GLOBAL AUTOMOTIVE SENSOR MARKET DEMAND, SUPPLY AND OPPORTUNITIES:

Estimation and Forecast of (2015–2022)

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1 REPORT SCOPE

1.1 REPORT COVERAGE

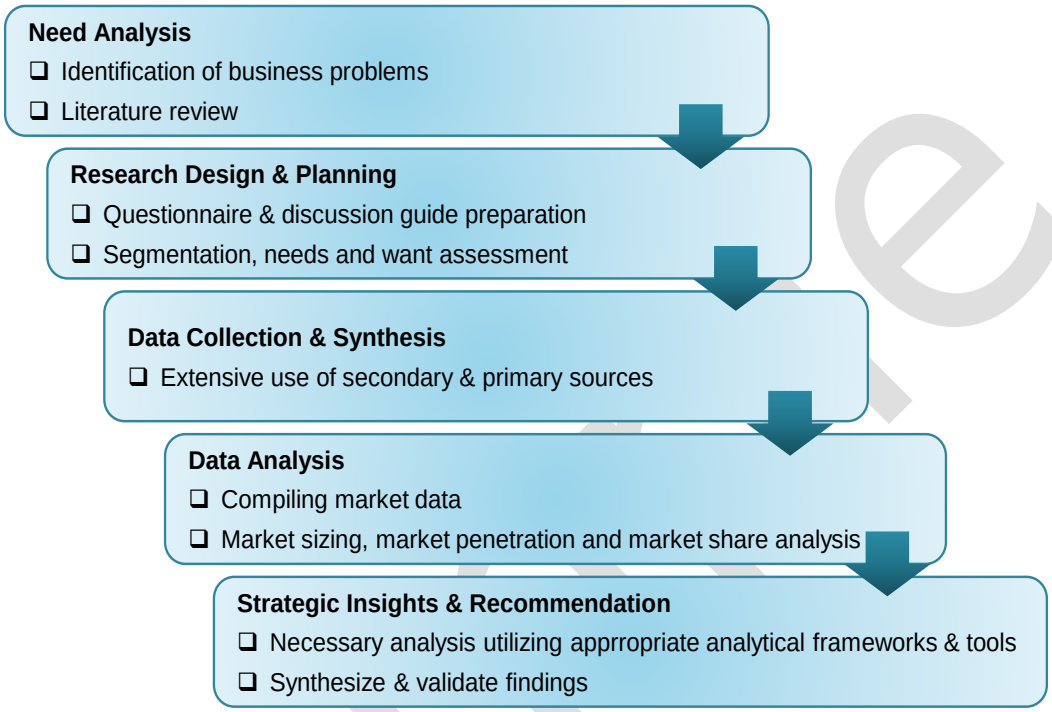
- Global passenger car segments including conventional and alternate fuel (electric vehicles)
- Global heavy vehicle segment includes trucks and off-road vehicles
- Market by sensor types covers all the sensors being used across global automotives
  - The chapter presents market statistics of sensors used in passengers cars but doesn't include the sensors in other segments, i.e. heavy vehicles
- Market By vehicle types covers a detailed analysis of sensors being used across different types of vehicle and maps it to end use point in the passenger cars
  - The chapter also presents a total market value for heavy vehicle segment
- Market by technology qualitatively covers the emerging MEMS and NEMS sensor
- Market by geography presents a detailed market statistics for global passenger car across each country under study
  - The market value for sensors in heavy vehicle is presented by regions

1.2 BIS RESEARCH METHODOLOGY

We exhaustively use both primary sources (in-house experts, industry thought leaders, market players, and independent consultants) and secondary sources (a host of paid and unpaid databases) along with analytical tools to build our forecast and predictive models.

FIGURE 1

BIS RESEARCH METHODOLOGY



Source: BIS Research

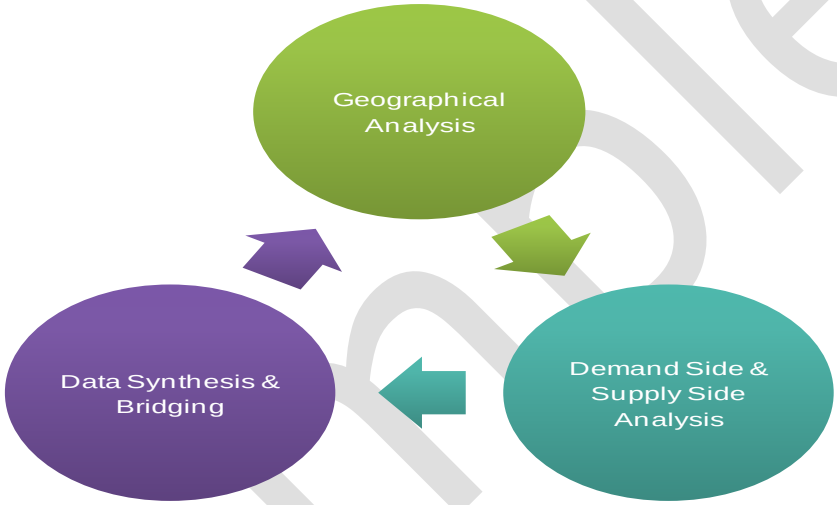
The primary sources are comprised of industry experts from automotive and sensor industries as well as preferred suppliers, manufacturers, distributors, administrators, solution providers, technology developers, alliances, consortiums, and other organizations related to the segments of this industry's value chain. All primary sources were interviewed to obtain and verify critical qualitative & quantitative information and assess the future prospects.

