
# NXP's TJA108x FlexRay transceiver family

# NXP: your partner in FlexRay business

## FlexRay history and NXP's role and contribution

*A brief review*

The history of FlexRay started in the late 1990s, when several car makers recognized that their future In-Vehicle Networking (IVN) requirements could not be solved with existing networks such as CAN. These car makers therefore decided to found a consortium – FlexRay Consortium – to develop and drive the adoption of an industry standard – FlexRay – for high-speed, time-triggered communication networks for automotive applications. NXP Semiconductors (formerly Philips Semiconductors) was invited to become one of the founding (core) members of this FlexRay Consortium and has been leading the Physical Layer Working Group ever since. Because of its core membership, NXP Semiconductors (NXP) also holds a chair in the Steering Committee and Executive Board of the FlexRay Consortium. NXP developed the first hardware solution to enable other Consortium members to perform system studies on FlexRay applications. This product is known as the TJA1080.

## NXP innovation- and volume-leader in automotive networking

*NXP has shipped more than 1,000,000 FlexRay transceivers!!*

An important milestone was achieved in late 2006, when the first car model using FlexRay networking was taken into mass production: the BMW X5, which uses NXP's TJA1080 in an active damping control system. In 2008, BMW launched the current 7-series, with a FlexRay network consisting of a maximum 15 nodes supporting several applications. FlexRay is thus no longer only in a development phase; it is also in a mass-production phase, with actual cars on the road. As a result, NXP has already shipped more than 1,000,000 FlexRay transceivers. This volume milestone shows all the more that NXP brought FlexRay into the industrialization phase.

## FlexRay is getting global

*FlexRay and JASPAR[1] requirements merged into one (global) standard*

The Japanese automotive industry decided that it would be beneficial to have a domestic consortium to focus on FlexRay applications. This led to the formation of the JASPAR consortium, in 2004, under the leadership of Toyota, Nissan and Honda. NXP joined JASPAR in 2007, not only to get a clear understanding of the differences between FlexRay and JASPAR applications, but also to actively contribute to JASPAR Working Groups. Meanwhile, the FlexRay Consortium and JASPAR aligned on a common physical layer specification, the Electrical Physical Layer Specification (EPL) V3.0, which will be released by the end of 2009.

NXP founded by Philips

Recognizing the importance of Japanese car industry, NXP has installed an extensive automotive team in Japan to adequately support its automotive customers.

[1] JASPAR: Japan Automotive Software Platform Architecture

## NXP's TJA1080

*FlexRay enabler and first FlexRay transceiver in mass production*

As the world's first silicon for the FlexRay electrical physical layer, the TJA1080 proves FlexRay's power and versatility. This device has played a key role in driving new, advanced communication systems into cars by offering an extensive feature set, excellent EMC performance, and high ESD protection.

Ever since the TJA1080 was taken into mass production, NXP has benefitted from market feedback and its experience in mass producing this part. This very valuable information helped to define new products for future applications and to tailor the product specifications and features to the wishes of NXP's customers. Of course NXP's transceiver products also comply with automotive quality and reliability requirements. To achieve this NXP used its 'Design-for-Excellence' approach during the development phase.

## TJA1080A

*Building on experience*

Market feedback taught us that some fine-tuning of the TJA1080 was needed, which could not be implemented in a product running in mass production. This was the reason for introducing a successor part: the TJA1080A. At the same time, the FlexRay Consortium also finalized the first test specification for conformance testing. The TJA1080A was tested and passed in November 2007, becoming the first FlexRay-conforming transceiver in the market.

The TJA1080A transceiver offers significant enhancements over its predecessor, the TJA1080:

- Improved power-on reset behavior
- Fully conforms to EPL V2.1 Rev. A
- Reduced emission on bus lines
- Higher RF immunity and a guaranteed 60 ns minimum bit time for enhanced system robustness
- Wakeup via a dedicated FlexRay data frame, which is an EPL V3.0 feature

Like the TJA1080, the TJA1080A can be configured as a node transceiver or as an active star coupler with one branch. This makes the TJA1080A the most versatile FlexRay transceiver available in the market. The TJA1080A has been in production since 2009.

Both the TJA1080 and the TJA1080A laid the foundation of the maturation of the FlexRay physical layer. More than a million of these 2 devices are on the road.

