

# Automotive Infotainment Guide



 TEXAS INSTRUMENTS



Audio  
Data converters  
Embedded processors  
Interface  
Microcontrollers  
Power management  
Wireless connectivity

# Automotive infotainment guide

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### Texas Instruments' commitment to transportation

Texas Instruments (TI) is committed to providing innovative automotive technologies that make safer, greener and more enjoyable driving experiences. With deep understanding and expertise in analog and embedded processing, Texas Instruments provides a rich portfolio for the automotive/ transportation space. TI is committed to providing superior cost-effective solutions to the transportation market along with benchmark service in terms of excellent product documentation, on-time delivery and conformance to specifications.

TI makes it possible to achieve the quality, reliability and cost goals needed to succeed in today's marketplace.

#### Automotive qualified products (Q1)

TI's automotive qualified products are indicated by the Q1 suffix. The Q1 indicates that a product has met TI's stringent automotive standards and includes:

- 180-day product change notification from final notice
- Extended temperature qualification
- Automotive documentation service
- Target zero defects

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# Automotive infotainment guide

## Design considerations

With the race to deliver the best features in new cars escalating, the infotainment system is now a key focus in the automotive design process. To support the growing importance of infotainment, Texas Instruments offers a strong portfolio and design support. TI's broad analog and digital embedded and applications processing portfolio provides improved audio quality and system speed, efficient power management and low power consumption for applications such as car audio, navigation systems, power supply, as well as in-car and personal entertainment.

Infotainment systems combine entertainment, multi-media and driver information functions in one module. They offer AM/FM or satellite radio, DC/DVD player for music and video, navigation system, data and multi-media ports (USB, *Bluetooth*<sup>®</sup>, line in, line out, video in) as well as general and vehicle status information.

### Audio input/output

The audio input front end and audio output is often combined into a single codec. The audio line level input from the source is converted into digital samples by the ADC and feed to the system's DSP. On the output side, ADCs convert the digital output to an analog signal, which is amplified to the levels needed by the speakers or headphones used with the system. By using Class-D amplifiers the system's power efficiency can exceed 90% while maintaining low THD. This improved efficiency leads to significant size, weight and heat reductions. TI's Class-D car audio solutions exhibit extremely low EMI levels and are being used in OEM systems with stringent EMC requirements.

The audio DSP performs I/Q demodulation and outputs digital audio and data. This includes functions like:

- Volume, treble, bass and sound effects
- Mixing input channels and digitally processing multiple channels
- Performing sound effects processing such as Dolby<sup>®</sup> Pro Logic<sup>®</sup> II, SRS<sup>®</sup> Circle Surround<sup>™</sup> II, TruSound and other audio algorithms
- The uC + DSP controls the user interface, bus interface and network interface as well as GPS navigation and touch screen control
- It is also used to process and output video data from multiple sources

### Power management

The power supply is connected to the 12 V or 24 V board net and regulates down/up to voltages for DSP, uC, memory and ICs and functions in the infotainment system. In some cases there may be 10 or more different power rails, making the design of the power supply a critical task when trying to design for size, cost and efficiency.

Linear regulators with low quiescent current help reduce battery leakage current during standby operating modes (ignition off), are load dump voltage tolerant for direct battery devices and need low drop-out and tracking for low battery crank operation.

Beyond providing increased conversion efficiencies, switching power supplies provide:

- EMI improvement with slew rate control of the switching FET
- Frequency hopping
- Spread spectrum or triangulation method for attenuation of peak spectral energy
- Low I<sub>q</sub>
- Soft start for power sequencing and in rush current limitation
- Phased switching for multiple SMPS's regulators to minimize input ripple current and lower input capacitance
- Higher switching frequency for smaller components (L and C's)
- SVS functions for brown out indications.

# Automotive infotainment guide

## Design considerations

### Bi-directional FPD-link III

Communication interfaces allow data exchange between independent electronic modules in the car, the remote sub modules of the infotainment system as well as external devices like USB memory or video sources.

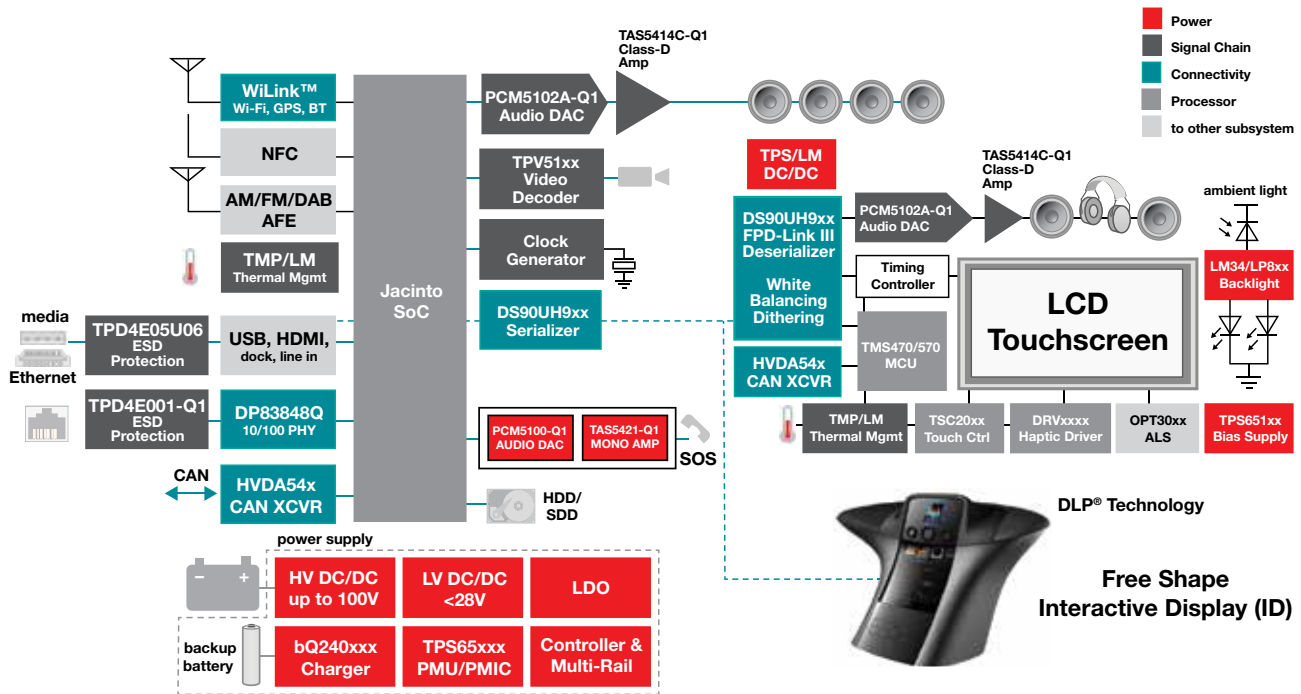
Bi-directional FPD-Link III embedded clock Ser/Des with ultra-low EMI signaling integrate data, clock, and real-time control over a single twisted wire pair.

### High-speed CAN

High speed CAN (up to 1 Mbps, ISO 119898) is a two wire, fault tolerant differential bus. With a wide input common mode range and differential signal technology it serves as the main vehicle bus for connecting the various electronic modules in the car with each other. LIN supports low speed (up to 20 kbps) single bus wire networks, primarily used to communicate with remote sub functions of the infotainment system. LVDS interfaces are used to transfer large amounts of data (e.g. HD video data) via a high speed serial connection to an external location like a video screen.

### Wireless connectivity

For multimedia streaming, hands-free calling and A2DP stereo with easy pairing, a highly integrated combination chip that enables Wi-Fi®, Bluetooth®, and GPS/GLONASS is connected to the host processor.



Automotive infotainment block diagram.

# Data converters/audio

## Automotive data converters/audio solutions

### 6-in/6-out, 2-DAC/2-ADC, 100-dB/93-dB, 24-bit audio CODEC with integrated PLL and embedded miniDSP

#### TLV320AIC3254-Q1

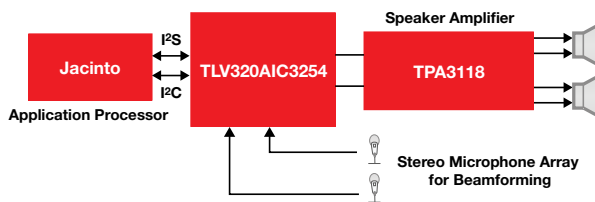
The TLV320AIC3254-Q1 is a very flexible low power and low voltage stereo audio CODEC with integrated miniDSP.

The miniDSP can run advanced audio processing algorithms, like echo and noise cancellation, while offloading host processor. The miniDSP cores are fully software controlled.

The AIC3254 supports PowerTune™ technology which lets the user set the power consumption vs. SNR trade-off under any usage model.

Digital microphone support is also provided for improved system level noise immunity. It has a PLL which accepts any input clock between 512 kHz - 50 MHz and excellent SNR and THD performance.

In addition, amplifier functionality such as mic bias, pre-amp, and stereo headphone drivers are integrated in the codec, reducing solution size and parts count.



Audio CODEC block diagram.

#### Key features

- Stereo audio DAC with 100 dB SNR
- Stereo audio ADC with 93 dB SNR
- Embedded miniDSP
- Stereo headphone outputs
- Stereo line outputs
- Programmable microphone bias
- Programmable PLL

Learn more at:

[www.ti.com/tlv320aic3254-q1](http://www.ti.com/tlv320aic3254-q1)

### 112/106/100-dB, 2-ch, 32-bit, ultra-low out-of-band noise audio DAC with 2.1-V<sub>RMS</sub> ground centered outputs and integrated PLL

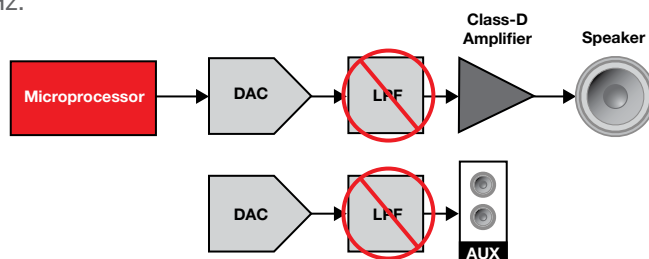
#### PCM5102A-Q1/PCM5101A-Q1/PCM5100A-Q1

The PCM510xA-Q1 provides 2.1-V<sub>RMS</sub> ground centered outputs, allowing designers to eliminate DC blocking capacitors on the output, as well as external muting circuits traditionally associated with single supply line drivers.

The integrated PLL on the device removes the requirement for a system clock (commonly known as master clock), allowing a 3-wire I<sup>2</sup>S connection and reducing system electromagnetic interference (EMI).

The PCM510xA-Q1 family of audio DACs uses advanced current segment architecture to greatly reduce out-of-band noise, which could make the traditional 20 kHz low-pass filter a thing of the past in many automotive audio systems.

The PCM510xA-Q1 family of audio DACs offers up to 20-dB lower out-of-band noise, reducing EMI and aliasing iPMcN downstream amplifiers and analog-to-digital converters (ADCs) from traditional 100 kHz OBN measurements all the way to 3 MHz.



#### Key features

- No DC blocking capacitors required
- Ultra-low out-of-band noise; no Low pass filter required
- 2.1 V<sub>RMS</sub> ground centered outputs
- Integrated PLL
- Single 3.3 V supply

Learn more at:

[www.ti.com/PCM5102A-Q1](http://www.ti.com/PCM5102A-Q1)

# Data converters/audio

## Automotive data converters/audio solutions

### 110-dB/103-dB, 4-ch, 4-ADCs, 24-bit audio ADC with universal front end, I<sup>2</sup>C or SPI control, and integrated PLL

#### PCM1865-Q1/PCM1864-Q1 **NEW**

The PCM186x's highly flexible audio front end supports input levels from small-mV microphone inputs to 2.1 V<sub>RMS</sub> line inputs without external resistor dividers. The PCM186x family integrates many system-level functions that assist or replace some DSP functions.

The PCM186x is differentiated by an integrated on-chip phase locked loop (PLL) that generates real audio-rate clocks from any clock source between 1 MHz and 50 MHz. The PLL is programmed to generate audio clocks based on any incoming clock rate. For example, a 12 MHz clock in the system can be used to generate clocks for a 44.1 kHz system.

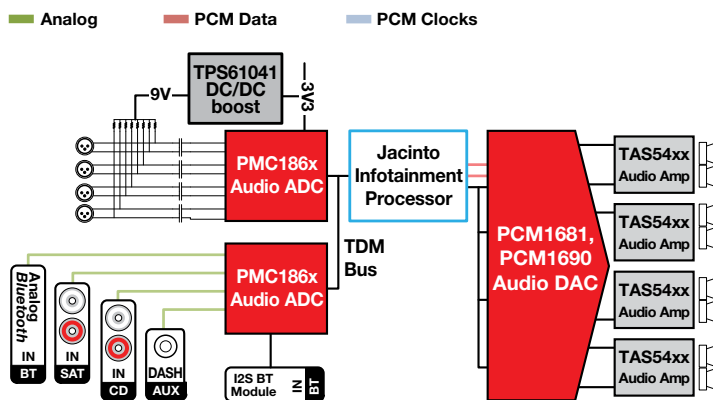
All these features are available using a single 3.3 V power supply.

#### Key features

- Up to 110 dB dynamic range
- Integrated PLL
- Universal analog mic input, 2.1 V<sub>RMS</sub> full scale; no need for external resistor dividers
- Universal front end: 2 V<sub>RMS</sub> MUX, MIX, PGA, Aux ADC and up to 4 independent mono ADCs; no need for external programmable-gain amplifier

Learn more at:

[www.ti.com/PCM1865-Q1](http://www.ti.com/PCM1865-Q1)



### 1-ch, analog input automotive Class-D audio amplifier with load dump and I<sup>2</sup>C diagnostics

#### TAS5421-Q1 **NEW**

The TAS5421-Q1 is a mono digital audio amplifier, ideal for use in automotive emergency call (eCall), telematics, instrument cluster, and infotainment applications.

The TAS5421-Q1 provides 4-W output power into 4 Ω at less than 10% THD+N from a 5 V<sub>DC</sub> supply (and up to 22 W into 4 Ω at less than 10% THD+N from a 14.4 V<sub>DC</sub> automotive battery). The wide operating voltage range and excellent efficiency make the device ideal for start-stop support or operation from a backup battery when required.