The research study also involves the usage of extensive secondary sources, directories, company websites, and annual reports. It also makes use of databases such as IEEE, Hoovers, Bloomberg, Business-week, Factiva, and One-Source to collect useful and effective information for an extensive, technical, market-oriented, and commercial study of the global market.

1.3 RESEARCH METHODOLOGY FOR GLOBAL MARKET STUDY

FIGURE 2

DIFFERENT PHASES OF RESEARCH METHODOLOGY FOR GLOBAL MARKET



Source: BIS Research Analysis

1.3.1 GEOGRAPHICAL ANALYSIS

The Geographical Analysis of the report covers the region-wise trends in the market. The market statistics for each of the major geographies are also given in this chapter. Besides identifying the key growth enablers in the market based on a detailed "push and pull" forces analysis, the chapter also undertakes an extensive Porters Five Forces analysis.

In estimating and forecasting the geographical market size and potential, purchasing power parity GDP (Gross Domestic Product) estimates for the benchmark year (2015) is derived from a host of sources such as the national income and products accounts from the Organization for Economic Co-Operation and Development (OECD), the European Bank for Reconstruction and Development (EBRD), the World Bank, Eurostat, the U.S. Central Intelligence Agency (CIA) and statistical bureaus of individual countries. The GDP data for individual countries are then

converted to the U.S. dollars by valuing each country's output at the U.S. prices for the benchmark year, thereby addressing the issue of fluctuating exchange rate.

1.3.2 DEMAND SIDE & SUPPLY SIDE ANALYSIS

As the goal of the study was to estimate demand and identify growth opportunity in the market segment, a thorough analysis of demand side dynamics was undertaken. In this process various suppliers were interviewed and probed to understand the buying behavior across different demography. With detailed analysis (both primary and secondary) of suppliers (manufacturers, and channel partners), the supply side dynamics were understood to get a complete picture of the market and triangulate the market data.

For each of the sensor types and end-use application types, a detailed secondary and primary (suppliers) research was done to understand the dynamics of the industry leading players. Some of the key factors that were probed during this process include market size (volume & value), market share (by sensor types, technology, vehicle type, and by geography), market channels and key segments, and regulations among others.

1.3.3 DATA SYNTHESIS & BRIDGING

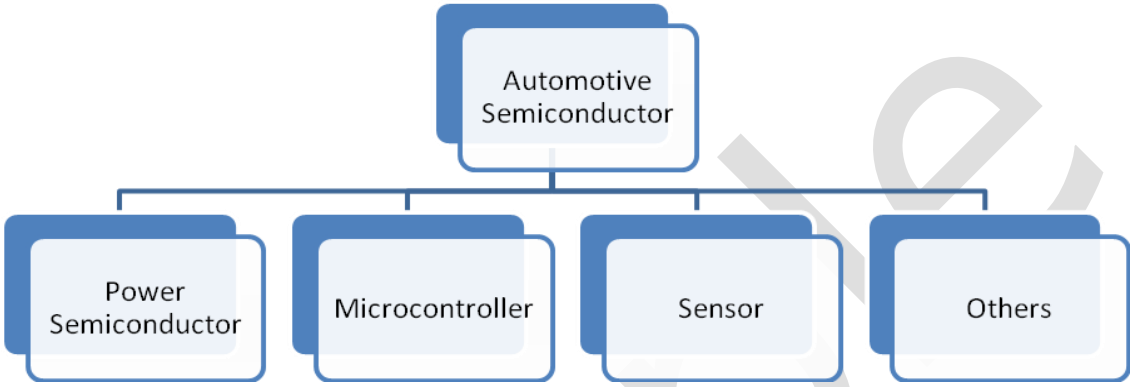
Following comprehensive market engineering which involves calculations of market statistics, its crackdown, its size estimations, its share analysis, its forecast, and data triangulation further primary research was undertaken to gather missing information, verify, and validate the critical numbers arrived at industry trends, and key players of each type of product and application market. Extensive qualitative and further quantitative analysis are also undertaken from all the numbers arrived at in the complete market engineering process, in order to list key information throughout the study.