In order to further drive FlexRay adoption, two new and cost-effective products have been released in 2009 and two more are currently in development. Released are the node transceivers **TJA1081** and **TJA1082** and currently in development are the **TJA1085**, a 4-branch active star coupler and the **TJA1083**, which is an EPL V3.0 and JASPAR compliant node transceiver.

## TJA1081

*Basic 'Clamp 30' node transceiver*

Similar to the TJA1080A, the TJA1081 provides error diagnosis and status register readout functions. This device is a cost-optimized 'Clamp 30' node transceiver (without star functionality), in an SSOP16 package. The TJA1081 can be used as a drop-in replacement for the TJA1080A. The TJA1081 has a very low current consumption in sleep and standby mode and supports minimum bit times down to 60 ns, herewith outperforming the EPL V3.0 specification. The TJA1081 also supports ECU low power management via the INH pin and the 'EPL V3.0' wakeup mechanism via a dedicated FlexRay data frame. The TJA1081 successfully passed the EPL V2.1 Rev. A conformance test and has been in production since 2009.

## TJA1082

*Basic 'Clamp 15' node transceiver*

The TJA1082 brings together all the knowledge and know-how that NXP obtained from developing and manufacturing the TJA1080 and the TJA1080A. The TJA1082 is optimized for ECUs that are switched off by the ignition key ('Clamp 15' operation) and is easy to apply and to design in. Due to the tailored functionality, compared to the TJA1080A, the package size and footprint are smaller and the pin count is lower. The TSSOP14 package, which has a footprint of only 4 mm by 6.4 mm, makes the TJA1082 nearly as small as a standard high-speed CAN transceiver in an SO8 package (such as the NXP TJA1050 and TJA1040). The TJA1082 is compliant with EPL V2.1 Rev. B.

Like the TJA1080A and the TJA1081, the TJA1082 supports minimum bit times down to 60 ns and a wakeup mechanism via a dedicated FlexRay data frame. It also has a low-power receiver, which is active in stand-by mode. Besides this, several protection and diagnostics functions are available: undervoltage detection, bus error detection and temperature protection. This diagnostic information can be transferred to a microcontroller using a standard SPI interface. The TJA1082 operates from a normal 5 V supply voltage and can interface to a microcontroller with a wide range of supply voltages. The TJA1082 has been in production since 2009.

## TJA1083

*The 'global' transceiver EPL V3.0 and JASPAR compliant*

The JASPAR activities resulted in some differing transceiver requirements, which have been incorporated in EPL V3.0 and are specified in the functional class called 'Bus driver - Increased voltage amplitude transmitter'. Anticipating the release of EPL V3.0, NXP started the development of a 'global' FlexRay transceiver – TJA1083 - which is not only EPL V3.0 compliant but also meets the JASPAR specific requirements. Due to its 'global' concept, the TJA1083 will achieve higher volumes; higher volumes will boost quality and economies of scale. The TJA1083 is pin- and footprint-compatible to the TJA1082, making it a logical and easy upgrade to EPL V3.0.

The TJA1083 is under development and samples will be available in Q1 2010. Release of this product is scheduled in Q1 2011.

## TJA1085

*World's first EPL V3.0 compliant 4-branch active star coupler with enhanced bus error detection*

The FlexRay standard allows passive bus topologies and topologies with an active star coupler, or a mix of these. From the beginning, FlexRay networks have been built around active star couplers consisting of several branches. The versatile TJA1080A was used for these first implementations of star architectures. However, for a cost-optimized, mass-production solution, a dedicated star coupler product is preferred. For this reason, we have added the TJA1085 star coupler to our FlexRay portfolio.

This 4-branch active star coupler – basically replacing four instances of a single TJA1080A – will be compliant with FlexRay EPL V3.0, thus ensuring optimized timing behavior and a 100% fit to protocol mechanisms. With its enhanced bus error detection and diagnosis, the TJA1085 enables faster and more reliable error confinement. Branch-wise 'partial networking' completes the TJA1085's unique feature set.

TJA1085 is under development and samples will be available in Q1 2010. Release of this product is scheduled for Q4 2010.

## NXP: your partner in FlexRay business

NXP is the market leader in IVN transceivers and a FlexRay market shaper. Moreover, thanks to our unparalleled track record in IVN volume supply, we can provide excellent supply security. To enable easy design-in of our products, we offer extensive IVN system knowledge and responsive customer support. For released FlexRay products, we provide transceiver simulation models and support network topology simulations for car OEMs.

