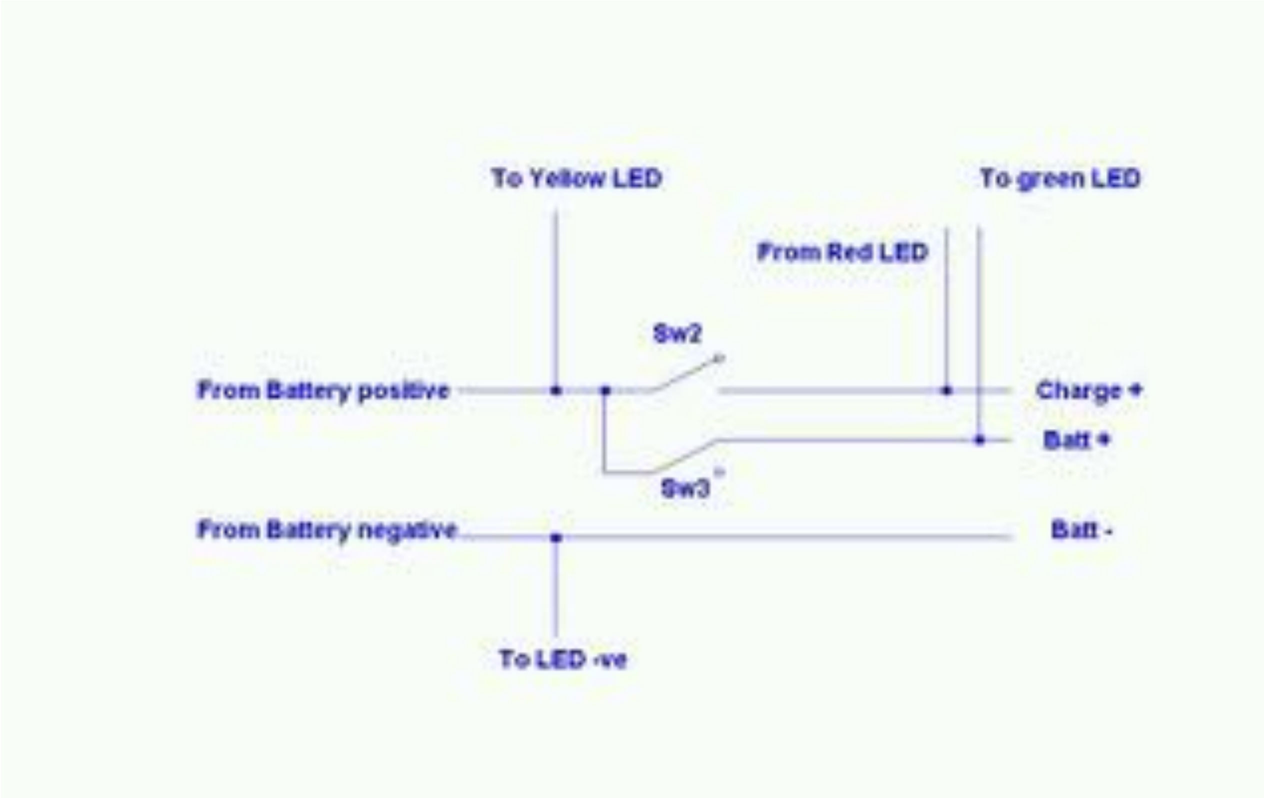


Adjustment.

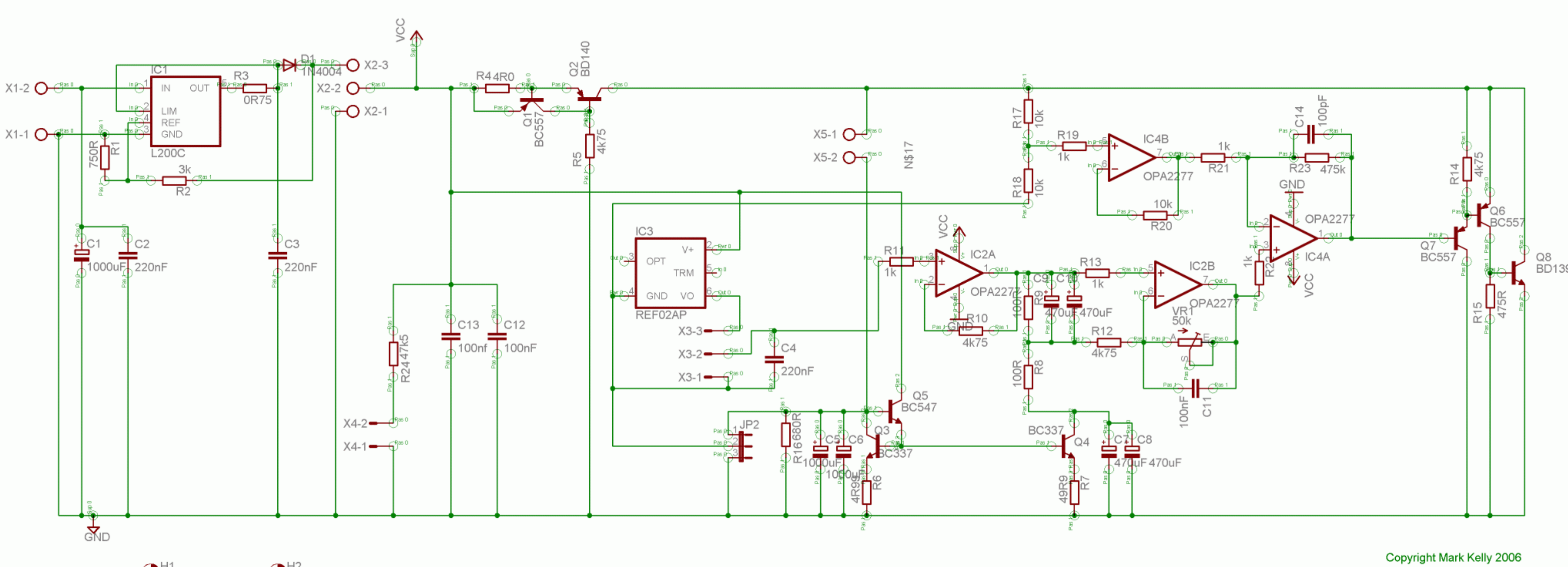
Before setting the voltage adjust VR1 all the way down (anticlockwise). For very low current motors such as the Maxon motor it is recommended to bypass the motor terminals with a resistance of approximately 1 k to give the Widlar current mirror some idle current which improves its linearity.

