AC/DC 130307 User Guide

Updated 1/9/15

Overview

The AC/DC is a single axis servo drive designed to interface with Centroid's MPU11 control system. AC/DC has improved fault tolerance and increased power handling when compared to previous Centroid drives. AC Brushless or DC brush servomotors can be driven by AC/DC in any combination up to 8 axes.

AC/DC Features

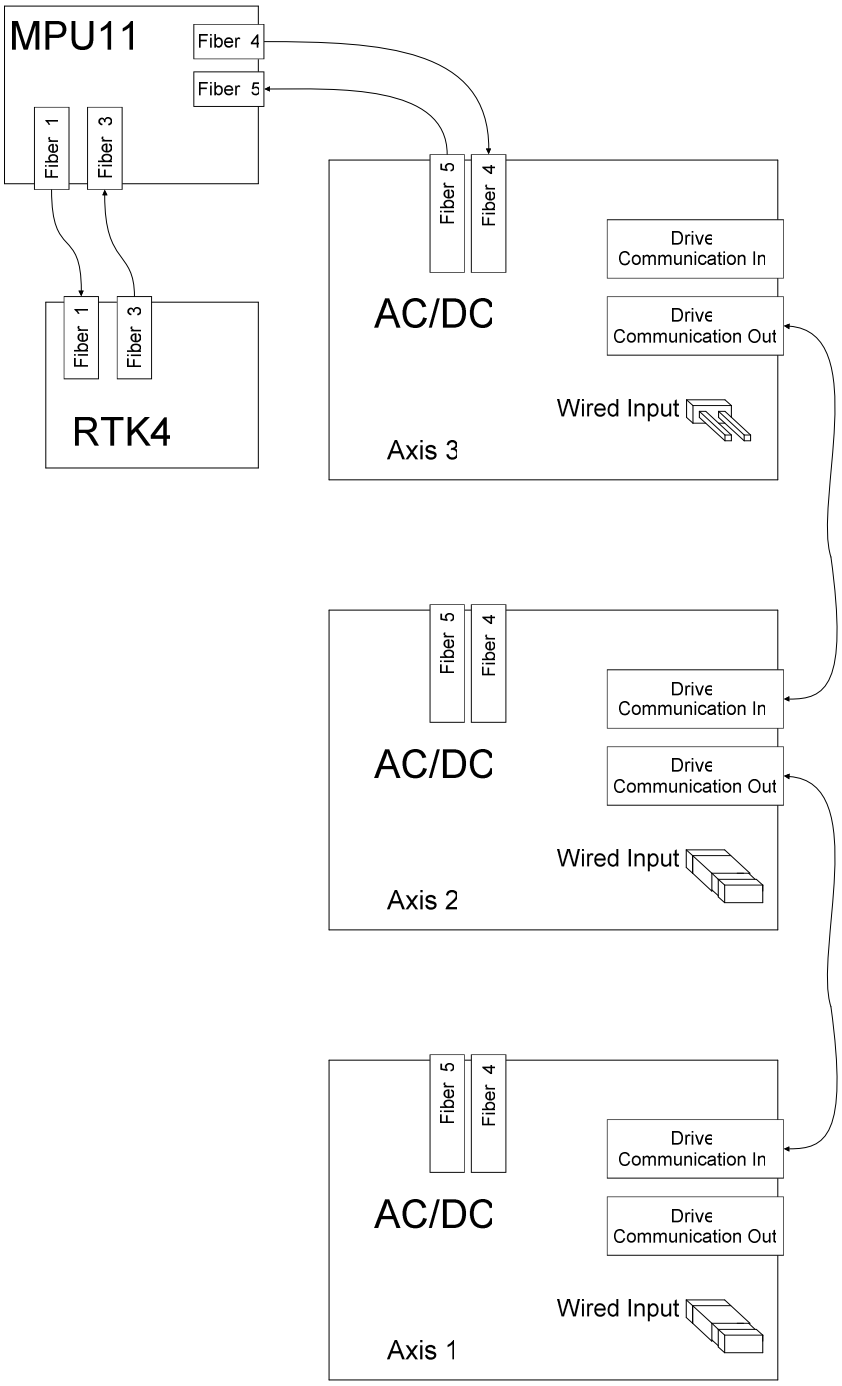
Function:	Servo Drive
Encoder Input:	Differential incremental (A, B, Z, U, V, W channels)
	BiSS B or C (select models)
Drive Protocol Support	DriveBus Protocol
Drive Application:	AC Brushless or DC Brush Motors
Current rating per axis (AC/DC-30):	5 to 30 Amps
Current rating per axis (AC/DC-60):	10 to 60 Amps
Motor Voltage:	50 to 340 Volts
Dimensions (W*D*H):	9.75 * 6 * 4 inches

AC/DC Connection Overview

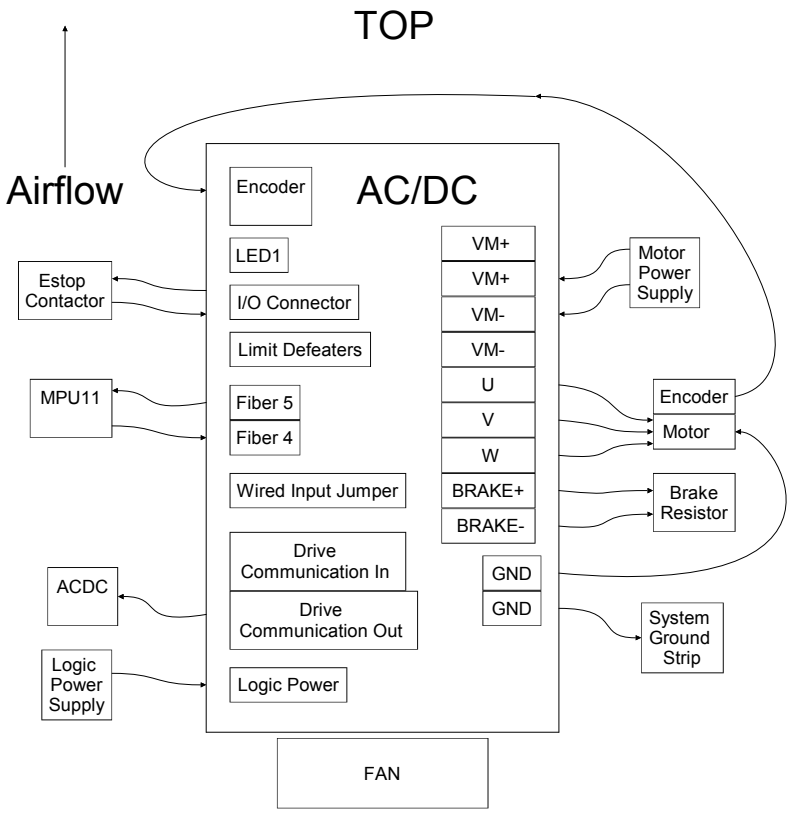
Up to eight AC/DC units can be connected to a MPU11 motion control card. The AC/DCs will negotiate their axis numbers based on the order they are connected. The last AC/DC in the communication chain will initiate communication and start numbering axes at 1. LED1 will display a rotating flash pattern at a startup while each AC/DC determines its location in the communication chain. After about 10 seconds negotiation completes, LED1 shows the axis number, and normal operation begins. If the decimal point is lit and a number is flashing on LED1, this indicates an error condition that can be found in the "LED1 Error Codes" section.

