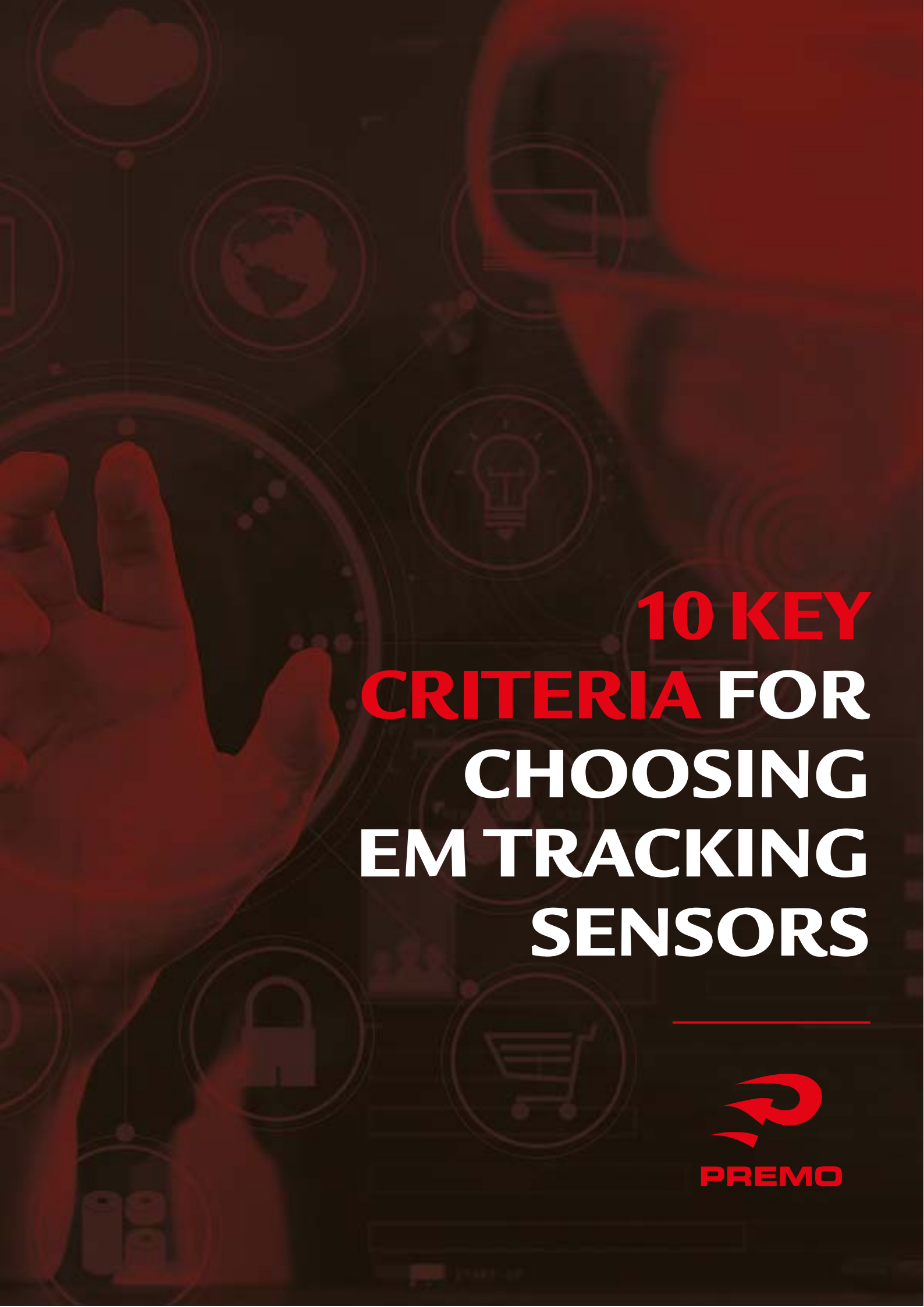


10 KEY CRITERIA FOR CHOOSING EM TRACKING SENSORS

PREMO

10 KEY CRITERIA FOR CHOOSING EM TRACKING SENSORS

PREMO

Índex

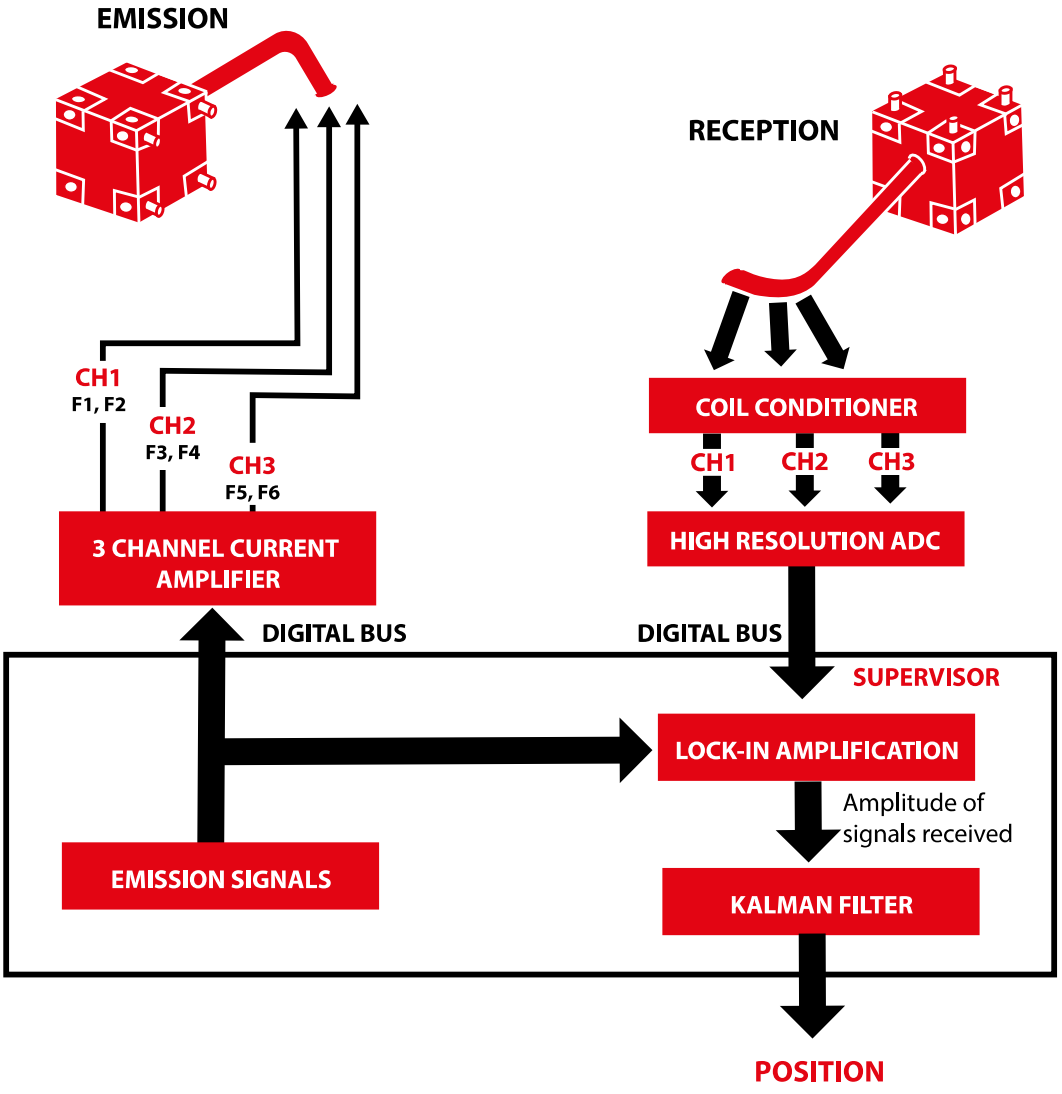
Abstract

Hardware designers have to confront a very wide array of quick decisions when setting and freezing a design. Choosing state-of-the-art standard components that are commodities like capacitors, resistors, Op Amps or drivers is relatively fast, as there are plenty of compatible options, of similar performance and cost.

However, when it comes to DSP (digital signal processors) and microcontrollers, a joint decision is usually made between the hardware engineer and the system architect, taking into consideration software/firmware designs as latency, computing capacity, memory, A/D D/A resolution and the capacity for real-time error compensation and correction.

Choosing the right digital hardware in virtual reality and augmented reality systems is one of the most important decisions you will make, and it's trickier than it seems.

Every aspect of the future product, from cost to performance, flexibility and marketing strategies will depend on those decisions for the duration of the product lifetime.