Use the dip switches and resistors to select the working range of the potentiometer to suit the voltage adjustment required for the motor speed. The circuit is arranged so that the two sets are selected via the toggle switch, the toggle of which "points" to the selected adjustment potentiometer. The left hand pot uses the rear set of resistors / DIP switches, the right hand pot uses the front. The DIP switches short the resistors in the "on" position. If all the resistors are shunted the potentiometer has a working range of 100%. If resistors are selected in to give a total of 50k the potentiometer has a working range of 10% thus giving finer speed control.

To set the range, select resistors to give the centre point of the potentiometer at the required voltage, the full scale output of the controller being 10.0 volts. For say 7.5 volts we would need the pot centred at 12.5k / 37.5k so we would select 10k plus half the pot above the set point and 20k,10k, 4k75 plus half the pot below. The DIP switches would thus be set to 1,0,1,1,1,0,0,0.

Before adjusting the current compensation measure the resistance of the motor as presented at the terminals on the board (including any shunt resistance as above). Take an appropriate adjustable resistance (eg a 100 ohm multiturn trimpot) and make a compensation resistance by adjusting the value as close to the resistance of the motor as you can get, using the same measurement device. Disconnect one lead of the motor wiring from the terminal, turn the controller on, measure and note the output voltage at the board terminals. For best accuracy this should be done with an output voltage above 5 volts. Turn the controller off.

Insert the compensation resistance in series between the (disconnected) board terminal and motor lead. Turn the controller on and measure the voltage present at the motor. Adjust VR1 until this voltage equals the voltage noted in step 1 above. For best accuracy this should be done with the motor loaded with a consistent load (eg running the turntable) and the board terminal voltage must be below 10 volts. Turn the controller off, remove the compensation resistance and reattach the motor wiring to the board terminal.


IC1 L200C
IC3 REF02AP
IC2A OPA2277
IC2B OPA2277
IC4A OPA2277
IC4B OPA2277
Q1 BC557
Q2 BD140
Q3 BC337
Q4 BC337
Q5 BC547
Q6 BC557
Q7 BC557
Q8 BD139
D1 1N4004
VCC
GND
N$17
JP2
VR1 50k
Copyright Mark Kelly 2006

The L200 is shown as the vertical version (L200CV) as that's what the software had.The connector X6 was drafted in reverse so it and X3 must be wired so they reverse polarity.

I have drafted in two sets of adjustment potentiometers - one pair (VR2, VR3) are 3/4 inch horizontal multiturn types which would be accessible through holes in the front panel (this is what will be supplied). The other pair (VR4, VR5) are shown as three pin connectors. If you want single turn adjustment from the front panel you can mount 9mm single turn pots (eg Spectrol 248-7-10 or similar) in the positions shown as VR4, VR5.

DO NOT mount two sets of pots, they don't work very well in parallel.

Here is a parts list for the components which go on the boards. The number following the Dale resistor description is the Dale code (value1 value2 value3 exponent). 4k75 is 475 x 10^1 so will be coded 4751. Note for kits: due to an ordering error one of the 1k resistors will actually be a Welwyn R55C.

Part	Value	Device	Package
C1	1000uF	Rubycon ZL 25V	E5-13
C2	220nF	Wima MKP 100V	C5B7.2
C3	220nF	Wima MKP 100V	C5B7.2
C4	220nF	Wima MKP 100V	C5B7.2
C5	1000uF	Rubycon ZL 16V	E5-10,5
C6	1000uF	Rubycon ZL 16V	E5-10,5
C7	470uF	Rubycon ZL 16V	E3,5-8
C8	470uF	Rubycon ZL 16V	E3,5-8
C9	470uF	Rubycon ZL 16V	E3,5-8
C10	470uF	Rubycon ZL 16V	E3,5-8
C11	100nF	Wima MKP 100V	C5B5
C12	100nF	Wima MKP 100V	C5B5
C13	100nf	Wima MKP 100V	C5B5
C14	100pF	Wima MKP 100V	C5B3
D1	1N4004	1N4004	DO41-10
IC1	L200C	Nat. Semi L200 C	L200S
IC2	OPA2277	BB OPA 2277PA	DIL08
IC3	REF02	BB REF02AP	DIL08
IC4	OPA2277	BB OPA 2277PA	DIL08
JP2	JP2E	2.54mm 3 pin header	
Q1	BC557	BC557	TO92
Q2	BD140	BD140	TO126
Q3	BC337	BC337	TO92
Q4	BC337	BC337	TO92
Q5	BC547	BC547	TO92
Q6	BC557	BC557	TO92
Q7	BC557	BC557	TO92
Q8	BD139	BD139	TO126
R1	750R	Dale RN55 1/8 watt 1% 7500	0309/12
R2	3k	Dale RN55 1/8 watt 1% 3011	0309/12
R3	0R75	Dale RS1A1watt 1%	0617/22
R4	4R0	Dale RS1A1watt 1%	0617/22
R5	4k75	Dale RN55 1/8 watt 1% 4751	0309/12
R6	4R99	Dale RN55 1/8 watt 1% 4R99	0309/12
R7	49R9	Dale RN55 1/8 watt 1% 49R9	0309/12
R8	100R	Dale RN55 1/8 watt 1% 1000	0309/12
R9	100R	Dale RN55 1/8 watt 1% 1000	0309/12
R10	4k75	Dale RN55 1/8 watt 1% 4751	0309/12
R11	1k	Dale RN55 1/8 watt 1% 1001	0309/12
R12	4k75	Dale RN55 1/8 watt 1% 4751	0309/12
R13	1k	Dale RN55 1/8 watt 1% 1001	0309/12
R14	4k75	Dale RN55 1/8 watt 1% 4751	0309/12

