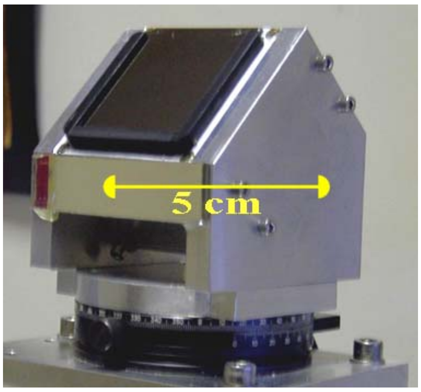
Italian National Agency for New Technologies, Energy and Sustainable Economic Development

ACCURATE ELECTRONIC SOLAR COMPASS

ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) has invented an electronic solar compass that can be used to determine with remarkable accuracy the direction of an observed point with respect to the true geographic North. This solar compass is patent pending RM2012A000664 (filed on 27th December, 2012).



Prototype of the electronic solar compass developed and tested by ENEA.

The electronic solar compass is composed of an electro-optic sensor that detects the position of the sun, a GPS device that provides the Greenwich time and the coordinates of the compass, an optical pointer, a goniometer for measuring angles and a microprocessor, which elaborates the data and provides the angle of observation with respect to true North in real time. An innovative algorithm based on Kepler's laws allows determining the sun ephemeris and the North-South direction by knowing the local time and its geographic coordinates.

ENEA electronic solar compass mounted on a theodolite.

ENEA solar compass can even work on other planets by substituting the Earth astronomical parameters with those of the planet, and by substituting the GPS with an internal clock.

Its main advantages are the **very good accuracy** (better than **1 arcminute or 1/60 degree**) and reliability, the low cost, the small size and weight, the short measurement time (few seconds), the easy operation and the applicability everywhere in the world, because it works independently of the Earth magnetic field.

ENEA electronic solar compass used during the alignment of a solar concentrator.

Current and Potential Domains of Application

- *Solar power installation and alignment.*
- *Environmental survey.*
- *Directional controls for radar installation.*
- *Directional controls for tunnel construction.*
- *Accurate measurements of buildings orientation.*
- *Remote control of robot navigation in all the planets of the solar system.*
- *Use as primary standard for calibration of other compasses.*

ENEA is looking for partners interested to start an industrial production, to study the integration of this compass to other instruments, as well as transfer of know-how and patent rights.

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SPECIFICATIONS OF THE ENEA ELECTRONIC SOLAR COMPASS

Weight	≤ 0.8 Kg	**Accuracy of azimuth determination**	≤ 1’
Size	6(w) × 6(d) × 6(h) cm	**Measuring range**	Tested up to 54 Km
Sensor	CMOS or CCD	**Operating area**	Every latitude
Measurement time	< 20 s	**Power consumption**	< 10 mW
Output	Azimuth of the pointed direction		

EXPERIMENTAL TESTS

Target	**Distance from the compass**	**Experimental azimuth measured by the ENEA compass**	**Theoretical azimuth from geographic coordinates of Google maps**	**Difference in arcminutes**
Compass on a panoramic point at the ENEA Research Centre				
Antenna on Monte Mario – Rome	21.9 Km	+120° 52.3'	+120° 51.92'	+0.4'
Cross on the cupola of S. Peter Cathedral in Rome	20.2 Km	+117° 8.8'	+117° 9.45'	-0.7'
Top of Monte Rocca Romana, near Trevignano	54 Km	+137° 58.6'	+137° 58.73'	-0.1'
Compass on a terrace of a building at the ENEA Research Centre				
Telecom tower antenna in Rome EUR	15.3 Km	+80° 38’ 28”	+80° 39’ 36”	-1.1’
Cross on the cupola of S. Peter and Paul church in Rome EUR	17.5 Km	+93° 55’ 7”	+93° 56’ 57”	-1.8’
Cross on the tower of Montecompatri	3.5 Km	-75° 03’ 36”	-75° 04’ 18”	+0.7’
Compass at the Doganella spring, near Rocca Priora (Rome)				
Antenna on Monte Cavo	5.5 Km	+62° 7’ 42”	+62° 8’ 18”	-0.6’

Target	Distance from the compass	Experimental azimuth measured by the ENEA compass	True azimuth of the milestone (IGM)	Difference in arcminutes
Compass at the Military Geographic Institute (IGM) Center in Florence to measure the relative orientation of two calibration stones				
IGM stone 2 seen from stone 1	0.1 Km	-57° 02’ 36”	-57° 02’ 48”	+0.2’

From the tables above, we note that the average accuracy of 0.7’ (obtained comparing the azimuth measured by ENEA compass with those calculated by the Faureragani and Google maps) is of the same order of the precision of the maps.
When measuring the azimuth of IGM boundary stones whose coordinates are known with an uncertainty of 0.02’, the accuracy of the ENEA compass comes out to be 0.2’.