



# TEF668X

Low IF tuner high performance one-chip

Rev. 1 — 30 July 2013

Product short data sheet



## 1. General description

---

The Low IF Tuner High performance One chips, TEF6686 and TEF6688, are single-chip radio ICs including an AM/FM radio tuner and software-defined radio signal processing. They extend NXP Semiconductors' broad, industry-proven car radio single tuner portfolio, offering outstanding radio performance with the widest range of features and state of the art software algorithms at most optimized system costs.

Both devices are available in HVQFN packages occupying the smallest PCB space and are suitable for dual- and multi-layer PCBs. The radio receiver includes highest feature sets, the FM/AM front-ends, tuning synthesizer, channel filtering, FM Channel Equalization, FM multipath improvement, demodulation, FM stereo decoding, weak signal processing, noise blanking and RDS and provides an interface to a DARC demodulator/decoder.

The TEF6686 and TEF6688 can provide stereo audio in digital format on the I<sup>2</sup>S outputs and on the audio DAC outputs. The TEF6688 supports the digital radio standards HD Radio and Digital Radio Mondiale (DRM) digital radio when used with NXP Semiconductors' digital radio coprocessors such as SAF356X and SAF360X.

## 2. Features and benefits

---

- Alignment free digital receiver including tuner and software-defined radio processing
- Command based high-level user interface combining high control flexibility with ease of control
- Read information with device and tuning status, reception quality and RDS data
- FM receiver with a tuning range of 65 MHz to 108 MHz covering Eastern Europe (OIRT), Japan, Europe and US bands
- AM receiver covering LW, MW and full SW
- Fully integrated tuning system with low phase noise and fast tuning
- FM LNA with AGC
- State-of-the art FM Improved Multipath Suppression
- FM Channel Equalization
- Soft Mute on Modulation
- Stereo High Blend
- FM mixer for frequency conversion to a low IF complex signal (AM SW)
- AM LNA with AGC, matching active and passive antenna applications
- AM mixer for frequency conversion to a low IF complex signal



- High dynamic range Sigma Delta IF ADC
- Digital IF signal processing including decimation, shift to baseband, AGC control, I/Q correction, variable IF bandwidth filtering (PACS) and demodulation
- FM stereo decoding
- TEF6688 baseband I<sup>2</sup>S output supporting HD Radio and DRM<sup>1</sup> with external digital radio coprocessor (SAF356X or SAF360X)
- Blending function for HD Radio reception (TEF6688)
- AM and FM noise blanking, Signal quality detection and weak signal processing
- Advanced RDS and RBDS demodulation and decoding
- MPX output supporting DARC demodulator
- One I<sup>2</sup>S input and one I<sup>2</sup>S output
- Two mono audio DACs
- Single 3.3 V supply voltage
- Fast mode I<sup>2</sup>C-bus (400 kHz)
- Configurable GPIO pins for RDS, Quality Status Interrupt and generic I<sup>2</sup>C-bus controlled I/O
- Qualified in accordance with AEC-Q100

### 3. Applications

The TEF668X is a single tuner AM/FM receiver for automotive applications and supports analog AM/FM and HD/DRM reception (HD/DRM is supported in TEF6688 only).

Additionally, due to a common technology platform, the TEF668X can be combined with TEF701X, SAF775X and SAF360X for optimal system application through common crystal oscillator sharing.

### 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supply voltage</b>						
V <sub>DDA(RF)(3V3)</sub>	RF analog supply voltage (3.3 V)	on pin VDDA_RF	3.0	3.3	3.5	V
V <sub>DDA(IF)(3V3)</sub>	IF analog supply voltage (3.3 V)	on pin VDDA_IFADC	3.0	3.3	3.5	V
V <sub>DDD(3V3)</sub>	digital supply voltage (3.3 V)	on pin VDD_DIGITAL	3.0	3.3	3.5	V
<b>Current in FM mode</b>						
I <sub>DDA(RF)</sub>	RF analog supply current	on pin VDDA_RF	33	37	42	mA
I <sub>DDA(IFADC)</sub>	IF ADC analog supply current	on pin VDDA_IFADC	81	94	110	mA
I <sub>DDD</sub>	digital supply current	on pin VDDD	37	38	48	mA
<b>Current in AM - MW/LW mode</b>						
I <sub>DDA(RF)</sub>	RF analog supply current	on pin VDDA_RF	34	40	48	mA