Fiber optic communication connects the AC/DC communication chain to the MPU11 motion control card. AC/DCs are connected to each other through the "Drive Communication In" and Drive Communication Out" wire connections. The "Wired Input" jumper must be set on drives that do not use fiber communication.

Typical AC/DC Communication Connections



Typical AC/DC Connections



AC/DC Power Connections

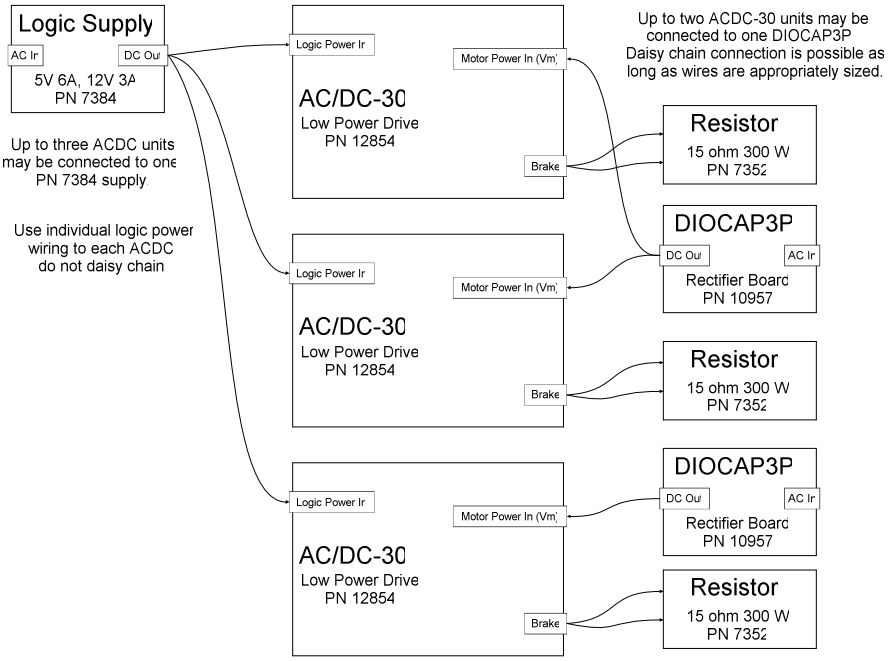
Connector Terminal	Function	Notes
VM+	Motor voltage +	Motor voltage negative terminals are duplicated to assist repeating power wires to multiple drives.
VM-	Motor voltage -	Motor voltage positive terminals are duplicated to assist repeating power wires to multiple drives.
U	Motor Phase	U or black wire for AC motor. Not used for DC motor.
V	Motor Phase	V or red wire for AC motor. Black wire for DC motor.
W	Motor Phase	W or white wire for AC motor. Red wire for DC motor.
BRAKE+	Brake Resistor	Brake resistor wires. Use 15 ohm resistor for AC/DC-30 and 7.5 ohm resistor for AC/DC-60.
BRAKE-	Brake Resistor	
Chassis Ground	Ground and shield	Connect the blue and/or green motor wire (drain) to one ground terminal. Connect the other to the system ground point.

Minimum Wire Gauge (AWG)

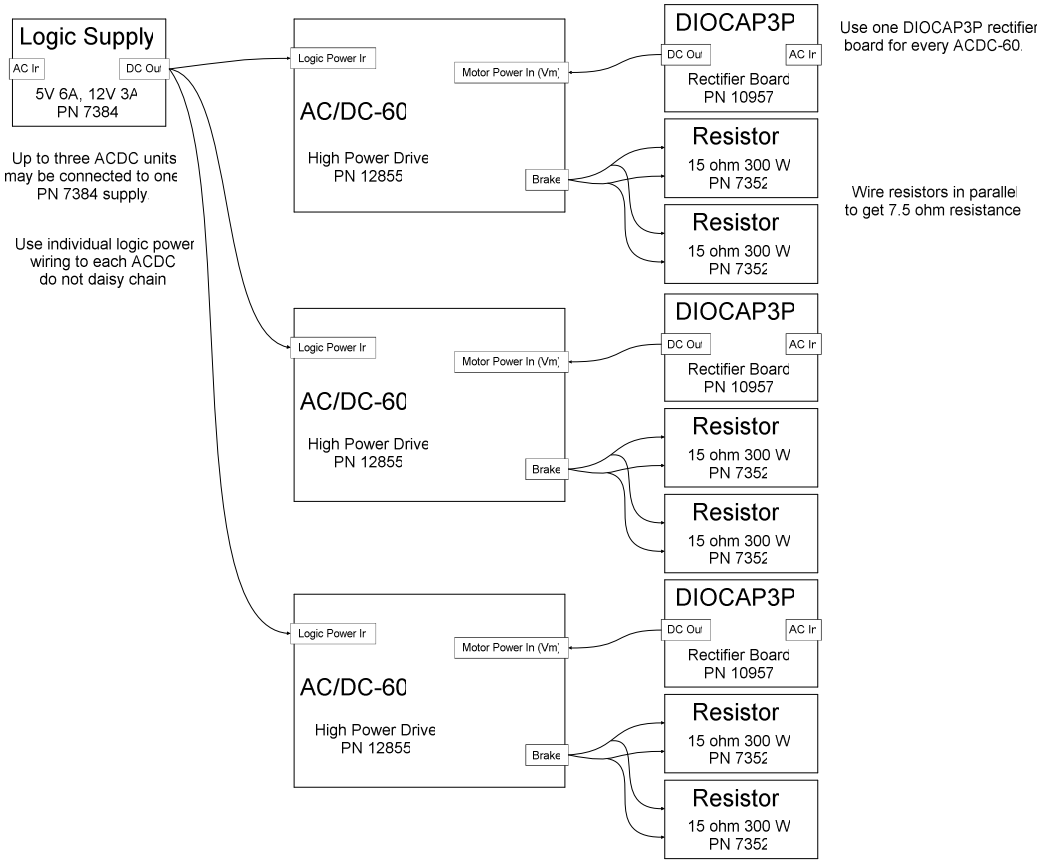
	Motor Power Cable	Vm+, Vm-	Brake+, Brake-	Logic Power
AC/DC-30	16	14	16	16
AC/DC-60	12	10	12	16

Recommendations for typical applications – cable lengths, drive current setting, and motor loads may change requirements.
Logic power wires may be smaller if voltage at supply is adjusted to offset voltage drop.

AC/DC-30 Accessory Components



AC/DC-60 Accessory Components



Encoder Connection

AC/DC accepts incremental quadrature encoders and BiSS serial protocol encoders. The type of encoder will be automatically detected when logic power is applied. The encoder must be connected before applying power, or the AC/DC will report an encoder type of "none" and will not attempt to control a motor.

