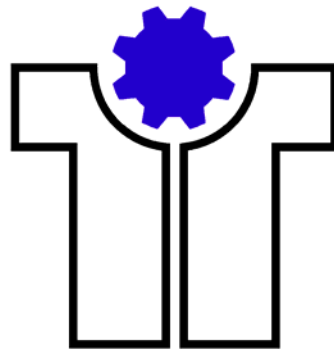


December 14th 2007

TORQUETEST TESTREPORT

“MGT magnetic couplings and transmissions”



TorqueTest

MGT

Magnetic Gearing & Turbine Corp

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0 to 6.000 Upm
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1. Test report MGT magnetic face couplings and Parallel transmission

1.1 Introduction

This is the complete test report of the magnetic face couplings, and the magnetic parallel transmission from MGT.

The couplings are categorized, see attachment. Tests are done in rejection and attraction and in different configurations. Three coupling parts on both driven and driving side was the limit. Air gaps of 1, 3 and 5mm were used with face couplings. Airgap of 1,5mm was used with the parallel transmissions. Since the couplings are not always flat, the air gap could not be determined very secure. This should be taken into account when interpreting the results. Every measurement was done three times.

assemble

The face couplings were built-up out of 2, 3, 4, 5 or 6 discs. More than 4 does not seem economical. The parallel transmissions were built-up out of 1 against 1 disc, too 4 against 4 discs with single disc en double disc

assemble.

See attachments for a description of the test system. All test results are attached in tables and graphs.

User pages were made and attached to simplify the choice of couplings.

1.2 Efficiency

The efficiency of the couplings is between 99 and 100%. The exact number for each coupling is difficult to measure, since the efficiency is very high and the measurement before and after the couplings are almost the same and in the same range as the tolerance of the measuring instruments. Therefore the efficiency cannot be determined more accurate.

1.3 Selection

See the user page to select the right coupling for the job. To select a coupling two out of three variables must be known; speed, torque and power.

We advise to use 2/3 of the torque, as measured in the test, see the user page. So if 15 Nm is measured, $15 \cdot \frac{2}{3} = 10$ Nm is advised as nominal torque.

Selection on speed and power is possible on the user page.

Formula used: $P = T \cdot \omega$

P = Power in W

T = Torque in Nm



ω = Speed in rad/s

or

$$P=(T*n)/9550$$

P = Power in kW

T = Torque in Nm

n = Speed in rpm

If the coupling size and assembly is selected, one issue remains; the moment of inertia. If the moment of inertia (\approx weight) of the driven side is too high, the driven item will not speed up, the coupling will slip. Adjusting the acceleration or ramp-up of the driving motor might solve the problem. However, it will not always be possible to influence the ramp-up of the driving side. A bigger coupling with more torque, can also solve the problem.

The power necessary to speed up the driven part, can be calculated. The power should also be transmitted by the coupling. This is up to the user, sales engineer or designer to determine.

Calculation of minimum acceleration time t_{min} :

$$t_{min} = (J*\omega)/T \quad \text{or} \quad t_{min} = (J*n*2*\pi)/(60*T)$$

t_{min} = min. acceleration time in seconds

J = moment of inertia in kgm^2

n= speed in rpm

ω = speed in rad/second

T = torque in Nm

With $J=m*r^2$

m = mass in kg

r = radius in m

At the maximum torque, the coupling is slipping. The remaining torque, slip torque, is nil, i.e. less than 5% of max torque.



1.4 Magnetic conduct

Built-in as reject or as attraction is both possible. The highest torque is achieved with no air gap in attraction. The couplings however, are not flat enough to realise this in most cases. It is rather dangerous to work with these couplings. The magnets are strong and it is painful to come between to coupling parts. It is advisable to use gloves, when handling these couplings and think carefully how to mount the couplings. The assembly with rejection is safer and easier. So we advise to use the couplings in rejection. Most test are done in rejection.

1.5 Speed

The face-coupling tests are done at low speed (150 rpm), the parallel transmission tests are done at 350 rpm. This does not influence the measured torque. The maximum speed depends on the stability of the discs. This was not a part of the test requirements as ordered. We have no information about the disc materials and the maximum allowable speed of the disc assemblies.

1.6 Recommendation

We recommend to use air gaps as small as possible, e.g. 1 or 2mm. The coupling can be used with bigger air gaps, but the loss of torque is significant. The couplings should be produced as flat as possible.

The couplings can be assembled with 2 or more discs. More than 2-2 does not seem economical. A bigger coupling might be better, in that case.