That being said, the performance of a virtual and augmented reality motion tracking system also lies in the selection of the right tracking technology:

- Visual/ Optical
- IMU (Inertial Measurement Units)
- Electromagnetic, within which we can point out two types:
  - · DC permanent or pulsed magnets
  - · AC Electromagnetic sensing

Techonology	Cost	Latency	Precision	Range	Line of sight
3Dcoilcube	👍 👍	👍 👍	👍 👍 👍	👍 👍	👍 👍 👍
IMU[1]	👍 👎	👎	👍 👎	👍	👍
Visual/ Optical	👎	👍 👎	👍	👍	👎 👎 👎

Notes (1): Inertial Measurament Unit (Sensor array with Gyroscope, Accelerometer & Magnetometer).

The capacity to make a portable system that requires no line of sight and that is not inertial, wireless and even battery-less relies on these initial decisions

3DCoils, the pristine 3D EM tracker for virtual and augmented reality.

Introducing 3DCoil, the pristine 3D EM tracker for virtual and augmented reality.
Among its many advantages, it boasts:

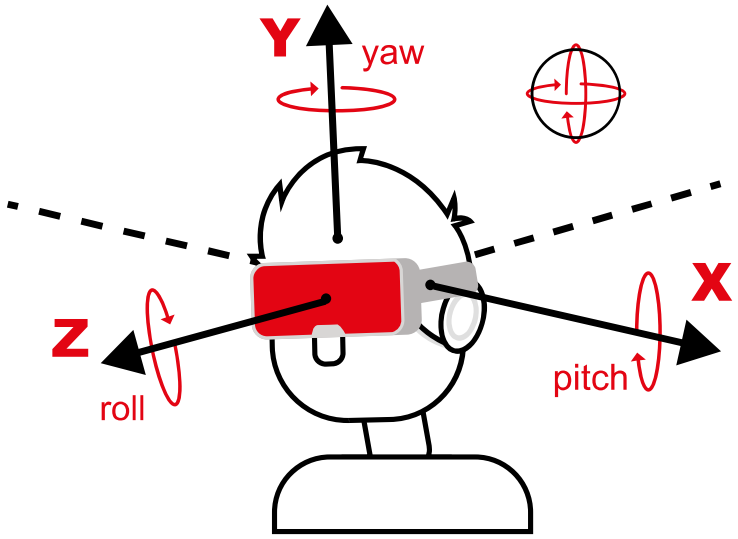
- ✓ Lower Latency: Real-time data output provide immediate feedback without post-processing of position and orientation data.
- ✓ No line of sight needed: LF Magnetic Fields can reach antennae through solid objects.
- ✓ Sensors are never occluded.
- ✓ No fixed referenced emitter or multiple fixed calibration elements.
- ✓ Can deliver longer range tracking than competing technologies.
- ✓ Operates at lower power levels.
- ✓ Offers the best signal-to-noise ratios.
- ✓ Multiple tracking systems can be used in the same environment, without any cross-talk interference.
- ✓ Can be embedded inside any kind of enclosure or housing, except for ferromagnetic materials.
- ✓ Even completely covered, they still track position and orientation seamlessly, due to the long wavelength and low field attenuation in paramagnetic and diamagnetic environments.
- ✓ No Drift.
- ✓ Unmatched precision of 0,01m, with reliable & repeatable tracking results.

3DCoilCubes™ and 3DCoils™ are extremely flexible 3D EM trackers for VR, entirely customizable and easy to setup. It is possible to fine-tune the settings to meet application needs or environment changes.

So, what key parameters should you look at to choose a TX emitter coil or a specific RX receiving sensor coil? The present article is a quick guide for HW and System Architects:

Virtual and augmented reality, full of advantages

Choosing the right product in TX/RX 3D tracking sensor for VR



We have created a short-list of recommended parameters to look into:

1 Function & performance

2 R&D and prototyping Lean Innovation Support

3 DFM (Design For Manufacturability)
- Scale
- Assembly
- Packaging
- Manufacturing mode

4 Time-to-Market

5 3D magnetic performance

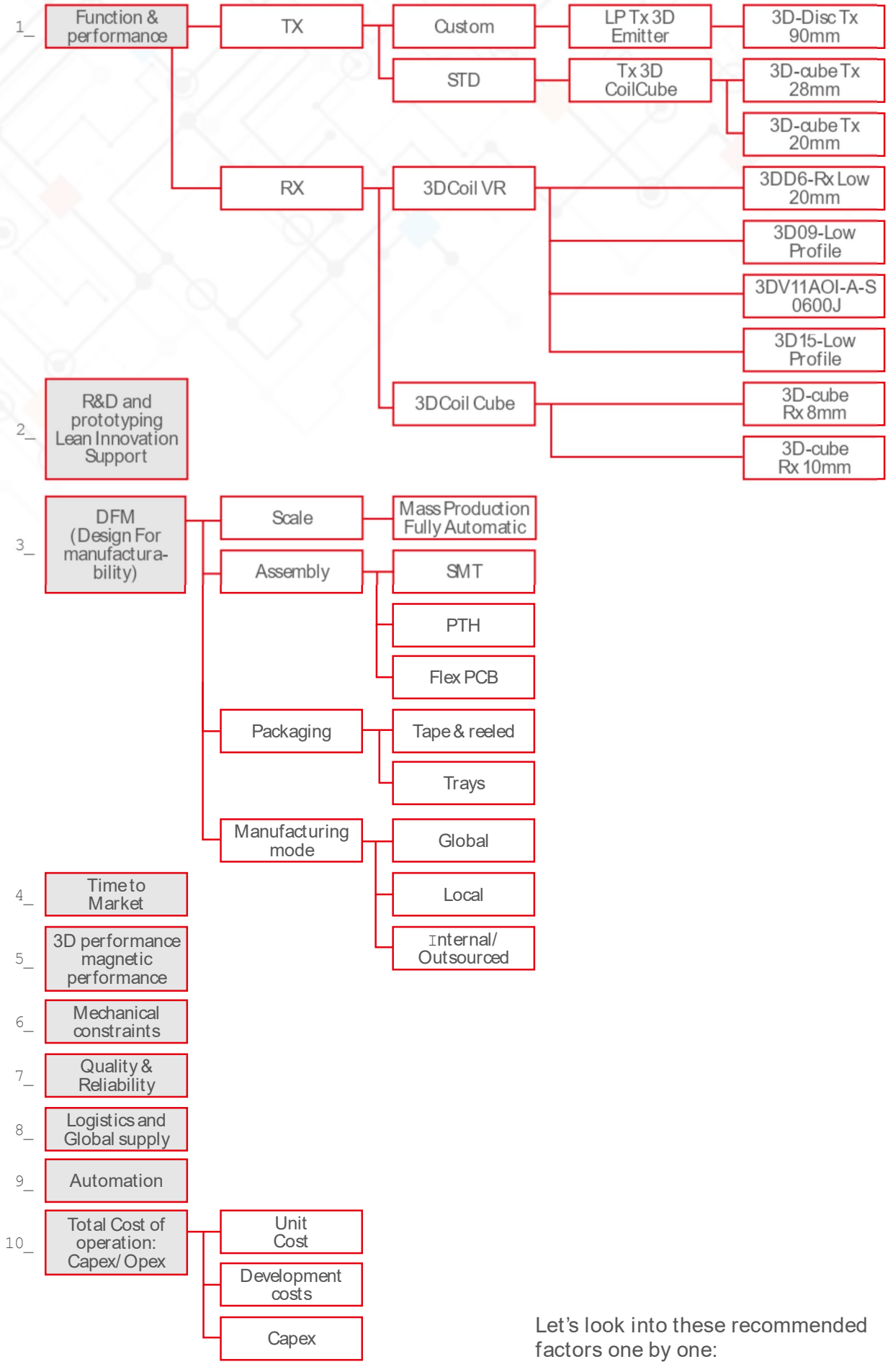
6 Mechanical constraints

7 Quality & reliability

8 Logistics and global supply

9 Automation

10 Total cost of operation : Capex / Opex



Let's look into these recommended factors one by one:

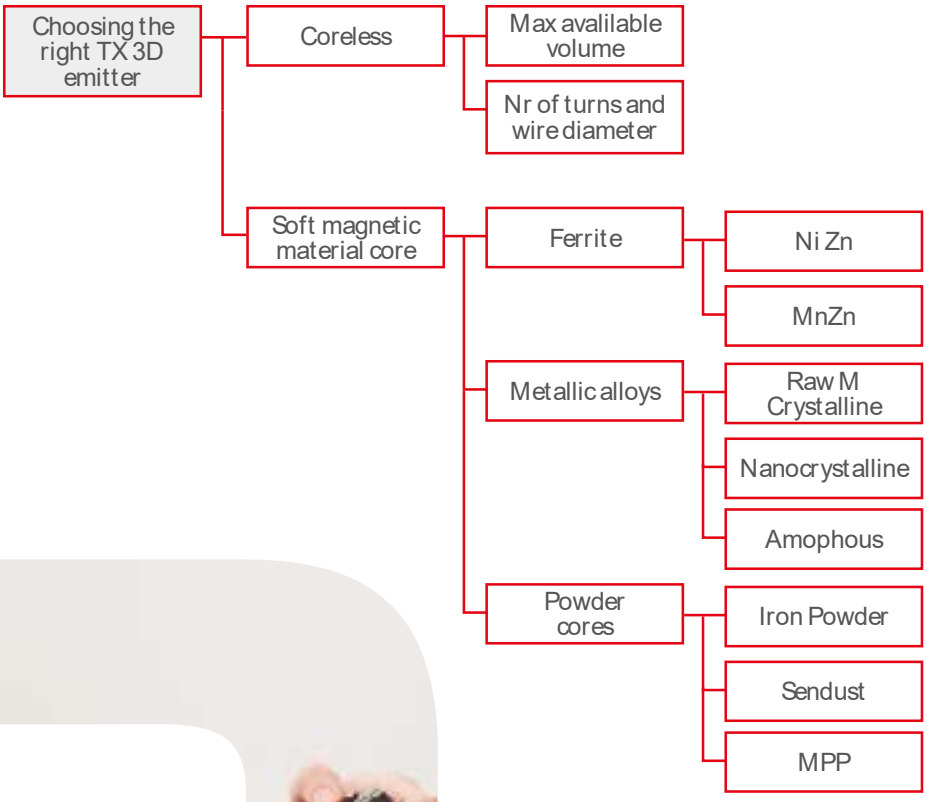
1_ Function & performance

The maximum available power, i.e. the maximum TX Current, will determine the max H Field intensity. The constraints of the systems will be related to material magnetic saturation as a function of N x I product in the TX emitter antennas (N being the number of turns and I the electric current).

TX emitter antennae's maximum capabilities are determined by soft magnetic material induction saturation (if a ferrite or any equivalent soft magnetic material is used), and by max output current, as a consequence of the output equivalent impedance if the TX emitter coil is a 3D Air coil. In that case there would be no magnetic saturation as the core is the air. However, the impedance of the coils would limit the factors, mostly composed of the DC and AC resistance (in the real part) and the inductance (in the imaginary part).

Once you have chosen the performance needed, comes the time to choose:

- The right size for your product.
- The core material composition: ferrite, nanocrystalline, amorphous, mpp cores or air cores.
- The maximum size: this directly impacts the magnetic induction generated, as it is proportional to the cross sectional area of the core.



In Premo's line of TX 3D motion tracking electromagnetic transmission coils, we recommend 3DCoilCubes™, a low profile 3D TX antenna built with soft magnetic materials to minimize volume and size and maximize the generated magnetic field as a multiple of the effective magnetic permeability.

Air coils do have less THD than soft magnetic material coils. However you should take into account that they are bulky and their generated fields are usually weaker and less directional.

Premo uses high frequency, high permeability MnZn ferrite cores, or PBM, or Alma cores in its 3DCoilCubes™ and Lp 3D TX emitter antennas for VR.

2_ R&D and prototyping

When choosing the physical shape of the EM tracker for VR, most non-experts select the simpler geometry forms like spheres and cubes. This is logical when looking for the simplest way to generate equal fields in all 3 orthogonal axis.

Nonetheless, the search for isotropy can also be respected and enhanced with asymmetric core shapes, making for isotropic TX electromagnetic motion tracking emitter antennas that generate identical Bx, By, Bz magnetic induction orthogonal vectors that are identical, all the while every axis can present different geometries as the induction vector B is a function of I (current), N (number of turns of the winding), u (effective magnetic permeability of the core), f (frequency), l (length of the magnetic circuit) and A (the cross sectional area of the core).

There are infinite combinations of the parameters that give identical values of B with different shapes. Therefore, there is no need to seek geometric symmetry in the quest for isotropy.