1. DRM includes DRM30 and DRM+ (band I and II)

Table 1. Quick reference data ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I <sub>DDA(IFADC)</sub>	IF ADC analog supply current	on pin VDDA_IFADC	63	74	86	mA
I <sub>DDD</sub>	digital supply current	on pin VDDD	33	34	46	mA
<b>Current in Standby mode</b>						
I <sub>DDA(RF)</sub>	RF analog supply current	on pin VDDA_RF	0	0.3	2	mA
I <sub>DDA(IFADC)</sub>	IF ADC analog supply current	on pin VDDA_IFADC	25	37	45	mA
I <sub>DDD</sub>	digital supply current	on pin VDDD	15	24	35	mA

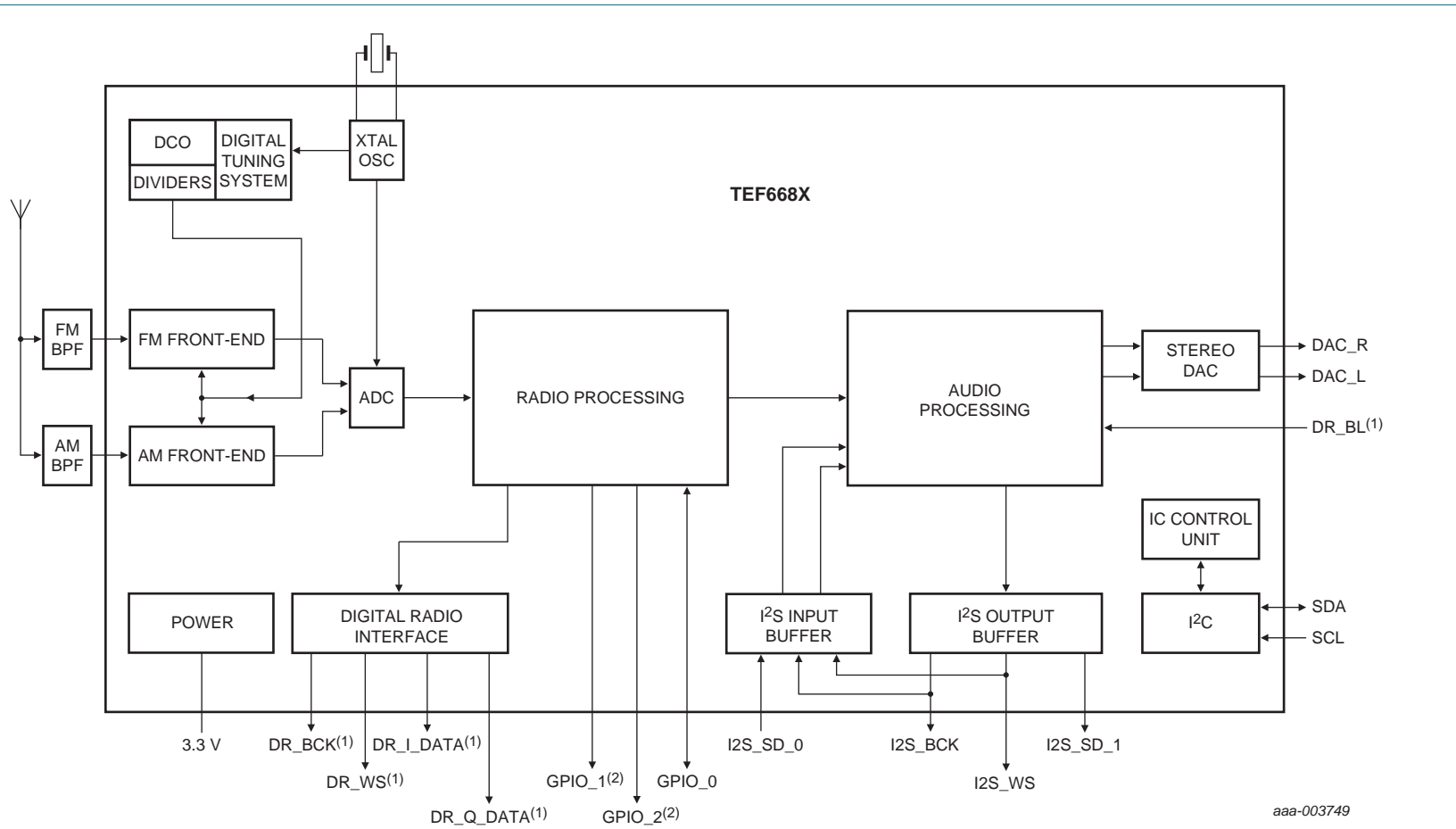
## 5. Ordering information

Table 2. Ordering information

Type number	Package		Version
	Name	Description	
TEF6686HN/V101	HVQFN32	plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5 × 5 × 0.85 mm <sup>[1]</sup>	SOT617-3
TEF6688HN/V101			

[1] Wettable sides to allow for optical inspection.

