Comparison of Magnetorquer Performance

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Presentation to CubeSat Workshop

8th August 2010

SSBV Group

Satellite Services BV

SATELLITE SERVICES LTD

Zelinda LM

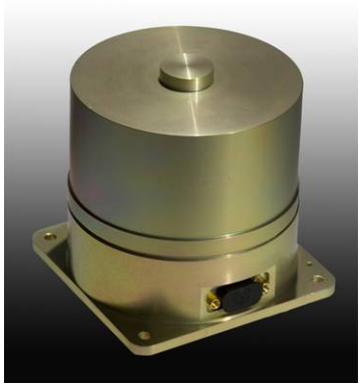
Space Services

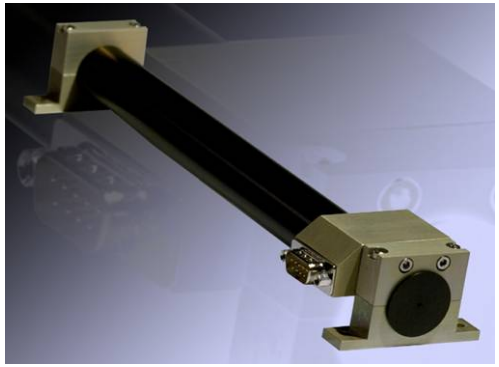
ATS-Media

Background

SATELLITE SERVICES LTD

- Focused on the development and marketing of products for the Space Segment
- Focus is on satellite sub-system design and manufacture
- Growing number of license agreements with small satellite and sub-system manufactures
- Worldwide customer base





Magnetorquer Function

Magnetorquers produce a torque on the spacecraft by interacting with the Earth's Magnetic field:

$$T=MxB$$

Advantages:

- *Low power consumption*
- *Low volume*
- *Simplicity and reliability*
- *Simple operation*

Disadvantages:

- *Low Torque*
- *No Torque along Earth's magnetic field*
- *Difficult beyond LEO*

Suitable for:

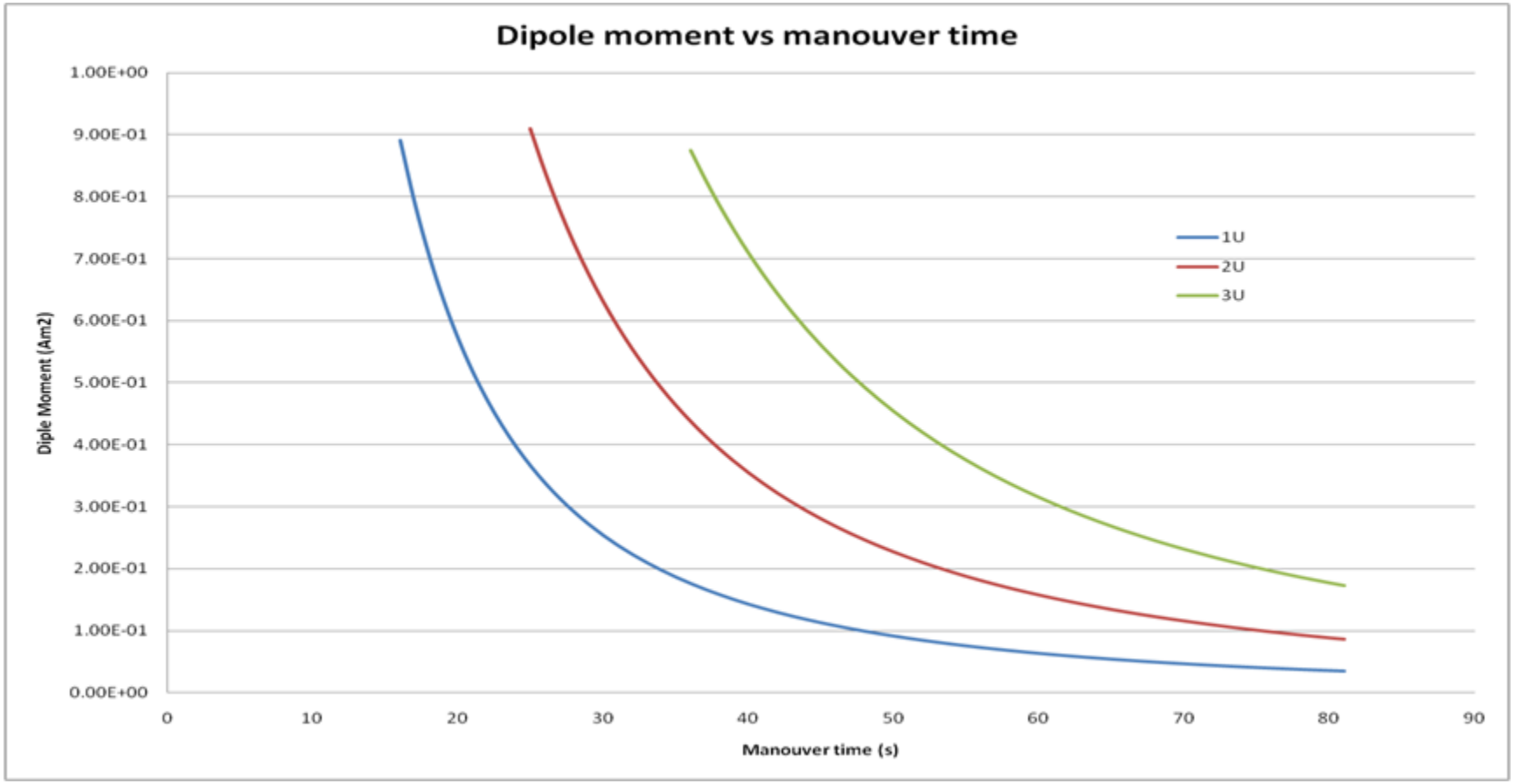
- *Initial De tumbling due to the low power consumption and very low power availability during the phase*
- *Reaction Wheel (if any) unloading*
- *Two axes control of momentum stabilized satellites (Momentum wheel)*