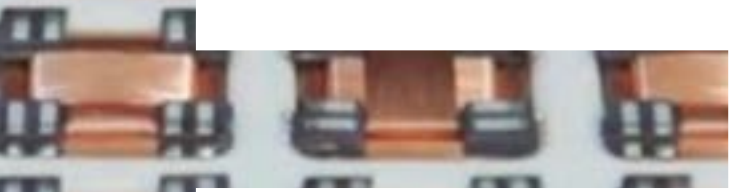
3_ DFM (Design For manufacturability)

Winding a few turns around a bobbin, a coil-former or directly over a piece of magnetic core is a very simple operation that can lead to confusion. This simple process may be good for a mockup sample but, when you need to produce millions, the most important factors to take into account are high repeatability, isotropy and a high merit Pgure of MTBF that assures not only 0ppm in Peld failures, but most importantly, 0ppm during the product lifetime.

When choosing an EM tracking sensor for your project, you not only have to consider the early stage of design, it's also vital to look into cost per million, quality, performance, reliability and automatic mass production with reasonable low capex per unit.

Premo 3DCoilCubes™ and 3DCoils™ for VR/AR EMTS are designed for mass production. 3Dcoil technology is already used in wearables, M2M systems, robotics, general IoT applications, RFID access control and for multiple LF wake-up functions to other HF and UHF systems. They are massively produced and have been for over 20 years, providing over 50% of the global automotive production of Passive Keyless Entry Systems for automobiles. Furthermore, we guarantee:

- Scale: very high volumes make investments in automation highly proPtable and achievable as well as competitive sourcing of the best possible materials.
- Assembly: DFM assures that the assembly of 3DCoilCubes™ and 3DCoils™ for Electromagnetic Motion Tracking Sensors in VR/AR and RFID can be done fully and automatically at high speed. Typical SMT machines can assemble over 90,000 components per hour, thus requiring very strict packaging and connection standards. SMT with AOI in standard Tape & Reel of our components makes assembly fast, inexpensive and reliable.
- Packaging: Jedec standard compatible trays allow components to occupy minimum warehouse space, to travel safely, to be preserved from humidity and oxidation and to be assembled automatically.
- Manufacturing mode: Are you going to assemble the HW in-house or, as most of the designs nowadays in the world, do you plan to use an electronic Contract Manufacturer (CM) like Jabil, Flextronics or Foxconn among many others? We have long relationships with many contract manufacturers both in their HQ locations as well as with their facilities located in low cost countries around the world. Our customer service, account management, logistics, consignment stocks and providing continued quality and service is in place with many of these CM's globally. When choosing Premo 3DCoilCubes™ and 3DCoils™ for EMTS you have a full DFM package from design to supplying your chosen production location.



4_ Time to Market

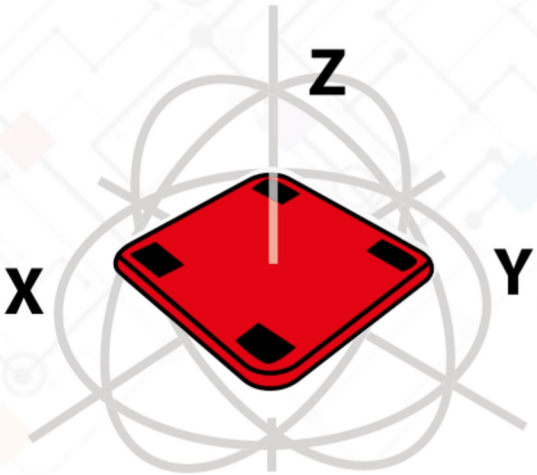
When you need to ramp up your product from 0 to millions in a few months, you need a supplier able to set up mass-scale, fully-automatic production in record time. Premo's in-house automation and the Business Model Innovation that re-engineered our business processes is key to offering the highest quality to our clients.

We changed our R&D and merged with our factory to create the first fully integrated FabLab for magnetics which can design and create any new idea in 24 hours. The key in attaining short time-to-market is not only lean innovation and lean prototyping, but the integration of multiple engineering skills working towards a common goal of generating new processes, creating automatic lines instead of merely products.

Sending automatic lines to our plants for the start is what gives us the competitive advantage of setting up innovative products and processes from 0 to several million pieces in a very short time (just a few weeks).