## 6. Block diagram



- (1) TEF6688
- (2) GPIO\_1 and GPIO\_2 are output only.

Fig 1. Block diagram

## 7. Limiting values

**Table 3. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DDA(RF)(3V3)}$	RF analog supply voltage (3.3 V)	on pin VDDA_RF	-0.5	+3.9	V
$V_{DDA(IF)(3V3)}$	IF analog supply voltage (3.3 V)	on pin VDDA_IFADC	-0.5	+3.9	V
$V_{DDD(3V3)}$	digital supply voltage (3.3 V)	on pin VDDD	-0.5	+3.9	V
$\Delta V_{DD(3V3-3V3)}$	supply voltage difference between two 3.3 V supplies	between pins VDDA_IFADC and VDDA_RF	-0.3	+0.3	V
$V_n$	voltage on any other pin		-0.5	$+V_{DDD(3V3)} + 0.3$	V
$I_{lu}$	latch-up current	all supply voltages below the maximum value	[1] -100	+100	mA
$V_{lu}$	latch-up voltage		-	$1.5 \times V_{DDD(3V3)}$	V
$T_{stg}$	storage temperature		-55	+150	°C
$T_{amb}$	ambient temperature		-40	+85	°C
$T_j$	junction temperature		-40	+125	°C

[1] In accordance with AEC-Q100-004.

## 8. Revision history

**Table 4. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
TEF668X_SDS v.1	20130730	Product short data sheet	-	-

## 9. Legal information

### 9.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

### 9.2 Definitions

**Draft** — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

**Short data sheet** — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

**Product specification** — The information and data provided in a Product data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the Product data sheet.

### 9.3 Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

**Right to make changes** — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use in automotive applications** — This NXP Semiconductors product has been qualified for use in automotive applications. Unless otherwise agreed in writing, the product is not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications** — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Limiting values** — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

**Terms and conditions of commercial sale** — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

**No offer to sell or license** — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

**Export control** — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

**Quick reference data** — The Quick reference data is an extract of the product data given in the Limiting values and Characteristics sections of this document, and as such is not complete, exhaustive or legally binding.

**Translations** — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

## 9.4 Licenses

### ICs with HD Radio functionality

NXP Semiconductors ICs with HD Radio functionality are manufactured under license from iBiquity Digital Corporation. Sale or distribution of equipment that includes this device requires a license, which may be obtained at: iBiquity Digital Corporation, 6711 Columbia Gateway Drive, Suite 500, Columbia MD 21046, USA. Telephone: +1 (443) 539 4290, fax: +1 (443) 539 4291, e-mail: [info@ibiquity.com](mailto:info@ibiquity.com).

## 9.5 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

**I<sup>2</sup>C-bus** — logo is a trademark of NXP B.V.

**HD Radio** — is a trademark of iBiquity Digital Corporation.

**HD Radio** — logo is a registered trademark of iBiquity Digital Corporation.

## 10. Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

## 11. Contents

---

<b>1</b>	<b>General description</b> .....	<b>1</b>
<b>2</b>	<b>Features and benefits</b> .....	<b>1</b>
<b>3</b>	<b>Applications</b> .....	<b>2</b>
<b>4</b>	<b>Quick reference data</b> .....	<b>2</b>
<b>5</b>	<b>Ordering information</b> .....	<b>3</b>
<b>6</b>	<b>Block diagram</b> .....	<b>4</b>
<b>7</b>	<b>Limiting values</b> .....	<b>5</b>
<b>8</b>	<b>Revision history</b> .....	<b>5</b>
<b>9</b>	<b>Legal information</b> .....	<b>6</b>
9.1	Data sheet status .....	6
9.2	Definitions .....	6
9.3	Disclaimers .....	6
9.4	Licenses .....	7
9.5	Trademarks .....	7
<b>10</b>	<b>Contact information</b> .....	<b>7</b>
<b>11</b>	<b>Contents</b> .....	<b>8</b>

---

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

---

© NXP B.V. 2013.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

Date of release: 30 July 2013

Document identifier: TEF668X\_SDS