R15	475R	Dale RN55 1/8 watt 1% 4750	0309/12
R16	680R	WelwynR55C 1/8 watt 1% 681R	0309/12
R17	10k	Dale RN55 1/8 watt 1% 1002	0309/12
R18	10k	Dale RN55 1/8 watt 1% 1002	0309/12
R19	1k	Dale RN55 1/8 watt 1% 1001	0309/12
R20	10k	Dale RN55 1/8 watt 1% 1002	0309/12
R21	1k	Dale RN55 1/8 watt 1% 1001	0309/12
R22	1k	Dale RN55 1/8 watt 1% 1001	0309/12
R23	475k	Dale RN55 1/8 watt 1% 4753	0309/12
R24	47k5	Dale RN55 1/8 watt 1% 4752	0309/12
VR1	50k	Spectrol 1/2" vertical multiturn	RJ9W
X1	AK300/2	2 pin 5.08mm	AK300/2
X2	AK300/3	3 pin 5.08mm	AK300/3
X3	L03P	3pin 2.54mm polarised	L03P
X4	L02P	2 pin 2.54mm polarised	L02P
X5	AK300/2	2pin 5.08mm	AK300/2
R25	2k49	Dale RN55 1/8 watt 1% 2491	0309/12
R26	4k75	Dale RN55 1/8 watt 1% 4751	0309/12
R27	10k	Dale RN55 1/8 watt 1% 1002	0309/12
R28	20k	Dale RN55 1/8 watt 1% 2002	0309/12
R29	20k	Dale RN55 1/8 watt 1% 2002	0309/12
R30	10k	Dale RN55 1/8 watt 1% 1002	0309/12
R31	4k75	Dale RN55 1/8 watt 1% 4751	0309/12
R32	2k49	Dale RN55 1/8 watt 1% 2491	0309/12
R33	2k49	Dale RN55 1/8 watt 1% 2491	0309/12
R34	4k75	Dale RN55 1/8 watt 1% 4751	0309/12
R35	10k	Dale RN55 1/8 watt 1% 1002	0309/12
R36	20k	Dale RN55 1/8 watt 1% 2002	0309/12
R37	20k	Dale RN55 1/8 watt 1% 2002	0309/12
R38	10k	Dale RN55 1/8 watt 1% 1002	0309/12
R39	4k75	Dale RN55 1/8 watt 1% 4751	0309/12
R40	2k49	Dale RN55 1/8 watt 1% 2491	0309/12
S2	SW_DIP-8	8switch DIP 2.54mm	EDG-08
S3	SW_DIP-8	8switch DIP 2.54mm	EDG-08
SW1	DPDT	C&K horizontal DPDT	LSP13
VR2	5k	3/4" Bourns horizontal multiturn	PT-SPIN
VR3	5k	3/4" Bourns horizontal multiturn	PT-SPIN
VR4	5k	optional	
VR5	5k	optional	
X6	L03P	3pin 2.54mm polarised	L03P

Decision Time.

Before you start you need to decide which version of the controller you want to try. If you want the error amplifer function for greatest stability and lowest noise, use all components and set JP2 to the forward position. If you wish you can decide not to use any or all of the six smoothing capacitors (C5 - C10 inclusive). This increases noise slightly and speeds up the current compensation circuit.

If you wish to run without the error amplifier, do not insert IC4 into its socket. In its place use a jumper wire between pins 2 and 3 of the socket. In this configuration at least three of the smoothing capacitors (C5, 7 and 9) must be installed. You can decide to run with reference return to ground (JP2 at rear postion) or with reference return to motor return (JP2 at forward position).

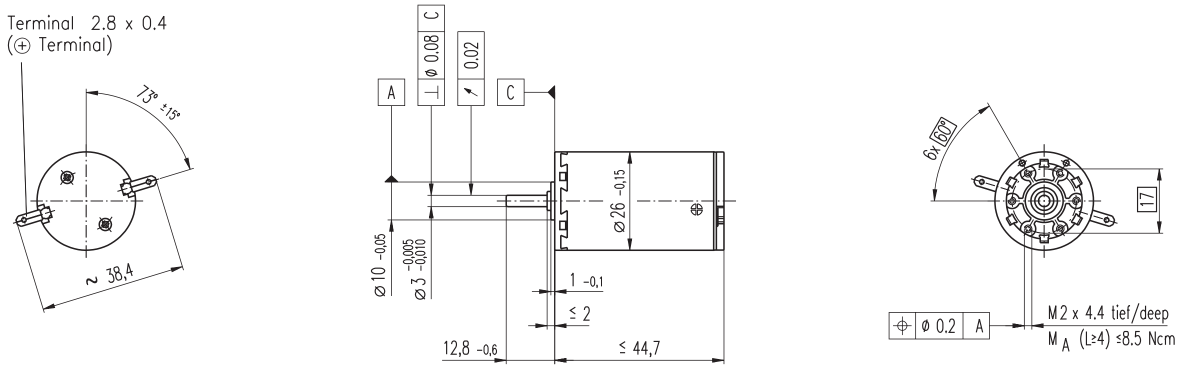
Construction:

Pack the board in order of height, soldering as you go:

Resistors

A-max 26 ∅26 mm, Precious Metal Brushes CLL, 7 Watt, CE approved

High*Power*



M 1:2

- Stock program
- Standard program
- Special program (on request)

Order Number

Motor Data			110181	110182	110183	110184	110185	110186	110187	110188	110189	110190	110191
	Values at nominal voltage												
1	Nominal voltage	V	4.5	6.0	9.0	12.0	15.0	18.0	24.0	30.0	36.0	42.0	48.0
2	No load speed	rpm	7310	8670	6160	6780	6720	6690	5670	6090	6780	6570	6050
3	No load current	mA	78.8	77.6	30.1	26.3	20.7	17.1	9.96	8.89	8.75	7.14	5.5
4	Nominal speed	rpm	6830	8070	4970	5310	5060	5000	3930	4360	5060	4820	4280
5	Nominal torque (max. continuous torque)	mNm	4.46	5.03	11.3	13.7	15.7	15.6	15.3	15.3	15.2	15.0	15.0
6	Nominal current (max. continuous current)	A	0.840	0.840	0.840	0.840	0.762	0.625	0.390	0.336	0.310	0.253	0.204
7	Stall torque	mNm	67.3	73.5	58.8	63.5	63.6	62.1	50.3	54.2	60.2	56.4	51.4
8	Starting current	A	11.5	11.2	4.25	3.78	3.01	2.43	1.25	1.16	1.20	0.930	0.683
9	Max. efficiency	%	84	84	84	84	84	84	83	84	84	84	83
	Characteristics												
10	Terminal resistance	Ω	0.390	0.536	2.12	3.17	4.99	7.41	19.2	25.8	30.1	45.1	70.2
11	Terminal inductance	mH	0.0402	0.0509	0.227	0.332	0.528	0.770	1.90	2.57	2.99	4.34	6.68
12	Torque constant	mNm / A	5.84	6.57	13.9	16.8	21.2	25.5	40.1	46.7	50.3	60.6	75.2
13	Speed constant	rpm / V	1640	1450	689	569	451	374	238	205	190	158	127
14	Speed / torque gradient	rpm / mNm	109	119	105	108	106	108	114	113	114	117	119
15	Mechanical time constant	ms	16.4	15.9	14.9	14.8	14.7	14.7	14.8	14.8	14.8	14.9	14.9
16	Rotor inertia	gcm²	14.3	12.8	13.5	13.1	13.2	13.0	12.5	12.5	12.4	12.1	12.0