NXP sees the FlexRay market developing quickly. Increasingly, OEMs around the world are adopting FlexRay technology by implementing FlexRay networks in their vehicles. NXP's next-generation FlexRay physical layer products target enhanced features, like partial networking, enhanced EMC, reduced current consumption ('green driving'), and a higher level of integration and, as a result, optimized system cost.

All NXP's FlexRay transceivers are FlexRay compliant. This ensures proper interoperability with FlexRay compliant protocol controllers and FlexRay compliant physical layer devices without exception and under all circumstances.

## Potential FlexRay applications

- Vehicle Dynamics (braking, suspension, steering)
- Driver assistance
- Intelligent Parking Assist
- Adaptive Cruise Control
- Fuel Control Systems
- Traction Control Unit
- Intelligent Power Assisted Steering
- Lane Departure Warning System
- Electronic Power Assisted Steering
- Electronic Stability Control

## TJA108x selection guide

| | TJA1080A | TJA1081 | TJA1082 | TJA1083 | TJA1085 |
|---|---|---|---|---|---|
| **Main characteristics** | | | | | |
| FlexRay Node functionality | Yes | Yes | Yes | Yes | Yes |
| Active Star functionality | Yes | No | No | No | Up to 4 branches |
| EPL compliance | V2.1 Rev. A | V2.1 Rev. A | V2.1 Rev. B | V3.0 | V3.0 |
| Minimum bit time | 60 ns | 60 ns | 60 ns | 60 ns | 60 ns |
| Minimum transmitter output voltage of 900 mV (JASPAR) | No | No | No | Yes | No |
| Auto I/O-level adaptation to host/controller interface (VIO) | Yes | Yes | Yes | Yes | Yes |
| Mode control | STBN and EN pins | STBN and EN pins | STBN pin | STBN pin | SPI |
| Bus guardian interface | Yes | Yes | Yes | Yes | Yes |
| **Power management** | | | | | |
| Standby and sleep mode | Yes | Yes | Standby only | Standby only | Yes |
| Low power management with INH switch(es) | 2 INH switches | 1 INH switch | No | No | 1 INH switch |
| Sleep current | < 65 µA | < 65 µA | < 47 µA | T.b.d. | T.b.d. |
| Wakeup via symbol or a (EPL3.0) dedicated FlexRay frame | Yes | Yes | Yes | Yes | Yes |
| Wakeup source recognition (local or remote) | Yes | Yes | N/a | N/a | Yes |
| **Diagnosis** | | | | | |
| Over-temperature detection | Yes | Yes | Yes | Yes | Yes |
| Short-circuit on bus lines | Yes | Yes | Yes | Yes | Yes |
| Clamping of pins TXEN and BGE | Yes | Yes | Yes | Yes | Yes |
| Under-voltage detection (on specified pins) | $V_{BAT}$, $V_{CC}$, $V_{IO}$ | $V_{BAT}$, $V_{CC}$, $V_{IO}$ | $V_{CC}$, $V_{IO}$ | $V_{CC}$, $V_{IO}$ | $V_{BAT}$, $V_{CC}$, $V_{IO}$ |
| Information provided by ERRN pin | Error and status | Error and status | Simple error indication | Simple error indication | No |
| Error diagnosis and status vector readout via SPI | No | No | Yes | Yes | Yes |
| Enhanced bus error detection with selective branch shut-down | No | N/a | N/a | N/a | Yes |
| **Protections** | | | | | |
| ±8 kV ESD protection for off-board pins | HBM | HBM | HBM and IEC61000-4-2 | HBM and IEC61000-4-2 | HBM and IEC61000-4-2 |
| Bus pins short-circuit proof to battery voltages of 14 and 42 V and ground | Yes | Yes | Yes | Yes | Yes |
| Fail-safe behavior incase of an under-voltage | Yes | Yes | Yes | Yes | Yes |
| Passive behavior of bus lines when unpowered | Yes | Yes | Yes | Yes | Yes |
| **Other** | | | | | |
| Package | SSOP20 | SSOP16 (fits on TJA1080A footprint) | TSSOP14 | TSSOP14 (fits on TJA1082 footprint) | HVQFN44 |
| Availability | In production | In production | In production | Sampling Q1, 2010 | Sampling Q1, 2010 |

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