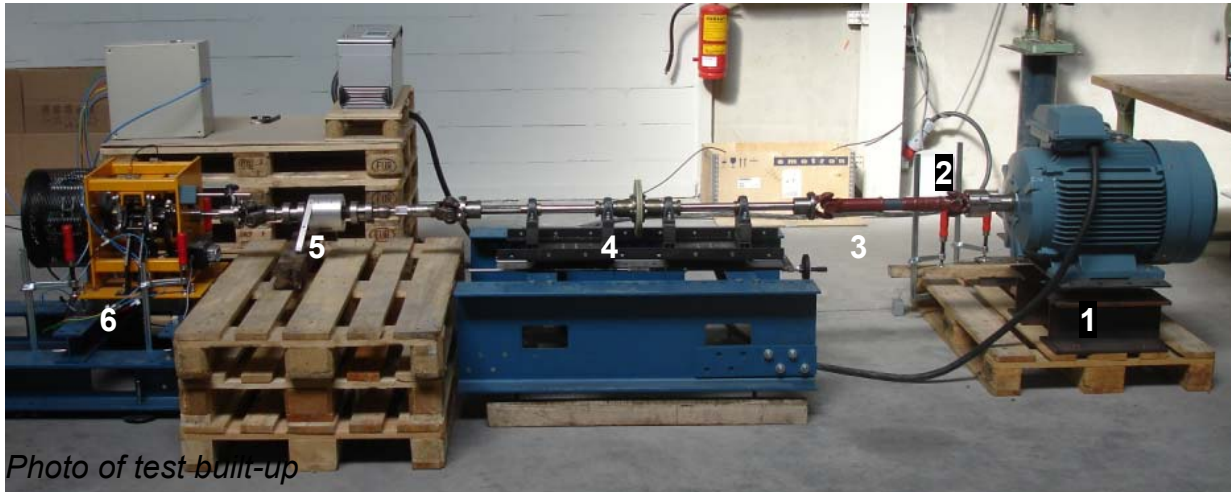
With the $\varnothing 130$ transmission we have no really results because the disc with the diameter 130mm have a too small diameter, and the magnets overlaps each other.

That's why there's no torque results and graph.

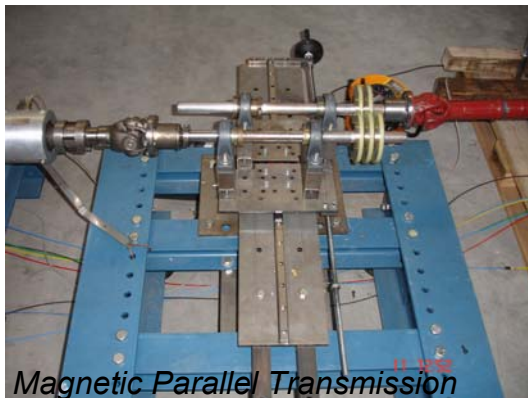
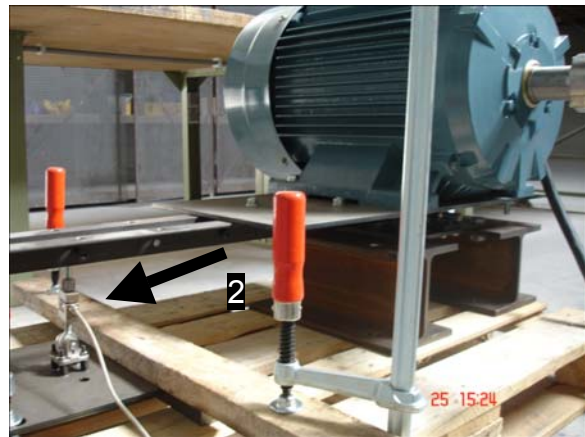
We advise to use the couplings in rejection. This is easier in mounting and safer.

Mounting of these couplings should be done with care. Determine the mounting sequence before assembly. Use gloves for protection.

1.7 Test System face coupling / parallel transmission



1. Motor
2. Loadcell
3. Cardan shaft
4. Test object
5. Torque sensor
6. Brake stand



1.8 Loadcell

The torque at the driver side, is measured with an arm and loadcell under the motor.
The loadcell is a 50 kg loadcell on an arm of 370 mm.

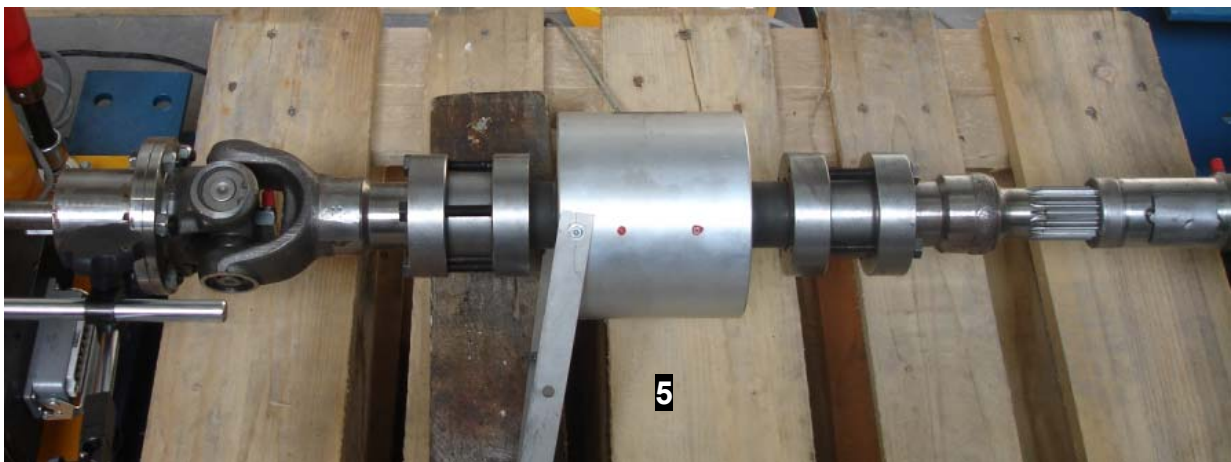
$$T = F * a$$

T = Torque in Nm

F = Force in N

a = arm in m

The accuracy of the loadcell is 0,5%. Type Velomat DZA-40A-50kg-1.20 serial number VX34020592-L25A-0001



1.9 Torque sensor

The torque at the driven side is measured with a torque sensor. The accuracy of the sensor is 0,5 %. Type KTR Dataflex 42/500, ± 500 Nm, serial number 42-26.