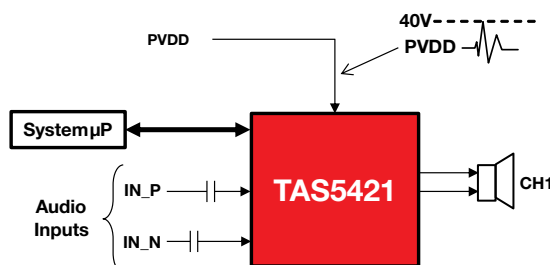
TAS5421-Q1's integrated load-dump protection reduces external voltage clamp cost and size, and the onboard load diagnostics report the status of the speaker through I<sup>2</sup>C.

#### Key features

- Mono Class-D audio amplifier
- 4 W output power at 5 V at 10% THD+N
- 22 W output power at 14.4 V at 10% THD+N
- 4.5 V to 18 V operating range
- Differential analog input
- Load diagnostic functions:
  - Open and shorted output load
  - Output-to-power and -ground shorts
- Protection and monitoring functions:
  - Short-circuit protection
  - 40 V load dump protection

Learn more at:

[www.ti.com/product/TAS5421-Q1](http://www.ti.com/product/TAS5421-Q1)



# Data converters/audio

## Component recommendations

### Audio ADCs

| Device            | Product description  | Key specifications   |
|-------------------|--|--|
| <b>PCM1865-Q1</b> | 110-dB, 4-ch, 4-ADCs, 24-bit audio ADC with universal front end, I <sup>2</sup> C or SPI control, and integrated PLL | 4-ch differential inputs; 4-ADCs; 110-dB SNR; 24-bit; universal analog mic input, 2-V <sub>RMS</sub> full scale; 192 kHz; I <sup>2</sup> C or SPI control; 8 analog inputs with MUX and PGA; analog pre-mix function before PGA/MUX; single 3.3 V supply; integrated PLL |
| <b>PCM1864-Q1</b> | 103-dB, 4-ch, 4-ADCs, 24-bit audio ADC with universal front end, I <sup>2</sup> C or SPI control, and integrated PLL | 4-ch differential inputs; 4-ADCs; 103-dB SNR; 24-bit; universal analog mic input, 2-V <sub>RMS</sub> full scale; 192 kHz; I <sup>2</sup> C or SPI control; 8 analog inputs with MUX and PGA; analog pre-mix function before PGA/MUX; single 3.3 V supply; integrated PLL |
| <b>PCM1862</b>    | 103-dB, 4-ch, 2-ADCs, 24-bit audio ADC with universal front end, I <sup>2</sup> C or SPI control, and integrated PLL | 4-ch differential inputs; 2-ADCs; 103-dB SNR; 24-bit; universal analog mic input, 2-V <sub>RMS</sub> full scale; 192 kHz; I <sup>2</sup> C or SPI control; 8 analog inputs with MUX and PGA; analog pre-mix function before PGA/MUX; single 3.3 V supply; integrated PLL |
| <b>PCM1860</b>    | 103-dB, 4-ch, 2-ADCs, 24-bit audio ADC with universal front end, hardware control, and integrated PLL                | 4-ch differential inputs; 2-ADCs; 103-dB SNR; 24-bit; universal analog mic input, 2-V <sub>RMS</sub> full scale; 192 kHz; hardware control; 8 analog inputs with MUX and PGA; analog pre-mix function before PGA/MUX; single 3.3 V supply; integrated PLL                |
| <b>PCM1808-Q1</b> | 99-dB, 2-ch, 24-bit audio ADC  | 2-ch; 99-dB SNR; 24-bit; 96 kHz; 5 V analog and 3.3 V digital supply   |
| <b>PCM1804-Q1</b> | Automotive catalog, 112 dB SNR stereo ADC with differential inputs   | 24-bit delta-sigma stereo A/D converter; dynamic range: 112 dB (typ); noise performance: SNR: 111 dB (typical); THD+N: -102 dB (typical); sampling rate up to 192 kHz; fully differential analog input: ±2.5 V   |
| <b>ADC3101-Q1</b> | 92-dB, 2-ch ADC with miniDSP   | 2-ch differential inputs; 92-dB SNR; 24-bit; 96 kHz; instruction-programmable embedded miniDSP; I <sup>2</sup> C control; 5 V analog and 3.3 V digital supply  |

*New devices are listed in bold red*

### Audio Codecs

| Device                  | Product description  | Key specifications  |
|-------------------------|--|---|
| <b>PCM3168A-Q1</b>      | 6-IN/8-OUT, 6-DAC/8-ADC, 112-dB/107-dB, 24-bit audio CODEC   | Differential input/output 6-ch/8-ch; 6-DAC/8-ADC; 110-dB/112-dB SNR; 96-kHz/192 kHz; 24-bit; I <sup>2</sup> C or SPI control; 5 V analog and 3.3 V digital supply   |
| <b>TLV320AIC3106-Q1</b> | 10-IN/7-OUT, 2-DAC/2-ADC, 102-dB/92-dB, 24-bit audio CODEC   | Differential input/output 10-ch/7-ch; 2-DAC/2-ADC; 102-dB/92-dB SNR; 96-kHz/96-kHz; 24-bit; I <sup>2</sup> C or SPI control; 3.3 V analog and 1.8 V digital supply  |
| <b>TLV320AIC3104-Q1</b> | 6-IN/6-OUT, 2-DAC/2-ADC, 102-dB/92-dB, 24-bit audio CODEC  | Differential input/output 6-ch/6-ch; 2-DAC/2-ADC; 102-dB/92-dB SNR; 96-kHz/96-kHz; 24-bit; I <sup>2</sup> C or SPI control; 3.3 V analog and 1.8 V digital supply   |
| <b>TLV320AIC23B-Q1</b>  | 3-IN/4-OUT, 2-DAC/2-ADC, 100-dB/90-dB, 24-bit audio CODEC with integrated headphone amplifier      | Differential input/output 3-ch/4-ch; 2-DAC/2-ADC; 100-dB/90-dB SNR; 96-kHz/96-kHz; 24-bit; 3.3 V analog and 1.8 V digital supply                                    |
| <b>TLV320AIC3254-Q1</b> | 6-IN/6-OUT, 2-DAC/2-ADC, 100-dB/93-dB, 24-bit audio CODEC with integrated PLL and embedded miniDSP | Differential input/output 6-ch/6-ch; 2-DAC/2-ADC; 100-dB/93-dB SNR; 192-kHz/192-kHz; 24-bit; I <sup>2</sup> C or SPI control; 3.3 V analog and 1.8 V digital supply |

### Audio DACs

| Device             | Product description  | Key specifications   |
|--------------------|--|--|
| <b>PCM1690-Q1</b>  | 113-dB, 8-ch, 24-bit audio DAC   | 8-ch DAC; 113-dB SNR; 192-kHz; 24-bit; 5 V analog and 3.3 V digital supply   |
| <b>PCM1681-Q1</b>  | 105-dB, 8-ch, 24-bit audio DAC   | 8-ch DAC; 105-dB SNR; 192-kHz; 24-bit; 5 V analog and 3.3 V digital supply   |
| <b>PCM1794A</b>    | 132-dB, 2-ch, 24-bit audio DAC   | 2-ch DAC; 132-dB SNR; 192-kHz; 24-bit; 5 V analog and 3.3 V digital supply   |
| <b>PCM5242-Q1</b>  | 114-dB, 2-ch, 32-bit, ultra low out-of-band noise audio DAC with 4.2-V <sub>RMS</sub> ground centered outputs and integrated PLL | 2-ch DAC; 114-dB SNR; 384-kHz; 32-bit; 3.3 V analog and 3.3 V or 1.8 V digital supply  |
| <b>PCM1789-Q1</b>  | 24-bit, 192-kHz sampling, enhanced multi-level $\Delta\Sigma$ stereo, audio digital-to-analog converter                          | 24-bit multi-level delta-sigma stereo D/A converter; dynamic range: 113 dB (typ); noise performance: SNR: 113 dB (typical); THD+N: -94 dB (typical); sampling rate up to 192 kHz |
| <b>PCM1808-Q1</b>  | Single-ended, analog input 24-bit, 96 kHz stereo A/C audio converter   | 24-bit delta-sigma stereo A/C converter, 99 dB dynamic range with -93 dB THD+N, power down and reset capability by halting system clock, 96 kHz sampling rate                    |
| <b>PCM5102A-Q1</b> | 112-dB, 2-ch, 32-bit, ultra low out-of-band-noise audio DAC with 2.1-V <sub>RMS</sub> ground centered outputs and integrated PLL | 2-ch DAC; 112-dB SNR; 384-kHz; 32-bit; 3.3 V analog and 3.3 V or 1.8 V digital supply  |
| <b>PCM1753-Q1</b>  | 106-dB, 2-ch, 24-bit, software-controlled audio DAC  | 2-ch DAC; 106-dB SNR; 192-kHz; 24-bit; 5 V supply  |
| <b>PCM1754-Q1</b>  | 106-dB, 2-ch, 24-bit, hardware-controlled audio DAC  | 2-ch DAC; 106-dB SNR; 192-kHz; 24-bit; 5 V supply  |
| <b>PCM5101A-Q1</b> | 106-dB, 2-ch, 32-bit, ultra low out-of-band-noise audio DAC with 2.1-V <sub>RMS</sub> ground centered outputs and integrated PLL | 2-ch DAC; 106-dB SNR; 384-kHz; 32-bit; 3.3 V analog and 3.3 V or 1.8 V digital supply  |
| <b>PCM5100A-Q1</b> | 100-dB, 2-ch, 32-bit, ultra low out-of-band-noise audio DAC with 2.1-V <sub>RMS</sub> ground centered outputs and integrated PLL | 2-ch DAC; 100-dB SNR; 384-kHz; 32-bit; 3.3 V analog and 3.3 V or 1.8 V digital supply  |

### Sample rate converters

| Device            | Product description   | Key specifications   |
|-------------------|---|--|
| <b>SRC4192</b>    | 144-dB dynamic range, 192-kHz asynchronous stereo sample rate converter | 144-dB dynamic range; 192-kHz sampling rate; 16:1/1:16 IN-to-OUT/OUT-to-IN sampling range; single 3.3 V supply |
| <b>SRC4190-Q1</b> | 128-dB dynamic range, 192-kHz asynchronous stereo sample rate converter | 128-dB dynamic range; 192-kHz sampling rate; 16:1/1:16 IN-to-OUT/OUT-to-IN sampling range; single 3.3 V supply |

# Data converters/audio

## Component recommendations

### Digital audio receivers

| Device            | Product description                     | Key specifications   |
|-------------------|---|--|
| <b>DIR9001-Q1</b> | 96-kHz digital audio interface receiver | 28-kHz to 108-kHz sample frequency, low clock jitter: 50 ps (typ), 100 ps (max), 3.3-V, single supply, 5-V, tolerant digital input |

*Preview devices are listed in bold teal.*

### Class-D audio amplifiers

| Device                  | Product description   | Key specifications  |
|-------------------------|---|---|
| <b>TAS5414C-Q1</b>      | 4-ch, analog single-ended input Class-D audio amplifier with load dump protection and I <sup>2</sup> C diagnostics                          | 4-ch Class-D audio amplifier; analog single-ended; 28 W/ch output power into 4 Ω at 14.4 V, 10% THD; 50 W/ch output power into 4 Ω at 14.4 V, 10% THD; patented pop-and-click reduction technology; I <sup>2</sup> C diagnostics; 50 V load dump protection |
| <b>TAS5424C-Q1</b>      | 4-ch, analog differential input Class-D audio amplifier with load dump protection and I <sup>2</sup> C diagnostics                          | 4-ch Class-D audio amplifier; analog single-ended; 28 W/ch output power into 4 Ω at 14.4 V, 10% THD; 50 W/ch output power into 4 Ω at 14.4 V, 10% THD; patented pop-and-click reduction technology; I <sup>2</sup> C diagnostics; 50 V load dump protection |
| <b>TAS5514C-Q1</b>      | 4-ch, standalone, analog single-ended input automotive Class-D amp with load dump protection and diagnostics (no I <sup>2</sup> C required) | 4-ch Class-D audio amplifier; analog single-ended; 28 W/ch output power into 4 Ω at 14.4 V, 10% THD; 50 W/ch output power into 4 Ω at 14.4 V, 10% THD; patented pop-and-click reduction technology; I <sup>2</sup> C diagnostics; 50 V load dump protection |
| <b>TAS5630</b>          | 2-ch, analog differential input Class-D audio amplifier   | 2-ch Class-D audio amplifier; analog differential input; 300 W/ch output power into 4 Ω at 50 V, 10% THD; 240 W/ch output power into 4 Ω at 24 V, 1% THD  |
| <b>TAS5760</b>          | 2-ch, digital input Class-D audio amplifier   | 2-ch Class-D audio amplifier; digital input; 28 W/ch output power into 4 Ω at 14.4 V, 10% THD; 42 W/ch output power into 8 Ω at 24 V, 10% THD   |
| <b>TPA3116</b>          | 2-ch, analog differential input Class-D audio amplifier   | 2-ch Class-D audio amplifier; analog differential input; 28 W/ch output power into 4 Ω at 14.4 V, 10% THD; 50 W/ch output power into 4 Ω at 21 V, 10% THD   |
| <b>TPA3118</b>          | 2-ch, analog differential input Class-D audio amplifier   | 2-ch Class-D audio amplifier; analog differential input; 28 W/ch output power into 4 Ω at 14.4 V, 10% THD; 30 W/ch output power into 8 Ω at 24 V, 10% THD   |
| <b>TAS5421-Q1</b>       | 1-ch, analog input automotive Class-D audio amplifier with load dump and I <sup>2</sup> C diagnostics                                       | 1-ch Class-D audio amplifier; analog differential input; 22 W/ch output power into 4 Ω at 14.4 V, 10% THD; I <sup>2</sup> C diagnostics; 40 V load dump protection  |
| <b>TPA3111-Q1</b>       | 1-ch, analog input automotive Class-D audio amplifier   | 1-ch Class-D audio amplifier; analog differential input; 10 W/ch output power into 8 Ω at 11 V, 10% THD   |
| <b>TLV320DAC3100-Q1</b> | 1-ch, digital input automotive Class-D audio amplifier  | 1-ch Class-D audio amplifier; digital input; 2.5 W/ch output power into 4 Ω at 5.5 V, 10% THD; 1.6 W/ch output power into 8 Ω at 5.5 V, 10%   |