1.3.4 AUTOMOTIVE MARKET ESTIMATION – A SNAPSHOT

In the past few years, semiconductor market continues to grow at a rate faster than the global GDP and automotive segment of semiconductor industry promises to be one of the key drivers for such growth. As more preference is given to safety, security and comfort, the application of semiconductor in vehicles is growing at a fast rate. The global market of automotive semiconductor has increased by almost XX% from $XX billion in 2013 to $XX billion in 2014. The semiconductor content in an automobile comprise of the following four segments.

FIGURE 3

AUTOMOTIVE SEMICONDUCTOR PRODUCT CATEGORIES



Source: BIS Research

Sensors comprise of a significant percentage i.e. XX% for an average vehicle, and are imperative in ensuring security and other features for any vehicle. Sensors being a part of semiconductor in vehicles will grow with the rise in automotive semiconductor market. One way of computing the market size of global automotive sensors is to determine the sensor content in semiconductor of an automobile.

The semiconductor content as well as the fraction of sensor in semiconductors varies not only with the type of vehicle but also with the models of automobiles. For example, if we talk about cars, the semiconductor content in a high end car is about four times that of mid and low end car.

The amount of semiconductor content across various automotives by types was estimated by taking weighted average using the following formula:

Average Semiconductor ($) = ∑ (Number of Car Models Produced **X** Semiconductor content in the model ($))

TABLE 1

SEMICONDUCTOR CONTENT IN ONE CAR ($)

Car Types	Car Models	2012	2013	2014
Conventional Fuel Car	High End Car($)	XX	XX	XX
	Mid and Low end Car ($)	XX	XX	XX
Alternate Fuel Car	Electric Car ($)	XX	XX	XX
	Hybrid Electric Car	XX	XX	XX

Source: BIS Research Market Estimates

The above estimate was verified through primary participants and subsequently through secondary research.

1.4 REPORT DESCRIPTION

The count of sensors used in automobiles has increased significantly, owing to the increasing demand of safety and environmental concerns both from the perspective of governmental agencies and end-users. Sensors such as pressure, temperature, motion, and position sensors are used across the key end-point applications within an automobile, viz. chassis, power train, and body system. The involvement of semiconductor monoliths such as Bosch, Infineon, and Sensata among others have resulted in a highly competitive market place, raising price wars and rapid technological advancement in the global market.

The report is a meticulous compilation of the different aspects of the automotive sensor market including the porter's five forces analysis, market dynamics, key consortiums, , market breakdown by vehicle and sensor types and key geographical locations. The market values form a critical part of the report, therefore, the revenue generated from sales of automotive sensors for different passenger car types and heavy vehicles have been mentioned separately.
The scope of the report has been limited to passenger cars and heavy vehicles; however, special emphasis has been given to the significant vehicle types, i.e. conventional fuel cars and electric cars. However, qualitative analysis of heavy vehicles along with market estimation and forecast by region has been included in the report.

The passenger cars segment has been segmented by different vehicle type namely-high, medium, and low end vehicles along with electric cars. The market value and volume for different sensor types have been estimated and forecasted on the basis of these vehicle types only.

The report has profiled the key market players operating in the global automotive sensor market such as Bosch, Delphi, Denso, Infineon, and Sensata among others. Moreover, the report has a separate segment for the key market developments and strategies that the market players are adopting to sustain and grow in the global automotive sensor market.

The global automotive sensor market is expected to grow over $XX billion by 2022, at an estimated CAGR of XX% from 2015 to 2022. While APAC will continue to lead the global market through the forecast period, significant revenue flow are expected from Europe and America. Optical sensors will continue to be the largest revenue generating sensor type, however, temperature sensor will be closely following and reach $XX billion by 2022. Motion sensors have been identified as the fastest growing sensor type with a CAGR of XX% through the forecast period. The increasing demand of electric vehicles, owing to its potential to cut down consumption of imported fuel and being environmental friendly makes it the fastest growing vehicle type for automotive sensors globally.

2 MARKET DYNAMICS

2.1 DRIVERS

The automotive sensor market bounced back to a growth trajectory, owing to a host of factors such as: increasing consumer demand for safety, security, comfort and efficiency; stringent government regulations, rising demand for high end and mid end vehicles owing to increasing disposable income in the developing countries, expansion of global auto-manufacturers into new emerging markets, and increasing sensor content in automobile as per Moore's law.

The following section explains in detail about each driver faced by automotive sensor market

2.1.1 INCREASING CONSUMER DEMAND FOR SAFETY, SECURITY, COMFORT AND EFFICIENCY

While safety and security features come first in heavy duty on and off road vehicle operation, the performance demands (efficiency as well as comfort) by customers to increase productivity and minimize vehicle downtime are driving OEMs (Original Equipment Manufacturers) to utilize more sensors in passenger vehicles to achieve all of these important goals. Such diverse portfolio of vehicle control and management sensors helps vehicles operate safely, increase productivity and maximize vehicle uptime.