But also.....

- *Three axis control when low power and volume is available on board the spacecraft*
- *High efficiency manoeuvres*

Attitude Manoeuvres

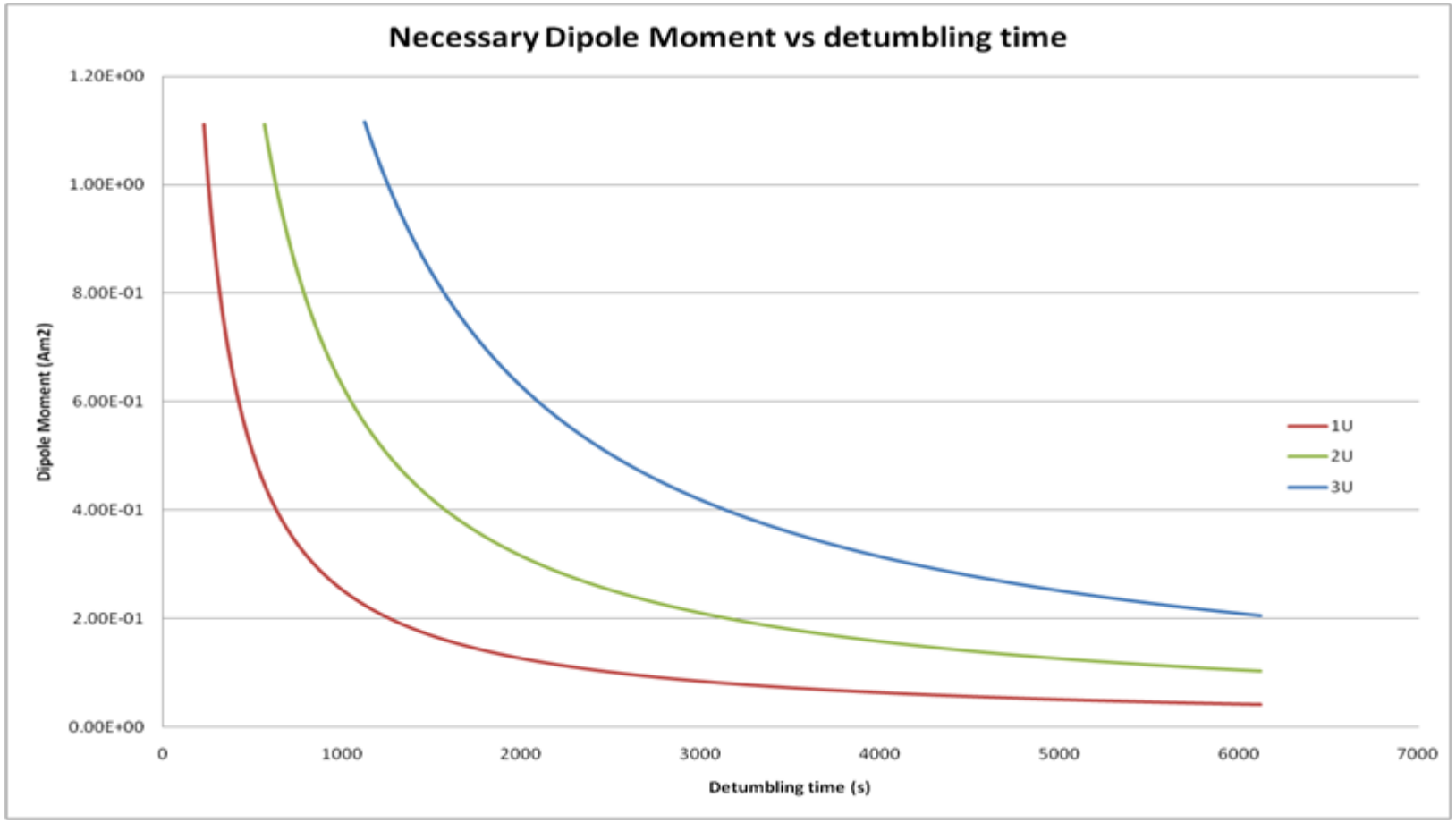
Necessary Dipole Moment to perform a 90deg manoeuvre @400km vs requested time in the best case i.e. Earth's magnetic field perpendicular to the rotation axis