1.10 Disc description

Type

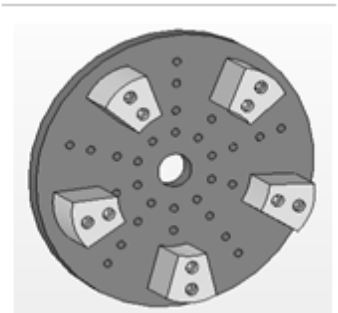
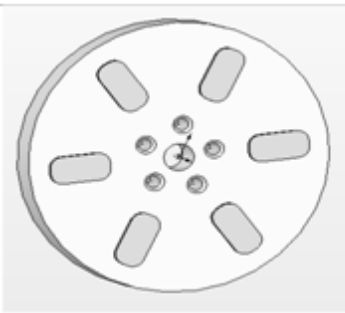
A

B

C

D steel disc

E alum. disc



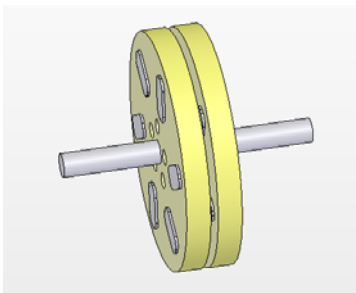
Diameter

Outside-diameter magnetic wheels
Outside-diameter magnetic blocks

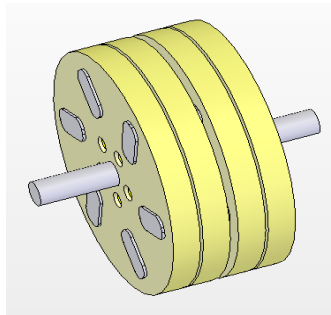
Magnetic orientation

Rejection
Attraction

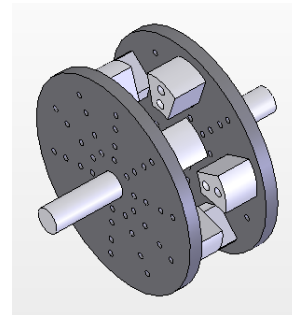
1.11 Combination description



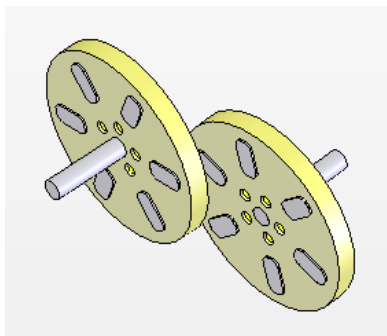
Face coupling



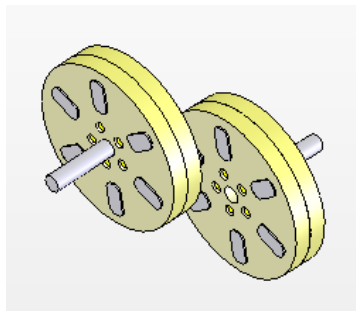
Face coupling 2x2



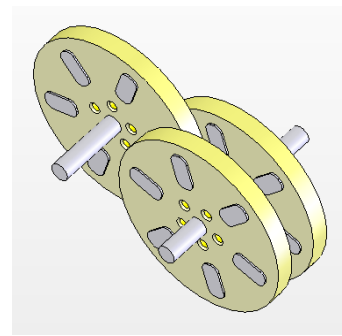
Face coupling with assemble magnets.



Parallel Transmission 1x1 single assembly.