Migration of safety and comfort attributes from high-end segment vehicles to mid-range vehicles, growth of new and more complex safety features and advanced driver assistance systems (ADAS) is increasing the average semiconductor content (sensor content) per vehicle.

Leading automotive sensor manufactures such as Bosch, Denso, and Infineon Technologies are active working to provide technologically advanced, safer and secure sensor based products for various automotive applications.

For example, Denso is working towards developing two core technologies for improving passenger safety and security: "Sensing technology" that monitors the driving environment/driver/automobile condition on a real time basis; and human machine interface

(HMI) technology to provide drivers with requisite video and audio content at the right time and in an easily interpreted format.

2.1.2 STRINGENT GOVERNMENT REGULATIONS

Demand for automotive sensor in automobiles is also increasing due to strict government regulations for automobile safety and emissions. These regulations are increasing demand for sensors in applications such as engine management System (EMS), tire pressure monitoring system (TPMS), electronic stability control (ESC) system, occupant detection and advanced driver assistant systems (ADAS).

For instance, the Corporate Average Fuel Economy (CAFE) standards are driving OEMs (Original Equipment Manufacturers) to raise overall fleet miles per gallon (MPG) to XX MPG for cars and light-duty trucks by model year 2025.

Leading automotive sensor and semiconductor manufacturers across the world are introducing latest engine management system and micro controller units (MCUs) that incorporate large number of different sensors, to comply with CAFE vehicle emission standard regulations.

On December, 2014, Delphi introduced latest Delphi Multec Gasoline Direct Injection (GDi) Engine Management Systems (EMS) to comply with existing and future vehicle emission standards including CAFE, Euro IV, Euro V and Euro VI, and the U.S. Environmental Protection Agency (EPA) and California Air Resources Board (CARB) standards, such as Tier 2, LEV, ULEV II, SULEV and PZEV and other regulatory bodies such as European Automobile Manufacturers Association (ACEA) for greenhouse gas emissions requirements.

On August 2014, leading Japanese supplier of advanced semiconductor solution, Renesas Electronics Corporation introduced latest RH850/C1x Series of 32-bit microcontrollers (MCUs) for motor control in hybrid electric vehicles (HEVs) and electric vehicles (EVs). The MCUs are designed as per CAFE vehicle emission standards and ISO 26262 functional safety standards.

3 AUTOMOTIVE MARKET BY SENSOR TYPE

3.1 INTRODUCTION

TABLE 2

AVERAGE NUMBER OF SENSORS IN PASSENGER CARS BY VEHICLE TYPE IN DEVELOPING COUNTRIES

Particulars	2014	2015	2016	2018	2020	2021	2022
High End	XX	XX	XX	XX	XX	XX	XX
Medium End	XX	XX	XX	XX	XX	XX	XX
Low End	XX	XX	XX	XX	XX	XX	XX
Electric	XX	XX	XX	XX	XX	XX	XX

Source: ME-BIS Research

While the average count of sensors for high end vehicles was XX in developed regions, the number dropped to XX for developing countries such as India and Middle East countries among others. The average number of sensors for each vehicle type is expected to double by the end of forecast period. The increase will be most visible in medium end and electric vehicles.

TABLE 3

GLOBAL MARKET VOLUME FOR AUTOMOTIVE SENSORS IN PASSENGER CARS (MILLION UNITS), 2015-2022

Type of Car	2014	2015	2016	2018	2020	2021	2022	CAGR
High End	XX	XX	XX	XX	XX	XX	XX	XX%
Mid End	XX	XX	XX	XX	XX	XX	XX	XX%
Low End	XX	XX	XX	XX	XX	XX	XX	XX%
Electric	XX	XX	XX	XX	XX	XX	XX	XX%
Total	XX	XX	XX	XX	XX	XX	XX	XX%

Source: ME-BIS Research

The global market volume for automotive sensors was XX billion units in 2014 which is expected to grow over XX billion at a CAGR of XX% through 2015 to 2022. With medium end vehicles dominating the global automotive market, the revenue from sensors going into this vehicle type will be maximum, growing over XX billion units by 2022 at a CAGR of XX% through the forecast period.

Market value from sensors going into high end models from BMW, Audi, and Jaguar among others will grow at a CAGR of XX% through the forecast period, to reach XX billion units by 2022.