- *0.2 Am2 Dipole Moment Magnetic Torquer is a good compromise to have good agility for 1U, 2U and 3U cubesat*
- *Magnetic Torquer with dipole moment <0.06Am2 are not suitable for attitude maneuvers*

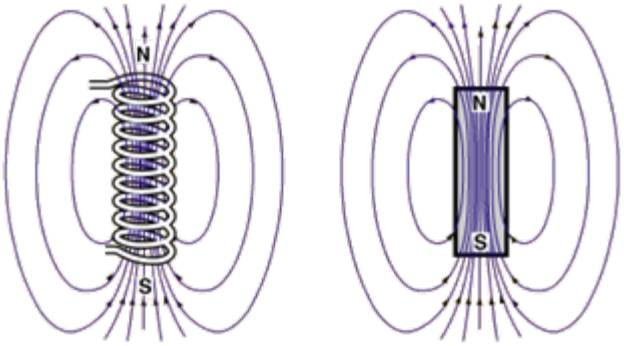
De-tumbling

Necessary Dipole Moment to perform the detumbling @ 400km vs requested time



- *0.2 Am2 Dipole Moment Magnetic Torquer is a good compromise to have perform detumbling in a reasonable time*
- *Magnetic Torquer with dipole moment <0.06Am2 increase drastically the detumbling time and the risk to run out of power*

Air core vs Metal core Torquer



Introducing a metal core in the magnetic torquer increase the dipole moment of the solenoid
The metal core is able to increase the dipole moment up to 300 times!

To reach the same dipole moment with air core magnetic actuator you need to:

Increase the enclosed area and/or the number of turns

Increase the wire length

Increase the wire diameter to maintain the same power consumption

Increase the wire mass which eventually overcome the mass of the metal bar

Or

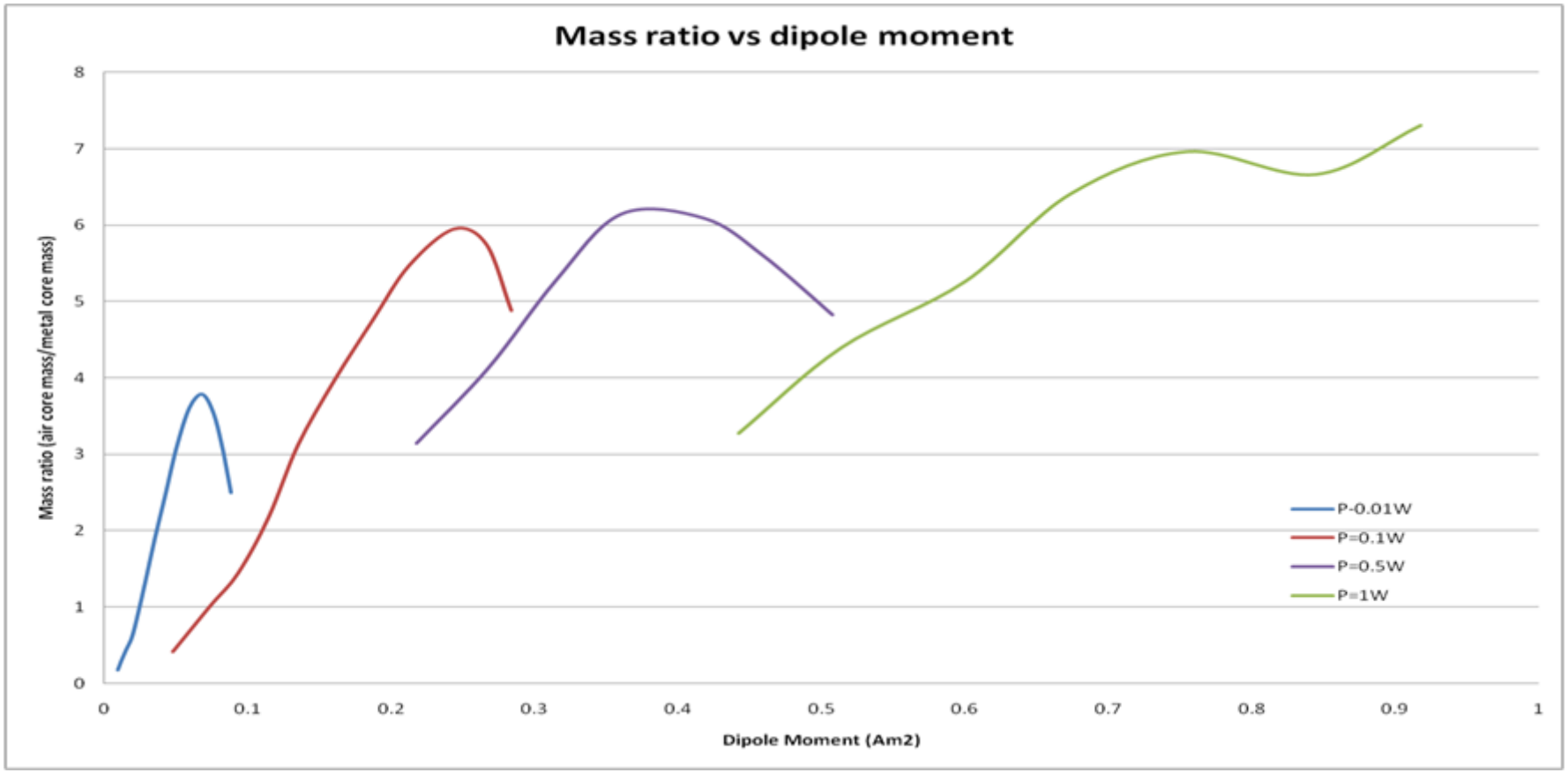
Increase the current flowing Into the windings

Increase the power consumption

Mass comparison

Magnetic Torquer mass ratio (air core/metal core) for a given Dipole Moment for different power consumption