Specifications

Thermal data

17	Thermal resistance housing-ambient	13.2 K / W
18	Thermal resistance winding-housing	3.2 K / W
19	Thermal time constant winding	12.4 s
20	Thermal time constant motor	772 s
21	Ambient temperature	-30 ... +65°C
22	Max. permissible winding temperature	+85°C

Mechanical data (sleeve bearings)

23	Max. permissible speed	11000 rpm
24	Axial play	0.1 - 0.2 mm
25	Radial play	0.012 mm
26	Max. axial load (dynamic)	1.7 N
27	Max. force for press fits (static)	80 N
28	Max. radial loading, 5 mm from flange	5.5 N

Mechanical data (ball bearings)

23	Max. permissible speed	11000 rpm
24	Axial play	0.1 - 0.2 mm
25	Radial play	0.025 mm
26	Max. axial load (dynamic)	5.0 N
27	Max. force for press fits (static)	75 N
28	Max. radial loading, 5 mm from flange	20.5 N

Other specifications

29	Number of pole pairs	1
30	Number of commutator segments	13
31	Weight of motor	117 g

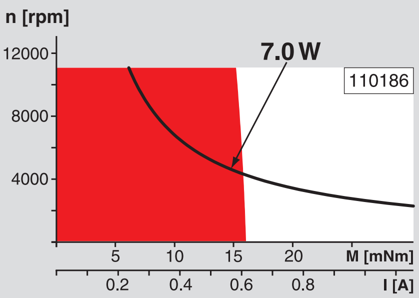
CLL = Capacitor Long Life

Values listed in the table are nominal.
Explanation of the figures on page 47.

Option

Ball bearings in place of sleeve bearings
Pigtails in place of terminals
Without CLL

Operating Range



Comments

Continuous operation
In observation of above listed thermal resistance (lines 17 and 18) the maximum permissible winding temperature will be reached during continuous operation at 25°C ambient.
= Thermal limit.

Short term operation
The motor may be briefly overloaded (recurring).

Assigned power rating

maxon Modular System

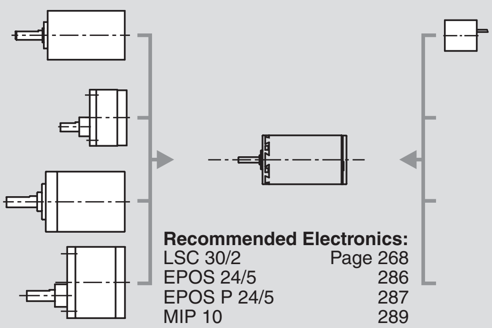
Overview on page 16 - 21

Planetary Gearhead
∅26 mm
0.5 - 2.0 Nm
Page 226

Spur Gearhead
∅30 mm
0.07 - 0.2 Nm
Page 227

Planetary Gearhead
∅32 mm
0.4 - 6.0 Nm
Page 228 / 229 / 232

Spur Gearhead
∅38 mm
0.1 - 0.6 Nm
Page 234



Encoder MEnc
∅13 mm
16 CPT, 2 channels
Page 262

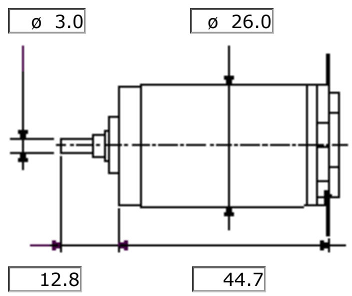
Recommended Electronics:

LSC 30/2	Page 268
EPOS 24/5	286
EPOS P 24/5	287
MIP 10	289
Notes	**18**

A-max 26

Ø 26 mm, Precious Metal Brushes CLL, 7 Watt

High *Power*



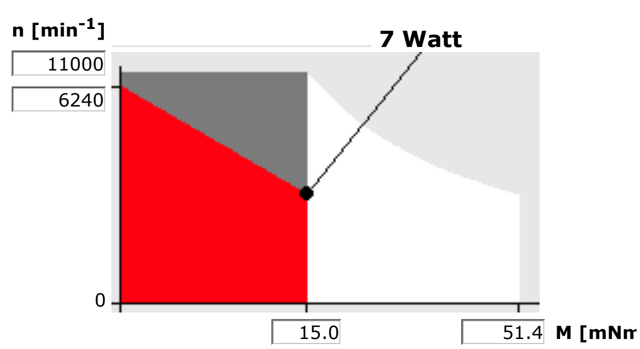
Dimensions in mm.
This schematic is not drawn to scale.

Order no.		**110191**
Motor data		
Power rating	W	7.0
Nominal voltage	Volt	48.0
No load speed	min^{-1}	6050
Stall torque	mNm	51.4
Speed/torque gradient	min^{-1} mNm^{-1}	119
No load current	mA	6
Starting current	mA	683
Terminal resistance	Ohm	70.2
Max. permissible speed	min^{-1}	11000
Max. continuous current	mA	204
Max. continuous torque	mNm	15.0
Max. power output at nominal voltage	mW	8110
Max. efficiency	%	83.0
Torque constant	mNm A^{-1}	75.2
Speed constant	min^{-1} V^{-1}	127
Mechanical time constant	ms	15
Rotor inertia	gcm^2	12.0
Terminal inductance	mH	6.68
Thermal resistance housing-ambient	KW^{-1}	13
Thermal resistance rotor-housing	KW^{-1}	3.2
Thermal time constant winding	s	11