TABLE 4

GLOBAL MARKET VALUE FOR AUTOMOTIVE SENSORS IN PASSENGER CARS ($ MILLION), 2015-2022

Type of Car	2014	2015	2016	2018	2020	2021	2022	CAGR
High End	XX	XX	XX	XX	XX	XX	XX	XX%
Mid End	XX	XX	XX	XX	XX	XX	XX	XX%
Low End	XX	XX	XX	XX	XX	XX	XX	XX%
Electric	XX	XX	XX	XX	XX	XX	XX	XX%
Total	XX	XX	XX	XX	XX	XX	XX	XX%

Source: ME-BIS Research

Automotive sensors for medium end vehicles dominated the global market in 2014 with a share of $XX billion which is expected to grow over $XX billion by the end of the forecast period. The global market value for automotive sensors was $XX billion in 2014 which is expected to grow over $XX billion by the end of the forecast period, at a CAGR of XX% through 2015 to 2022.

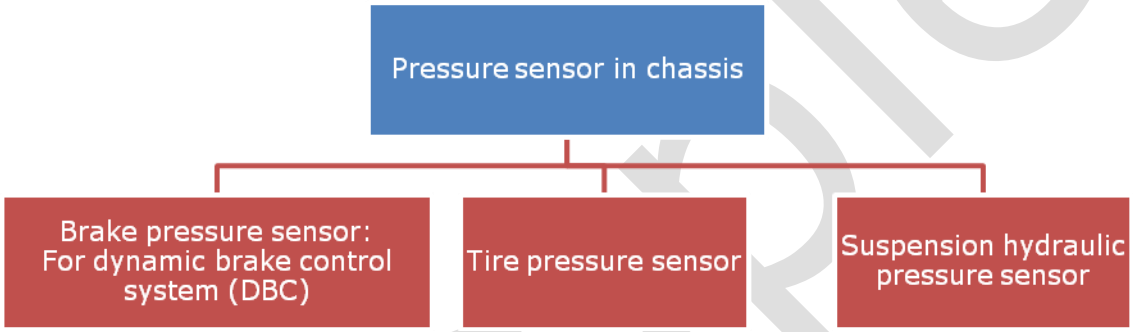
Electric vehicles will be increasingly using different sensor types, generating $XX million by 2022 at an estimated CAGR of XX% through 2015 to 2022.

3.2 PRESSURE SENSOR

3.2.1 PRESSURE SENSOR TYPES –CHASSIS

FIGURE 4

CHASSIS PRESSURE SENSORS



Source: BIS Research

Brake pressure sensors are designed for dynamic brake control in vehicle stability system to measure high pressure, improve brake effectiveness during emergency braking situations.

Tire pressure sensors are part of electronic tire monitoring system (TPMS) designed for measuring tire air pressure which is reported to electronic control unit and finally to the driver. Schrader International Inc. (US) is considered a global leader in TPMS technology. In 2014, Schrader invested $XX million at its Springfield, Tenn. (US) tire pressure monitoring system sensors plant for serving markets in US, Europe, Russia and in several Asia-Pacific countries, considering the demand for TPMS technology in vehicles is rising and becoming a global safety legislation.

In 2014, Malaysian company Salutica Allied Solutions Sdn. Bhd introduced world's first Bluetooth-operated (compatible with android as well iOS operating system) advanced tire pressure monitoring system, FOBO tire for in-car monitoring applications of intelligent vehicles such as hybrid cars, plug-in cars among others.

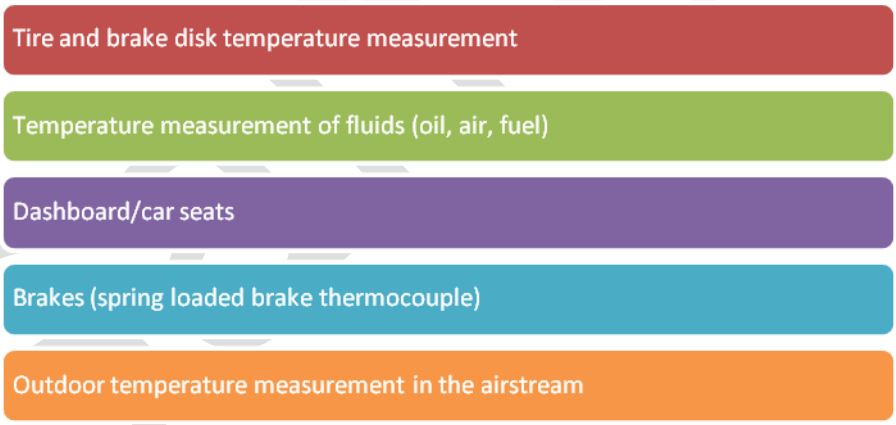
3.3 TEMPERATURE SENSOR

Temperature sensor monitors temperature of fluids, gases, other physical components that are involved in running an automobile. Temperature sensors are used in chassis, power train as well as in body system applications. Such sensors are increasingly being used in emerging emission control technologies such as SCR (Selective catalytic reduction) for a regular checkup of the exhaust temperature. According to the EPA (Environmental Protection Agency), all heavy duty diesel engines developed post January 1, 2010 have been compelled to bring harmful emissions such as nitrogen oxides (NOx) and particulate matter (PM) to nearly zero levels.