Maximum metal core torquer length 7cm
Maximum air core torquer diameter 9cm

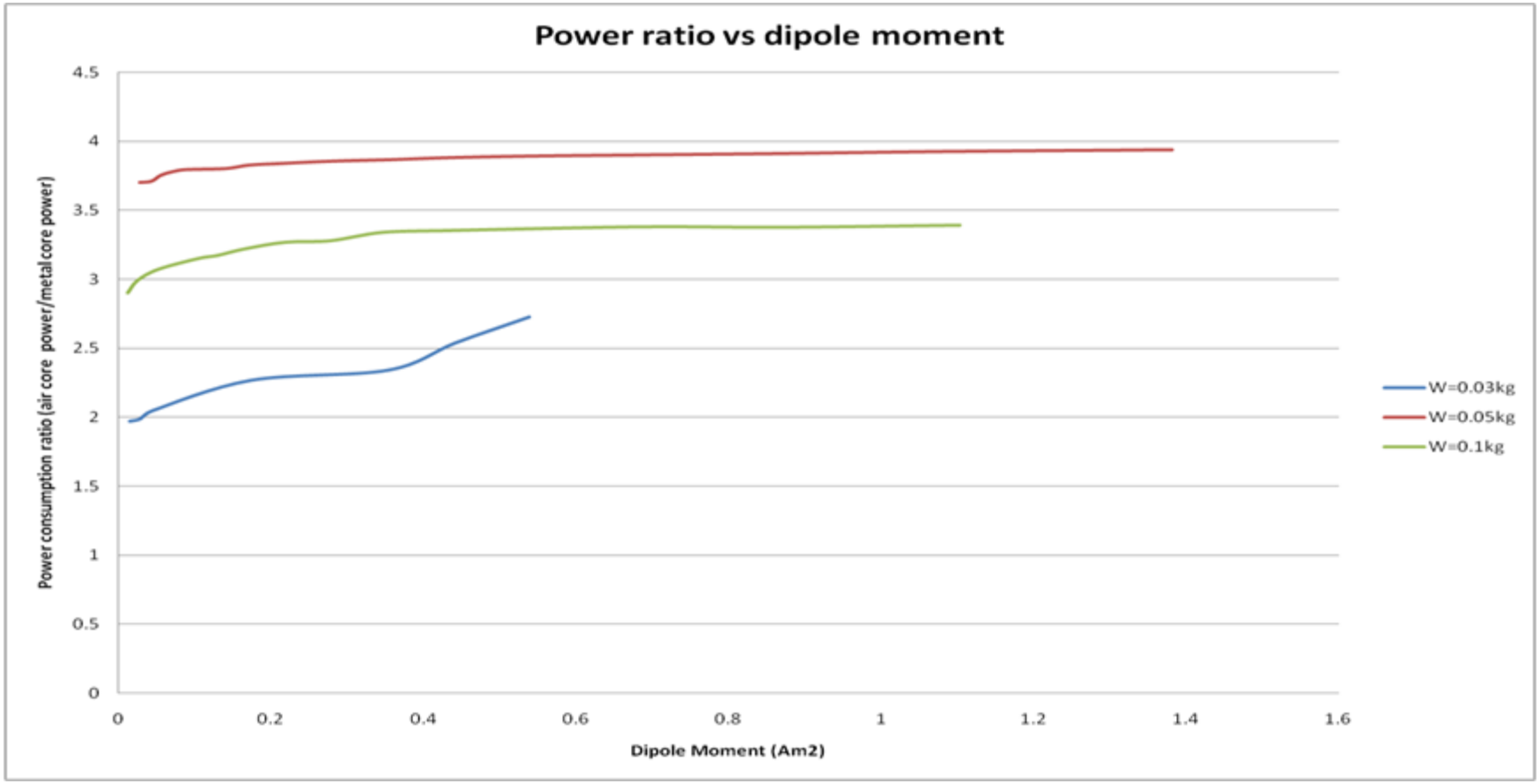


The air core magnetic torquer are convenient in terms of mass only if very low required dipole moment <0.06Am2

Power consumption comparison

Magnetic Torquer power consumption ratio (air core/metal core) for a given Dipole Moment for different torquer mass

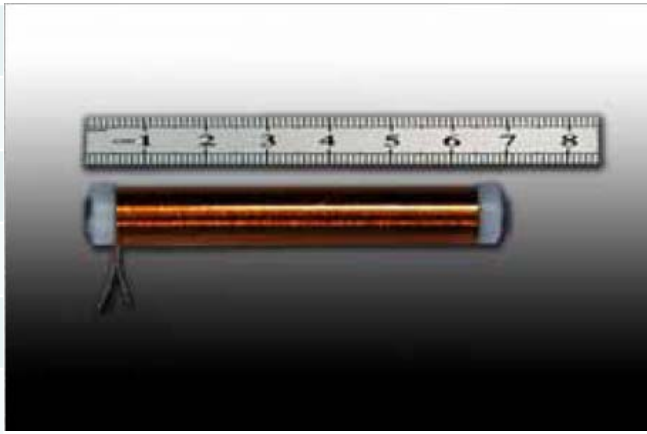
Maximum metal core torquer length 7cm
Maximum air core torquer diameter 9cm



The metal core torquer is always more efficient wrt the air core one for a given Dipole moment and a maximum mass

Satellite Services Torquer

Functional Characteristics	Magnetic moment: >0.2Am^2
	Linearity: +/- 5% across operating design range
	Residual moment: <0.001Am^2
	Power: typically 200mW from 5 Volt supply
	Operating range: -35^{o}C to +75^{o}C
	Random Vibration: 15g rms
	Lifetime: >10 years
Physical Characteristics	Length: 7cm
	Overall diameter: <9 mm
	Mounting: tied and bonded directly to PCB
	Mass: 30 grams
Interfaces	Coil wires solder direct to PCB pads



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