The key in attaining short time-to-market is not only lean innovation and lean prototyping, but the integration of multiple engineering skills working towards a common goal of generating new processes, creating automatic lines instead of merely products.

5_ 3D performance magnetic performance



Premo invented 3DCoils™ and developed their industrial applications to several fields globally for the last 20 years. This experience allowed us to file for several patents, and fine-tune the portfolio of solutions for our customers' best interests.

Products have been engineered to maximize performance in different applications depending on the system requirements (frequency, min sensitivity in mV/A/m or mV/uT, circuit selectivity, Q factor, self resonance frequencies, THD, cross talk, capacitive coupling, temperature stability, mechanical constraints, shock and vibration resistance, humidity resistance and IP protection, etc.). We have engineered a very wide range of available solutions that maximize performance for a max given volume.

Since 1962 we have been testing, evaluating, tuning and fine tuning the best materials from the top global suppliers of magnetic materials. The very low high frequency losses of NiZn ferrites combined with its very high resistivity have made it the preferred choice for metallized sensors and Rx receiving antennae in RFID.

A deep understanding of the effective combination of materials and shapes and their impacts on effective magnetic permeability lead to always choose either the best L/D ratio or, when for the sake of symmetry this is not possible, we choose the best material to keep the induced voltage for a given magnetic induction at maximum.

Magnetic performance of 3DCoilCubes™ and 3DCoils™, (both TX and RX) have the following characteristics:

- Magnetic permeability of the core (real and imaginary).
- Shape and size of the core.
- High frequency losses of the core (eddy currents and hysteresis losses).
- Losses in the winding (DC, AC and capacitive losses related to interwinding capacitances.
- Windings configuration.

6_ Mechanical constraints

No VR/AR system has unlimited space, or an ideal way to incorporate the device into the mechanism. Resistance to impacts, vibrations and drops, as well as the IPXX index of protection against humidity or solvents, are some of the advantages of choosing 3DCoils.

EMTS sensors for VR/AR typically need to work reliably within a range of 1.5 to 4 meters and we excel at designing the right TX for its RX (larger TX antennas require smaller RX sensors and vice versa).

7_ Quality & Reliability

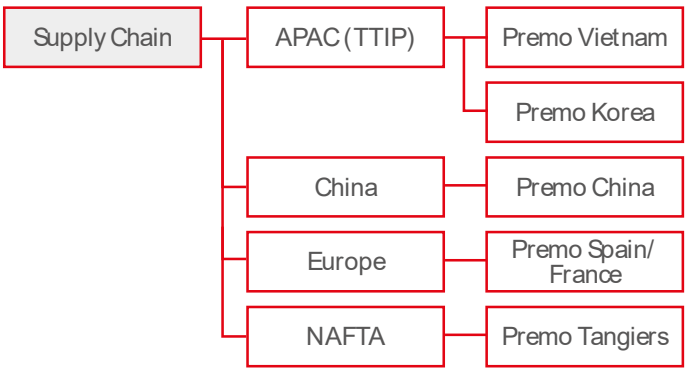
When choosing a TX and RX set of 3D emitter coil for electromagnetic motion tracking in virtual and augmented reality, quality is a major factor:

- Parts with 0ppm Peld failures must necessarily be produced automatically and fully tested in all key electromagnetic and mechanic parameters.
- Expected lifetime of the products should be consistent with the reliability of the parts in the systems and their MTBF.

3DCoilCubes™ and 3DCoils™ have been engineered to meet quality requirements and beat lifetime expectations. Over 180Mpcs are already present in cars, robots, access systems and IoT devices globally.

8_ Logistics and Global supply

Premo has its own sales and logistics ofPces, as well as exclusive partners in 57 countries and covers the main trading areas of the world from its 3 main plants.