Specifications

- Axial play — 0.1- 0.2 mm
- Max. load of **sleeve bearings**
  - axial (dynamic) — 1.7 N
  - radial (5 mm from flange) — 5.5 N
  - Press-fit force (static) — 80 N
- Max. load of **ball bearings**
  - axial (dynamic) — 5.0 N
  - radial (5 mm from flange) — 21 N
  - Press-fit force (static) — 75 N
- Radial play **sleeve bearings** — 0.012 mm
- Radial play **ball bearings** — 0.025 mm
- Ambient temperature range — -30/+ 65 °C

Operating range



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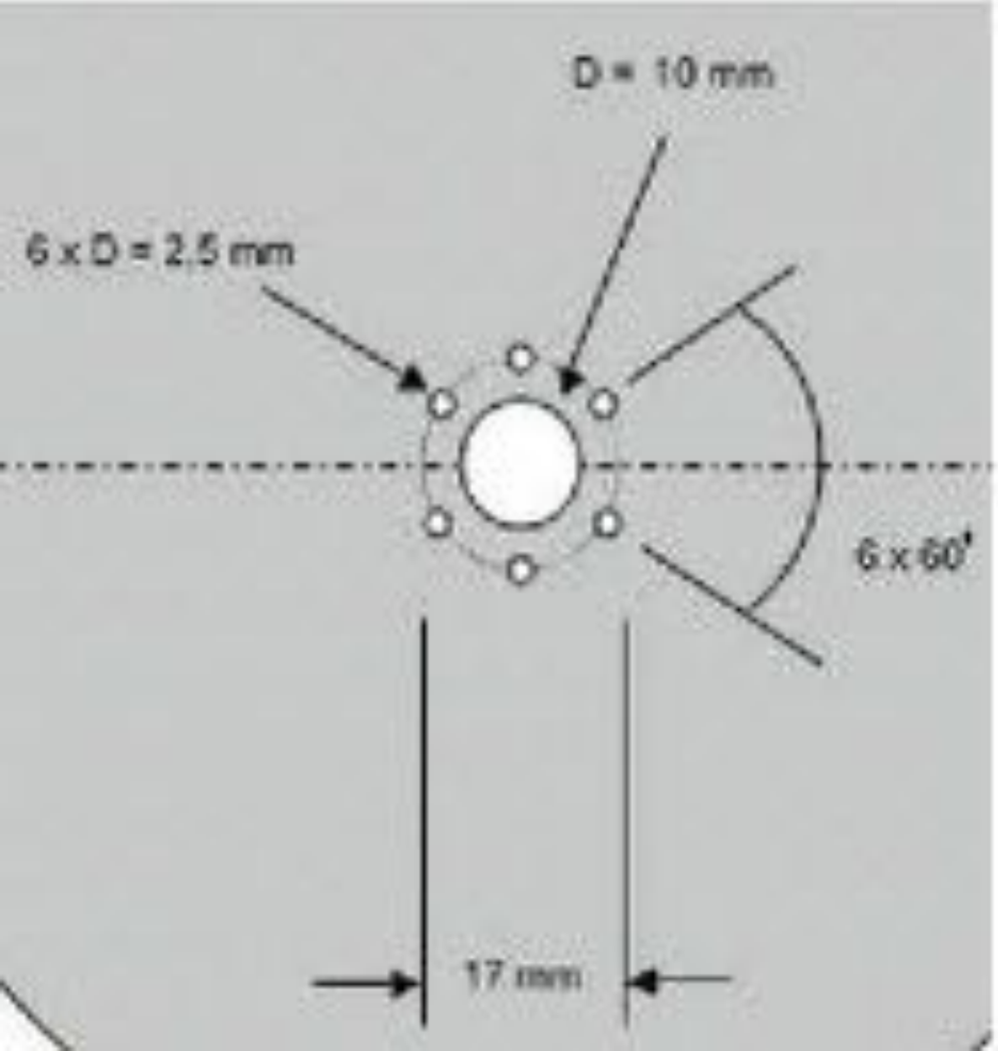
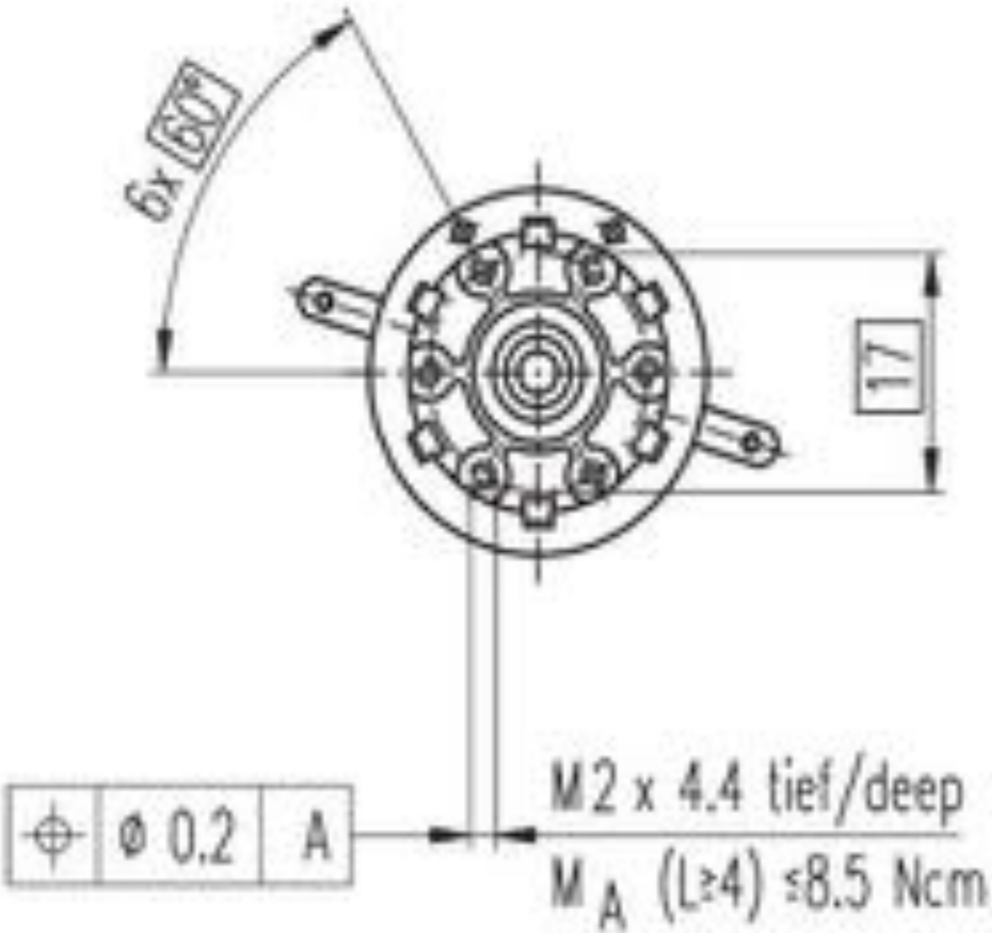
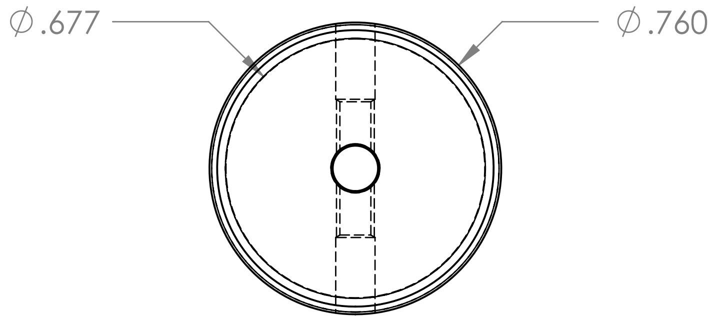
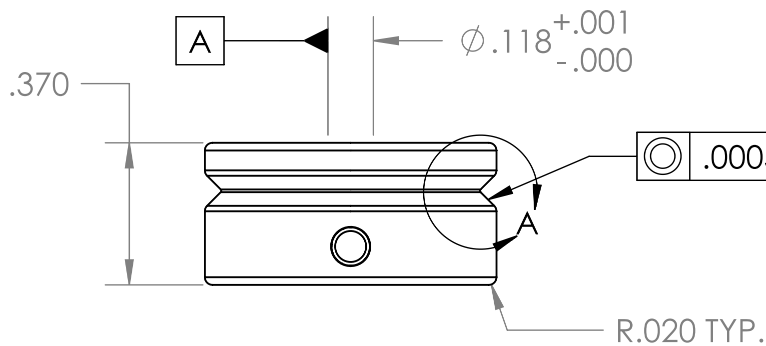
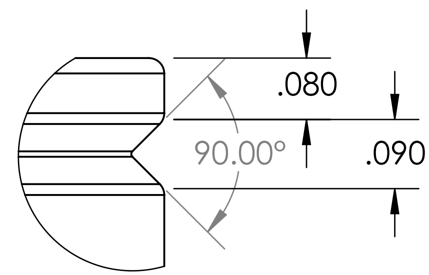