Incremental quadrature encoders must have RS422 type differential outputs to work with AC/DC. The outputs have additional voltage level requirements described in a table that follows. Incremental commutation encoders for use with AC brushless (PMSM) motors have commutation channels (U, V, W) in addition to the position channels (A, B, Z). These additional channels are used to indicate rotor position for smooth initial startup. Commutation channels must be aligned using the "move sync" functions in CNC11 when mounting a new encoder.

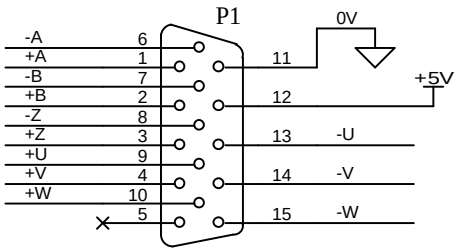
Incremental quadrature encoders for DC brush motors require only A, B, and Z position channels. Notice that the A and B channels are swapped for DC encoders to reverse the count direction and maintain backward compatibility with older Centroid DC systems.

BiSS protocol encoders communicate all needed information over only two differential pairs. This type of encoder is available in single and multi-turn absolute versions. The more advanced protocol allows for a very high number of counts per revolution, which enables very smooth motion and high accuracy.

Encoder Channel Voltage Requirements

Characteristic	Min.	Typ.	Max.	Unit
Encoder channel low level	0.0	0.3	0.5	V
Encoder channel high level	3.0	3.5	5.0	V

ACDC Encoder Connector Pinout



P1 Face View

Mating Connector Solder Side View

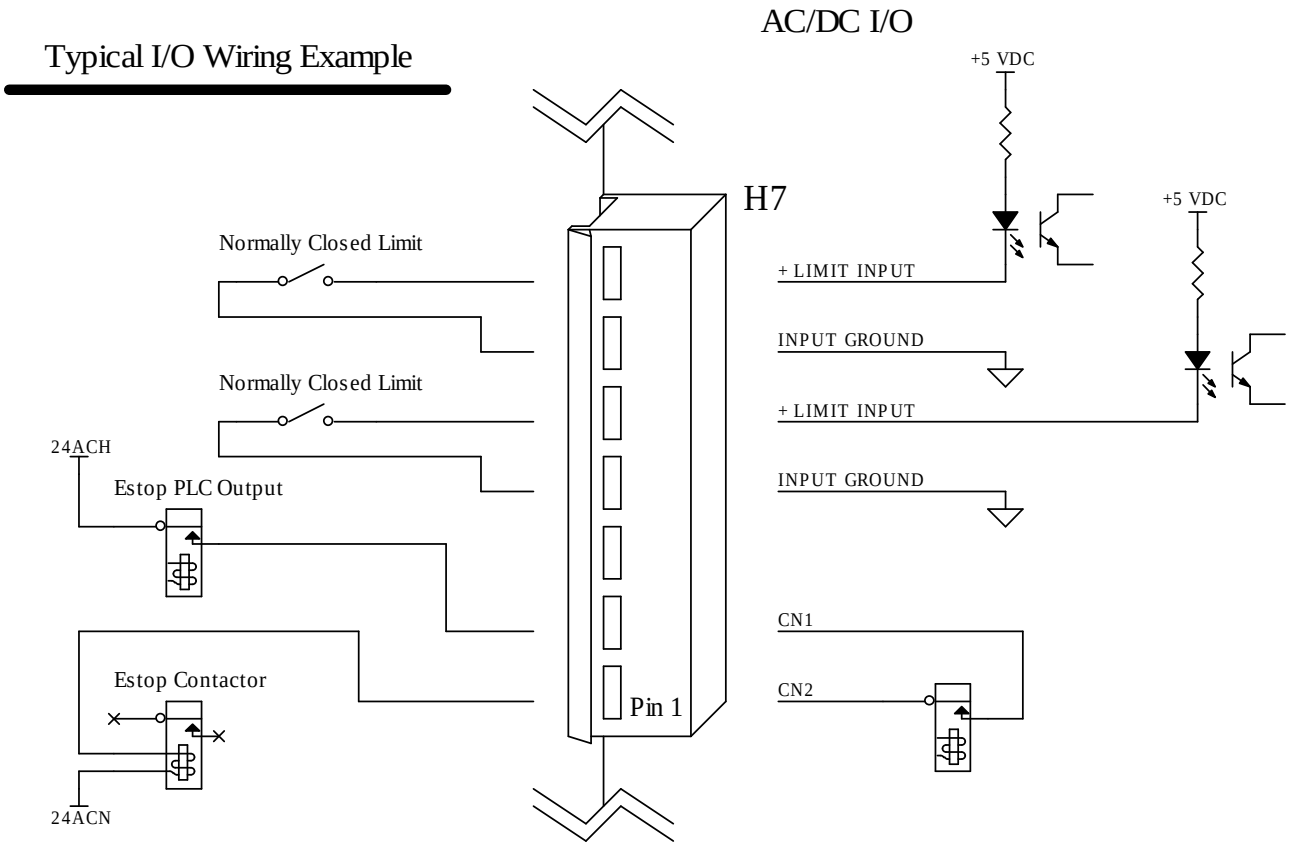
P1	Encoder Type		
Pin	AC Incremental	DC Incremental	BiSS Protocol
1	+A	+B	-
2	+B	+A	-
3	+Z	+Z	+Data
4	+V	-	-
5	-	-	-
6	-A	-B	-
7	-B	-A	-
8	-Z	-Z	-Data
9	+U	-	+Clock
10	+W	-	-
11	0V	0V	0V
12	+5V	+5V	+5V
13	-U	-	-Clock
14	-V	-	-
15	-W	-	-
Case	Shield / Drain	Shield / Drain	Shield / Drain

Count Directions

Motor	Encoder Count Direction (while turning shaft clockwise, looking at mounting flange)
Brushless	PID screen Abs Pos increases
Brush	PID screen Abs Pos decreases

AC/DC Inputs and Outputs

The 7 pin I/O connector provides a fault output and limit inputs. Limit switches are normally wired to the PLC and not the AC/DC. The drive fault relay output should be wired in series with the Estop power circuit.



Parameter Setup

Parameter	Setting	Description
300-307	1 through 8	Drive axis mapping
308-315	7 through 14	Encoder assignments
357-364	Motor Dependent	Maximum RPM, may also be set from drive PID screen
340-347	1.75	Precision mode delay
256	2	Drive mode
21-24	Motor dependent	Motor heating coefficients axes 1-4
132-135	Motor dependent	Motor heating coefficients axes 5-8
25-28	Motor dependent	Motor cooling coefficients axes 1-4
236-239	Motor dependent	Motor cooling coefficients axes 5-8
29	Motor dependent	Motor temperature warning level
30	Motor dependent	Motor temperature error level
374	255	Debug log axis inclusion (bitwise)
375	4000	Debug log size (samples) 0 to 32768
376	1	Debug log collection type 1 = current data, 2 = position data
284-291	Depends on resistor	Brake resistor wattage

Heating and Cooling Parameter Values
(Machine Units: Inches)