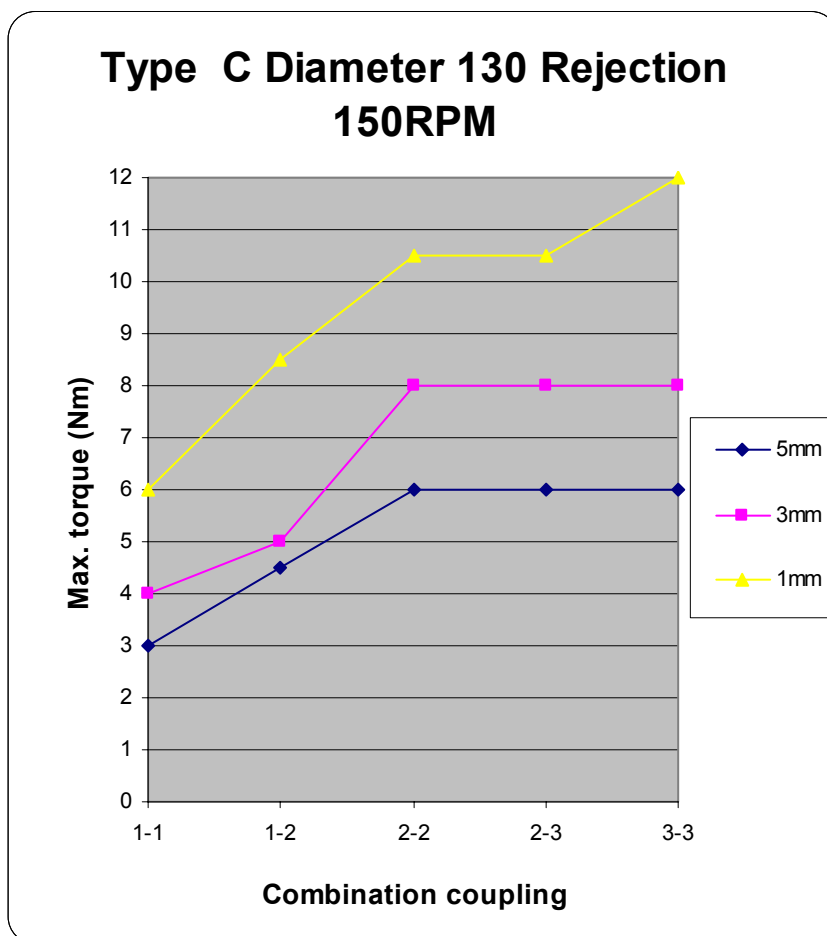


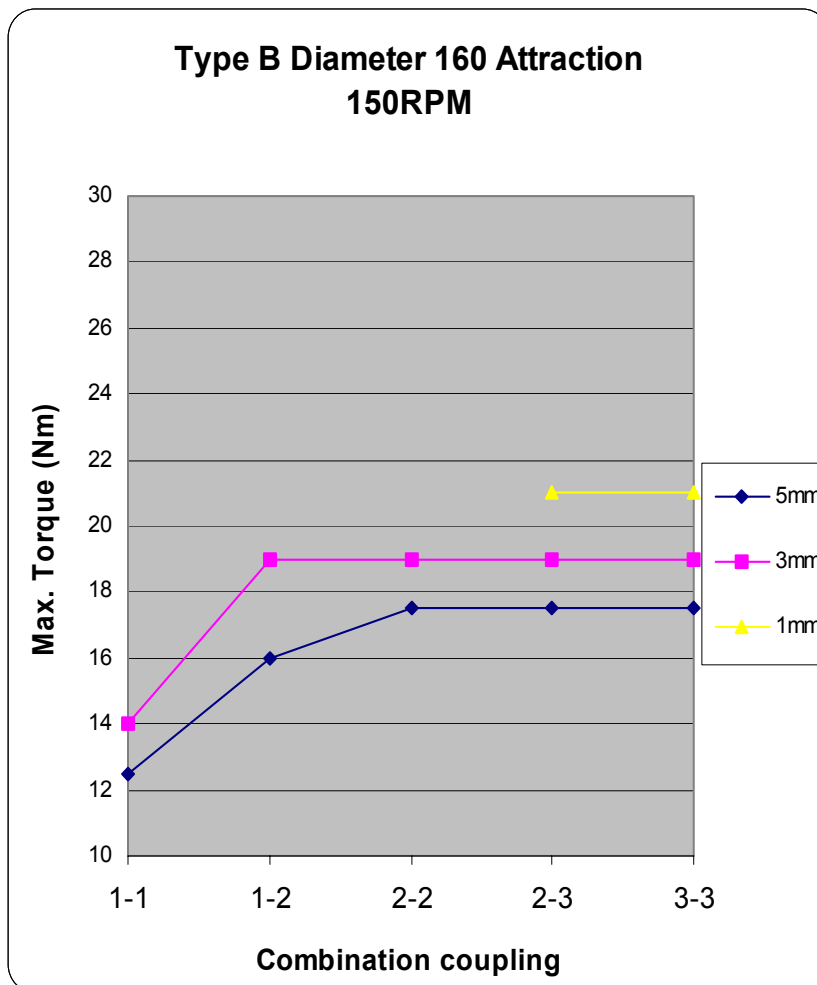
Parallel Transmission 1x1 double assembly.