D = 10 mm
6 x D = 2.5 mm
6 x 60°
17 mm


6x 60°
17
Ø 0.2
A
M2 x 4.4 tief/deep
M A (L≥4) ≤8.5 Ncm







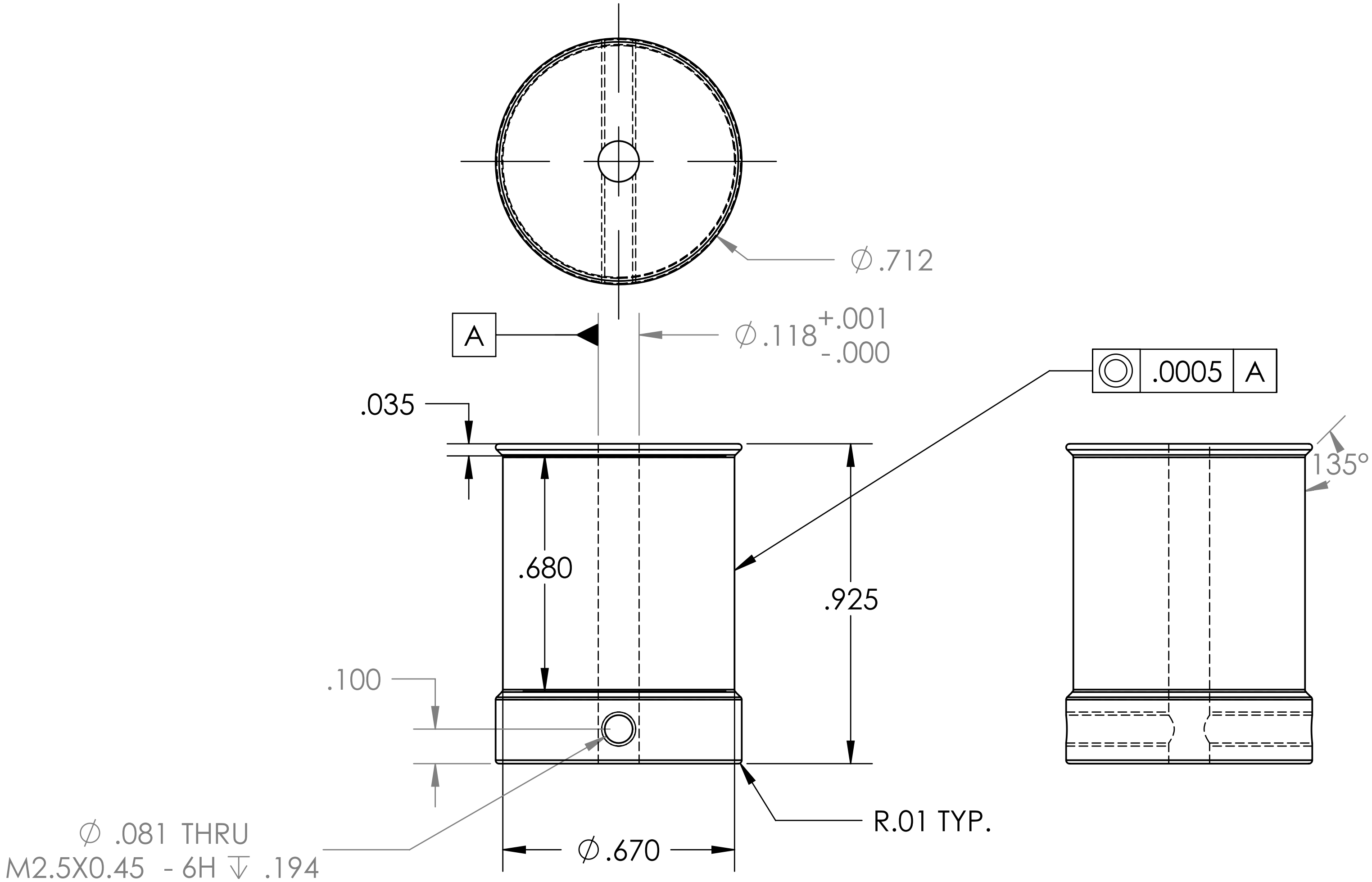
DETAIL A
SCALE 4 : 1

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .1 BEND ± 1 TWO PLACE DECIMAL ± .01 THREE PLACE DECIMAL ± .005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