Provider	Model	Alias	Heating Parameter	Cooling Parameter
Centroid	HDM82E8-76S	SEM 750W	156.5817	6.4103
Centroid	APM-SE15AXK1-CT2	Mecapion 1kW	2.5671	4.5045
Centroid	HJ130C8-64S	1kW	7.9778	3.3333
Centroid	HJ130G8-88S	2kW	3.0612	2.7778
Centroid	HJT155D8-110S	4kW	1.3287	2.7778
Centroid	HJT155B8-110S	3kW	3.4830	2.7778
Centroid	APM-SE22A	Mecapion 2kW	1.3291	4.0650
Centroid	APM-SF30G	Mecapion 2.9kW	1.0248	5.3763
Centroid	APM-SF44G	Mecapion 4.4kW	0.4429	4.7619
Fanuc	A06B-0631-B0xx	Fanuc Black Cap 00	60.4690	11.1111
Fanuc	A06B-0613-B0xx	Fanuc Black Cap 0	4.0135	3.3333
Fanuc	A06B-0614-B025	Fanuc Black Cap 5	3.6486	3.0303
Fanuc	A06B-0601-Bxxx	Fanuc Black Cap 10	0.5017	1.6667
Fanuc	A06B-0602-Bxxx	Fanuc Black Cap 20	0.2527	1.5873
Fanuc	A06B-0632-Bxxx	Fanuc Yellow Cap 00M	120.4052	11.1111
Fanuc	A06B-0641-Bxxx	Fanuc Yellow Cap 0M	12.3874	3.7037
Fanuc	A06B-0642-Bxxx	Fanuc Yellow Cap 5M	7.1351	3.3333
Fanuc	A06B-0651-B012	Fanuc Yellow Cap 10M	2.8668	2.3810
Fanuc	A06B-0652-Bxxx	Fanuc Yellow Cap 20M	1.1149	2.0833
Fanuc	A06B-0653-Bxxx	Fanuc Yellow Cap 30M	0.5902	1.9608
Fanuc	A06B-0374-Bxxx	Fanuc Red Cap 0-0SP	16.6116	8.3333
Fanuc	A06B-0313-Bxxx	Fanuc Red Cap 0S	26.4090	3.7037
Fanuc	A06B-0314-Bxxx	Fanuc Red Cap 5S	14.9505	3.3333
Fanuc	A06B-0514-Bxxx	Fanuc Red Cap 5S/3000	4.8340	3.3333
Fanuc	A06B-0316-Bxxx	Fanuc Red Cap 6S	6.3282	3.0303
Fanuc	A06B-0320-Bxxx	Fanuc Red Cap 6S/3000	4.0692	3.0303
Fanuc	A06B-0315-Bxxx	Fanuc Red Cap 10S	7.2561	2.7778
Fanuc	A06B-0317-Bxxx	Fanuc Red Cap 10S/3000	1.7904	2.7778
Fanuc	A06B-0505-Bxxx	Fanuc Red Cap 20S/1500	1.4384	2.5641
Fanuc	A06B-0502-B065#7000	Fanuc Red Cap 20S	0.9969	2.5641
Fanuc	A06B-0590-Bxxx	Fanuc Red Cap 30S	1.5897	2.5641
Fanuc	A06B-0506-Bxxx	Fanuc Red Cap 30/2000	0.4730	2.5641
Fanuc	A06B-0581-Bxxx	Fanuc Red Cap 40	0.2965	1.8519
Fanuc	A06B-0123-Bxxx	Fanuc Red Cap Alpha 3/3000	26.4090	3.7037
Fanuc	A06B-0127-Bxxx	Fanuc Red Cap Alpha 6/2000	16.0374	3.3333
Fanuc	A06B-0128-Bx77 #70xx	Fanuc Red Cap Alpha 6/3000	5.0293	3.3333
Fanuc	A06B-0142-Bxxx	Fanuc Red Cap Alpha 12/2000	5.4121	2.7778
Fanuc	A06B-0143-Bx75 #70xx	Fanuc Red Cap Alpha 12/3000	1.7445	2.7778
Fanuc	A06B-0146-Bxxx	Fanuc Red Cap Alpha 22/1500	2.4760	2.5641
Fanuc	A06B-0147-Bx75 #70xx	Fanuc Red Cap Alpha 22/2000	1.1063	2.5641
Fanuc	A06B-0151-Bxxx	Fanuc Red Cap Alpha 30/1200	2.2628	2.3810
Fanuc	A06B-0152-Bxxx	Fanuc Red Cap Alpha 30/2000	0.8804	2.3810
Fanuc	A06B-0034-Bxxx #000x	Fanuc Red Cap Beta 6/2000	20.0468	4.1667
Fanuc	A06B-0141-Bx75#7008	Fanuc Red Cap Alpha C12/2000	12.0400	2.7778
Fanuc	A06B-0145-Bxxx	Fanuc Red Cap Alpha C22/1500	2.4760	2.5641
Fanuc	A06B-0063-Bx0x	Fanuc Red Cap Beta 4/4000is	56.9187	8.3333

Fanuc	A06B-0075-B203	Fanuc Red Cap Beta 8/3000is	34.9260	8.3333
Fanuc	A06B-0078-Bx0x	Fanuc Red Cap Beta 12/3000is	9.6681	6.6667
Fanuc	A06B-0085-Bx0x	Fanuc Red Cap Beta 22/2000is	6.5645	5.5556
Fanuc	A06B-0511-Bxxx	Fanuc Red Cap Early 0	11.7374	3.7037
Fanuc	A06B-0512-Bxxx	Fanuc Red Cap Early 5	10.8766	3.3333
Fanuc	A06B-0501-Bxxx	Fanuc Red Cap Early 10	3.4637	2.7778
Fanuc	A06B-0505-Bxxx	Fanuc Red Cap Early 20M	1.7194	2.5641
Fanuc	A06B-0502-Bxxx	Fanuc Red Cap Early 20	0.9672	2.5641
Fanuc	A06B-0503-Bxxx	Fanuc Red Cap Early 30	0.7993	2.5641
Fanuc	A06B-0506-Bxxx	Fanuc Red Cap Early 30R	0.4600	2.5641