### Digital audio processors

| Device         | Product description  | Key specifications  |
|----------------|--|---|
| <b>DA710</b>   | DSPs for multi-channel, multi-zone decode applications   | Fixed and floating point, 256 BGA, up to 300 MHz, SDRAM           |
| <b>DA70x</b>   | DSPs for multi-channel, multi-zone decode applications   | Floating point, 144 QFP, up to 250 MHz, SDRAM                     |
| <b>DA830</b>   | DSPs for multi-channel, multi-zone decode applications with integrated ARM and additional connectivity | Fixed and floating point, 250 BGA, up to 300 MHz DSP + ARM, SDRAM |
| <b>DA828</b>   | DSPs for multi-channel/zone decode applications with integrated ARM                                    | Fixed and floating point, 176 QFP, up to 400 MHz DSP + ARM, SDRAM |
| <b>DA810</b>   | DSPs for multi-channel/zone decode applications with additional connectivity                           | Fixed and floating point, 256 BGA, up to 400 MHz, SDRAM           |
| <b>DA808</b>   | SPs for multi-channel, multi-zone decode applications with additional connectivity                     | Fixed and floating point, 176 QFP, up to 400 MHz, SDRAM           |
| <b>DA807</b>   | DSPs for multi-channel, multi-zone decode applications with additional connectivity                    | Fixed and floating point, 176 QFP, up to 266 MHz, SDRAM           |
| <b>DA805</b>   | DSPs for multi-channel, multi-zone decode applications with additional connectivity                    | Fixed and floating point, 176 QFP, up to 266 MHz                  |
| <b>DA804/2</b> | DSPs for multi-channel, multi-zone decode applications with additional connectivity                    | Fixed and floating point, 80 QFP, up to 250 MHz                   |

### Touch screen controllers

| Device            | Product description   | Key specifications  |
|-------------------|---|---|
| <b>TSC2008-Q1</b> | Automotive catalog nano-power touch screen controller with SPI                                    | Single 1.2 V to 3.6 V supply, low power: (12 bit), enhanced IEC ESD protection 25 kV air - 15 kV contact, on-chip temperature measurement, auxiliary input, touch pressure measurement  |
| <b>TSC2007-Q1</b> | Automotive catalog nano-power touch screen controller with I <sup>2</sup> C                       | Single 1.2 V to 3.6 V supply (no separate I/O supply), 22 k/11 kSPS throughput in high-speed mode (3.4 MHz), high-speed I <sup>2</sup> C serial interface, 12- or 8-bit resolution mode, on-chip temperature measurement, touch pressure measurement, enhanced IEC ESD protection 25 kV Air - 15 kV contact |
| <b>TSC2013-Q1</b> | TSC2013-Q1 12-bit, nanopower, 4-wire dual-touch screen controller with I <sup>2</sup> C interface | 1.2 V to 3.6 V, 12-bit, nanopower. Supports pinch, rotate and zoom functionality over standard 4-wire interface. Touch pressure measurement. Register programmable. Available in QFN and TSSOP packages.  |



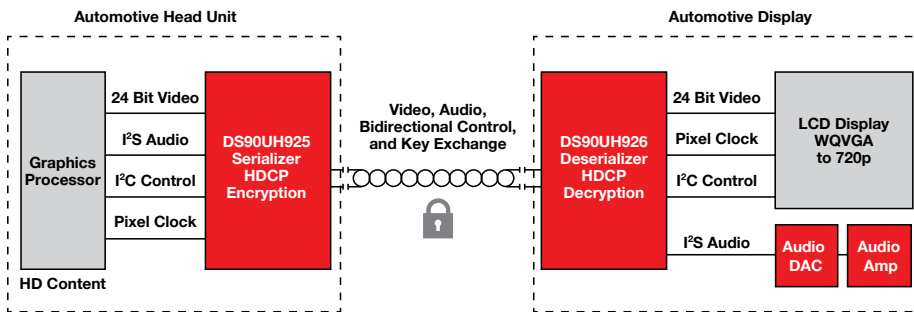
# Interface

## Automotive interface solutions

### FPD-link III Ser/Des

#### DS90UH925/6Q

The DS90UH925Q serializer, in conjunction with the DS90UH926Q deserializer, provides a solution for secure distribution of content-protected digital video within automotive entertainment systems. This chipset translates a parallel RGB video interface into a single pair high-speed serialized interface. The digital video data is protected using the industry standard high bandwidth digital content protection (HDCP) copy protection scheme, enabling playback of content-protected media. The serial bus scheme, FPD-Link III, supports video and audio data transmission and full duplex control including I<sup>2</sup>C communication over a single differential link. Consolidation of video data and control over a single differential pair reduces the interconnect size and weight, while also eliminating skew issues and simplifying system design.



#### Key features

- Integrated HDCP cipher engine with on-chip key storage
- Bidirectional control interface channel interface with I<sup>2</sup>C compatible serial control bus
- Supports high definition 720 pixels digital video format
- RGB888 + VS, HS, DE and synchronized I<sup>2</sup>S audio supported
- 5 to 85-MHz PCLK supports high definition resolutions, dual-view displays and 24-bit color depth
- Single 3.3 V operation with 1.8-V or 3.3 V compatible LVCMOS I/O interface
- AC-coupled STP interconnect up to 10 meters
- Parallel LVCMOS video inputs
- I<sup>2</sup>C compatible serial control bus for configuration (DS90UH926Q)
- DC-balanced and scrambled data with embedded clock simplifies interconnects and reduces the number of cables and connectors
- Adaptive cable equalization (DS90UH926Q)
- HDCP content protected
- Supports HDCP repeater application
- @ SPEED link BIST mode and LOCK status pin (DS90UH926Q)
- EMI minimization (SSCG and EPTO) (DS90UH926Q)
- Image enhancement (white balance and dithering) and internal pattern generation
- Low power modes minimize power dissipation
- Automotive grade product: AEC-Q100 grade two qualified
- >8 kV HBM and ISO 10605 ESD rating
- Backward compatible modes

Learn more at: [www.ti.com/ds90uh925-6q](http://www.ti.com/ds90uh925-6q)

# Interface

## Component recommendations

### FPD-link II and III Ser/Des

| Device  | Application(s)  | Parallel data | Pixel clock   | Equalization | Spread spectrum | Other features   | ESD                 |
|---|-----------------|---------------|---------------|--------------|-----------------|--|---------------------|
| <b>FPD-link III with embedded bidirectional control bus</b> |                 |               |               |              |                 |  |                     |
| DS90UH925/6   | Display         | 24 (27) CMOS  | 5 to 85 MHz   | Adaptive     | Y               | HDCP, repeater, I <sup>2</sup> S audio, white balance, dithering | 8 kV HBM, ISO 10605 |
| DS90UB925/6   | Display         | 25 (27) CMOS  | 6 to 85 MHz   | Adaptive     | Y               | Repeater, I <sup>2</sup> S audio, white balance, dithering       | 8 kV HBM, ISO 10605 |
| DS90UB913/4   | Camera          | 10 or 12 CMOS | 10 to 100 MHz | Adaptive     | Y               | 2:1 input mux  | 8 kV HBM, ISO 10605 |
| DS90UB903/4   | Display         | 18 (21) CMOS  | 10 to 43 MHz  | Y            | Y               | —  | 8 kV HBM, ISO 10605 |
| DS90UB901/2   | Camera          | 14 (16) CMOS  | 10 to 43 MHz  | Y            | Y               | —  | 8 kV HBM, ISO 10605 |
| <b>FPD-link II</b>  |                 |               |               |              |                 |  |                     |
| DS90UR910   | Display, camera | CSI-2         | 10 to 65 MHz  | Y            | —               | —  | 8 kV HBM, ISO 10605 |
| DS90UR907/8   | Display         | 4 LVDS        | 5 to 65 MHz   | Y            | Y               | —  | 8 kV HBM, ISO 10605 |
| DS90UR905/6/16  | Display         | 24 (27) CMOS  | 6 to 65 MHz   | Y            | Y               | White balance, dithering   | 8 kV HBM, ISO 10605 |
| DS90UR903/4   | Display         | 18 (21) CMOS  | 10 to 43 MHz  | Y            | Y               | —  | 8 kV HBM, ISO 10605 |
| DS99R421/124  | Display         | 3 LVDS        | 5 to 43 MHz   | Y            | Y               | —  | 8 kV HBM, ISO 10605 |
| DS90UR241/124   | Display, camera | 24 CMOS       | 5 to 43 MHz   | —            | —               | —  | 8 kV HBM, ISO 10605 |
| DS90C241/124  | Display, camera | 24 CMOS       | 5 to 35 MHz   | —            | —               | —  | 8 kV HBM, ISO 10605 |

### LVDS

| Device         | Product description                        | Key specifications   |
|----------------|--|--|
| SN65LVDS051-Q1 | Dual, high-speed LVDS transmitter/receiver | Single 3.3-V supply, meets ANSI TIA/EIA-644-1995 standard, signaling rates up to 400 Mbps  |
| SN65LVDM050-Q1 | Dual, high-speed LVDS transmitter/receiver | Single 3.3-V supply, signaling rates up to 500 Mbps  |
| SN65LVDM051-Q1 | Dual, high-speed LVDS transmitter/receiver | Single 3.3-V supply, signaling rates up to 500 Mbps, TIA/EIA-644 standard compliant devices  |
| SN65LVDS84A-Q1 | FlatLink™ transmitter                      | 3.3-V supply voltage, 197-Mbps data rate, very low EMI, 21 data channels plus clock-in low-voltage TTL inputs and 3 data channels plus clock-out low-voltage differential signaling (LVDS) outputs |
| SN65LVDS86A-Q1 | FlatLink™ receiver                         | 21 inputs, 163 MBs   |

### CAN transceivers

| Device                 | Product description   | Key specifications  |
|------------------------|---|---|
| SN65HVDA1040A-Q1       | 5 V high speed CAN transceiver                                    | Low-power standby mode with wake, common mode bus stabilization output  |
| SN65HVDA1050A-Q1       | 5 V high speed CAN transceiver                                    | Silent mode, common mode bus stabilization output   |
| SN65HVDA54x-Q1 Family  | 5 V high speed CAN transceivers (HVDA540, HVDA541, HVDA542)       | I/O level shifting (all), low-power standby mode (540), low-power standby mode with wake (541), and silent mode (542)                         |
| SN65HVDA54x5-Q1 Family | 5 V high speed CAN transceivers (HVDA540-5, HVDA541-5, HVDA542-5) | Low-power standby mode (540-5), low-power standby mode with wake (541-5), and silent mode (542-5)   |
| SN65HVDA55x Family     | 5 V high speed CAN transceivers (HVDA551, HVDA553)                | Enhanced ESD and transient protection, low-power standby mode with wake, I/O level shifting (551), common mode bus stabilization output (553) |

### LIN transceivers

| Device         | Product description | Key specifications  |
|----------------|---------------------|---|
| TPIC1021A-Q1   | LIN transceiver     | LIN specification 2.0 compliant, 5 V or 3.3 V I/O support, up to 20 kbps, low current consumption         |
| SN65HVDA100-Q1 | LIN transceiver     | LIN specification 2.0 compliant, extended operation with supply from 5 V to 27 V DC, external wake up pin |

### Analog switches

| Device         | Product description  | Key specifications   |
|----------------|--|--|
| CD74HC4051-Q1  | High-speed, CMOS logic, analog multiplexers/demultiplexers                                   | 2-V to 6-V supply voltage, high-noise immunity NIL = 30%, NIH = 30% of V <sub>CC</sub> , V <sub>CC</sub> = 5 V |
| CD74HCT4067-Q1 | High speed CMOS 16-channel analog multiplexer/demultiplexer with TTL inputs                  | 4.5 V to 5.5 V supply, low power consumption, low 70 Ω on resistance   |
| SN74HC4851-Q1  | 8-channel, analog multiplexer/demultiplexer with injection-current effect control            | 2-V to 6-V V <sub>CC</sub> supply, 2 to 6 node voltage, low crosstalk between switches                         |
| SN74HC4852-Q1  | Dual, 4-to-1 channel, analog multiplexer/demultiplexer with injection-current effect control | 2-V to 6-V V <sub>CC</sub> supply, injection-current cross coupling <1 mV/mA, I <sub>CC</sub> 10 μA            |

# Interface

## Component recommendations

### ESD protection

| Device               | Product description  | Key specifications   |
|----------------------|--|--|
| <b>TPD4E001-Q1</b>   | Ideal for automotive infotainment: dual USB2.0, Ethernet, and LVDS   | 4-channel, 1.5 pF, ESD protection, 15 kV IEC air gap, 8 kV IEC contact   |
| <b>TPD2E001-Q1</b>   | Ideal for automotive infotainment: single USB2.0   | 2-channel, 1.5 pF, ESD protection, 15 kV IEC air gap, 8 kV IEC contact   |
| <b>TPD4E05U06-Q1</b> | Ideal for automotive infotainment: USB3.0 and HDMI   | 4-channel, 0.5 pF, ESD protection, 15 kV IEC air gap, 12 kV IEC contact  |
| <b>TPD2E2U18-Q1</b>  | Ideal for automotive Infotainment: high voltage ESD protection for single USB2.0, Ethernet, and LVDS             | 2-channel, 2 pF, 18 VRWM, ESD protection, 15 kV IEC air gap, 8 kV IEC contact  |
| <b>TPD3S714-Q1</b>   | Ideal for automotive infotainment: USB interface protection with short-to-battery and short-to-ground protection | 3-channel, 18 VRWM, short-to-battery and short-to-ground protection, ESD protection, 15 kV IEC air gap, 8 kV IEC contact |