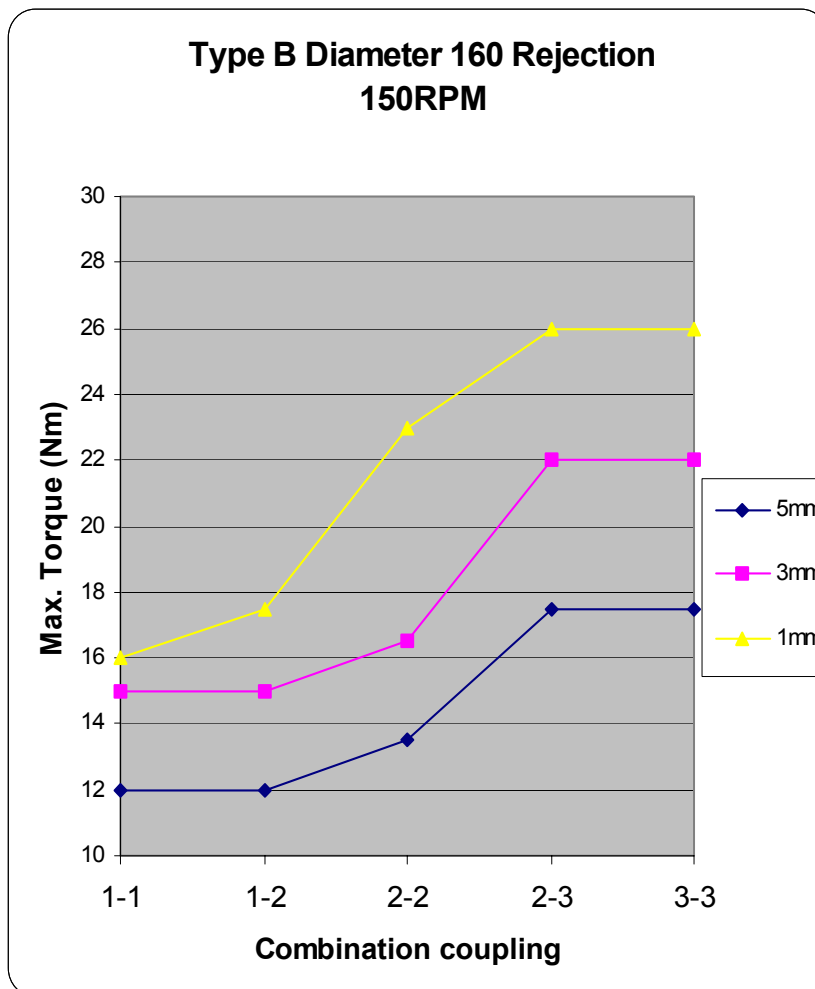


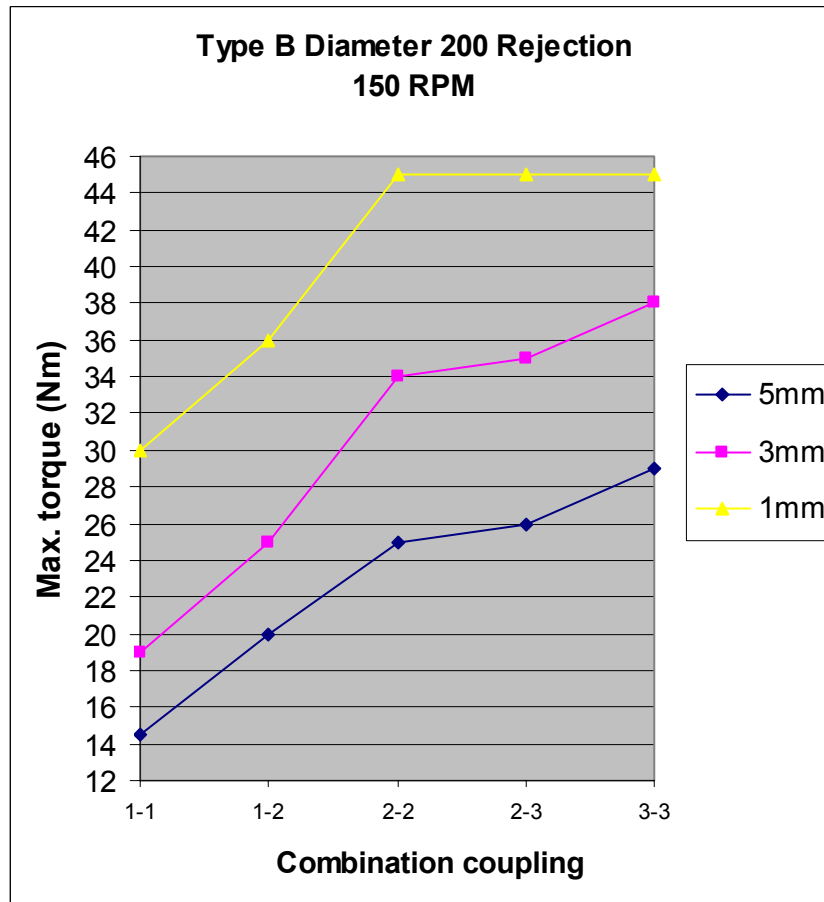
Parallel Transmission 1x2 single assembly.