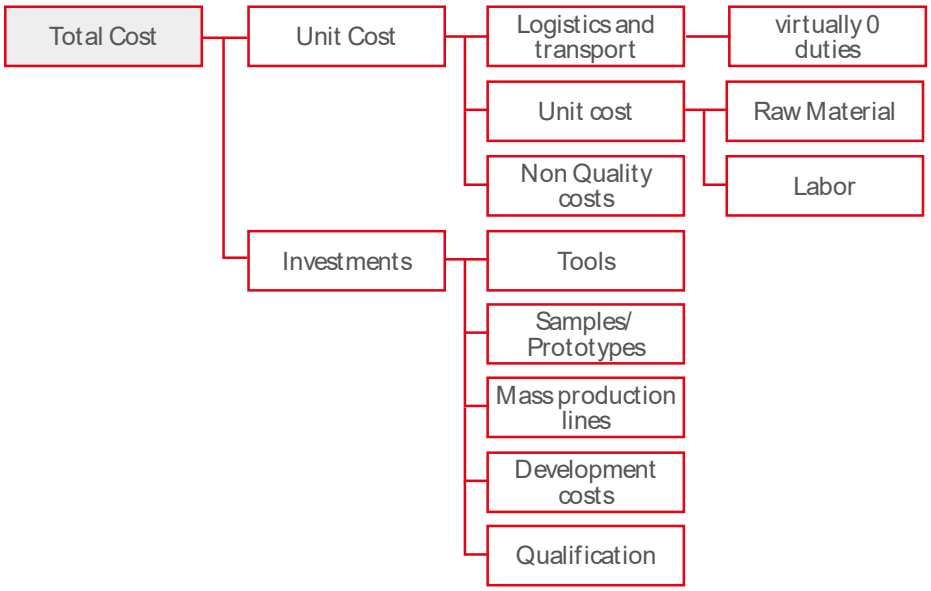


9_ Automation

The degree of automation of our plants is very high, regardless the cost of local labor in each country we invest in. We believe it important to have the best automatic processes for the sake of quality, reliability and capacity.

10_ Total Cost of operation: Capex / Opex

Premo 3DCoilCubes™ and 3DCoils™ are designed as the output of a process. This means that the total cost to the customer goes beyond unit cost:



Premo's unique value proposition is guaranteeing the best possible performance, at the lowest overall costs. After all, lower unit costs do not mean that prices won't explode once production multiplies.

Conclusion

Choosing Electromagnetic Tracking sensors for VR has been proved to be tricky and complex and often a combination of different expertise is needed , from pure electronic hardware Design to Physics of Magnetism to systems reliability, manufacturing engineering and logistics. The present paper gives 10 simple takeaway hints into the main aspects to be considered when making a Design in or proj3ect sourcing decision. Mass production , scalability and DFM are key aspects that will ensure a minimum overall cost and no supply chain sourcing issues or reliability problems. As a conclusion we would highlight that an EMTS is not just a coil winding over a magnetic core or bobbin but a key element in the reliability and performance of the whole immersive VR / AR system and that the capacity to produce millions in short term at ef Pcient cost reliably should be seriously considered.

Mass production , scalability and DFM are key aspects that will ensure a minimum overall cost and no supply chain sourcing issues or reliability problems.

Author Bio

Born in Malaga, Spain, Ezequiel Navarro is a Industrial Engineer (MEE) from UPM. He has been Director, Chief of Sales and CTO of Premo (Global Leader in Innovative Magnetics) for many years and was promoted to CEO in 2006.

Passionate about engineering, he has dedicated his life to research and development, always aiming to improve the fields of the 4th Industrial Revolution: RFID, NFC, VR, AR, IoT, EV and M2M. He is an expert in growth and strategy, intellectual property, investors relations, business development, institutional relations, MBO and LBO funding, and has participated in the firm's expansion in Morocco, China, India, Japan, France, South Korea and Vietnam. He boasts extensive knowledge in the financial and technological sectors, and considerable experience in management and business management. Other than being an electronic engineer certified by the UMA and having a Master in Industrial Engineering, Renewable Energy and Sustainability given by UNED, he has also earned a Master in Corporate Finance, an Executive Master in Financial Management, an Executive MBA and a Master in General Management.

He is also a member of the Board of Directors of AMETIC (Association of Electronics, Information and Communications Technologies, Telecommunications and Digital Content Companies), and PIMEC (Micro, small and medium-sized businesses of Catalonia) and fellow CEO member of the panel of participating companies at Cre100do.

Additionally, Ezequiel is a professor at Pompeu Fabra University, teaching international negotiation and management skills to many eager students, and occasionally at some of the other main business schools in Spain, such as the Business Institute or EADA.

PREMO S.L.
Severo Ochoa 47
Parque Tecnológico de Andalucóa
29590 Campanillas - Málaga - Spain

+34 951 231 320
+34 609 556 716

Jorge Hermoso Global Sales Manager

jorge.hermoso@grupopremo.com

3dcoil.grupopremo.com