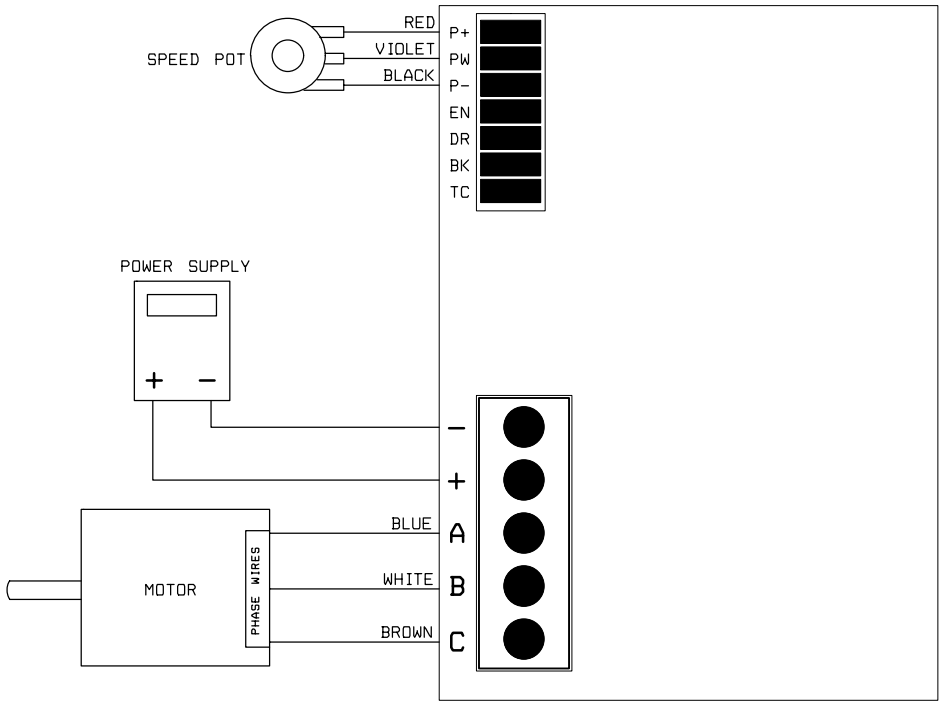
please send the order to: mail@koford.com

Part number:

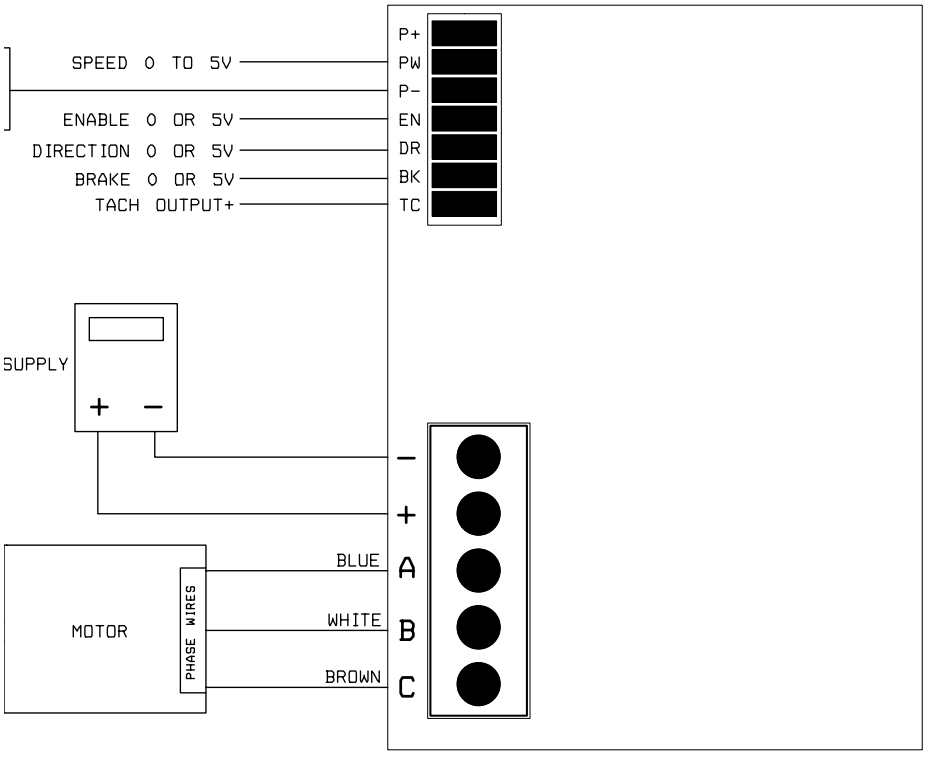
S24V30A-40A closed loop speed control drive 6,200rpm