*Preview devices are listed in bold teal.*

### Voltage level translators

| Device                  | Product description   | Key specifications   |
|-------------------------|---|--|
| <b>SN74AVC4T245-Q1</b>  | 4-bit dual-supply bus transceiver with configurable voltage translation                                 | 4-bit, 1.2 V to 3.6 V, 380 Mbps, I <sub>CC</sub> 16 μA, output enable pin  |
| <b>SN74AVC8T245-Q1</b>  | 8-bit dual-supply bus transceiver with configurable voltage translation                                 | 8-bit, 1.2 V to 3.6 V, 320 Mbps, I <sub>CC</sub> 25 μA, output enable pin  |
| <b>SN74AVC16T245-Q1</b> | 16-bit dual-supply bus transceiver with configurable voltage translation                                | 16-bit, 1.2 V to 3.6 V, 380 Mbps, I <sub>CC</sub> 60 μA, output enable pin   |
| <b>TXB0104-Q1</b>       | 4-bit bidirectional voltage-level translator with auto direction sensing                                | 4-bit, 1.2 V to 3.6 V on port A, 1.65 V to 5.5 V on port B, 100 Mbps   |
| <b>TXB0106-Q1</b>       | 6-bit bidirectional voltage-level translator with auto direction sensing                                | 6-bit, 1.2 V to 3.6 V on port A, 1.65 V to 5.5 V on port B, 100 Mbps   |
| <b>PCA9306-Q1</b>       | Dual bi-directional I <sup>2</sup> C-bus and SMBus voltage level-translator with auto direction sensing | 2-bit, 1.2 V to 3.3 V on V <sub>REF1</sub> , 1.8 V to 5.5 V on V <sub>REF2</sub> , 1.5-ns maximum propagation delay to accommodate standard-mode and fast-mode I <sup>2</sup> C devices and multiple masters, lock-up-free operation for isolation |

### Thermal management

| Device               | Product description  | Key specifications   |
|----------------------|--|--|
| <b>TMP101-Q1</b>     | Digital temperature sensor with I <sup>2</sup> C serial interface, prog. thermostat/alarm function       | ±3°C max accuracy, alert function, IQ = 75 μA max, I <sup>2</sup> C interface to MCU, SOT-23 package                                       |
| <b>TMP102-Q1</b>     | Low power digital temperature sensor with SMBus/two-wire serial interface in SOT563                      | ±3°C max accuracy, alert function, IQ = 10 μA max, I <sup>2</sup> C interface to MCU, 1.6 mm x 1.6 mm SOT-563 package                      |
| <b>TMP411-Q1</b>     | ±1°C remote and local digital temperature sensor with N-factor and series resistance correction          | Local = ±1°C max accuracy, remote = ±1°C max accuracy, dual alert functions, IQ = 475 μA max, I <sup>2</sup> C interface to MCU            |
| <b>TMP112-Q1</b>     | Ultra-high accuracy, low power, digital temperature sensor in SOT563 package                             | ±3°C max accuracy alert function, IQ = 10 μA max, I <sup>2</sup> C interface to MCU, 1.6 mm x 1.6 mm SOT-563 package                       |
| <b>TMP75B-Q1</b>     | 1.8 V capable digital temperature sensor in Industry standard LM75 footprint                             | ±3°C max accuracy 1.8 V supply and I <sup>2</sup> C interface to MCU, industry standard package  |
| <b>TMP451-Q1</b>     | 1.8 V supply remote and local digital temperature sensor with N-factor and series resistance correction  | Local = ±1°C max accuracy remote = ±1°C max accuracy, dual alert functions, IQ = 250 μA max, I <sup>2</sup> C interface to MCU             |
| <b>LM60-Q1</b>       | Analog temperature sensor with 2.7 V supply  | ±3°C max accuracy gain = 6.25 mV/°C, IQ = 130 μA max   |
| <b>LM26LV-Q1</b>     | 1.6 V, LLP-6 factory preset temperature switch and temperature sensor                                    | Local sensor = ±2.3°C max accuracy; switch: factory preset trip point, ±2.3°C max accuracy   |
| <b>TMP302-Q1</b>     | Low power, 1.4 V temperature switch in SOT563  | 16 pin-selectable trip points, trip point accuracy = ±2°C max from +40°C to +125°C, IQ = 15 μA max, 1.6 mm x 1.6 mm SOT563 package         |
| <b>INA210-215-Q1</b> | Analog voltage output, high/low-side measurement, bi-directional zero-drift series current shunt monitor | Gain of 75 V and 200 V to 1000 V/V, VOS = 35 μV gain of 75 and 200 to 1000 max, IQ = 115 μA max, -0.3 V to +26 V common mode voltage range |
| <b>INA220B-Q1</b>    | Bi-directional current/power monitor with I <sup>2</sup> C interface                                     | Current, voltage, or power output, VOS = 50 μV max, 0 V to +26 V common mode voltage range, I <sup>2</sup> C interface to MCU              |

### Clocks

| Device              | Product description   | Key specifications   |
|---------------------|---|--|
| <b>CDCE937-Q1</b>   | 3-PLL, integrated VCXO, spread spectrum clocking, 2.5 V or 3.3 V LVCMOS outputs                     | Low jitter of 60 ps peak to peak period, EEPROM/I <sup>2</sup> C/pin programming, XTAL or LVCMOS input, integrated on-chip VCXO with external XTAP, 7 LVCMOS outputs |
| <b>CDCE949-Q1</b>   | 4-PLL, integrated VCXO, spread spectrum clocking, 2.5 V or 3.3 V LVCMOS outputs                     | Low jitter of 60 ps peak to peak period, EEPROM/I <sup>2</sup> C/pin programming, XTAL or LVCMOS input, integrated on-chip VCXO with external XTAP, 9 LVCMOS outputs |
| <b>CDCS503-Q1</b>   | Spread spectrum clock generator   | Up to ±2% spread spectrum clocking to reduce EMI, pin programmable, 1 LVCMOS input and output, single 3.3 V supply   |
| <b>CDCVF2505-Q1</b> | 3.3 V PLL clock driver for general purpose and SDRAM apps, with spread spectrum clock compatibility | 24 M to 200 MHz operating frequency, <150 ps cycle-to-cycle jitter, <150 ps propagation delay, on-chip series damping resistor, automatic input clock detector       |

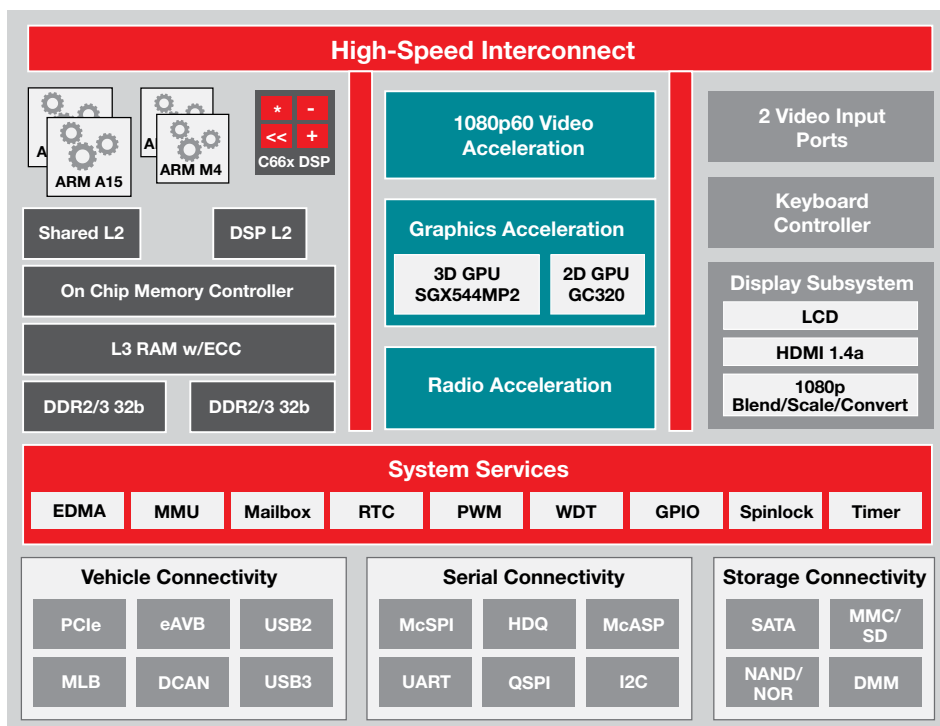
# Microcontrollers/embedded processors

## Automotive microcontroller/embedded processor solutions

### Automotive infotainment processors

Texas Instruments provides full system solutions for connected automotive infotainment. Our unparalleled solutions combine industry-leading hardware and solutions with a comprehensive software ecosystem. Automotive infotainment processors enable cost-effective, scalable and feature-rich automotive applications such as automotive infotainment head units and rear-seat entertainment systems with solutions that smartly integrate industry-leading ARM® cores, graphics accelerators, software-defined radio, speech recognition, high-definition video and both wired and wireless connectivity, as well as the right mix of peripherals for automotive use cases.

TI provides processor technology leadership, complete bills of materials that are optimized for innovative automotive capabilities, and full solution interoperability. TI further demonstrates its commitment to quality by pursuing applicable automotive qualifications for its parts and has a zero-DPPM strategy.



Functional block diagram.

#### Key features

- 28-nanometer CMOS process for maximum system performance and low power
- ARM® Cortex®-A15 core up to 1.5 GHz
- DSP core: floating/fixed-point C66x™ up to 700 MHz
- 3D-graphics processing unit (GPU) subsystem, including POWERVR™ SGX544 dual-core running up to 532 MHz
- 2D-graphics accelerator (BB2D) subsystem, including Vivante™ GC320 core
- Image and video accelerator high-definition (IVA-HD) subsystem capable of up to 1080p60 encode/decode
- Two ARM® Cortex®-M4 image processing unit (IPU) subsystems, each including two ARM® Cortex®-M4 microprocessors over 200 MHz
- Highly flexible display subsystem supporting multiple video/graphics pipelines and multiple simultaneous high-definition display outputs (both parallel and HDMI interfaces)
- Video input capture and video processing subsystems
- Other peripheral highlights (1.8/ 3.3-V IOs)
  - One USB3.0 and two UBS2.0 subsystems
  - MMC/SD, and NAND/Async interface support
  - Vehicle peripherals: MOST MLB150, PCIe Gen2, Gigabit Ethernet AVB w/3 port switch, PATA, SATA, multiple CAN, audio serial ports, SPI, UART, and I<sup>2</sup>C ports
  - External memory interface supporting two 32-bit wide DDR2/3
  - Optional security features
- Power (1.1-V/1.2-V core, 1.8-V/3.3-V IOs): support for dynamic voltage scaling and SmartReflex™ technology for power/performance management

Learn more at: [www.ti.com/solution/automotive\\_infotainment](http://www.ti.com/solution/automotive_infotainment)

# Microcontrollers/embedded processors

## Component recommendations

### Embedded processors – automotive infotainment processors

| Device  | Product description   | Key specifications   |
|---|---|--|
| <b>DRA64x<br/>Jacinto 4 Family</b>              | 5 high performance ARM® Cortex®-A8 (CA8) + Neon infotainment processor targeted at mid to high-tier automotive applications like fully featured head units requiring high definition video support; rich automotive peripheral integration; includes programmable DSP to support software customizations like digital radio                                     | CA8 + Neon, 2x Cortex M3, SGX530 3D graphics, 2D composition, C674x DSP with radio accelerators, IVA-HD multi-standard codecs (up to 1080p30fps), hardware accelerated display subsystem, 2x 32 bit EMIFs supporting DDR2-800 and DDR3-800 (400 MHz), multiple video input and display output ports (including HDMI v1.3), support of key automotive interfaces such as CAN, MOST, gigabit Ethernet AVB, SATA, PCIe, MLB                                   |
| <b>DRA60x/DRA61x<br/>Jacinto 5 Entry Family</b> | High performance ARM® Cortex®-A8 (CA8) + Neon infotainment processor targeted at entry-level automotive applications like telematics/e-call boxes and entry head units; key automotive peripheral integration; optional display and graphics support  | CA8+ Neon, optional SGX530 3D graphics engine and optional 24 bit WXGA LCD controller, 1x 16 bit EMIF supporting DDR2-400 (200 MHz) or DDR3-600 (300 MHz), support of key automotive interfaces such as CAN, MOST, gigabit Ethernet AVB  |
| <b>DRA62x<br/>Jacinto 5 Eco Family</b>          | Cost-optimized version of J5, high performance ARM® Cortex®-A8 (CA8) + Neon infotainment processor targeted at mid to high-tier automotive applications like fully featured head units (without need of video support); rich automotive peripheral integration; includes programmable DSP to support software customizations like digital radio                 | CA8 + Neon, 2x Cortex M3, SGX530 3D graphics, 2D composition, C674x DSP with radio accelerators, hardware accelerated display subsystem, single 32 bit EMIFs supporting DDR2-800 and DDR3-800 (400 MHz), multiple video input and display output ports (including HDMI v1.3), support of key automotive interfaces such as CAN, MOST, gigabit Ethernet AVB, SATA, PCIe, MLB  |
| <b>DRA65x<br/>Jacinto 5 Family</b>              | High performance ARM® Cortex®-A8 (CA8) + Neon infotainment processor targeted at mid to high-tier automotive applications like fully featured head units (without need of video support); rich automotive peripheral integration; includes programmable DSP to support software customizations like digital radio   | CA8 + Neon, 2x Cortex M3, SGX530 3D graphics, 2D composition, C674x DSP with radio accelerators, hardware accelerated display subsystem, 2x 32 bit EMIFs supporting DDR3-1066, multiple video input and display output ports (including HDMI v1.3), support of key automotive interfaces such as CAN, MOST, gigabit Ethernet AVB, SATA, PCIe, MLB  |
| <b>DRA74x<br/>Jacinto 6 Family</b>              | High performance dual ARM® Cortex®-A15 (CA15) + Neon + HW virtualization extensions infotainment processor targeted at mid to high-tier automotive applications like fully featured head units requiring high definition video support; rich automotive peripheral integration; includes programmable DSP to support software customizations like digital radio | Dual CA15 + Neon, 2x Cortex M4, dual SGX530 3D graphics, 2D composition, upgraded C66x DSP with radio accelerators, upgraded IVA-HD multi-standard codecs (up to 1080p60fps), hardware accelerated display subsystem, 2x 32 bit EMIFs supporting DDR2-800 and DDR3-800 (400 MHz), multiple video input and display output ports (including HDMI v1.4a), support of key automotive interfaces such as CAN, MOST, gigabit Ethernet AVB, SATA, PCIe gen2, MLB |

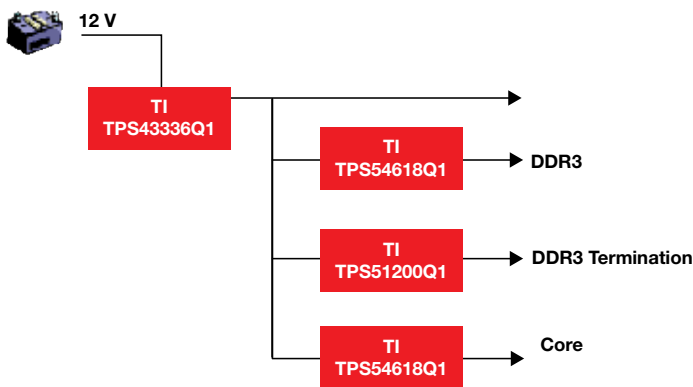
### SWIFT™ 6- V, 6-A synchronous step-down converter

#### TPS54618RTE-Q1

The TPS54618RTE-Q1 SWIFT™ integrated circuit is a full-featured 6- V, 6-A, synchronous step-down current-mode converter with two integrated MOSFETs. The input voltage range of 2.95 V to 6 V is well suited for regulating off the 5 V and 3.3 V bus voltage in an automotive subsystem.

