Turbochargers for Downsized Gasoline Engines.
Outlines

Drivers for Gasoline Turbocharged Engine

Turbocharger Technical Solutions

BW New Generation Turbochargers for Otto Engine
Fig. 1 Specific power and torque as a function of time.
Comparison between Turbo & N.I. Engine (1.2L Otto)

Max. Torque 170Nm/2000rpm

Max. Power 85kW/6000rpm
Vehicle requirements

- Reduced CO2 Emission.
- Reduced NOx Emissions.
- Downsizing, Installation space saved.
- Improved Dynamic Response (esp. low speed).
Gasoline Downsizing & Turbocharging in Europe 2008-2015

Focus of Development

First Assumption!

Need to speed up: Costs, innovation

Downsizing Trend has major market impact
Passenger Car Gasoline Turbo

Units [Thousands]

- Variable Turbine
- Bi-Turbo (W/G)
- Waste gate

2008: 1% Variable Turbine, 10% Bi-Turbo, 89% Waste gate
2009: 1% Variable Turbine, 10% Bi-Turbo, 89% Waste gate
2010: 1% Variable Turbine, 9% Bi-Turbo, 89% Waste gate
2011: 1% Variable Turbine, 9% Bi-Turbo, 89% Waste gate
2012: 10% Variable Turbine, 90% Bi-Turbo, 1% Waste gate
2013: 9% Variable Turbine, 90% Bi-Turbo, 1% Waste gate
2014: 90% Variable Turbine, 1% Bi-Turbo, 1% Waste gate
2015: 90% Variable Turbine, 1% Bi-Turbo, 9% Waste gate
Outlines

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Technical Requirements for gasoline engines

**Engine Targets**
- Reduced CO2 emission (140 g/km)
- Reduced NOx emissions
- Improved Dynamic Response
- Reduced fuel consumption

**Engine Technologies**
- Downsizing
- Variable valve control
- Gasoline direct injection
- Lean burn engines
- Miller cycle
- Variable compression “eps”
- Nox storage catalytic converter

**Charging Technologies**
- VTG for 1050 °C
- R2S-gasoline 1050 °C
- Variable Compressor
- Electronic control devices
- E-Booster combined charging
- Twin-Scroll turbines 1050 °C
- Low thermal inertia (steel cast, AGI)
# Technical requirements of the pass car turbocharger for gasoline engines

## Engine technologie

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### **Downsizing**
- Mean effectiv pressure
- Low end torque

### **Transient behavior**
- Reduced inertia moment
- T- efficiency at low speed
- Using puls energy

### **Transient behavior**
- Improved transient response

### **Reduced fuel consumption**
- High exhaust gas temp.
- 1050 °C

### **Engine performance**
- Improved driveability
- T/C – control systems
Turbocharger Solutions

- 1) Twin Turbo
- 2) Gasoline VTG.
- 3) AGI technology.
- 4) Twin Scrolls
- 5) Integrated with manifold.
VW 1.4l gasoline engine (Twin-charger)

- SPEC:
- Rated power: 125kW,
- Max. torque: 240Nm@1750rpm~4500rpm.
- O~100km / h: 7.9S.
- 100Km/l: 7.2L / 100km.
New technology Gasoline VTG

VTG model
Resistant temperature: 1050°C
Improve efficiency at low end
Actuator Control: Electron or pneumatic
Compressor housing integrated with CRV
Water cooled
Temperature Distribution after Full Load Accel.

- Most critical case: Maximum acceleration under full load
- Permanent High Temperatures no problem even with component temperature of 1000°C
VTG TC for Porsche 911

3.6l gasoline engine
0-60mph under 4s
Top speed 192mph
615Nm@1950rpm~5000rpm

VTG TC
Heat resistant up to 1000°C
Emission level: EU 5
Air gap insulated turbine housing “AGI-technology”

**Double wall, complete**

**Air-Gap-Insulated (AGI)**

**Benefits:**
- Reduced weight (aprox. Reduction 35%)
- Low thermal inertia ➞ Reduced cat light off
- Reduced radiation of heat ➞ lower surface temperature
- Efficiency and flow-rate characteristics equal to casted turbine housings

**Condition:**
- High production volume
- Very high tooling costs
New technology **twin scroll**

**General advantages and disadvantages of Twinscroll applications**

**Advantages of Twinscroll T/H:**

- Effect of pulse energy (impulse incitation of turbine wheel?)
  - torque improvement
Twinscroll simulation analysis

Mass Flow
Distributed to both Scroll

RB:
m = 0.115kg/s
n_{ATL} = 182.500min^{-1}
WG-Klappe geschlossen
OPEL 2.0l gasoline engine

- 2.0l DGI
- 192Kw@5500rpm
- 350Nm@1800~4500rpm
AUDI 1.8TSI

K03
Resistant temperature: 980℃
250Nm@1800rpm~4500rpm
132kW@5500rpm
Turbine housing integrated with manifold
Compressor housing integrated with noise absorber and E_CRV

BorgWarner
Turbo & Emissions Systems
Opel 1.6l TCI

Specification:
- K03
- Turbine housing material: D5S
- Exhaust gas temperature: 950°C

K03
1.6 ltr; I4
132 kW @ 5800 rpm
230 Nm @ 2000 rpm
Outlines

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Turbocharger Technical solutions

BW New Generation Turbochargers for Otto Engine
Our Solutions:

- Specially developed range
- High grade materials
- Water-cooled bearing casings
- Further developed systems for high temperature applications up to 1,050°C
- New generation of turbines and impellers
- Different boost concepts depending on engine strategy:
  - waste gate and boost pressure control valves – variable turbines – twin flow turbines – eBooster™
- Special design solutions such as integrated exhaust manifolds
New generation of gasoline T/C, B0x C/S

Power Range of new B0 gasoline:

1. B031 (based on KP C/S)
   50 – 75 kW
2. B035 (based on KP C/S)
   70 – 100 kW
3. B039 (based on KP C/S)
   90 – 130 kW
4. B040, B045 (based on B02 C/S)
   130 – 160 kW
5. B050, B053 (based on B03 C/S)
   160 – 250 kW

B031 – B039: Focus on 0.6 – 1.6 L Engine