AC/DC Motor Setup

Motor Type			Position PID			Motor	Current PID								
Provider	Model	Alias	P	I	D	Enc CPR	Poles	Current	Angle	P	I	D	Inertia	Kt	Max RPM
Centroid	HDM82E8-76S	SEM 750W	0.3	0.002	0.1	8192	8	6	0.02	2.5	0.1	0	0.0009	5.64	3900
Centroid	HR70A4-64S	SEM 400W	0.0	0.001	0.0	8192	4	4.2	0.012	1.5	0.1	0	0.0003	1.56	5000
Centroid	APM-SE15AXK1-CT2	Mecapion 1kW	1.5	0.020	3.0	8192	8	20.1	0.007	1.5	0.1	0	0.0106	5.25	5000
Centroid	LDSM85-CS	Leedan 750W	0.5	0.010	0.3	8192	8	10.8	0.006	0.9	0.1	0	0.0029	5.52	3000
Centroid	HJ130C8-64S	1kW	1.0	0.020	3.0	40000	8	30	0.007	2.5	0.1	0	0.0140	4.67	4000
Centroid	HJ130G8-88S	2kW	3.0	0.020	3.0	8192	8	48	0.008	2	0.1	0	0.0230	6.36	3400
Centroid	HJT155D8-110S	4kW	2.0	0.020	5.0	40000	8	60	0.015	3	0.1	0	0.0480	8.06	2727
Centroid	HJT155B8-110S	3kW	1.0	0.020	3.0	4194304	8	48	0.013	5	0.1	0	0.0290	8.06	2727
Centroid	APM-SE22A	Mecapion 2kW	0.0	0.000	0.0	8192	8	48	0	0	0	0	0.0154	5.27	5000
Centroid	APM-SE30AXK3-CT	Mecapion 3.0kW	2.0	0.020	3.0	8192	8	51	0	1.5	0.07	0	0.0201	5.00	5000
Centroid	APM-FF30G	Mecapion 2.9kW	9.0	0.060	10.0	524288	8	45.6	0	2.5	0.08	0	0.0410	7.52	3000
Centroid	APM-FF44G	Mecapion 4.4kW	15.0	0.250	15.0	524288	8	60	0	1.5	0.04	0	0.0654	5.95	3000
Centroid	GMR3340-30	16 inlb	0.5	0.020	0.4	8000	0	12.6	x	2	0.1	0	0.0031	2.53	3200
Centroid	GM3340-30	16 inlb Ferrite Magnet	0.5	0.020	0.4	8000	0	12	x	2.5	0.1	0	0.0030	2.53	3200
Centroid	GM4030-41	29 inlb	0.8	0.020	0.7	8000	0	15.9	x	2	0.1	0	0.0163	3.44	3500
Fanuc	A06B-0631-B0xx	Fanuc Black Cap 00	1.0	0.020	1.0	40000	0	12	x	0.75	0.08	0	0.0018	1.52	2000
Fanuc	A06B-0613-B0xx	Fanuc Black Cap 0	1.3	0.020	2.0	40000	0	24	x	0.75	0.08	0	0.0252	2.12	2000
Fanuc	A06B-0614-B025	Fanuc Black Cap 5	1.0	0.020	3.0	40000	0	24	x	2	0.1	0	0.0434	4.23	2000
Fanuc	A06B-0601-Bxxx	Fanuc Black Cap 10	9.0	0.020	10.0	40000	0	48	x	3.5	0.1	0	0.1736	4.72	1500
Fanuc	A06B-0602-Bxxx	Fanuc Black Cap 20	10.0	0.020	12.0	40000	0	60	x	3.5	0.1	0	0.2864	6.74	1500
Fanuc	A06B-0632-Bxxx	Fanuc Yellow Cap 00M	0.4	0.005	0.4	40000	0	8	x	2	0.1	0	0.0039	2.20	2000
Fanuc	A06B-0641-Bxxx	Fanuc Yellow Cap 0M	1.0	0.020	1.0	40000	0	15	x	2	0.1	0	0.0220	3.73	2000
Fanuc	A06B-0642-Bxxx	Fanuc Yellow Cap 5M	2.0	0.020	1.8	40000	0	18	x	6	0.1	0	0.0320	5.80	2000
Fanuc	A06B-0651-B012	Fanuc Yellow Cap 10M	9.0	0.020	7.5	40000	0	24	x	3.5	0.1	0	0.1130	8.85	1500
Fanuc	A06B-0652-Bxxx	Fanuc Yellow Cap 20M	10.0	0.020	12.0	40000	0	36	x	3.5	0.1	0	0.1649	11.28	1500
Fanuc	A06B-0653-Bxxx	Fanuc Yellow Cap 30M	10.0	0.020	12.0	40000	0	48	x	3.5	0.1	0	0.3211	13.89	1200
Fanuc	A06B-0374-Bxxx	Fanuc Red Cap 0-0SP	2.0	0.020	3.0	40000	8	24	0	2	0.1	0	0.0074	2.13	3000
Fanuc	A06B-0313-Bxxx	Fanuc Red Cap 0S	2.0	0.020	3.0	40000	8	12	0	2.2	0.1	0	0.0174	4.01	3000
Fanuc	A06B-0314-Bxxx	Fanuc Red Cap 5S	2.0	0.020	3.0	40000	8	15	0	2.2	0.1	0	0.0330	6.32	2000
Fanuc	A06B-0514-Bxxx	Fanuc Red Cap 5S/3000	2.0	0.020	3.0	40000	8	30	0	2.2	0.1	0	0.0330	3.57	3000
Fanuc	A06B-0316-Bxxx	Fanuc Red Cap 6S	3.0	0.020	5.0	40000	8	24	0	2.2	0.1	0	0.0486	6.51	2000
Fanuc	A06B-0320-Bxxx	Fanuc Red Cap 6S/3000	3.0	0.020	5.0	40000	8	30	0	2.2	0.1	0	0.0486	5.22	3000
Fanuc	A06B-0315-Bxxx	Fanuc Red Cap 10S	5.0	0.020	7.0	40000	8	21	0	2.2	0.1	0	0.0868	9.64	2000
Fanuc	A06B-0317-Bxxx	Fanuc Red Cap 10S/3000	5.0	0.020	7.0	40000	8	45	0	2.2	0.1	0	0.0868	4.82	3000
Fanuc	A06B-0505-Bxxx	Fanuc Red Cap 20S/1500	10.0	0.020	12.0	40000	8	48	0	2.5	0.08	0	0.1476	8.57	1500
Fanuc	A06B-0502-B065#7000	Fanuc Red Cap 20S	10.0	0.020	12.0	40000	8	60	0.003	2.5	0.08	0	0.1800	7.13	2000
Fanuc	A06B-0318-Bxxx	Fanuc Red Cap 20S/3000	0.0	0.000	0.0	40000	8	60	0	0	0	0	0.1476	4.32	3000
Fanuc	A06B-0590-Bxxx	Fanuc Red Cap 30S	10.0	0.020	12.0	40000	8	45	0	2.5	0.08	0	0.2083	14.96	1200