The TPS54618RTE-Q1 enables small designs by integrating the MOSFETs, implementing current-mode control to reduce external component count, reducing inductor size by enabling up to 2 MHz switching frequency, and minimizing the IC footprint with a small 3-mm x 3-mm thermally enhanced QFN package.

The SwitcherPro™ software tool, available at [www.ti.com/switcherpro](http://www.ti.com/switcherpro), supports the TPS54618RTE-Q1.

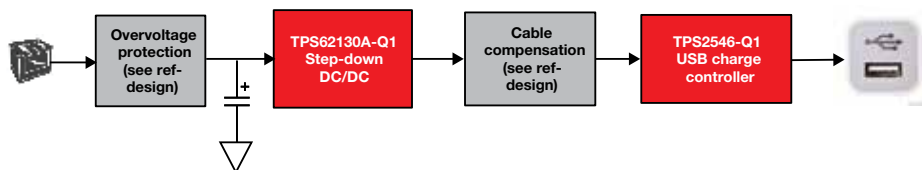
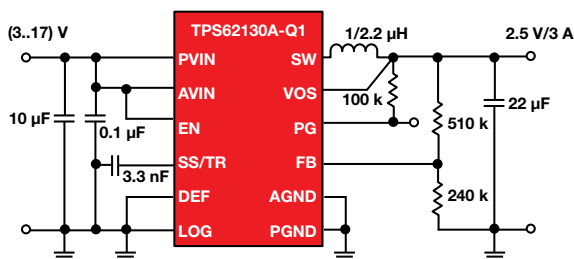


Learn more at: [www.ti.com/tps54618rte-q1](http://www.ti.com/tps54618rte-q1)

### Small-size and cost-effective power supply for USB/ HDMI ports17 VIN, 3 A step-down converter in 3 x 3 QFN package

#### TPS62130A-Q1

The TPS62130A-Q1 family is an easy-to-use synchronous step down DC/DC converters optimized for automotive applications with high power density. A high switching frequency of typically 2.25 MHz allows the use of small inductors and provides fast transient response as well as high output voltage accuracy by utilization of the DCS-Control™ topology.



Get more information: [www.ti.com/TPS62130A-Q1](http://www.ti.com/TPS62130A-Q1)

#### Key features

- Device temperature Grade 1: –40°C to 125°C ambient operating temperature range
- Device HBM ESD classification Level H2
- Device CDM ESD classification Level C4B
- Two 12 mΩ (typical) MOSFETs for high efficiency at 6 A loads
- 300 kHz to 2 MHz switching frequency
- 0.8 V ±1% voltage reference overtemperature (–40°C to 150°C)
- Synchronizes to external clock
- Adjustable slow start and sequencing
- UV and OV power-good output
- Thermally enhanced 3-mm x 3-mm 16-pin QFN

#### Key features

- Total PCB solution size (includes overvoltage protection, cable-compensation and USB controller): 550 mm<sup>2</sup>
- Small 2.2 µH inductor (4 mm x 4 mm) capacitors
- DCS-control™ topology: fast AC line and load transient response
- 100% duty cycle
- 17 µA typ Iq
- Power good output
- 3 x 3 QFN package

#### Applications

- Automotive USB/ HDMI ports
- Infotainment

#### Ti designs

- Overvoltage protection (PMP9757)
- Cable-compensation (PMP9756)

# Power management

## Component recommendations

### Low-dropout regulators (LDOs)

| Device                | Product description  | Key specifications   |
|-----------------------|--|--|
| <b>TPS79850-Q1</b>    | 50 V high-voltage micropower low-dropout linear regulators   | 50 mA, 50 V $V_{IN}$ , 40 $\mu$ A operating and 1 $\mu$ A in shutdown  |
| <b>TPS7B4250-Q1</b>   | 40 V, 50 mA low-dropout tracking regulator   | 4 V to 40 V $V_{IN}$ , 5 mV ultra-low tracking accuracy, short to GND, reverse polarity and short to battery protection  |
| <b>TPS7A1650-Q1</b>   | 60 V, 5 $\mu$ A Iq, 100 mA, low-dropout voltage regulator with enable and power good                   | Wide input voltage range: 3 V to 60 V; ultra-low quiescent current: 5 $\mu$ A; quiescent current at shutdown: 1 $\mu$ A  |
| <b>TPS51200-Q1</b>    | 3 A DDR termination LDO for DDR, DDR2, DDR3 and low power DDR3/DDR4                                    | Input voltage supports both 2.5 V and 3.3 V, built-in soft start, UVLO and OCL   |
| <b>TPS7A6601-Q1</b>   | 40 V, 20 $\mu$ A Iq, low-dropout 150 mA linear regulator   | 4 to 40 V $V_{IN}$ , 1.5 to 5 V adjustable output 2% accuracy, very low quiescent current, 12 $\mu$ A typical at light load with enable and PG and programmable delay                  |
| <b>TPS7A6633-Q1</b>   | 40 V, 20 $\mu$ A Iq low-dropout 150 mA linear regulator  | 4 V to 40 V $V_{IN}$ , 3.3 V fixed output 2% accuracy, very low quiescent current, 12 $\mu$ A typical at light load, with enable and PG and programmable delay                         |
| <b>TPS7A6550-Q1</b>   | 300-mA 40-V low-dropout regulator with ultra-low quiescent current                                     | Low dropout voltage; 4-V to 40-V wide input voltage range with up to 45-V transients; 300-mA maximum output current  |
| <b>TPS7A6933-Q1</b>   | 40 V, 20 $\mu$ A Iq low-dropout 150 mA linear regulator  | 4 V to 40 V $V_{IN}$ , 3.3 V fixed output 2% accuracy, very low quiescent current, 12 $\mu$ A typical at light load with voltage supervision and RESET, PG and programmable delay      |
| <b>TPS7A6950-Q1</b>   | 150 mA, 5 V low quiescent current low-dropout voltage regulator  | 4 V to 40 V $V_{IN}$ , 5 V fixed output, 2% accuracy, very low quiescent current, 12 $\mu$ A typical at light load, with enable and PG and programmable delay                          |
| <b>TPS76501-Q1</b>    | 5- V, low-dropout voltage regulator  | 150 mA, 3% tolerance, open-drain power good output with thermal shutdown protection  |
| <b>TPS7A6050-Q1</b>   | 300-mA 40-V low-dropout regulator with ultra-low quiescent current                                     | 4-V to 40-V wide input voltage range with up to 45-V transients; 300-mA maximum output current; ultra-low quiescent current  |
| <b>TPS7A6150-Q1</b>   | 300-mA 40-V low-dropout regulator with ultra-low quiescent current and enable                          | 4-V to 40-V wide input voltage range with up to 45-V transients; low dropout voltage; 300-mA maximum output current; ultra-low quiescent current                                       |
| <b>TPS7A6650-Q1</b>   | 150 mA, 5 V low quiescent current low-dropout voltage regulator  | 4 V to 40 V $V_{IN}$ , 5 V fixed output, 2% accuracy, very low quiescent current, 12 $\mu$ A typical at light load, with enable and PG and programmable delay                          |
| <b>TPS7B6701-Q1</b>   | 40 V, 25 $\mu$ A Iq, low-dropout 450 mA linear regulator   | 4 V to 40 V $V_{IN}$ , 1.5 V to 18 V adjustable output 2% accuracy, very low quiescent current, 15 $\mu$ A typical at light load with enable and reset and programmable delay          |
| <b>TPS76950-Q1</b>    | Ultra-low power, 100 mA, low-dropout linear regulator  | Adjustable voltage, 1- $\mu$ A quiescent current in standby mode, over-current limitation  |
| <b>TLE4275-Q1</b>     | 5- V, low-dropout voltage regulator, 450 mA  | 5.5 V to 42-V supply, 2% accuracy, very low current consumption and ESD protection > 6 kV  |
| <b>LM2936Q-Q1</b>     | Ultra-low quiescent current LDO voltage regulator  | 5.5 V to 60 V $V_{IN}$ ; $V_{OUT}$ : 3 V, 3.3 V, 5 V; $I_{q} < 15 \mu$ A; 2% tolerance; $V_{DO} = 200$ mV; reverse battery protection; internal thermal shutdown protection            |
| <b>LM9036Q-Q1</b>     | Ultra-low quiescent current voltage regulator  | -45 V to 40 V $V_{IN}$ ; $V_{OUT}$ : 3.3 V, 5 V; reverse transient protection (-45 V); ultra low ground pin current  |
| <b>LM9076Q-Q1</b>     | 150 mA ultra-low quiescent current LDO regulator with delayed reset output                             | 3.65 V to 40 V $V_{IN}$ ; $V_{OUT}$ : 3.3 V, 5 V; ultra low ground pin current; 1.5% $V_{OUT}$ accuracy; low dropout voltage; delayed RESET output pin for low $V_{OUT}$ detection     |
| <b>LP2951-33-Q1</b>   | Automotive single output LDO, 100 mA, fixed (3.3 V), wide $V_{IN}$ range, RESET flag                   | Rated output current of 100 mA; low dropout: 380 mV (typ) at 100 mA; low quiescent current: 75 $\mu$ A (typ); 1.4% $V_{OUT}$ accuracy  |
| <b>LP2951-50-Q1</b>   | Automotive catalog single output, 100 mA, fixed, wide $V_{IN}$ range                                   | Rated output current of 100 mA; low dropout: 380 mV (typ) at 100 mA; low quiescent current: 75 $\mu$ A (typ); 1.4% $V_{OUT}$ accuracy  |
| <b>LP38691-ADJ-Q1</b> | 500 mA low dropout CMOS linear regulators with adjustable output stable with ceramic output capacitors | Precision (trimmed) bandgap reference; all WSON packages available in AECQ; thermal overload protection; 2.7 V to 10 V $V_{IN}$ ; $V_{DO}$ : 250 mV; 2% $V_{OUT}$ accuracy;            |
| <b>LP38691-Q1</b>     | 500 mA low dropout CMOS linear regulators stable with ceramic output capacitors                        | Precision (trimmed) bandgap reference; all WSON packages available in AECQ; thermal overload protection; 2.7 V to 10 V $V_{IN}$ ; 1 $\mu$ A off-state quiescent current; 55 $\mu$ A Iq |
| <b>LP38693-ADJ-Q1</b> | 500 mA low dropout CMOS linear regulators with adjustable output Stable with ceramic output capacitors | Precision (trimmed) bandgap reference; all WSON packages available in AECQ; thermal overload protection; 1 $\mu$ A off-state quiescent current; 55 $\mu$ A Iq                          |
| <b>LP38693-Q1</b>     | 500 mA low dropout CMOS linear regulators stable with ceramic output capacitors                        | Precision (trimmed) bandgap reference; all WSON packages available in AECQ; thermal overload protection; 2.7 V to 10 V $V_{IN}$ ; 55 $\mu$ A Iq; $V_{DO}$ 250 mV, 330 mV, 430 mV       |
| <b>LP3988-Q1</b>      | Micropower, 150 mA ultra low-dropout CMOS voltage regulator with power good                            | 2.7 V to 6 V $V_{IN}$ , 85 $\mu$ A Iq, power good flag output, short circuit current limit and thermal shutdown  |
| <b>LP3996-Q1</b>      | Dual linear regulator with 300 mA and 150 mA outputs and power-on-reset for automotive applications    | Power-on-reset function with adjustable delay; 1.5% accuracy; independent enable pin; 300 mA $I_{OUT2}$ ; 36 $\mu$ V <sub>RMS</sub> ; compatible with ceramic caps                     |