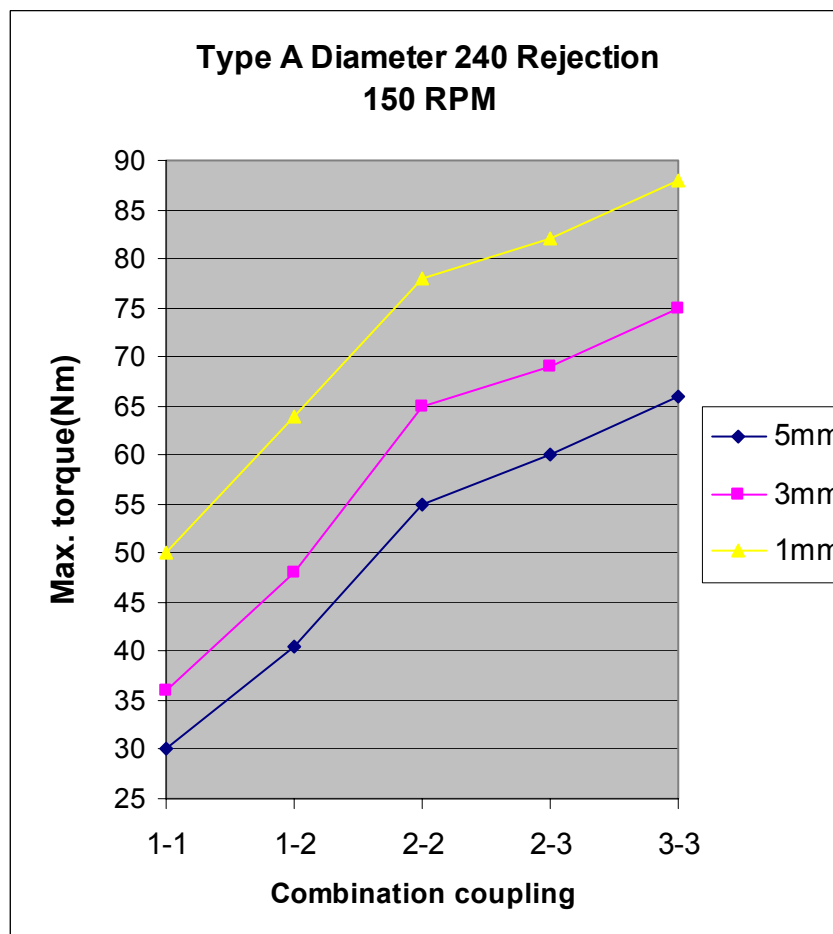
1.12 Face coupling test results graphs

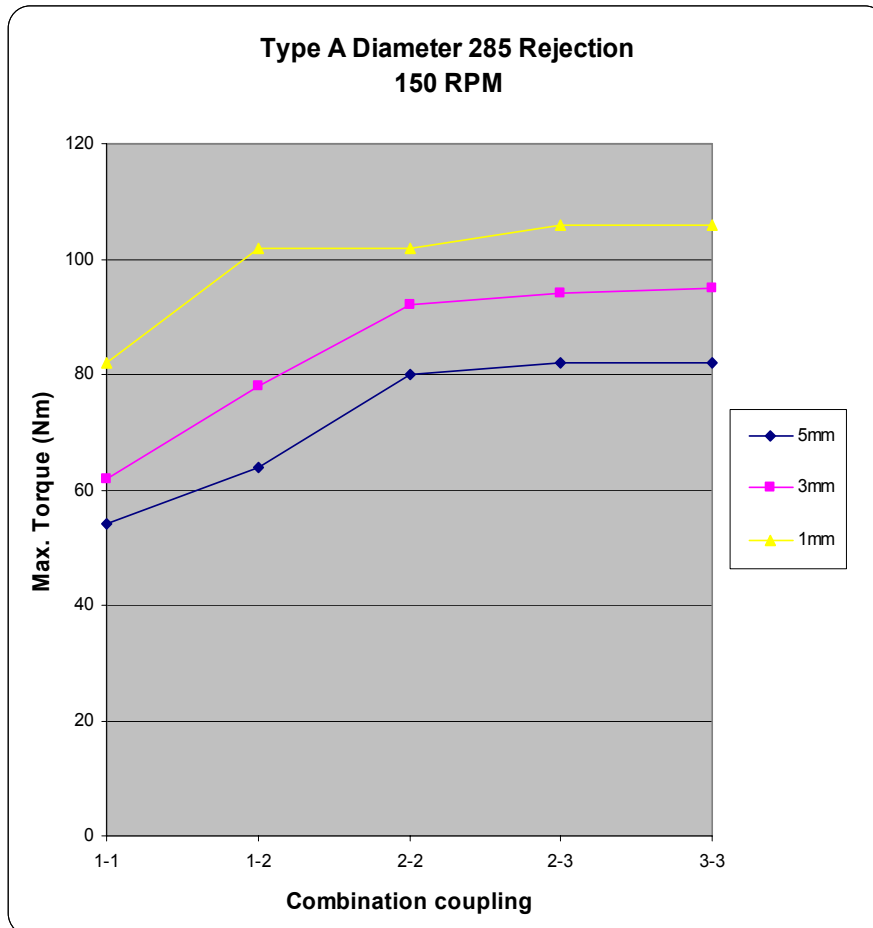


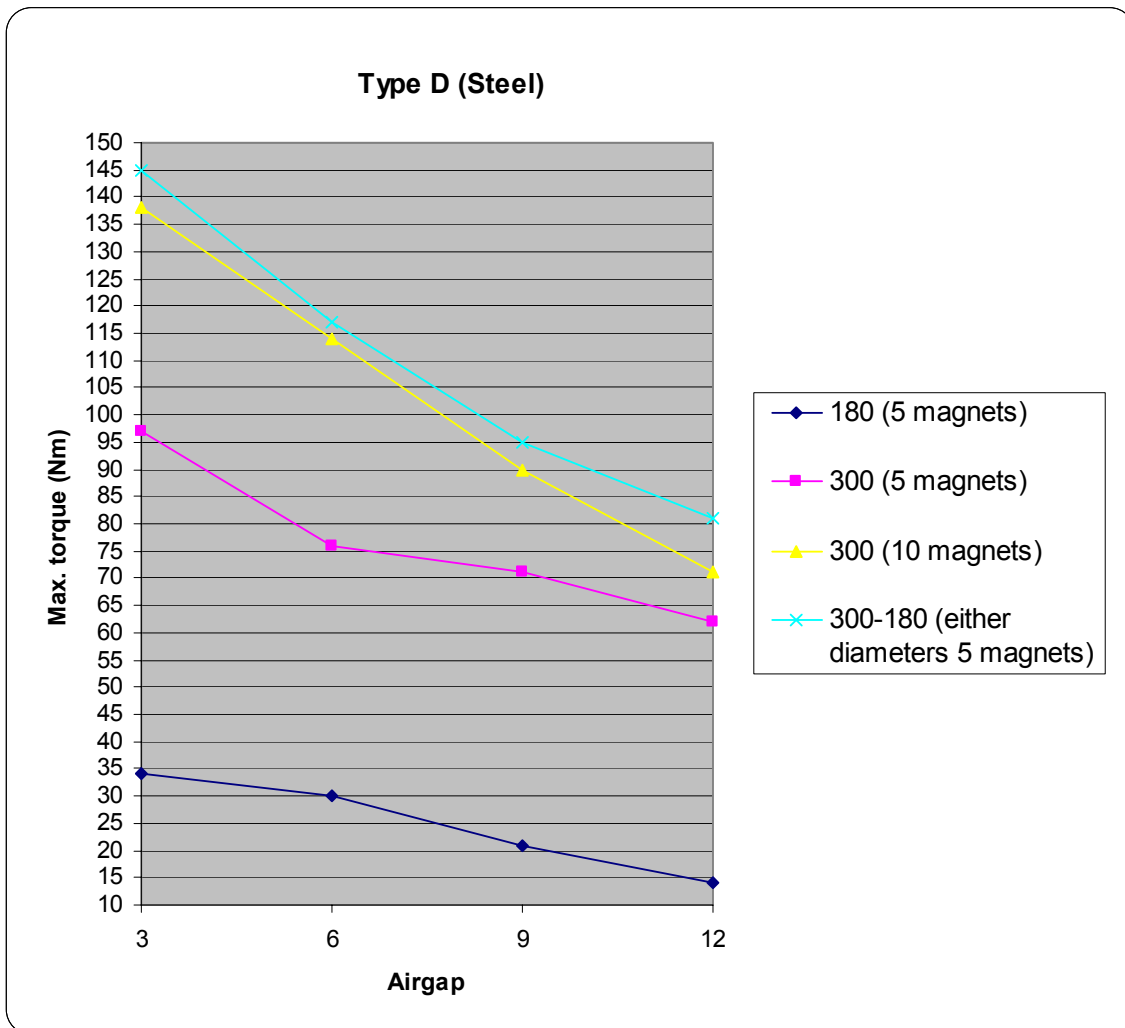


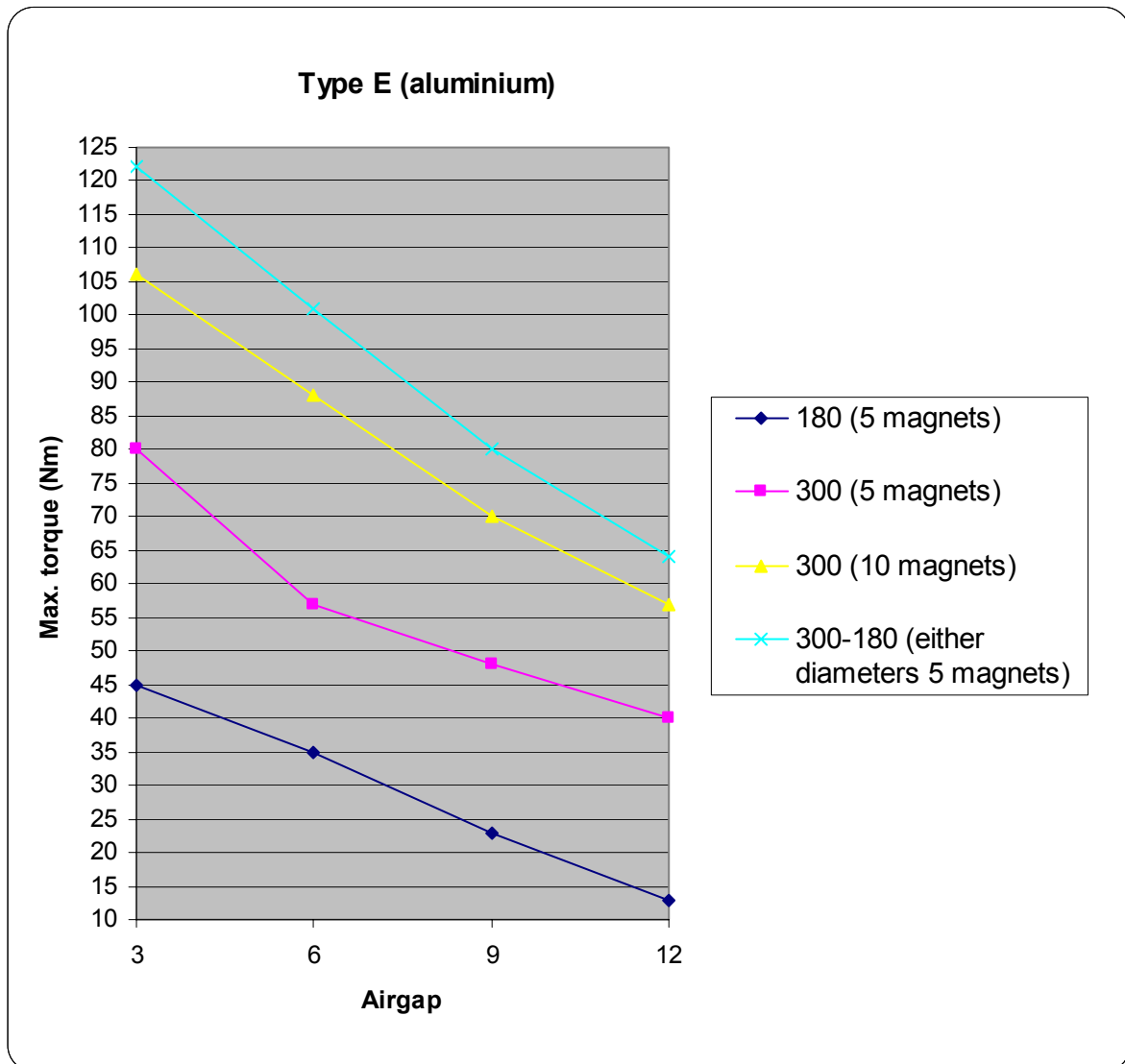