Following figure lists the key applications of temperature sensors in automobiles:

FIGURE 5

KEY APPLICATIONS OF AUTOMOTIVE TEMPERATURE SENSORS



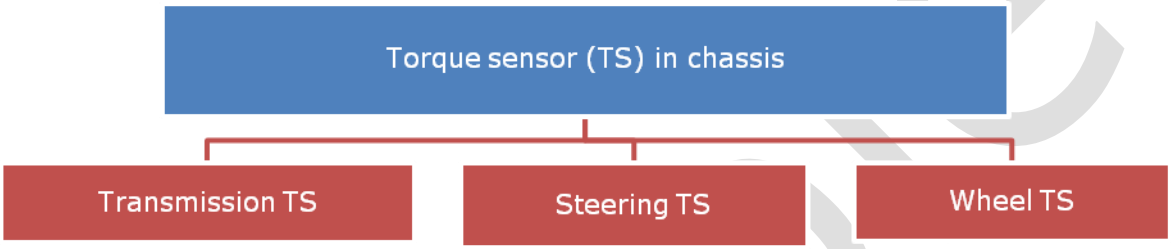
Source: BIS Research

The subsequent sections will provide detailed insights about the automotive temperatures sensor market along with key players and market statistics.

3.4 TORQUE SENSOR

FIGURE 6

CHASSIS TORQUE SENSOR



Source: BIS Research

Transmission torque sensor measures engine output torque as well transmission input torque while the wheel torque sensor or driveshaft torque sensor monitors transmission output torque. Both the torque sensors are important for vehicle traction control as well analysis of the gearbox efficiency. On the other hand, steering torque sensor measures how much steering assistance is required by feeding output to the electronic control unit of EPS system.

3.4.1 TORQUE SENSOR TYPES -POWER TRAIN

Torque sensors are used for various torque sensing applications in the power train (engine applications) of a vehicle. The figure below shows different types of torque sensors in a power train.

4 AUTOMOTIVE SENSOR BY VEHICLE TYPE

4.1 HEAVY VEHICLES

The heavy vehicle segments in the report includes two vehicle types- trucks and off-road (off-highway vehicles).

4.1.1 MARKET STATISTICS

TABLE 5

GLOBAL MARKET VALUE OF SENSORS IN HEAVY VEHICLES ($MILLION), 2015-2022

Type	2014	2015	2016	2018	2020	2021	2022	CAGR
Truck	XX	XX	XX	XX	XX	XX	XX	XX%
Off-Road	XX	XX	XX	XX	XX	XX	XX	XX%
Total	XX	XX	XX	XX	XX	XX	XX	XX%

Source: ME-BIS Research

The above table presents the estimated global market value of sensors in heavy vehicles from 2014 to 2022. The total market value of sensors in heavy vehicles in 2014 was $ XX million, out of which sensors in trucks accounted for $XX million which is expected to grow at a CAGR of XX% from 2015 to 2022. The value of off-road vehicles was $XX million in 2014 and is predicted to increase to $XX million by 2022.

4.1.2 SENSOR IN TRUCKS

Similar to the application of sensors in passenger cars, trucks makers are increasingly adopting sensors to ensure safety and better driving experience. Trucks are further segmented into Low Commercial Vehicles (LCV) and Heavy Commercial Vehicle (HCV). LCVs are the goods and carriage vehicles with Gross Vehicle Weight (GVW) below 6 tons while HCVs are the ones with

more than 6 tons GVW. Out of the total XX million unit commercial vehicles on road in 2014, the HCVs accounted for XX Million while the share of LCVs remained relatively lesser. However, it is expected that the growth of LCV will be higher owing to increased demand from market such as India.

Factors driving the demand of this segment in various emerging countries are increased need of LCV & HCV truck safety systems, hot spots ABS (Anti lock breaking system), ESC (Electronic Stability Control), and active braking. Whereas, in the developed countries, the rising adoption of telematics based integrated safety system is assisting this segment to grow. However, factors such as rising importance of supply chain optimization involving vehicle tracking, critical event alerts, operations management back office automation, scheduling and delivery confirmation among others, are together driving this market in all the regions.