SIZE	DWG. NO.	REV
A	String Pulley	
SCALE: 2:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1



		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .1 BEND ± 1 TWO PLACE DECIMAL ± .01 THREE PLACE DECIMAL ± .005	DRAWN			TITLE:
			CHECKED			
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL	COMMENTS:			SIZE A DWG. NO. SetScrewPulley REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 2:1 WEIGHT: SHEET 1 OF 1

5 4 3 2 1

TT Motor Speed Controller_FAQ

Q: What Allen tool to use with the pulley's small 2.5mm allen key?
A: The correct tool is #4, 0.05" tip Allen key.

Q: Does the 110191 maxon have enough torque to drive an idler wheel say with a 25 lb platter?
110191 Motor Specs : Stall torque: 51.4 mNm, Nominal torque: 15.0 mNm, Torque constant: 75.2 nMn/A
Not sure which torque value I should be looking at from the data sheet. I will be making a string drive first but perhaps experiment later on.
A: (From Mark Kelly), The 110191 will run an idler very happily - I've used one in my Garrard when testing my new motor drives.
Don't forget that this motor is more than three times as powerful as the original Garrard motor.
The kit drive, however, is not designed to achieve this, it was specifically designed for belt drive TTS. If you want to use the 110191 for an
idler you need a much higher voltage. An easy alternative is to use this drive plus the 110189 motor and up the current limit to maybe 500mA
(just reduce the value of the current limiter's emitter resistance).

Q: Does anyone know how much mass could be realistically used for a platter with this motor/controller?
Would something like a 50lb platter assembly be an issue?
A: (From Mark Kelly), A DC motor approximates a constant power source - at low speed (start up) it has high torque. If there are no significant energy losses it will eventually accelerate the most massive of platters.
Possible significant energy losses include bearing friction and belt slip.

Q: What is the pulley maximum weight that we can install on the Maxon Motor:
A: I got an email from Sean Henderson last night referencing spec sheet for the maxon motor. according to the spec sheet the maximum dynamic
axial load for the motor is 1.9 newtons which translates to 170 grams of mass. With a pulley that only weights 80 grams that should be a
non issue. As I recall the motor we are using uses sleeves and not ball bearings this limits that radial load to 5.5 newtons or
550 grams 5.5 mm from the flange. Even taking the large distance to the belt contact point, I can't imagine achieving 550 grams of force.
Patriz, I'm not sure what would have caused your motor to fail. None of these weights comes even close to the speced uses of the motor.
Also a max force of 80 newtons for press fitting is specified. I'm not sure how you would have done that. Thats 8.1 kg!!
Yikes. I'm not sure where you would hold on to do that.

I don't know for sure, but I don't think the weight should matter to the pulleys. On that note, if another GB is going to happen, I would suggest either aluminum or Delrin.

Q: Teres pulley, is it compatible with this controller.
A: Teres pulley diam=10.98mm, Teres platter diam=310.515mm, Platter/Pulley ratio = 310.515/10.98 = 28.3
Motor specs = 126rpm/V, 33-1/3rpm = motor 941 rpm= 7.5V, 45rpm = motor 1271rpm= 10.0V.
Controller range = 6.2 to 8.6V, so the Teres will only works on 33rpm...

Q: Just finished my design, but it seems that I can´t get no real control on the output voltage, the Min. and Max. are just in the 10th of a volt? I have around 11,22V to 12,30 volt on the output.
A1: Did you used the resistors DIP switch. By selecting the sw you select the range of adjustement for the speed potentiometer. Seem to me all the switches are in the wrong direction, try to inverse all the dip switches position. You should get the full range of adjustement.
A2: Hi. Reguarding your problem of adjustement, what do you install for R33, R34 close to the dip switch? These two resistors are new on this board. I included the option to insert other value of resistors there, giving more flexibility to the DIP switch resistor range.
If not used, you need to install wire jumper there, OR the DIP switch and potentiometer won't work. That may

also be your problem...

Q: What resistors you use for the ones that have to be calculated? I found around 64Ohm?
A: The calcultated resistor depend on the motor. I didn't have the exact same type, just use a small motor from a surplus store. Check the PDF for the procedure.

Q: Just one more question, how do the switches work? On/off (ok this is logic), but the charger, on and the main led switches off, is this correct? How does it work alone just with the battery?
A: Switches, First one on the left is Power-On. It is activated (Motor On) when UP. The right one is "Charge On", BUT activated when DOWN. So Both switches down = Motor-Off, Charge On. Both switches up = Motor ON, Charge Off (Battery only)

Q: How are the leds indicator working?
A: See Below:
BLUE: Power On, Motor is running
GRN: Battery is Ok, i-e Vbatt> 11.4V, Led start to dim for Vbatt<12V
YEL: Battery Trickle Charge. On if VCharger > 13.8V
RED: Battery Charging. On if VBatt is lower by 2V than VCharge

Q: How to use the two Motor/Charge switches.
A: Two switches on the left are for, Motor ON (SW2)-Left SW, Charge ON (SW3)-Right SW

SW2	SW3	Function
UP	UP	Motor ON / Charger OFF
DN	DN	Motor OFF / Charger ON
UP	DN	Motor ON / Charger ON
DN	UP	Motor OFF / Charger OFF

Q: How do I adjust the leds PCB for my own circuit?
A: These leds start to turn on at some very specific voltages. These voltages depends on the model of led you use. see previous question for the voltages
It means that for some leds, the get the correct threshold, you may need to bypass some of the signal diodes as I did (not the zener).
On my own circuit, I needed to bypass D53(GRN) and D57 (YEL) to get the correct threshold voltages.