P1 speed pot with knob and leads

Stand alone operation with speed pot, motor direction can be reversed by switching Blue and White leads



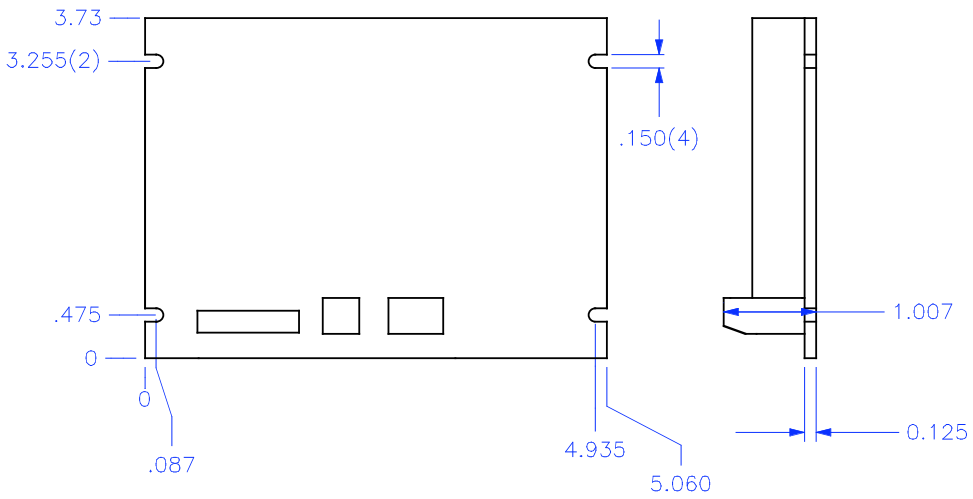
External control



KOFORD ENGINEERING, LLC

S36V30A digital sensorless motor driver 30A 10-32V

Ultra high efficiency miniature sensorless digital drive with 37kHz pwm frequency, designed for speed input from a pot, or form a 0-5V analog signal or an equivelant 5 volt pwm signal from a microcontroller. In the case of the pwm input the frequency should be above 8kHz to allow the drive to filter out the AC component of the signal. Between 0 and .5 volts the motor is off, the speed ramps to the maximum value as the input is increased from .5v to 4.5 volts. Between 4.5 and 5.0 volts the motor runs at full speed. The speed input should not exceed 5.0 volts. The drive has a sophisticated start up which will start higher inertia loads than is typical for sensorless drives. Once power supply, motor and speed pot are connected, the motor can be operated without the need for any adjustments, set up or programing. If reversible operation is required a SPDT switch can be added between DR and P- or a 0 or 5 volt signal from a microcontroller to DR can be used. If the switch is open the motor will run in the clockwise direction, if the switch is closed the motor will run in the counterclockwise direction. The Tach output is referenced to P-, and is a 5 volt square wave at 3 pulses per revolution per magnet pole pair (21 kHz=1,000 rpm). The EN input will turn off the motor if pulled to ground. To apply brake connect BRK to P+ with a swich, or use an external 5v signal connected between BRK and BG. The CV-5 braking module should be used when braking if the drive is used with a power supply instead of a battery. The drive can be custom programed for your specific application, for example to run at a fixed speed when power or the enable is applied.



Terminal block positions (motor lead hook up for Koford motors).

P+=connect to one side of pot (5.0v) (red)
PW=connect to pot wiper (center terminal) (purple)
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DR=leave unconnected for forward direction, hook to P- for reverse
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TC=tach/encoder output 3 pulses per revolution per magnet pole pair (21 kHz=1,000 rpm)
-=Connect to black (-) lead of power supply
+=Connect to red (+) lead of power supply
A=blue motor wire
B=white motor wire
C=brown motor wire

Ordering information:

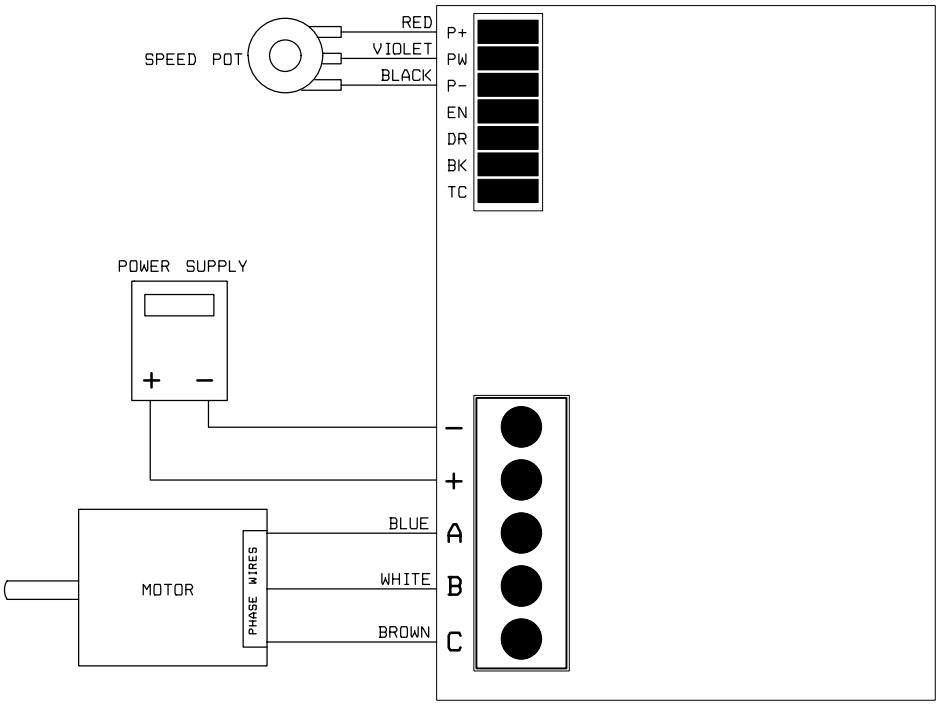
please send the order to: mail@koford.com

Part number:

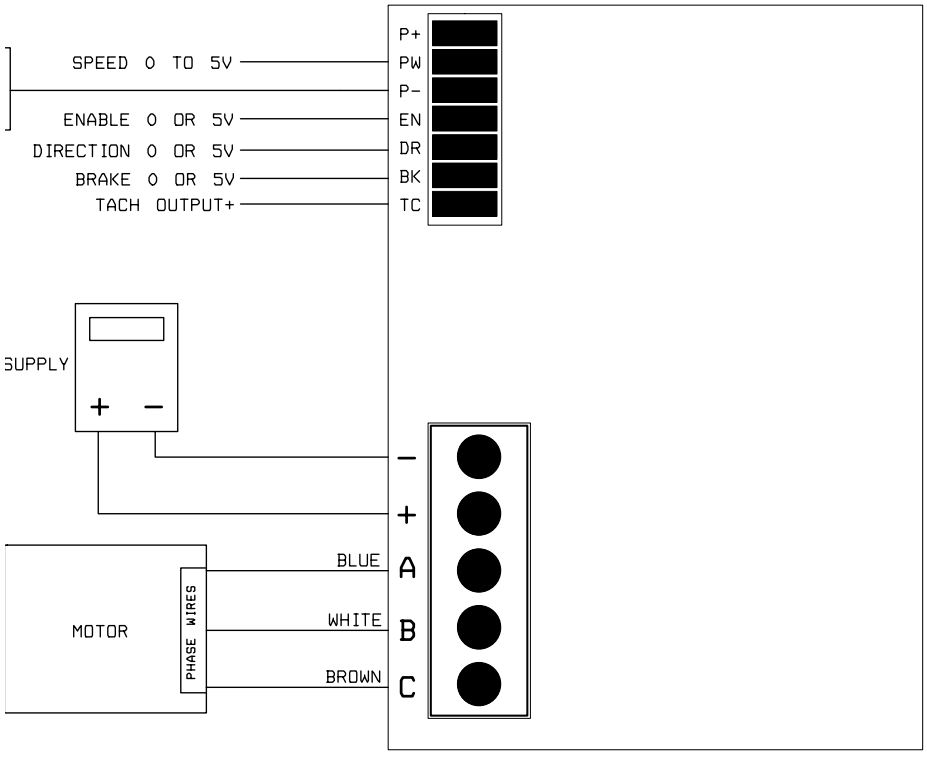
S36V30A-40A closed loop speed control drive 9,300rpm