Fanuc	A06B-0506-Bxxx	Fanuc Red Cap 30/2000	10.0	0.020	12.0	40000	8	60	0	2.5	0.08	0	0.2083	6.45	2000
Fanuc	A06B-0319-Bxxx	Fanuc Red Cap 30S/3000	10.0	0.020	12.0	40000	8	60	0	2.5	0.08	0	0.2083	5.38	3000
Fanuc	A06B-0581-Bxxx	Fanuc Red Cap 40	10.0	0.020	12.0	40000	8	60	0	2.5	0.08	0	0.2691	11.39	1200
Fanuc	A06B-0583-Bxxx	Fanuc Red Cap 40S/2000	0.0	0.000	0.0	40000	8	60	0	0	0	0	0.2691	8.51	2000
Fanuc	A06B-0123-Bxxx	Fanuc Red Cap Alpha 3/3000	1.0	0.020	1.0	40000	8	12	0	1.5	0.05	0	0.0122	4.07	3000
Fanuc	A06B-0127-Bxxx	Fanuc Red Cap Alpha 6/2000	2.0	0.020	3.0	40000	8	16.8	0	1.5	0.05	0	0.0234	6.76	2000
Fanuc	A06B-0128-Bx77 #70xx	Fanuc Red Cap Alpha 6/3000	3.0	0.020	5.0	40000	8	30	0.003	1.5	0.05	0	0.0234	3.75	4000
Fanuc	A06B-0142-Bxxx	Fanuc Red Cap Alpha 12/2000	3.0	0.020	5.0	40000	8	26.4	0	2	0.1	0	0.0555	8.51	2000
Fanuc	A06B-0143-Bx75 #70xx	Fanuc Red Cap Alpha 12/3000	5.0	0.020	7.0	40000	8	45	0	2	0.1	0	0.0555	4.82	3000
Fanuc	A06B-0146-Bxxx	Fanuc Red Cap Alpha 22/1500	10.0	0.020	12.0	40000	8	37.2	0	2.5	0.1	0	0.1042	11.01	1500
Fanuc	A06B-0147-Bx75 #70xx	Fanuc Red Cap Alpha 22/2000	10.0	0.020	12.0	40000	8	54	0	2.5	0.1	0	0.1042	7.32	2000
Fanuc	A06B-0148-Bxxx	Fanuc Red Cap Alpha 22/3000	0.0	0.000	0.0	40000	8	60	0	0	0	0	0.1042	4.26	3000
Fanuc	A06B-0151-Bxxx	Fanuc Red Cap Alpha 30/1200	10.0	0.020	12.0	40000	8	37.8	0	2.5	0.1	0	0.1476	14.83	1200
Fanuc	A06B-0152-Bxxx	Fanuc Red Cap Alpha 30/2000	10.0	0.020	12.0	40000	8	60	0	2.5	0.1	0	0.1476	9.26	2000
Fanuc	A06B-0153-Bx75 #70xx	Fanuc Red Cap Alpha 30/3000	0.0	0.000	0.0	40000	8	60	0	0	0	0	0.1476	5.57	3000
Fanuc	A06B-0157-Bx75 #700x	Fanuc Red Cap Alpha 40/2000	10.0	0.020	12.0	40000	8	60	0	2.5	0.1	0	0.1996	8.76	2000
Fanuc	A06B-0158-Bx75 #700x	Fanuc Red Cap Alpha 40/2000 (fan)	0.0	0.000	0.0	40000	8	60	0	0	0	0	0.1996	8.76	2000
Fanuc	A06B-0113-Bxxx #000x	Fanuc Red Cap Beta 0.5/3000	0.0	0.000	0.0	40000	8	8.4	0	0	0	0	0.0002	1.44	4000
Fanuc	A06B-0031-Bxxx #000x	Fanuc Red Cap Beta 1/3000	0.0	0.000	0.0	40000	8	9.6	0	0	0	0	0.0030	1.94	3000
Fanuc	A06B-0032-Bxxx #000x	Fanuc Red Cap Beta 2/3000	0.0	0.000	0.0	40000	8	9.6	0	0	0	0	0.0058	3.82	4000
Fanuc	A06B-0033-Bxxx #000x	Fanuc Red Cap Beta 3/3000	1.0	0.020	1.0	40000	8	15	0	2	0.1	0	0.0174	3.50	3000
Fanuc	A06B-0034-Bxxx #000x	Fanuc Red Cap Beta 6/2000	2.0	0.020	1.8	40000	8	15	0	2	0.1	0	0.0347	6.57	3000
Fanuc	A06B-0121-Bxxx	Fanuc Red Cap Alpha C3/2000	0.0	0.000	0.0	40000	8	9	0	0	0	0	0.0122	6.63	2000
Fanuc	A06B-0126-Bxxx	Fanuc Red Cap Alpha C6/2000	0.0	0.000	0.0	40000	8	10.8	0	0	0	0	0.0234	10.51	2000
Fanuc	A06B-0141-Bx75#7008	Fanuc Red Cap Alpha C12/2000	7.0	0.020	9.0	40000	8	18	0.01	4	0.08	0	0.0555	12.77	2000
Fanuc	A06B-0145-Bxxx	Fanuc Red Cap Alpha C22/1500	10.0	0.020	12.0	40000	8	37.2	0	4	0.08	0	0.1042	11.01	1500
Fanuc	A06B-0063-Bx0x	Fanuc Red Cap Beta 4/4000is	1.0	0.020	1.0	40000	8	12	0	2.5	0.1	0	0.0046	4.69	4000
Fanuc	A06B-0075-B203	Fanuc Red Cap Beta 8/3000is	2.0	0.020	1.8	40000	8	18	0.001	2.5	0.1	0	0.0103	7.26	3000
Fanuc	A06B-0078-Bx0x	Fanuc Red Cap Beta 12/3000is	5.0	0.020	7.0	40000	8	30	0	2.5	0.1	0	0.0208	6.76	3000
Fanuc	A06B-0085-Bx0x	Fanuc Red Cap Beta 22/2000is	10.0	0.020	12.0	40000	8	30	0	2.5	0.1	0	0.0520	11.08	2000
Fanuc	A06B-0511-Bxxx	Fanuc Red Cap Early 0	2.0	0.020	3.0	40000	8	21	0	2	0.1	0	0.0174	2.64	2000
Fanuc	A06B-0512-Bxxx	Fanuc Red Cap Early 5	2.0	0.020	5.0	40000	8	21	0.006	2	0.1	0	0.0330	5.40	2000
Fanuc	A06B-0501-Bxxx	Fanuc Red Cap Early 10	5.0	0.020	7.0	40000	8	33	0	2.2	0.1	0	0.0868	6.75	2000
Fanuc	A06B-0505-Bxxx	Fanuc Red Cap Early 20M	10.0	0.020	12.0	40000	8	45	0	2.5	0.08	0	0.1476	9.51	1500
Fanuc	A06B-0502-Bxxx	Fanuc Red Cap Early 20	10.0	0.020	12.0	40000	8	60	0	2.5	0.08	0	0.1476	7.36	2000
Fanuc	A06B-0503-Bxxx	Fanuc Red Cap Early 30	10.0	0.020	12.0	40000	8	60	0	2.5	0.08	0	0.2083	10.43	1200
Fanuc	A06B-0506-Bxxx	Fanuc Red Cap Early 30R	10.0	0.020	12.0	40000	8	60	0	2.5	0.08	0	0.2083	6.44	2000

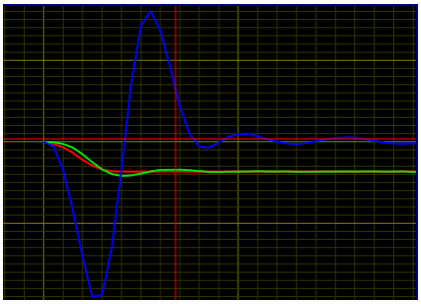
*Current is in amps. This needs to be converted to a percentage of full current to enter into the drive menu. The percentage will change depending on whether AC/DC 30 or AC/DC 60 is used.

Motor Tuning

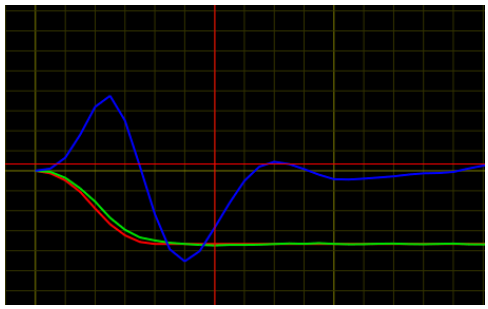
AC/DC tuning is performed from two menus in the CNC11 software. The drive menu (<F1>, <F3>, <F4>, <F8>) is used to set the current control parameters for the motor. The parameters in this menu, with the exception of inertia, do not change based on machine type, and can therefore be set once from the provided charts. Inertia is set to the motor inertia as a starting point. Once the motor is mounted to a machine, the inertia value will need to be increased to compensate for the additional inertia of the mechanical drive components.