4.2 CTS CORPORATION

4.2.1 COMPANY OVERVIEW

Particular	Specifications(as of 2014)
Website	www.ctscorp.com
Contact Details	CTS Automotive Products 1142 W. Beardsley Ave. Elkhart, IN 46514 USA Tel:574-389-2700 Fax: 574-295-7810
Year of Establishment	1896
Ownership Type	Public
Company Type	Designer and Manufacturer
Number of Employees	187400
Subsidiaries	CTS Electronic Components Inc., CTS Components Taiwan Ltd., CTS Japan Inc.
Competitors	Murata Manufacturing Co. Ltd., Delphi Automotive LLC

Source: CTS Corporation website, LinkedIn, BIS Research

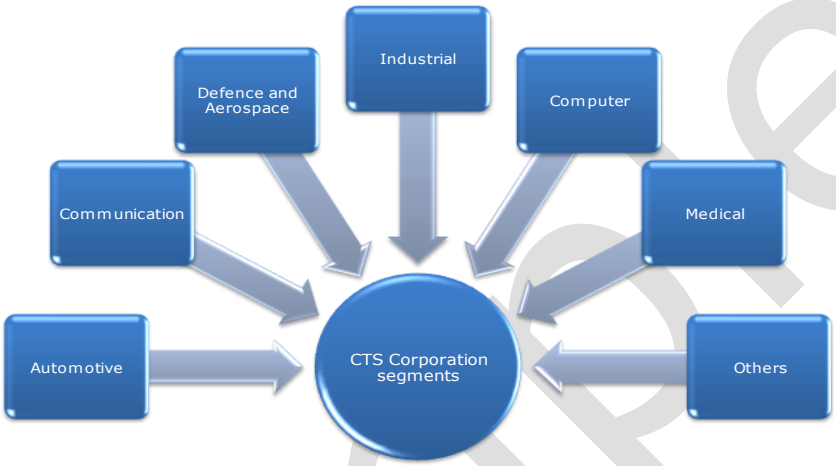
4.2.2 PRODUCT PORTFOLIO

CTS Corporation design, manufacture and sell a broad line of electronic component and sensors to original equipment manufacturers.

The company targets the following markets:

FIGURE 7

CTS CORPORATION PRODUCT SEGMENT



Source: BIS Research

The company's major market consists of automotive sensors and actuators used in consumer and commercial vehicles.

The company manufactures electronic components, switches, resistor networks, and potentiometers for communication infrastructure and computer markets.

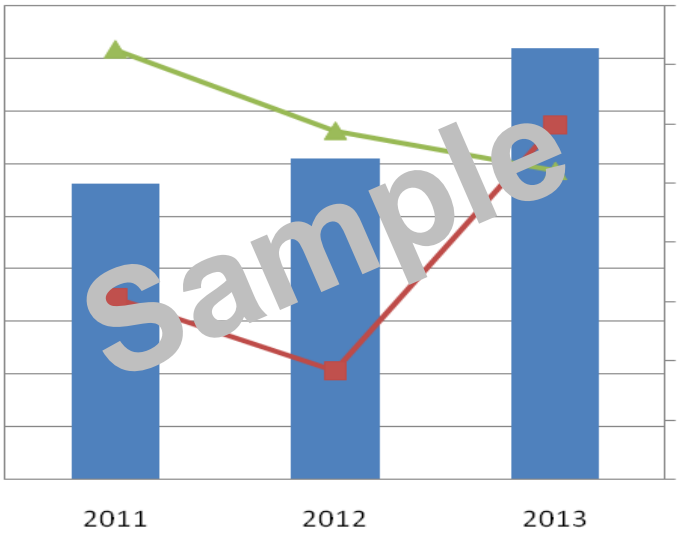
For the industrial, defense and aerospace markets, the company's main products are piezoelectric materials and substrates.