P1 speed pot with knob and leads

Stand alone operation with speed pot, motor direction can be reversed by switching Blue and White leads



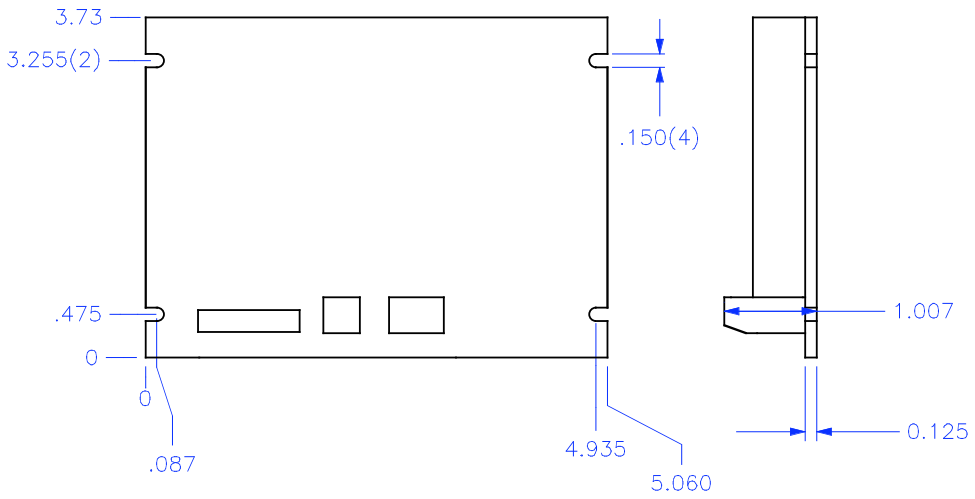
External control



KOFORD ENGINEERING, LLC

S48V30A digital sensorless motor driver 30A 10-54V

Ultra high efficiency miniature sensorless digital drive with 37kHz pwm frequency, designed for speed input from a pot, or form a 0-5V analog signal or an equivelant 5 volt pwm signal from a microcontroller. In the case of the pwm input the frequency should be above 8kHz to allow the drive to filter out the AC component of the signal. Between 0 and .5 volts the motor is off, the speed ramps to the maximum value as the input is increased from .5v to 4.5 volts. Between 4.5 and 5.0 volts the motor runs at full speed. The speed input should not exceed 5.0 volts. The drive has a sophisticated start up which will start higher inertia loads than is typical for sensorless drives. Once power supply, motor and speed pot are connected, the motor can be operated without the need for any adjustments, set up or programing. If reversible operation is required a SPDT switch can be added between DR and P- or a 0 or 5 volt signal from a microcontroller to DR can be used. If the switch is open the motor will run in the clockwise direction, if the switch is closed the motor will run in the counterclockwise direction. The Tach output is referenced to P-, and is a 5 volt square wave at 3 pulses per revolution per magnet pole pair (21 kHz=1,000 rpm). The EN input will turn off the motor if pulled to ground. To apply brake connect BRK to P+ with a swich, or use an external 5v signal connected between BRK and BG. The CV-5 braking module should be used when braking if the drive is used with a power supply instead of a battery. The drive can be custom programed for your specific application, for example to run at a fixed speed when power or the enable is applied.



Terminal block positions (motor lead hook up for Koford motors).

P+=connect to one side of pot (5.0v) (red)
PW=connect to pot wiper (center terminal) (purple)
P-=connect to other side of pot (ground) (black)
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DR=leave unconnected for forward direction, hook to P- for reverse
BK=unconnected or 0v=off, 5v=on

TC=tach/encoder output 3 pulses per revolution per magnet pole pair (21 kHz=1,000 rpm)
-=Connect to black (-) lead of power supply
+=Connect to red (+) lead of power supply
A=blue motor wire
B=white motor wire
C=brown motor wire

Ordering information:

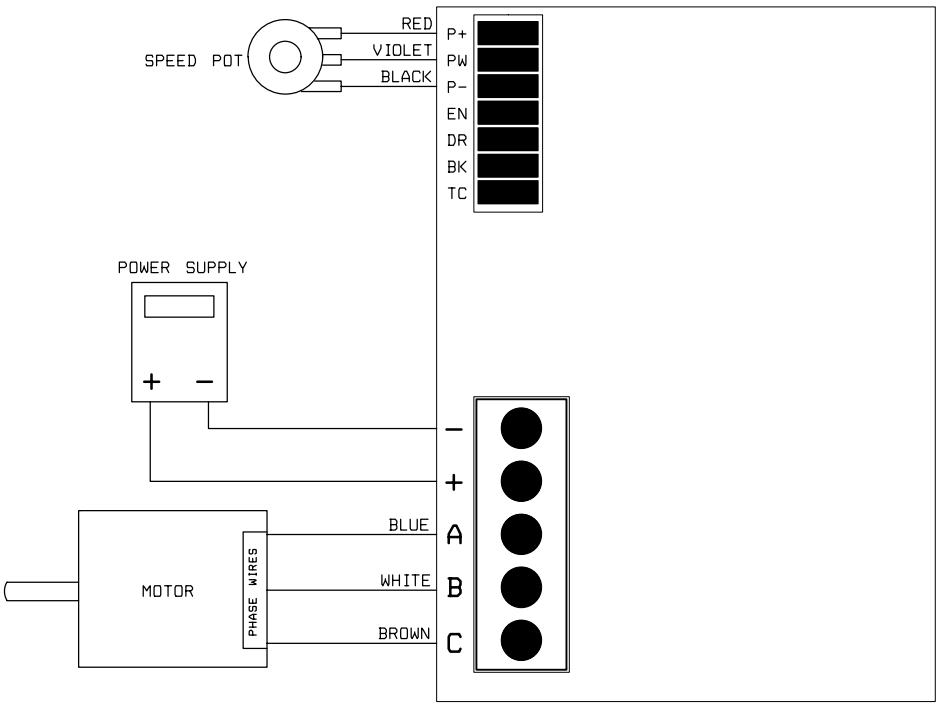
please send the order to: mail@koford.com

Part number:

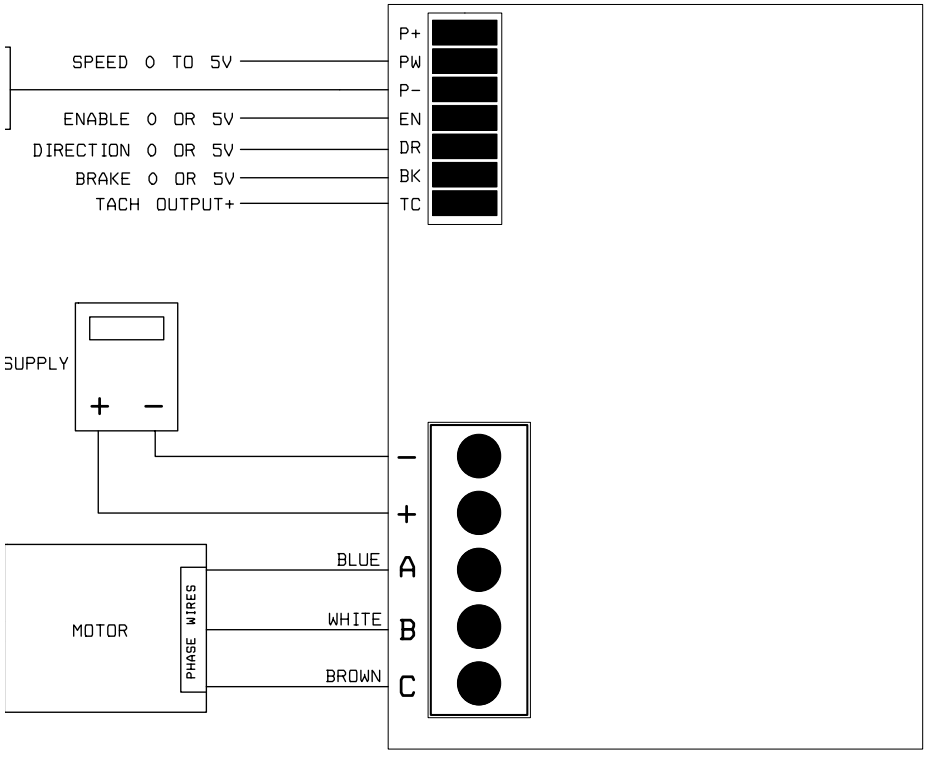
S48V30A-40A closed loop speed control drive 12,400rpm

P1 speed pot with knob and leads

Stand alone operation with speed pot, motor direction can be reversed by switching Blue and White leads