The following plots demonstrate the effect of the inertia setting. The green line is the motor velocity and the blue line is the error from expected velocity. In the first example, inertia is set to the motor inertia, but a load has been added, so the setting is too low. The error plot shows that the motor is behind the expected position on acceleration. In the second example, the inertia value has been increased too much. The motor moves ahead of its expected position during acceleration. In the third example, inertia has been set to a reasonably accurate value. The motor follows closely at the beginning of the move. Some lag occurs later in the move, but this may be minimized by tuning the position Kp and Kd gains.

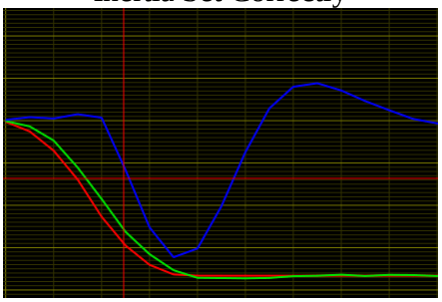
Inertia Set too Low



Inertia Set too High



Inertia Set Correctly

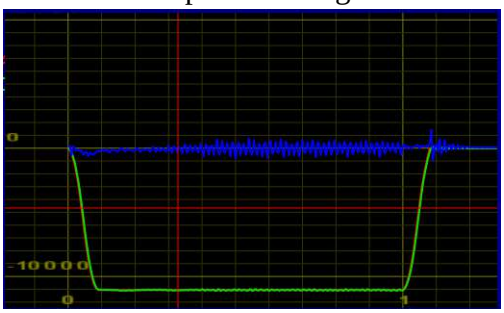


The PID Config menu (<F1>, <F3>, <F4>, <F1>) is used to tune the remainder of the motor control parameters. Start by entering the Position PID parameters given in the motor setup charts. Increase Kp until some oscillation is heard or seen on the PID tuning graph. Reduce the setting below the oscillation point to give some headroom for stability.

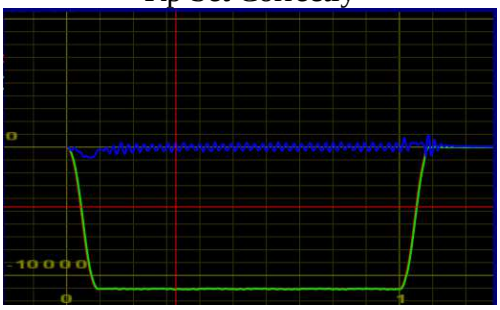
The following examples show the effect of Kp. In the first example, Kp is set too low. Large error peaks show where the motor is not following the requested path. Increasing Kp leads to the second example, where error is low throughout the move. However, there is an increasing oscillation in the error plot, indicating that the motor will soon become unstable. The third example demonstrates a Kp reduction to improve stability. The error plot has close to the minimum error achieved during tuning and does not have signs of instability.

Kp Set too Low

Kp Set too High



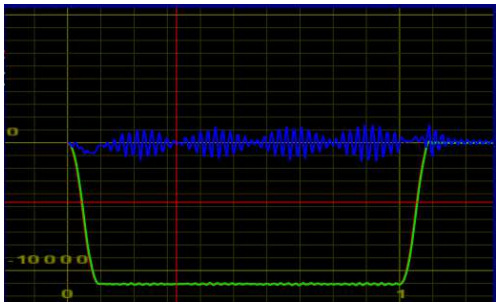
Kp Set Correctly



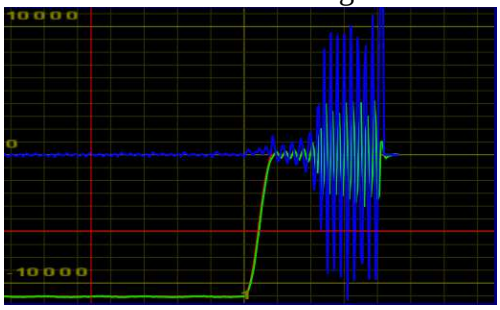
After Kp has been adjusted, continue to tuning Kd. The Kd term adds stability to the to the effects of Kp. If Kp or Kd have been adjusted far from the default values, a second iteration of the tuning procedure is recommended. Because the two terms are dependent on each other, a better Kd setting may allow Kp to adjusted for higher performance.

Incorrect Kd settings create oscillations. A low Kd setting creates low frequency oscillations. As Kd is increased, a high frequency oscillation will become noticeable. Often the high frequency oscillation will be audible before it is noticeable on the error plot. The example shows an extreme case of oscillation due to Kd set too high. When Kd is set properly, it will dampen the Kp contribution, giving a smooth error plot.

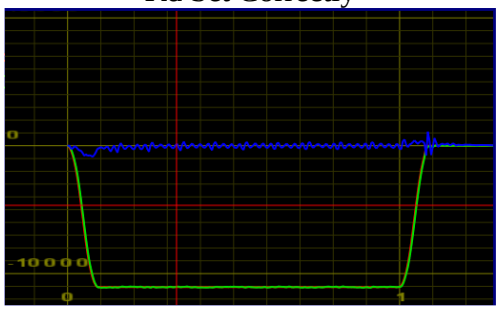
Kd Set too Low



Kd Set too High



Kd Set Correctly



LED1 Error Codes

Error Number	Meaning	Cause	Corrective Action
1	Communication Error	"Wired Input" Jumper set incorrectly or fiber 4 or cable connection not working properly	Set jumper properly and check communication cables.
2			
3			
4	Limit Tripped	any limit switch is tripped	Use the limit defeat switches to disable hardware limits
5	Drive Error	A serious fault has caused the drive to shut down	Check HSC Screen for error cause <F7>, <F9>, <F5>
6			
7			
8			
9			

Troubleshooting

Symptom	Possible Cause	Corrective Action
Brake resistor missing message	Brake resistor not connected	Connect appropriate braking resistor
	Brake resistor burned out	Replace resistor
	Too much line voltage ripple	Check line voltage, check for one or two 3 phase fuses blown
Motor overheating message appears after short run time	Parameters not correct	Check parameters 20-30, 132-135, and 236-239
	Software and firmware mismatch	Update CNC11 to v3.11 Rev 13 or newer, then update AC/DC from HSC screen
Brake Wattage Exceeded, Speed Limited!	It is estimated that a brake resistor was getting too hot.	Brake resistor wattage is too low for application.
		Parameters 284-291 are not set to match the brake resistor wattage.
		Program is too aggressive. Acceleration / deceleration time, speed, and machine mass create too much energy to dissipate. If upgrading the resistor is not possible, the alternative is to slow down the programmed moves.
Communication not working	Wired Input jumper set incorrectly	If incoming communication uses a wire cable, install jumper block. If incoming communication uses fiber optics, remove jumper.
Encoder counts not updating in PID screen <F1>, <F3>, <F4>	Communication error	Communication from MPU11 must be good for AC/DC to start up. See "Communication not working" symptom.
	Bad encoder connection	Encoder wired incorrectly or unknown type. See "Encoder Connection" Section

HSC Screen

The HSC screen (<F7>,<F9>,<F5>) shows the state of many of the AC/DC status bits. This screen is organized by DriveBus channels, therefore the channel number at the top of a column matches LED1 on the AC/DC. The columns are not reorganized by axis according to the drive mapping parameters.