*New devices are listed in bold red.*

# Power management

## Component recommendations

### DC/DC controllers and converters

| Device              | Product description  | Key specifications  |
|---------------------|--|---|
| <b>LM26001/3-Q1</b> | Switching regulators with high efficiency sleep mode   | Wide $V_{IN}$ range: 3 V to 38 V, high efficiency sleep mode, 40 $\mu$ A typical $I_q$ in sleep mode  |
| <b>TPIC74100-Q1</b> | 1.5 V to 40 V buck/boost switch-mode regulator   | Fixed 5 V output, programmable slew rate and frequency modulation for EMI consideration   |
| <b>TPS40200-Q1</b>  | 4.5 V to 52 V wide $V_{IN}$ range, nonsynchronous voltage-mode controller                                | 35 kHz to 500 kHz, integrated 200-mA PMOS-FET driver  |
| <b>TPS5430-Q1</b>   | 35.5 V to 36 V wide $V_{IN}$ range, 3 A step-down SWIFT™ converter                                       | Switching frequency 500 KHz fixed, high efficiency due to low rDSOn   |
| <b>TPS5420-Q1</b>   | 35.5 V to 36 V wide $V_{IN}$ range, 3 A step-down SWIFT™ converter                                       | 95% efficiency, adjustable-output voltage   |
| <b>TPS54x62-Q1</b>  | 3.6 V to 48 V wide $V_{IN}$ range low- $I_q$ , 65 $\mu$ A, step-down DC/DC converter                     | 200 kHz- 2.2 MHz switching frequency, 1 A to 3 A output current, 0.9 V to 18 V output voltage   |
| <b>TPS57160-Q1</b>  | 3.5 V to 60 V wide $V_{IN}$ range, 1.5 A step down SWIFT™ converter with Eco-Mode™                       | 100-kHz to 2.5-MHz switching frequency, synchronizes to external clock, 1.5 A output current (0.5 A and 2.5 A version also available)   |
| <b>TPS57114-Q1</b>  | 2.95 V to 6 V $V_{IN}$ range, 4 A, 2 MHz synchronous step down SWIFT™ DC/DC converter                    | 200 kHz to 2 MHz switching frequency, synchronizes to external clock, 4 A output current (2 A and 3 A version also available)   |
| <b>TPS54361-Q1</b>  | 4.5 V to 60 V, 3.5 A step-down DC/DC converter in 4 mm x 4 mm SON  | 152 $\mu$ A $I_q$ , 100 kHz to 2.5 MHz switching frequency, frequency synchronization, PG, EN, track, adj. soft start, 99% max. duty cycle, Eco-Mode™                         |
| <b>TPS54561-Q1</b>  | 4.5 V to 60 V, 5 A step-down DC/DC converter in 4 mm x 4 mm SON  | 152 $\mu$ A $I_q$ , 100 kHz to 2.5 MHz switching frequency, frequency synchronization, PG, EN, track, adj. soft start, 99% max. duty cycle, Eco-Mode™                         |
| <b>TPS51632-Q1</b>  | 2.5 V to 24 V, 3/2/1-phase step-down driverless controller for Nvidia Tegra® T40 CPUs with serial VID    | 300 kHz to 1 MHz switching frequency, D-CAP+ control, enable, power good, telemetry, light load efficiency, dynamic voltage scaling   |
| <b>TPS51604-Q1</b>  | Synchronous-buck FET drivers for high-frequency CPU core power   | Use with TPS51632 controller, 4.5 V to 28 V conversion input voltage, optimized for 5 V gate drive, 2 mm x 2 mm 8-WSON package with pad                                       |
| <b>TPS40200-Q1</b>  | 4.5 V to 52 V $V_{IN}$ range, nonsynchronous voltage-mode controller                                     | 200-mA internal P-FET driver, UVLO, external synchronization  |
| <b>TPS54061-Q1</b>  | SWIFT™ 4.7 V to 60 V, 200 mA synchronous step-down DC/DC converter                                       | 24.7 V to 60 V, 200 mA, 90 $\mu$ A low $I_q$ , 50 kHz to 1.1 MHz switching frequency, frequency synchronization, light load efficiency, fixed soft start, 3 x 3 SON           |
| <b>TPS54240-Q1</b>  | 3.5 V to 42 V $V_{IN}$ range, 2.5 A, 2.5 MHz step-down SWIFT™ converter with Eco-Mode™                   | 2.5 A, low $I_q$ 138 $\mu$ A, 100 kHz to 2.5 MHz switching frequency, frequency synchronization, light load efficiency, power good, adjustable soft start, MSOP and 3 x 3 SON |
| <b>TPS54340-Q1</b>  | SWIFT™ 4.5 V to 42 V, 3.5 A step-down DC/DC converter  | 4.5 V to 42 V, 3.5 A, 146 $\mu$ A low $I_q$ , 100 kHz to 2.5 MHz switching frequency, frequency synchronization, light load efficiency, fixed soft start, 8 pin HSOIC         |
| <b>TPS54360-Q1</b>  | SWIFT™ 4.5 V to 60 V, 3.5 A step-down DC/DC converter  | 4.5 V to 60 V, 3.5 A, 146 $\mu$ A low $I_q$ , 100 kHz to 2.5 MHz switching frequency, frequency synchronization, light load efficiency, fixed soft start, 8 pin HSOIC         |
| <b>TPS54540-Q1</b>  | SWIFT™ 4.5 V to 42 V, 5 A step-down DC/DC converter  | 4.5 V to 42 V, 5 A, 146 $\mu$ A low $I_q$ , 100 kHz to 2.5 MHz switching frequency, frequency synchronization, light load efficiency, fixed soft start, 8 pin HSOIC           |
| <b>TPS54560-Q1</b>  | SWIFT™ 4.5 V to 60 V, 5 A step-down DC/DC converter  | 4.5 V to 60 V, 5 A, 146 $\mu$ A low $I_q$ , 100 kHz to 2.5 MHz switching frequency, frequency synchronization, light load efficiency, fixed soft start, 8 pin HSOIC           |
| <b>TPS54618-Q1</b>  | SWIFT™ 2.95 V to 6 V, 6 A synchronous step-down DC/DC converter  | 2.95 V to 6 V, 6 A, 200 kHz to 2 MHz switching frequency, frequency synchronization, power good and tracking, adjustable soft start, 3 x 3 SON                                |
| <b>TPS62065-Q1</b>  | Step down buck converter   | 6 $V_{IN}$ , 2 A, 3 MHz, synchronous, 2 x 2 SON package   |
| <b>TPS62130-Q1</b>  | Step down buck converter   | 17 $V_{IN}$ , 3 A, synchronous, 3 x 3 QFN package   |
| <b>TPS62150-Q1</b>  | Step down buck converter   | 17 $V_{IN}$ , 1 A, synchronous, 3 x 3 QFN package   |
| <b>TPS62160-Q1</b>  | Step down buck converter   | 17 $V_{IN}$ , 1 A, synchronous, 2 x 2 SON package   |
| <b>TPS61175-Q1</b>  | Step up buck converter   | 3 A high-voltage, programmable frequency, HTSSOP  |
| <b>TPS62231-Q1</b>  | 2 V to 6 V $V_{IN}$ range, 0.5 A step down buck converter  | 0.5 A, 3 MHz ultra-small buck, DCS-control, 1 x 1.5 SON   |
| <b>TPS62290-Q1</b>  | 2.3 V to 6 V $V_{IN}$ range, 1 A step down buck converter  | 1 A, 2.25 MHz buck, 2 mm x 2 mm SON   |
| <b>TPS62090-Q1</b>  | Step down buck converter   | 3 A, 2.8 MHz/1.4 MHz buck, DSC-control, 3 x 3 QFN   |
| <b>TPS61240-Q1</b>  | 2.3 V to 5.5 V $V_{IN}$ range, 0.4 A step down buck converter  | 400 mA, 4 MHz boost, 2 x 2 SON  |
| <b>LM3481-Q1</b>    | 48 V wide $V_{IN}$ low-side N-channel controller for switching regulators                                | 2.97 V to 48 V supply, 100 kHz to 1 MHz adjustable and synchronizable frequency, 10 $\mu$ A shutdown current  |
| <b>LM22670-Q1</b>   | 3 A SIMPLE SWITCHER®, step-down voltage regulator with synchronization or adjustable switching frequency | Wide input voltage range: 4.5 V to 42 V, internally compensated, adjustable switching frequency and synchronization   |
| <b>LM22671-Q1</b>   | 500 mA SIMPLE SWITCHER®, step-down voltage regulator with adjustable frequency                           | Wide input voltage range: 4.5 V to 42 V, internally compensated, adjustable switching frequency and synchronization   |
| <b>LM22672-Q1</b>   | 1 A SIMPLE SWITCHER®, step-down voltage regulator with adjustable frequency                              | Wide input voltage range: 4.5 V to 42 V, internally compensated, adjustable switching frequency and synchronization   |
| <b>TPS62260-Q1</b>  | 2 V to 6 V $V_{IN}$ range, 0.6 A, 2.25 MHz buck converter  | 2.2 MHz switching frequency, output current up to 600 mA, force PW/PFM mode, 100% duty cycle; soft start capability   |
| <b>TPS624xx-Q1</b>  | 2.5 V to 6 V $V_{IN}$ range dual, adjustable, 2.25 MHz buck converter                                    | Switching frequency: fixed at 2.25 MHz; force PW/PFM mode; soft start capability; 100% duty cycle   |
| <b>LM22673-Q1</b>   | 3 A SIMPLE SWITCHER®, step-down voltage regulator with adjustable soft start and current limit           | Wide input voltage range: 4.5 V to 42 V, internally compensated, adjustable soft start and current limit  |
| <b>LM22674-Q1</b>   | 500 mA SIMPLE SWITCHER®, step-down voltage regulator with precision enable                               | Wide input voltage range: 4.5 V to 42 V, internally compensated, precision enable pin   |

*New devices are listed in bold red*



# Power management

## Component recommendations

### DC/DC controllers and converters

| Device                | Product description  | Key specifications  |
|-----------------------|--|---|
| <b>LM22675-Q1</b>     | 1 A SIMPLE SWITCHER®, step-down voltage regulator with precision enable                                  | Wide input voltage range: 4.5 V to 42 V, internally compensated, precision enable pin                               |
| <b>LM22676-Q1</b>     | 3 A SIMPLE SWITCHER®, step-down voltage regulator with precision enable                                  | Wide input voltage range: 4.5 V to 42 V, internally compensated, precision enable pin                               |
| <b>LM22677-Q1</b>     | 5 A SIMPLE SWITCHER®, step-down voltage regulator with synchronization or adjustable switching frequency | Wide input voltage range: 4.5 V to 42 V, internally compensated, adjustable switching frequency and synchronization |
| <b>LM22678-Q1</b>     | 5 A SIMPLE SWITCHER®, step-down voltage regulator with precision enable                                  | Wide input voltage range: 4.5 V to 42 V, internally compensated, precision enable pin                               |
| <b>LM22679-Q1</b>     | 5 A SIMPLE SWITCHER®, step-down voltage regulator with adjustable soft start and current limit           | Wide input voltage range: 4.5 V to 42 V, internally compensated, adjustable soft start and current limit            |
| <b>LM22680-Q1</b>     | 2 A SIMPLE SWITCHER®, step-down voltage regulator with precision enable                                  | Wide input voltage range: 4.5 V to 42 V, internally compensated, adjustable switching frequency and synchronization |
| <b>LM5574/5/6-Q1</b>  | SIMPLE SWITCHER® 75 V, step-down switching regulator   | 6 V to 75 V input range, frequency synchronization  |
| <b>LM25574/5/6-Q1</b> | SIMPLE SWITCHER® 42 V, step-down switching regulator   | 6 V to 42 V input range, frequency synchronization  |
| <b>LM2700Q-Q1</b>     | 600 kHz/1.25 MHz, 2.5 A, step-up PWM DC/DC converter   | 3.6 A, 0.08 Ω, internal switch; operating input voltage range of 2.2 V to 12 V                                      |
| <b>LM3671-Q1</b>      | 1.2 V, 5 V <sub>IN</sub> , 2 MHz, 600 mA, synchronous step-up PWM DC/DC converter                        | 5 V input range, AEC-Q100 grade 0 and 1 qualified   |
| <b>LM25085-Q1</b>     | 4.5 V to 42 V wide V <sub>IN</sub> constant on-time PFET buck switching controller                       | 100% duty cycle for low dropout, ultra-fast transient response  |
| <b>LM5085-Q1</b>      | 4.5 V to 75 V wide V <sub>IN</sub> constant on-time PFET buck switching controller                       | 100% duty cycle for low dropout, ultra-fast transient response  |
| <b>LM25088-Q1</b>     | 4.5 V to 42 V wide V <sub>IN</sub> non-synchronous buck controller                                       | Frequency dithering for EMI reduction, low Iq standby and shutdown  |
| <b>LM5088-Q1</b>      | 4.5 V to 75 V wide V <sub>IN</sub> non-synchronous buck controller                                       | Frequency dithering for EMI reduction, low Iq standby and shutdown  |
| <b>LM34919B-Q1</b>    | 6 V to 40 V ultra-small wide V <sub>IN</sub> 600 mA buck converter                                       | 2.6 MHz switching, tiny 2 mm x 2 mm μSMD package  |
| <b>LM34919C-Q1</b>    | 4.5 V to 40 V ultra-small wide V <sub>IN</sub> 600 mA buck converter                                     | 2.6 MHz switching, tiny 2 mm x 2 mm μSMD package  |
| <b>LM25010-Q1</b>     | 6 V to 42 V, 1 A step-down switching regulator   | Constant on-time control, operation up to 1 MHz   |
| <b>LM25011-Q1</b>     | 6 V to 42 V, 2 A wide V <sub>IN</sub> constant on-time switching regulator                               | Emulated ripple mode, adjustable current limit  |
| <b>LM5121-Q1</b>      | 3 V to 65 V wide V <sub>IN</sub> synchronous boost controller  | Disconnection switch control for input current limiting   |
| <b>LM5122-Q1</b>      | 3 V to 65 V wide V <sub>IN</sub> stackable synchronous boost controller                                  | Current sharing and phase interleaving for high current applications  |
| <b>LM5118-Q1</b>      | 3 V to 42 V wide V <sub>IN</sub> buck-boost controller   | Emulated current mode control, frequency synchronization to 500 kHz   |
| <b>LM25118-Q1</b>     | 3 V to 75 V wide V <sub>IN</sub> buck-boost controller   | Emulated current mode control, frequency synchronization to 500 kHz   |
| <b>LM5119-Q1</b>      | 6 V to 65 V wide V <sub>IN</sub> dual synchronous buck controller  | 2-channel or 2-phase operation with current sharing   |
| <b>LM25119-Q1</b>     | 4.5 V to 42 V wide V <sub>IN</sub> dual synchronous buck controller                                      | 2-channel or 2-phase operation with current sharing   |
| <b>LM25117-Q1</b>     | 6 V to 42 V wide V <sub>IN</sub> synchronous buck controller   | Emulated current mode control, analog current monitor   |
| <b>LM5117-Q1</b>      | 4.5 V to 42 V wide V <sub>IN</sub> synchronous buck controller   | Emulated current mode control, analog current monitor   |