4.2.3 FINANCIALS

4.2.3.1 Overall Financials

FIGURE 8

OVERALL FINANCIALS ($MILLION), 2011-2013

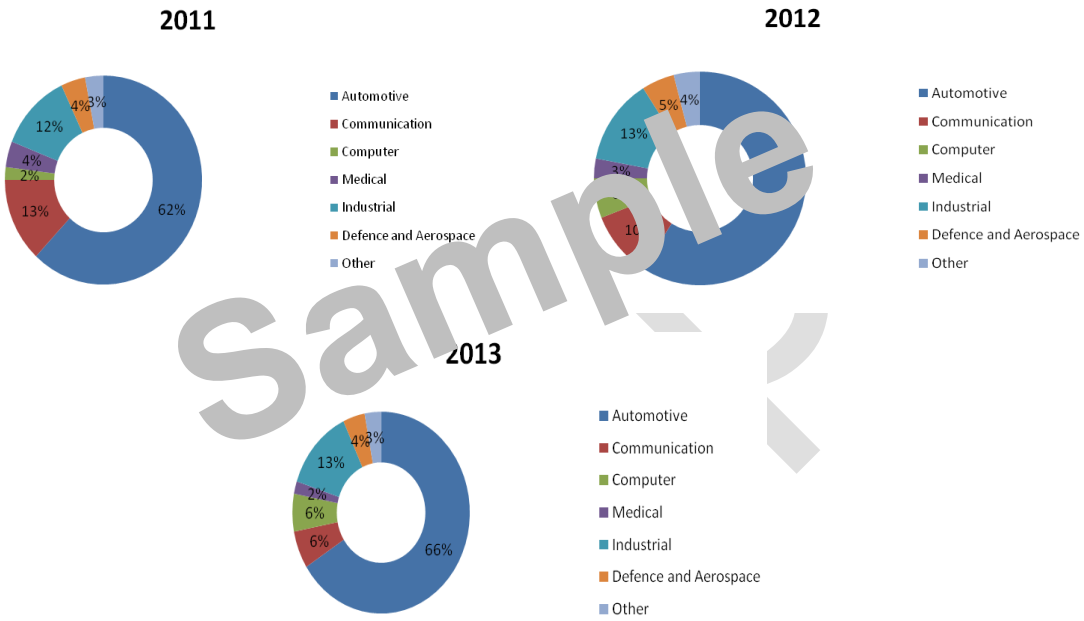


Source: BIS Research

4.2.3.2 Financials By Business Segment

FIGURE 9

NET REVENUE BY BUSINESS SEGMENTS, 2011-2013

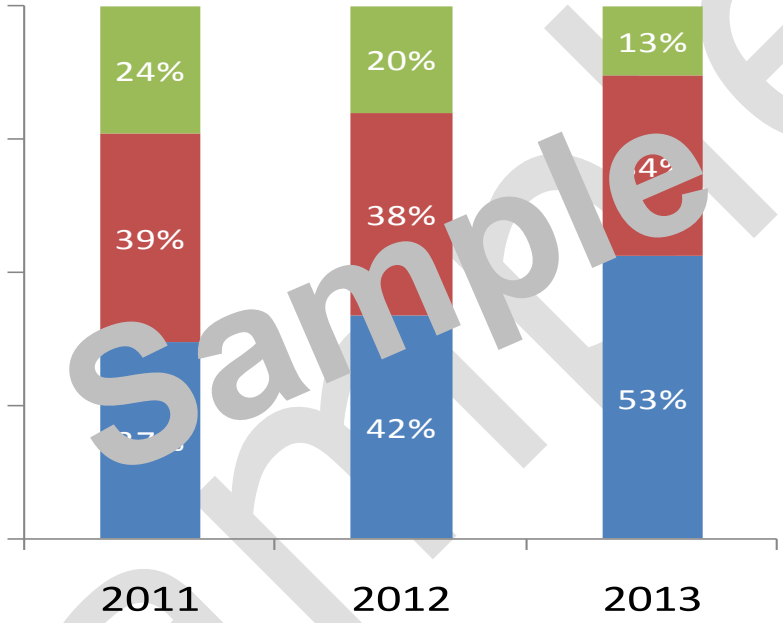


Source: BIS Research

4.2.3.3 Financials By Region

FIGURE 10

NET REVENUE BY REGION, 2011-2013



Source: BIS Research

4.2.4 KEY DEVELOPMENTS

Date	Strategy	Description
February 2015	Event	CTS Corporation announced that it had been awarded a new production program to supply accelerator pedal modules to a German automobile manufacturer
January 2015	Product Launch	CTS Corporation announced the addition of tactile switches to our product portfolio of DIP switches, mechanical encoders, optical encoders, precision potentiometers, position sensors and rotary switches.

Date	Strategy	Description
May 2014	Product Launch	CTS Corporation through its subsidiary announced new ClearPlex Waveguide Duplexer, delivering performance capable to air cavity with 2x to 4x smaller size for cellular infrastructure
May 2014	Product Development	CTS Corporation through its subsidiary developed new ultra jitter and excellent phase noise oscillators
January 2014	Collaboration	CTS Corporation collaborated with Microsemi to offer ultra-low Jitter solutions at lower cost by combining high performance crystal clock oscillators with ultra-low additive Jitter Fan-out Buffers
May 2013	Product Development	CTS Corporation developed oven controlled crystal oscillators (OCXOs), which used the unique internal heated resonator (IHR) technologies to significantly reduce power consumptions
May 2013	Product Launch	CTS Corporation introduced the ClearPlex Waveguide Ceramic Filter, a revolutionary RF ceramic filter that offered space and cost saving features as well as superior performance
February 2013	Event	CTS Electronic Manufacturing Solutions was awarded a second production program to provide printed circuit board assemblies for a leading global medical orthopedia firm
January 2013	Event	CTS Corporation Automotive products was awarded a second production program to supply brushless motor-driven actuators for active air-grill shutter systems
December 2012	Acquisition	CTS Corporation acquired D&R Technology and expanded its leadership position in automotive sensors

Source: CTS Corporation Website, BIS Research

4.2.5 ANALYST INSIGHT

CTS Corporation is a global leader in the design and manufacturing of electronic components, sensors and actuators. The company experienced a significant increase in sales since 2012

after the acquisition of D&R Technology. This explains the company's strategy of development by acquiring others whenever there is a need.

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