If an AC/DC fault occurs that is not explained in the message window, the user can refer to the HSC screen for further information on the cause of the fault. Some of the status bits are only useful for Centroid technicians, and are subject to change.

AC/DC firmware may be updated by pressing <Alt-F5> to enter the HSC screen (that is <F7>,<F9>,<Alt-F5> from the main CNC11 screen). The AC/DC firmware program is stored as ac1.hex in the CNC11 software's directory. The "Debug counter" in the HSC screen will count up while the new program is sent. After the program is sent, the AC/DC and software must be restarted for changes to take effect

HSC Screen Bit Definitions

Name	Description	Notes
BissReceptionErrors	BiSS Encoder Sensor Mode Reception Errors	Counter from 0 to 65535, count of errors during normal running
BissModeErrors	BiSS Encoder Register Mode Reception Errors	Counter from 0 to 65535, count of errors during setup
CycloneShutdowns	FPGA shutdown counter	The FPGA will shut down under the following conditions: two interrupts missed, DSP not started, reprogram enabled, or memory test in progress. Shutdowns should be 0 during normal operation.
EstimatedBrakeWattage	Minimum wattage rating for brake resistor	This value is updated from the time the drive is turned on until it is powered off.
LoadMeter	The greater of Total current or Current Request	Current reading shown by the load meters. Typically 0 to 65535, which corresponds to 0-30A for AC/DC-30 and 0-60A for AC/DC-60.
FatalError	Fatal error	A serious error has occurred and stopped operation. See other bits for cause of error. SV_MASTER_ENABLE rising edge will clear the fatal error.
Warning	Warning bit	A condition exists which may become serious, but does not warrant stopping the AC/DC immediately.
ErrorUVWInvalid	Commutation invalid state	Commutation tracks are all on or all off
ErrorUVWBadTransition	Commutation invalid state transition	Commutation tracks have changed by more than one zone
ErrorUVWBadSize	Incorrect number of encoder counts per zone	Counts per zone is incorrect by more than 6.25%. This may also be caused by incorrect encoder counts per revolution setting.
EncoderOK	Encoder is ready.	For BiSS, good data has been received in the last 0.2 seconds. For quadrature, A and B channels are differential.
QuadratureError	Encoder invalid state transistion	For quadrature encoder, A and B have changed at the same time. Encoder count is incorrect by at least one count.
EncoderMismatch	Requested encoder type does not match detected type	Not implemented
LineVoltageOn	Vm voltage is over 30V	DC motor voltage is applied
OvercurrentHighSide	High side overcurrent	Current over 187.5A (AC/DC-60) or 150A (AC/DC-30) for 500ns. Phase to phase, phase to Vm-, or phase to shield short.

OvercurrentLowSide	Low side overcurrent	Current over 187.5A (AC/DC-60) or 150A (AC/DC-30) for 500ns. Phase to phase, phase to Vm+, or phase to shield short.
OvervoltageMotor	Motor regeneration too high	Voltage at motor has exceeded 430V
OvervoltageLine	Vm supply is too high	Voltage has exceeded 370V
BrakeResistorMissing	Brake resistor not attached or burned out	Line voltage is on, brake IGBT is off, and collector voltage is low
BrakeIGBTOpen	Brake IGBT blown	Brake IGBT is on and collector voltage is high
MotorTemperatureSwitch	Motor internal over temperature detector	Not implemented
HeatsinkTemperatureSwitch	Drive heatsink over temperature detector	Not implemented, uses temperature sensor instead
PlusLimit	Plus limit input to drive	
MinusLimit	Minus limit input to drive	
DriveShutdown	Drive shutdown due to serious error	OvercurrentHighSide, OvercurrentLowSide, OvervoltageMotor, or OvervoltageLine may cause a shutdown
BrakeOnTooMuch	Brake resistor on too much	Brake on 100% for a 10 interrupt interval. The brake resistor resistance (ohms) is too high for the application.
OvercurrentSensor	Current exceeded sensor range	Current on any phase has exceeded sensor range for 0.5ms
WarningDriveHot	Drive temperature exceeded warning temperature	Parameter 29 warning temperature
ErrorDriveTooHot	Drive temperature exceeded error temperature	Parameter 30 error temperature
WarningMotorHot	Motor temperature estimate exceeded warning temperature	Parameter 29 warning temperature
AccelTooGreat	Requested acceleration greater than physically possible	Requested acceleration is compared to calculated maximum from motor parameters
ADCOffsetOK	ADC offsets adjusted to 0 successfully	More than about 1% error will cause offset adjust to fail
ErrorMotorTooHot	Motor temperature estimate exceeded error temperature	Parameter 30 error temperature
MoveSyncRunning	Move sync procedure active	Used by alignment routines
StepRunning	Current step running	Not implemented
TuneRunning	Auto tune running	Not implemented
ErrorParameterChange	Critical motor parameters have been changed with power on	The drive must be allowed to release power before changing some parameters
CommutationZone	Current commutation zone	
DrivePower	Drive maximum power indicator	1 for AC/DC-60, 0 for AC/DC-30
EncoderType	Active encoder type	0 for none, 1 for quadrature, 2 for BiSS
EstimatedDriveTemperature	Drive temperature	Temperature reported by heatsink temperature sensor
EstimatedMotorTemperature	Estimated motor temperature	Temperature estimated by AC/DC software routine
PositionErrorSum	Sum of error	Sum of errors
PidAverage	Average of position PID	Average of 64 load meter values
Debug counter	Subject to change	Upper nibble is drive number, remaining bits are the number of status packets received, switches to number of bytes received during firmware update

Specifications

Characteristic	Min.	Typ.	Max.	Unit
5 Volt Supply Current	1.9	-	-	A
12 Volt Supply Current	0.45	-	-	A
Input Pullup Voltage (Vinp)	-	5	-	VDC
Input On Voltage	3.75	-	-	VDC
Input Off Voltage	-	-	1.25	VDC
Input Operating current	9	11	15	mA
Relay Output Current	0.1	-	10	A @ 125VAC
Relay Output Current	0.1	-	5	A @ 30VDC
Motor Output Current (Low Power Model)	-	20*	30	A
Motor Output Current (High Power Model)	-	30*	60	A
Brake resistor resistance (Low Power Model)	14	15	16	ohms
Brake resistor resistance (High Power Model)	6.5	7.5	8.5	ohms
Motor Supply Voltage	50	300	340	VDC
Fiber Optic Length	-	-	100	feet
Drive Communication Cable Length	-	-	30	feet
Size: 9.75 * 6 * 4 (W*D*H)				Inches

*Typ. column is continuous rating for output current

Mounting Dimensions