*New devices are listed in bold red.*

### Integrated power management IC (PMIC)

| High input voltage (directly connected to the battery) |  |   |
|--|--|---|
| Device   | Product description  | Key specifications  |
| <b>TPS4333x-Q1</b>                                     | 2 V to 40 V wide V <sub>IN</sub> range, low Iq, 30 uA, single boost, dual synchronous buck controller  | Supports transients up to 60 V, 150 kHz to 600 kHz switching frequency, 0.9 V to 11 V output voltage, 0.7 A to 1.5 A peak gate drive current, boost frontend, frequency spread spectrum |
| <b>TPS4334x-Q1</b>                                     | 4 V to 40 V wide V <sub>IN</sub> range, low Iq, 30 uA, quad output power supply  | Supports transients up to 60 V, 150 kHz to 600 kHz switching frequency, dual synchronous boost controller with 0.6 A peak gate drive current, 2 A buck converter, 300 mA LDO            |
| <b>TPS4335x-Q1</b>                                     | 4 V to 40 V wide V <sub>IN</sub> range, low Iq, 30 uA, dual synchronous buck controller  | Supports transients up to 60 V, 150 kHz to 600 kHz switching frequency, 0.9 V to 11 V output voltage, 1.5 A peak gate drive current, frequency spread spectrum                          |
| <b>TPS65300-Q1</b>                                     | 5.6 V to 40 V wide V <sub>IN</sub> range, 3 MHz step-down regulator, 1x linear regulator and 2x linear regulator controller                    | 2 MHz to 3 MHz switching frequency, 5.3 V switch-mode regulator with integrated high-side switch, 5 V LDO 200 mA, 3.3 V LDO controller, 1.2 V LDO controller                            |
| <b>TPS65301-Q1</b>                                     | 5.6 V to 40 V wide V <sub>IN</sub> range, 3 MHz step-down regulator, 1x linear regulator and 2x linear regulator controller with sensor supply | 2 MHz to 3 MHz switching frequency, 5.45 V switch-mode regulator with integrated high-side switch, 5 V LDO 200 mA, 3.3 V LDO controller, 1.2 V LDO controller                           |
| <b>TPS65320-Q1</b>                                     | 3.6 V to 40 V wide V <sub>IN</sub> range, low-Iq, 110 uA, 2 MHz step-down buck converter and low-Iq, 40 uA, LDO regulator                      | Adj. 100 kHz - 2.5 MHz switching frequency, 3.2 A buck converter, 280 mA LDO  |
| Low input voltage                                      |  |   |
| Device   | Product description  | Key specifications  |
| <b>LM26480-Q1</b>                                      | Externally programmable dual high-current step-down DC/DC and dual linear regulators   | 2-1.5 A sync step-down DC/DC converters, and 2-300 mA linear regulators, 2.1 MHz PWM switching frequency  |
| <b>LP3907-Q1</b>                                       | Dual high-current step-down DC/DC and dual linear regulator with I <sup>2</sup> C-compatible interface 5 V input                               | 1 A/600 mA step-down DC/DC converters with dynamic voltage management (DVM), 2-300 mA linear regulators, 2.1 MHz PWM switching frequency  |
| <b>LP8728Q-Q1</b>                                      | Quad high-current step-down synchronous DC/DC 5 V input  | 1 A synchronous step-down, 600 mA synchronous step-down, 3.3 MHz switching frequency, spread spectrum for EMI reduction   |

# Power management

## Component recommendations

### Integrated power management IC (PMIC) (continued)

| Low input voltage |  |  |
|-------------------|--|--|
| Device            | Product description  | Key specifications   |
| TPS65000-Q1       | 2.3 V to 6 V input voltage range, 1 step-down converter, 2 linear regulators                                 | 2.25 MHz switching frequency, 600 mA buck and 2x 300 mA LDOs, 3x3 QFN                        |
| TPS659119-Q1      | 2.7 V to 5.5 V input voltage range, 3 step-down converters, 8 linear regulators /w I <sup>2</sup> C and RTC  | 2.7 MHz to 3.3 MHz switching frequency, 1.5 A peak current                                   |
| TPS658629-Q1      | 2.7 V to 5.5 V input voltage range, 3 step-down converters, 11 linear regulators /w I <sup>2</sup> C and RTC | 2.25 MHz switching frequency, 1.5 A peak current, LED drivers, PWM outputs, 11-ch ADC        |
| TPS65023-Q1       | 1.5 V to 6.5 V input voltage range, 3 step-down converters, 2 linear regulators with I <sup>2</sup> C        | 2.25 MHz switching frequency, 1.5 A peak current   |
| TPS659038-Q1      | 3.135 V to 5.25 V input voltage range, 7 step-down converters, 11 linear regulators                          | 1.7 MHz to 2.7 MHz switching frequency with external clock synchronization, 9 A peak current |
| TPS659039-Q1      | 3.135 V to 5.25 V input voltage range, 7 step-down converters, 6 linear regulators                           | 1.7 MHz to 2.7 MHz switching frequency with external clock synchronization, 9 A peak current |

### LCD/LED display solutions

| Device       | Product description  | Key specifications  |
|--------------|--|---|
| LP8860-Q1    | Low EMI, high performance, 4-channel LED driver for automotive lighting  | 3.0 V to 40 V input voltage range, 1:13000 dimming  |
| TPS65150-Q1  | Low input voltage, compact LCD bias IC with VCOM buffer  | 1.8-V to 6-V input voltage range, gate voltage shaping, integrated Vcom buffer  |
| TPS65131-Q1  | Positive and negative output DC/DC converter   | 2.7-V to 5.5-V input voltage range, dual adjustable output voltages up to 15 V and down to -15 V  |
| TPS65100-Q1  | Triple output LCD supply with linear regulator and Vcom buffer   | 2.7-V to 5.8-V input-voltage-range, 1.6-MHz fixed switching frequency, internal power-on sequencing, Vcom buffer, 3.3 V LDO   |
| TPS61196-Q1  | 6-string 400-mA WLED driver with independent PWM dimming for each string                                       | 8.0 V to 30 V input voltage range, 1:5000 dimming   |
| LP8861-Q1    | Easy to use 4-channel LED driver for automotive lighting   | 4.5 V to 40 V input voltage range, 1:10000 dimming  |
| TPS61085-Q1  | 650 kHz/1.2 MHz, 18.5 V step-up DC/DC converter  | 2.3 V to 6 V input voltage range, 18.5 V boost converter with 2.0 A switch current  |
| TPS65140-Q1  | 4-channel power supply for LCD monitor (5 V)   | 2.7-V to 5.8-V input-voltage-range, 1.6-MHz fixed switching frequency, internal power-on sequencing   |
| TPS65145-Q1  | Triple-output LCD supply with linear regulator and power-good output   | 2.7-V to 5.8- V, 1.6-MHz fixed frequency, internal power-on sequencing, thermal shutdown  |
| TPS61040-Q1  | Low-power DC/DC boost converter  | 1.8-V to 6- V, adjustable output voltage up to 28 V, lower output voltage ripple, low quiescent current   |
| TPS61041-Q1  | Low-power DC/DC boost converter  | 1.8-V to 6- V, SOT-23 package, small overall solution size, lower output voltage ripple   |
| TLC6C598-Q1  | 8-bit power shift register LED driver  | 8-bit power shift registers, 50 mA sink current per channel, 40 V transient protection on drain output, controlled switching time for EMI with thermal shutdown protection  |
| TLC6C5912-Q1 | 12-bit power shift register LED driver   | 12-bit power shift registers, 50 mA sink current per channel, 40 V transient protection on drain output, controlled switching time for EMI with thermal shutdown protection                                       |
| LM3431-Q1    | 3-channel constant current LED driver with integrated boost controller   | 4.5 V to 36 V input range   |
| LM3492/HC-Q1 | 2-ch individual dimmable wide V <sub>IN</sub> LED driver with boost/SEPIC converter and fast current regulator | Input voltage operating range: 4.5 V to 65 V; switching frequency: 200 kHz to 1 MHz; 1000:1 (LM3492) or 10000:1 (LM3492HC) contrast ratio; programmable LED current from 50 mA to 250 mA; Up to 65 V boost output |
| TLC5916-Q1   | 8-bit constant current sink LED driver   | 8-bit constant current from 5 mA to 120 mA with 256-step programmable current gain with open load, short load and overtemperature protection  |
| TLC5917-Q1   | 8-bit constant current sink LED driver   | 8-bit constant current from 5 mA to 120 mA with 256-step programmable current gain with open load, short load and overtemperature protection  |
| TLC5926-Q1   | 16-bit constant current sink LED driver  | 16-bit constant current from 5 mA to 120 mA with 256-step programmable current gain with open load, short load and overtemperature protection   |
| TLC5927-Q1   | 16-bit constant current sink LED driver  | 16-bit constant current from 5 mA to 120 mA with 256-step programmable current gain with open load, short load and overtemperature protection   |
| TLC5941-Q1   | 16-bit constant current sink LED driver  | 16-bit constant current from 5 mA to 60 mA with dot correction and internal PWM generator with open load and overtemperature detection  |
| TPS61161-Q1  | 1-ch LED driver with PWM brightness control  | Input voltage operating range: 2.7 V to 18 V; switching frequency: 600 kHz; drive 10 LEDs in series   |
| TPS61165-Q1  | White LED driver with digital and PWM brightness control   | 3 V to 18 V input voltage range, support 38 V load dump 100 mA boost LED driver   |

Preview devices are in **bold teal**.

# Power management

## Component recommendations

### High side switches (load switches) MOSFETs

| Device               | Product description  | Key specifications   |
|----------------------|--|--|
| <b>TPS1H100-Q1</b>   | 40-V, 100-mΩ single-channel smart high-side power switch   | Full diagnostic and protection with programmable current limit   |
| <b>TPS22968-Q1</b>   | 5.5 V, 4 A, 27 mΩ, 2-channel automotive catalog load switch with quick output discharge and adjustable rise time | 10-WSON wettable flanks package (3.0 mm x 2.0 mm x 0.75 mm with 0.5 mm pitch) AEC-Q100 grade 1   |
| <b>TPS22965-Q1</b>   | Ultra-low RON, 5.5 V/4 A load switch with configurable controlled turn on (Trise)                                | Integrated solution providing: 16 mΩ on-resistance, output discharge resistance, 2 μA (max) shutdown current, and configurable rise time for optimized timing and Power sequencing |
| <b>TPS22966-Q1</b>   | On ultra-low RON, 5.5 V/4 A dual-channel load switch with configurable controlled turn on (Trise)                | Integrated solution providing: 16 mΩ on-resistance, output discharge resistance, 2 μA (max) shutdown current, and configurable rise time for optimized timing and power sequencing |
| <b>CSD17313Q2-Q1</b> | 30-V N-channel NexFET™ power MOSFET in 2 mm x 2 mm SON package   | 5 A Id (max) (25C), 2.1 nC QG, 0.4 nC QGD, 10 V VGS, 1.3 V VGSTH   |
| <b>DRV8801-Q1</b>    | 16-bit 2.8 A brushed DC motor driver   | Up to 38 V operation; phase enable control I/F, current sense pin indicates coil current, fully protected  |
| <b>DRV8832-Q1</b>    | 16-bit 1 A brushed DC motor driver   | 2.7 V to 6.8 V operation; IIN/IN control interface, fully protected, 3 mm x 4.9 mm HTSSOP package  |

*Preview devices are in bold teal.*

### PWM power supply controllers

| Device               | Product description  | Key specifications  |
|----------------------|--|---|
| <b>UCC2813-1-Q1</b>  | Low-power BICMOS current-Mode PWM  | 500-μA operating supply current, operation to 1 MHz, ideal for battery operated systems   |
| <b>TPS40210-Q1</b>   | Automotive catalog wide input range current mode boost, SEPIC, and flyback controller                | Input voltage operating range: 4.5 V to 52 V; switching frequency: Up to 1 MHz; external clock sync and programmable closed-loop soft start       |
| <b>TPS2022-Q1</b>    | USB power distribution switch  | 2.7-V to 5.5-V supply, 50-mΩ N-channel MOSFET, high-side power switches, short-circuit and thermal protection                                     |
| <b>TPS2024-Q1</b>    | USB power distribution switch  | 2.7-V to 5.5-V supply, 50-mΩ N-channel MOSFET, high-side power switches, short-circuit and thermal protection                                     |
| <b>TPS2030-Q1</b>    | USB power distribution switch  | 2.7-V to 5.5-V supply, 50-mΩ N-channel MOSFET, high-side power switches, short-circuit and thermal protection                                     |
| <b>TPS2042B-Q1</b>   | USB dual, current-limited power-distribution switches  | 2.7-V to 5.5-V supply, 70-mΩ N-channel MOSFET, high-side power switches, short-circuit and thermal protection                                     |
| <b>TPS2051B-Q1</b>   | USB dual, current-limited power-distribution switches  | 2.7-V to 5.5-V supply, 70-mΩ N-channel MOSFET, high-side power switches, short-circuit and thermal protection                                     |
| <b>TPS2561-Q1</b>    | Automotive catalog dual channel precision adjustable current-limited power switches                  | 0.25 A to 2.5 A adj. current limit, 2.7 V to 6.5 V, 45 mΩ Rds(on), 15 KV/8 KV ESD protection, soft start, thermal, SC protection                  |
| <b>TPS2065-Q1</b>    | Automotive catalog single 1 A current-limited, power-distribution switches for USB applications      | Single, 1.5 A, fixed current limit, 2.7 V to 5.5 V, 70 mΩ Rds(on), active high enable, thermal, SC protection                                     |
| <b>TPS2066-Q1</b>    | Automotive catalog dual 1 A current-limited, power-distribution switches                             | Dual, 1.5 A, fixed current limit, 2.7 V to 5.5 V, 70 mΩ Rds(on), active high enable, thermal, SC protection                                       |
| <b>TPS2068-Q1</b>    | Automotive catalog current-limited, power-distribution switch  | Single, 2.1 A fixed current limit, 2.7 V to 5.5 V, 79 mΩ Rds(on), active low enable, thermal, SC protection                                       |
| <b>TS3USB221A-Q1</b> | Automotive catalog ESD protected, high-speed USB 2.0 (480-Mbps) 1:2 multiplexer/demultiplexer switch | USB 2.0 high-speed 1:2 mux/demux, with 7 kV ESD and IEC61000-4-2 immunity   |
| <b>TPS2543-Q1</b>    | Automotive catalog programmable 2.5 A current limited USB-CPC power switch                           | Two programmable ILIMITS, USB1.2 compliant, charge port control for many popular phones, tablets, with data switch                                |
| <b>TPS2511-Q1</b>    | Automotive catalog programmable 2.2 A current limited USB-CPC power switch                           | USB1.2 compliant, charge port control for BC1.2 and all popular phones, tablets, for charge only ports; load detect output for droop compensation |
| <b>TPS2546-Q1</b>    | Automotive catalog programmable 2.5 A current limited USB-CPC power switch                           | Two programmable ILIMITS, USB1.2 compliant, charge port control for all popular phones, tablets, with data switch, load detect output             |
| <b>TP2513A-Q1</b>    | Automotive catalog switchless dual USB-CPC (charge port controller)                                  | Manages data lines of two USB ports to provide charge port control (CPC) for all popular phones, tablets  |