Q: What enclosure is recommended for the PCB controller, ver 2.0?
A: Hammond 1455T2201 (L8.66" X W6.30" X H2.03") Digikey HM905-ND $26.00, Specs: http://www.hammondmfg.com/pdf/1455T2201.pdf

Q: What are the PCB Dimensions
A: W6.15" X D5.175"

Q: What is the range of Motor Voltage Adjustement?
A: Range (with my test motor, not the actual Maxon) is 6.2 to 11.2V. To test it, make sure that the dip switch are all set to close (short all the
resistors). This way it is only VR1 that is setting the speed set point. It is not working on the full range of the potentiometer. You'll see that the
speed vary very rapidly at some point. The sw and resistors are use to place the potentiometer range in the region where it can be use to be more precise
in adjusting the speed. If you use the 127rpm/V specs of the Maxon, you get a range of about 780 to 1420 rpm.

Q: What are the typical Battery Charger Voltages and Currents in Charge and Trickle modes?
A: Here voltages taken from two charging condition of the battery

	Vcharger (IC1, pin1)	VR3	Icharge	Vbatt
Battery needing charge (Red Led On):	15.5V	0.365V	486ma	12.47V

Battery charged Trickle only (Yel led):	23.5V	56mv	75ma	13.8V

These voltages are typical only. They vary during the charge/discharge cycle of the battery.

Q: How to increase the motor voltage range of about 6.2 to 11.2V (JP2 to Motor Return)
A: One way to lower the motor voltage is to use the circuit reference jumper JP2 and select GND.
I tried it and was able to get 0-10V. This however removes the motor current sensing, one of the feature of this circuit.
I don't know how this will impact on the motor controller performance. As you know I don't have the specified Maxon motor with me to try, just a cheap surplus store 12V test motor. The Maxon motor may give different voltages, since its current demand will be different.

Q: How can I test the PCB
A: It is a very simple circuit. Here a detailled testing procedure:

It is a very simple circuit. Troubleshooting steps:
1) First check the battery charger operation. I already sent you voltages for that. This will confirm IC1 section is OK.
2) Motor connected. Very simple check for Q1,Q2 and drive transistors Q6-Q8. Remove IC4 from its socket, then using a piece of wire, ground the base of Q7 (you can connect the gnd to the IC4 socket, pin1. The motor should turn on. Remove the gnd, the motor stop. This verify Q6,7 and 8 correct operation. Put back IC4.
3) Set JP2 to GND. This insure that most voltages are not referenced to GND. This also deactivate the motor current sensing Q3-Q4-Q5
4) Unplug IC2 and set VR1 trimmer to mid-point. Using an ohmeter measure VR1 value between IC2 socket pins 6-7. Set for 25 Kohms. Put IC2 back in.
5) Check IC3 Reference Voltage (Vref) source. You need absolutely 5.0V at pin6. This Vref is then send directly to the speed adjustement potentiometer VR2
    The output of VR2 is the speed setpoint voltage (Vsetpoint) level. It changes with VR2 position.
6) Check IC4A, pin 7 voltage. Should be VMotor+ / 2. For example if Vcc = 11.2V (Full speed), it should be 11.2/2 = 5.6V
7) Measure voltage at IC2A, pin3 (Vsetpoint). Vary VR1 from max to min. Vsetpoint must vary from 0-5V.
8) This controller compares a voltage proportionnal to the motor current (Q4 collector, JP2 sets to motor ref) and the Vsetpoint using a differential amplifier IC2B.
    The difference between Vmotor-Vsetpoint = Vcommand to IC4. If JP2 is sets to GND, then IC2B pin 7 will vary from 0-10V. Make sure that IC2B
    gain adjustement VR1 pot is not set to short, because in this case IC2B won't have any gain and the circuit won't work., see step 2
9) Finally IC4A gives a output control voltage for the drive transistors Q6-Q8 that is the difference between IC2B & IC4B outputs.
    For example, Set the speed pot VR2 to get 9V at VMotor+ terminal, then check IC4B,pin7=4.5V, IC2B,pin7=4.5V (sets by VR2 speed adj),
    then IC4A,pin1 = 8V. The circuit is 90% checked by now. You should be able to vary the motor speed using VR2.
10) Check of the Motor Current feedback Q3-Q5. Put JP2 to "Motor Return". Sets speed adj VR2 to Max speed.
    Check these voltages: R6 Voltage = Motor Current / 5R = 0.483V (with my motor)
    Base Q3-Q4 = 1.16V
    Collector Q4-R8 = 3.7V (This voltage varies with the Speed Adj setting even if motor speed is not changing up to a point where it does.
11) You may need to use a resistor between the motor terminal if its current is too low. See Adj. procedure for details

Q: What pulley is needed
A: Mark Kelly said: "For the 110191 motor with the 12V controller the pulley to platter step up ratio MUST NOT be greater than 24:1
  if you wish to include 45rpm" If using platter drive that is. Platters usually being 300mm?
  That means that with the 12volt supply a pulley should be 13mm wide.

Q: Mark Kelly explains is controller
A: The circuit uses a series / shunt regulator to control the output voltage, it needs to drop at least 2 Vbe across the series CCS.
It also needs to drop roughly 2 Vbe across the current mirror for the compensation circuit.
Taking 11.4V nominal supply - 4 x Vbe the max output voltage is around 9V.

The no-load voltage for the motor needs to be far enough below that for the motor to be able to develop enough torque to drive the platter.
Accordingly, I prefer a no-load voltage of 7.5 volts or less, the 110191 runs at 900rpm (x 20 for 45).
The absolute limit is 9V which is 1080RPM hence x 24. The motor will develop very little torque at this speed, so you would need to keep the battery very well charged.

There are several options to get around this:
1. Use a different pulley.
2. use 18V or 24V supply (watch the heatsinks on the transistors if you do this)
3. use an 110189 motor (the original Teres motor) for which 7.5 V = 1350 rpm
4. Use a 226774 motor for which 7.5V = 1538 rpm
5. build a different supply.
I chose option 1, I'm now working on option 5.

Q: What is the custom pulley material
A: If you decide to use aluminum for the pulley I would suggest using a T6 treated material.
Non treated bars are way to soft for the aplication and you will also end with a black fine tarnish (oxides) over the belt or string which will also adere to the platter rim.

Q: Can you tell what will you use for R24 with the Maxon Motor?
A: It is into Mark Kelly documentation, apge 11 of 14. He recommend to try 1K accross the motor terminal, this is R24