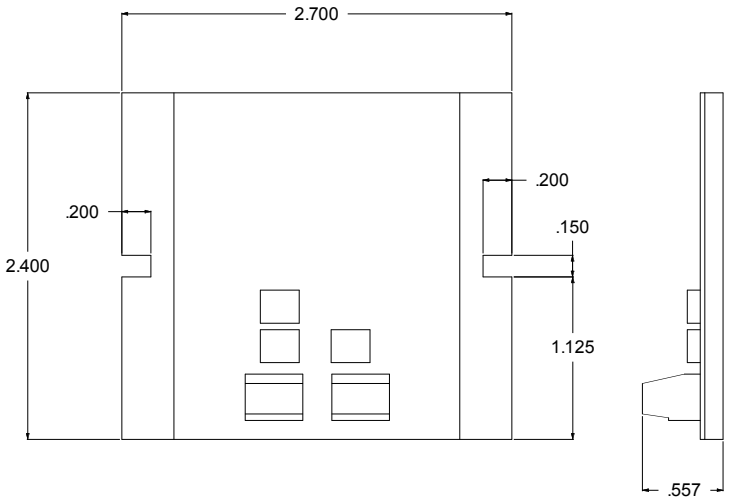


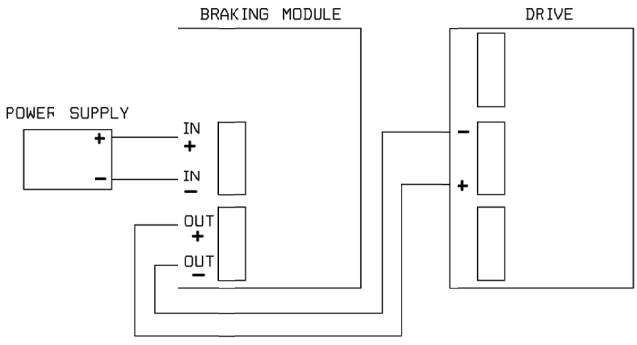
External control



CV-1 10 Amp, 24V braking module

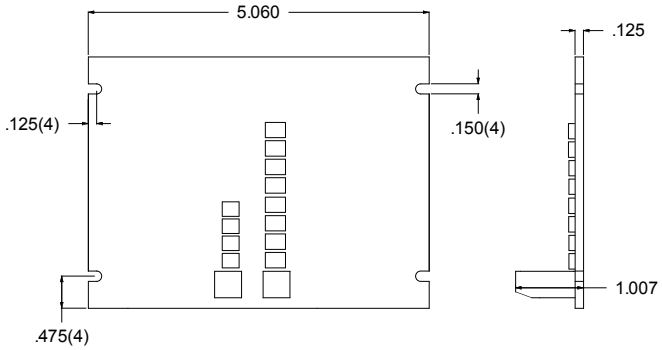
The CV-1 braking module is for use when a drive with braking function is connected to a power supply. If a battery supplies the power, the module is not needed. The module is needed on a system with a power supply because otherwise the regenerated energy would cause an overvoltage condition in the power supply. That would cause power supply shut off and/or power supply damage. The module contains Schottky diodes to prevent current backflow and also a TVS to absorb the transient braking energy. The TVS is needed because otherwise the braking energy would cause an overvoltage in the drive damaging it.

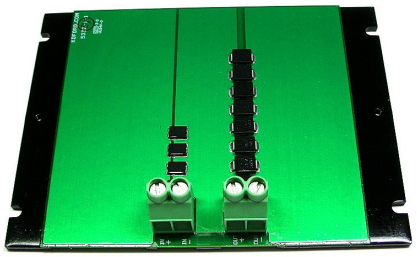


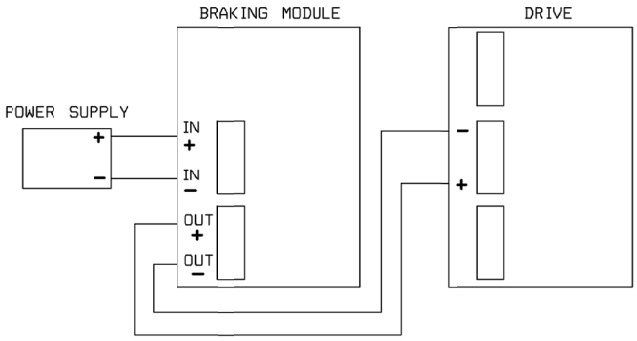


CV-3 40 Amp, 24V braking module

The CV-3 braking module is for use when a drive with braking function is connected to a power supply. If a battery supplies the power, the module is not needed. The module is needed on a system with a power supply because otherwise the regenerated energy would cause an overvoltage condition in the power supply. That would cause power supply shut off and/or power supply damage. The module contains Schottky diodes to prevent current backflow and also a TVS to absorb the transient braking energy. The TVS is needed because otherwise the braking energy would cause an overvoltage in the drive damaging it.