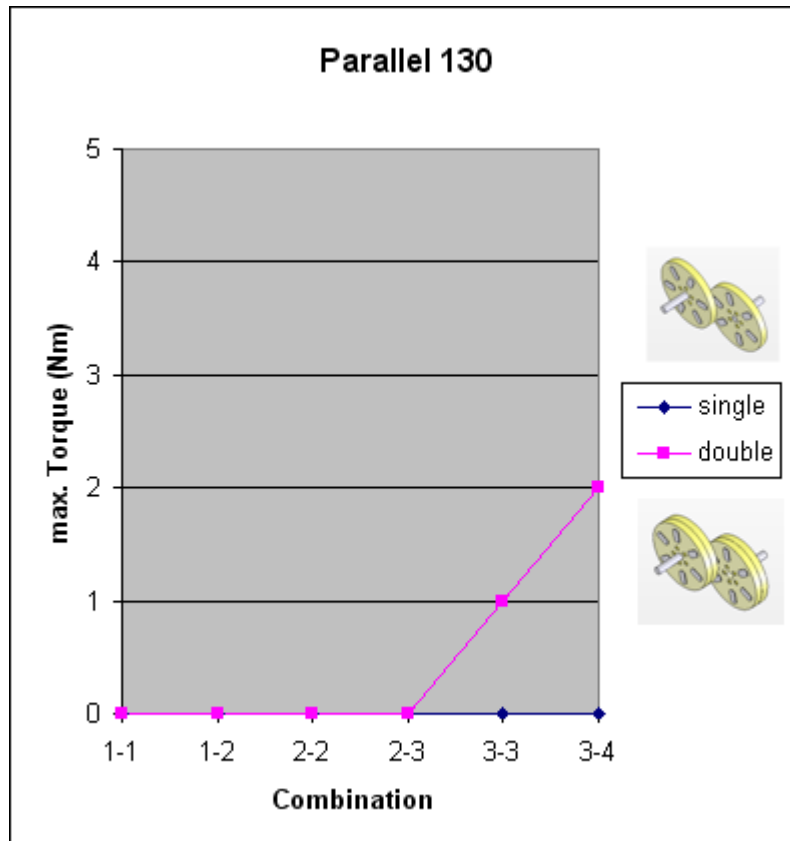




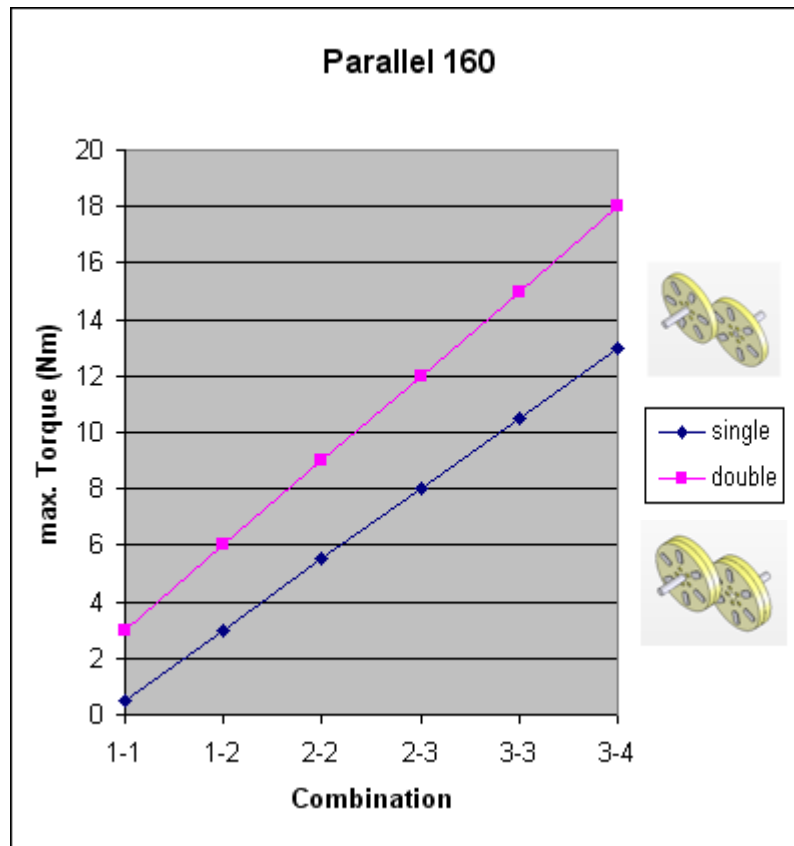




1.13 Parallel transmission test results graphs



With this transmission we have no really results because the disc with the diameter 130mm have a too small diameter, and the magnets overlaps each other. That's why there's no torque results and graph.



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