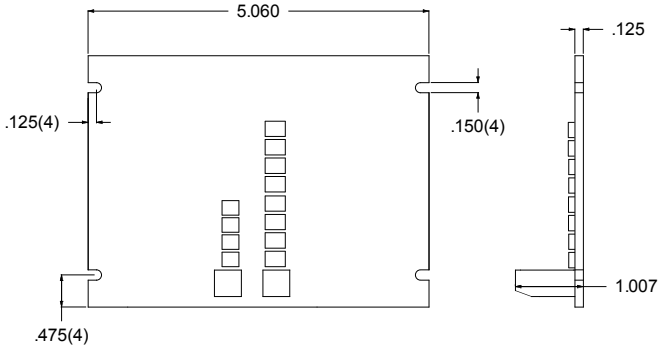


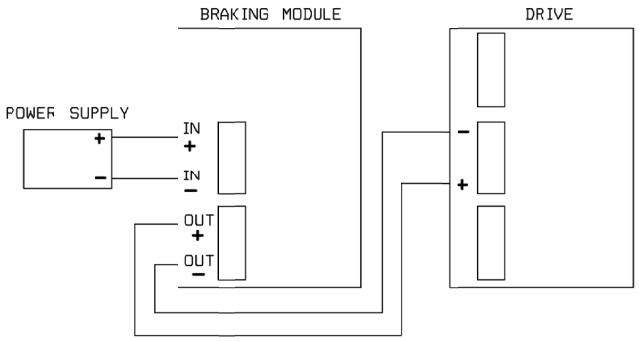




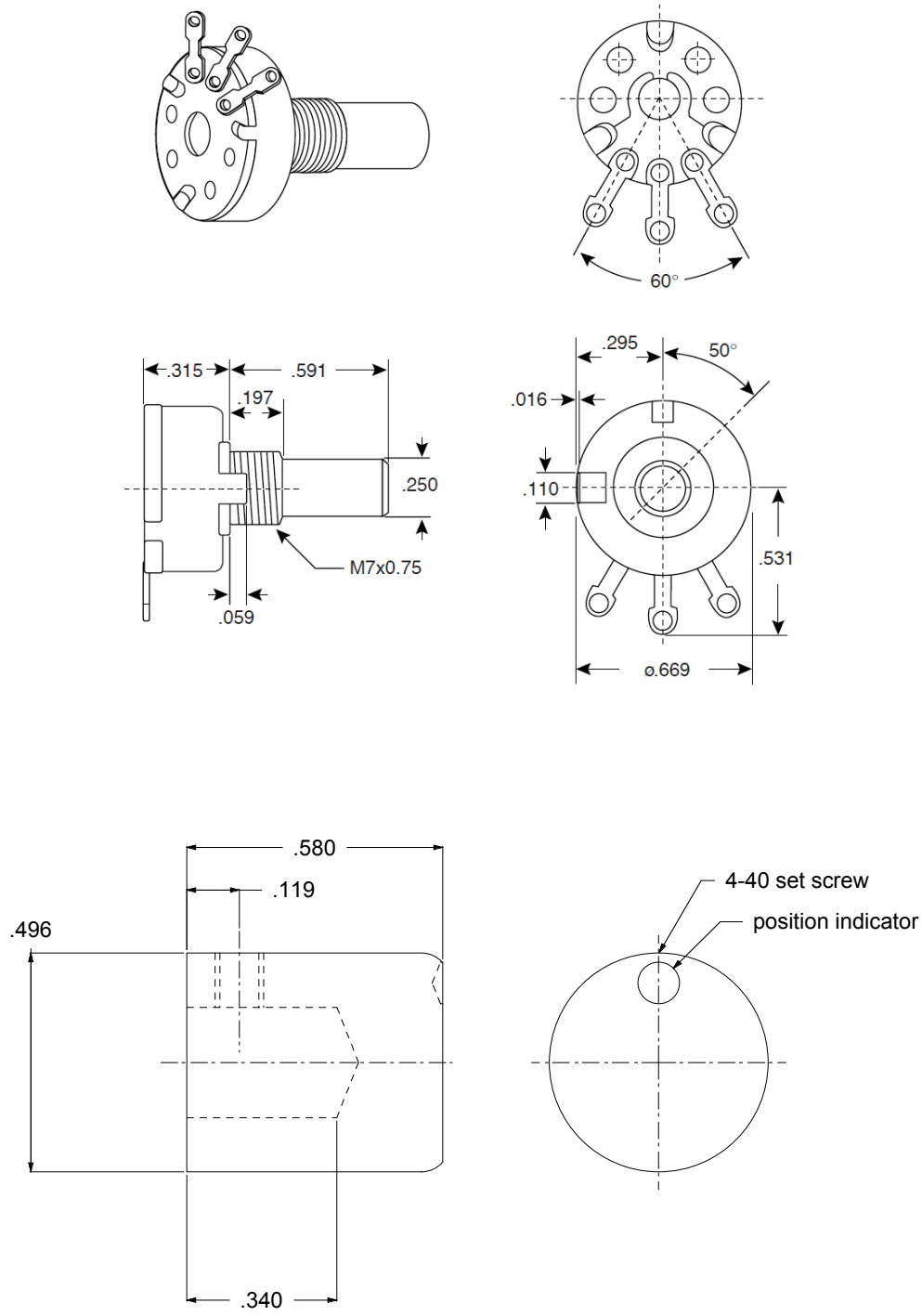
CV-5 40 Amp, 48V braking module

The CV-5 braking module is for use when a drive with braking function is connected to a power supply. If a battery supplies the power, the module is not needed. The module is needed on a system with a power supply because otherwise the regenerated energy would cause an overvoltage condition in the power supply. That would cause power supply shut off and/or power supply damage. The module contains Schottky diodes to prevent current backflow and also a TVS to absorb the transient braking energy. The TVS is needed because otherwise the braking energy would cause an overvoltage in the drive damaging it.





SPEED POT AND KNOB



Leads are 3.440" long stranded 22 gauge with TFE insulation.

Unit conversions

°F -32 ÷1.8=°C example: 212°F=100°C, °C x1.8+32=°F example: 100°C=212°F, in x 25.40=mm, mm x.03937= in., oz x 28.3495=g, oz-in x 7.06=mNm, mNm x .142=oz-in, Nm x 142=oz-in, rpm x .1047=rad s^{-1}, V/R/S x .1047=volts/rpm, 746 watts=1hp, lb-in^2 x .04144=oz-in-sec^2

Motor design

This motor is available in the sensorless configuration only. It is suitable for blowers, pumps, remotely piloted air, ground, sea and underwater devices. It is not suitable for positioning applications or for driving load with a high inertia.

The motor is an open configuration where air is pulled through the motor to cool it. The ball bearings are shielded and grease lubed.

Motor performance is with the listed Koford drive. These drives use block (6 step commutation) for highest performance. The use of other technologies such as sine commutation or field oriented control will result in reduced power and efficiency.

System efficiency

The system efficiency is different then the motor efficiency. The system efficiency takes into account motor losses, drive losses, and wiring losses. The choice of a drive will make a large difference in the total system efficiency. The test data is with the drive set to maximum speed. At less then 100% speed efficiency will be reduced. For example if a motor is operated at 12 volts with the speed control turned all of the way up, the efficiency will be better then if the motor is operated with 24 volts into the drive and the speed set at 50%. Although the motor speed is the same, there are additional losses in the drive and motor to drop the 24 volts down to 12 volts. The amount of these losses is determined by the drive and motor design. Higher frequency drives will slightly increase overall efficiency.

PWM basics

Variable speed drives operate using PWM where the voltage to the motor is rapidly turned on and off. This is the same as a switching power supply where the motor is the filter. A PWM drive operates like a transformer, for example if the motor pulls 20 amps at 12 volts and the input to the drive is 36 volts then the current reading on the power supply will be 12/36 x 20 or 6.66 amps (neglecting losses). A drive rated at 20 amps will only pull 20 amps from the power supply or battery if the speed is turned all of the way up (no PWM) and the motor curent draw is below the drives current limit.