*New Products in bold red.*

### Sequencer

| Device           | Product description | Key specifications   |
|------------------|---------------------|--|
| <b>LM3880-Q1</b> | Power sequencer     | Easiest method to sequence rails power up and power down control input voltage range of 2.7 V to 5.5 V |

### Voltage references

| Device             | Type   | Initial accuracy (%) | Temp drift (ppm) | Vo (V)         | Features                 |
|--------------------|--------|----------------------|------------------|----------------|--------------------------|
| <b>LM4040/1-Q1</b> | Shunt  | 0.1 to 2.0           | 100              | 1.2, 2.5       | No ext cap needed        |
| <b>LM4050/1-Q1</b> | Shunt  | 0.1 to 0.5           | 50               | Adj, 1.2 to 10 | Low noise                |
| <b>TL431/2-Q1</b>  | Shunt  | 0.5 to 1.0           | 50               | Adj, 2.5       | TL and TLV versions      |
| <b>REF3033A-Q1</b> | Series | 0.20                 | 50 to 75         | 3.3            | 1 mV dropout, 50 uA Iq   |
| <b>REF50xx-Q1</b>  | Series | 0.05 to 0.1          | 3 to 8           | 2.0 to 10      | Ultra high precision     |
| <b>LM4128-Q1</b>   | Series | 0.1 to 1.0           | 75 to 100        | 1.8 to 4.1     | Enable for shutdown mode |

# Haptics

## Automotive haptics solutions

### Easy-to-use, advanced HMI improves safety on the road

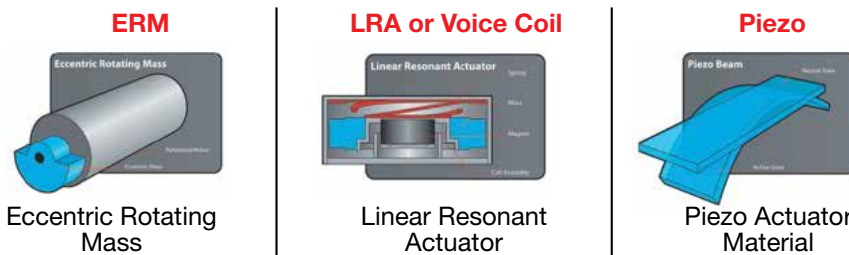
#### Solutions for ERM, LRA and Piezo actuators

As automotive in-car infotainment systems become increasingly complex, driver distraction has become a critical issue. Within the infotainment center console, capacitive touch buttons/sliders/knobs are being used to replace mechanical controls in addition to capacitive touchscreen LCDs. A major drawback in the use of these technologies is that they provide no tactile feedback when the driver is navigating through different menus and settings. This leads to the driver taking their eyes off the road to see if their input was accepted. Due to this, the automotive industry has placed a large importance on creating safe and innovative ways to keep the driver's eyes on the road and hands on the wheel.

- Touch interfaces are managing an increasing amount of dynamic content and features
- New guidelines published from NHTSA and the SAE set the criteria for maximum task and glance times
- Today's auto interface must be intuitive, easy to use, and offer rich features while maintaining safety standards and minimizing distractions

Haptics, by definition, refers to the sense of touch and is a technology that adds tactile feedback to electronic devices through the use of vibrations. By adding haptics, your finger will get the impression that you are pressing an actual button. Leading brands use haptics to create compelling, realistic user experiences and enhance driver safety.

#### Actuators



#### Key features

##### DRV2605L-Q1

- Integrated Immersion 123 Effect Waveform Library
- I<sup>2</sup>C controlled haptic playback engine
- Smart loop architecture
  - Automatic overdrive/braking
  - Automatic actuator diagnostic
  - Automatic level calibration
- External PWM input and GPIO trigger option
- 2.5 V to 5.2 V operation

##### DRV8662

- High-voltage Piezo haptics driver
- 50 VPP to 200 VPP capacitive drive
- Differential output
- Advanced boost converter with Integrated FET and diode
- Adjustable boost voltage and current limit
- Fast start up time of 1.5 ms
- Thermal protection

#### Applications

- Button panels
- Touch pads
- Touch screens
- Mechanical button/control replacement

| Device      | Description   | V <sub>OUT</sub> (max) (V) | Input signal                  | I <sub>Q</sub> (typ) | Startup time (ms) | Haptic actuator type | V <sub>S</sub> (max) (V) | V <sub>S</sub> (min) (V) | Operating temp range (°C) | Automotive qualified (Q1)    | Package  |
|-------------|---|----------------------------|-------------------------------|----------------------|-------------------|----------------------|--------------------------|--------------------------|---------------------------|------------------------------|----------|
| DRV2605L-Q1 | Haptic driver for ERM and LRA with built-in library and smart loop architecture | 5.5                        | I <sup>2</sup> C, PWM, analog | 0.6                  | 0.7               | ERM, LRA             | 5.5                      | 2.5                      | -40 to 85                 | Yes                          | VSSOP-10 |
| DRV8662     | Piezo haptic driver with integrated boost converter                             | 200                        | PWM, analog                   | 5                    | 1.5               | Piezo                | 5.5                      | 3                        | -40 to 70                 | Commercial version available | QFN-20   |

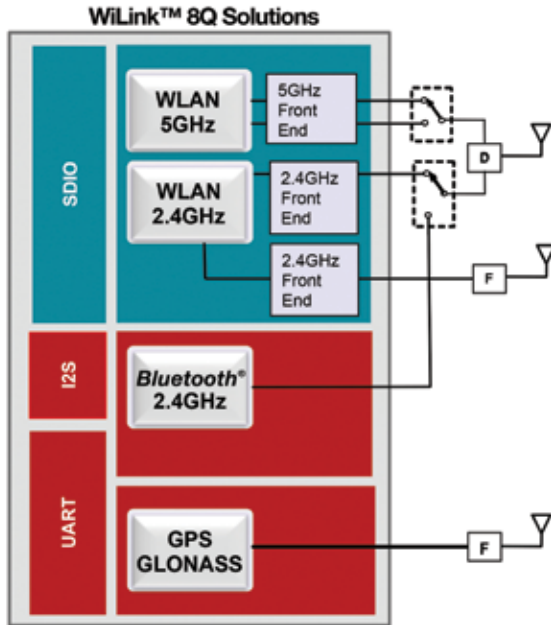
Get more information at: [www.ti.com/haptics](http://www.ti.com/haptics)

# Wireless connectivity

## Automotive wireless connectivity solutions

### WiLink™ 8Q – scalable Wi-Fi®, Bluetooth® and GNSS

The Texas Instruments WiLink™ 8Q product family brings high performing Wi-Fi®, Bluetooth® and GNSS positioning solutions to infotainment systems enabling close integration with mobile handsets and high-speed data traffic to multiple devices in parallel. The WiLink 8Q family has a scalable and flexible combo chip architecture where the pin-to-pin compatible devices enable hardware and software reuse across platforms. It offers the lowest power and best-in-class RF performance and co-existence.



Functional block diagram.

### WiLink™ 8Q solutions

| Available technology options   | WL187xQ | WL183xQ |
|--------------------------------|---------|---------|
| Dual-band 2 x 2 MIMO mobile    | WL1877  | WL1837  |
| Wi-Fi 802.11 a/b/g/n           | WL1873  | WL1833  |
| Wi-Fi 802.11 b/g/n             | WL1871  | WL1831  |
| Wi-Fi SS 40 MHz (HT40)         | •       | •       |
| GNSS                           | •       | —       |
| Bluetooth® 4.0 (including BLE) | •       | •       |

### Key features

- Integrated solution for Wi-Fi, Bluetooth® and GNSS
- Qualified following AEC-Q100 guidelines for automotive
- Bluetooth
  - Bluetooth 4.0, including Bluetooth low energy
  - Best-in-class sensitivity
  - On-chip mSBC codec
  - Shared UART for Bluetooth, GNSS control
  - PCM for audio
- Wi-Fi
  - IEEE 802.11a/b/g/n
  - Station/access point/Wi-Fi direct
  - Wi-Fi protected access 2 (WPA2) and setup (WPS)
  - 100 Mbps throughput
  - Wi-Fi Miracast™ ready
  - SDIO interface
- Location
  - Autonomous and assisted GNSS
  - Supporting four satellite systems in parallel: GPS, Glonass, QZSS and SBAS
  - Short TTFF, fast cold start
  - High tracking sensitivity
  - Sensors blending
  - Integrated LNA, support for external LNA/active antenna
  - On-chip position engine
- Leading co-ex performance through advanced techniques
- Operating temp. –40 to +85°C

Learn more at: [www.ti.com/wilink8q](http://www.ti.com/wilink8q)

# Wireless connectivity

## Automotive wireless connectivity solutions

### Automotive qualified **Bluetooth®** smart wireless MCU

#### CC2541-Q1

The **Bluetooth®** low energy CC2541-Q1 wireless microcontroller delivers new automotive use cases through low power, low cost and simplified automotive connectivity to emerging smartphone-controlled and wire-replacement applications. The CC2541-Q1 leverages the success of TI's broad-market **Bluetooth®** Smart solution (CC2541) and automotive connectivity offerings for combo Wi-Fi®, **Bluetooth®** and GNSS (WiLink™ 8Q) and dual-mode **Bluetooth®** (BL6450Q).

#### Featured tools and software

- CC2541 mini development kit (development kits)
- **Bluetooth®** low energy software stack and tools (software libraries)
- CC256x **Bluetooth®** hardware evaluation tool (calculation tools)

| Features   | Benefits   |
|--|--|
| <b>Full system solution:</b> <ul style="list-style-type: none"> <li>• Integrated wireless MCU</li> <li>• Royalty-free TI protocol stack, profile software and sample applications</li> <li>• Development kits, technical documents and worldwide support</li> </ul>  | <ul style="list-style-type: none"> <li>• Early realization of low-power, single-mode <b>Bluetooth®</b> smart sensor applications</li> </ul>  |
| <ul style="list-style-type: none"> <li>• Controller, host and application with integrated flash on one 6 mm x 6 mm device</li> <li>• Supports analog and digital peripherals</li> <li>• Flash-based firmware can be updated in the field and persistent data can be stored on-chip</li> <li>• Planned support for <b>Bluetooth®</b> 4.1 as well as proprietary modes at 250 Kbps, 500 Kbps, 1 Mbps and 2 Mbps</li> </ul> | <ul style="list-style-type: none"> <li>• Simplified design with one-chip, integrated and flexible solution</li> <li>• Applications can be written directly onto the CC2541-Q1</li> </ul> |
| <ul style="list-style-type: none"> <li>• Low power <b>Bluetooth®</b> low energy operation</li> <li>• Less than 1 microamp (mA) of sleep current with RTC and RAM retention</li> </ul>  | <ul style="list-style-type: none"> <li>• Can operate on a coin cell battery</li> <li>• Low average power allows application to remain on while the automobile is off</li> </ul>          |
| <ul style="list-style-type: none"> <li>• 95 dB link budget</li> <li>• Best-in-class coexistence with other 2.4 GHz devices</li> </ul>  | <ul style="list-style-type: none"> <li>• Link reliability supports high performance applications</li> </ul>  |
| <ul style="list-style-type: none"> <li>• -40 to 105°C temperature rating</li> </ul>  | <ul style="list-style-type: none"> <li>• Performance in extreme conditions faced in the automotive market</li> </ul>   |



### Near Field Communication (NFC)

The Texas Instruments NFC portfolio includes several products that will be Q100 qualified for automotive applications. The NFC portfolio enables **Bluetooth®** and Wi-Fi pairing/handover, personalize settings, configuration management and service interface and other applications such as GPS coordinates transfer from an NFC enabled device (eg. smartphone) to the car's infotainment system.

The TRF7970A is a full featured NFC transceiver that supports all three NFC operating modes: peer-to-peer, card emulation and reader/writer. It is a highly integrated multi-protocol (ISO14443A/B; ISO15693) NFC device that is designed to achieve ultra-low-power performance and is supported by the NFCLink firmware library which enables easy porting of NCI functions on a variety of embedded host processors.

The RF430CL330H is an NFC Tag Type 4B/ISO14443B dual interface dynamic NFC transponder that includes a SPI/I<sup>2</sup>C interface for connection to an MCU/MPU for an easy add on of NFC to existing embedded solutions.

Learn more at: [ti.com/nfc](http://ti.com/nfc)

# TI designs

## Reference designs for infotainment

### TIDA-00169: Automotive TFT-LCD display solution

| Description   | Features   |
|---|--|
| <p>This design implements a video over LVDS solution for automotive infotainment applications. It highlights the support of multi-touch with haptic feedback, LCD backlight control, and ambient light sensing, without the introduction of dedicated support lines back to the host processor. This design is implemented using two boards. The main electronics board, SAT0059 is where the deserializer, microprocessor, backlight controller, haptics drivers and power supply are located. The LCD interface board, SAT0096, is a physical and electrical interface to a specific LCD panel. The SAT0096 is designed for a Microtips UMSH-8596MD-20T display. If a different display is to be used, a new LCD interface board would likely need to be designed.</p> <p>Learn more at: <a href="http://www.ti.com/tool/TIDA-00223">www.ti.com/tool/TIDA-00223</a></p> | <ul style="list-style-type: none"> <li>Wide input voltage range: off battery 4.5 V to 40 V power supply</li> <li>All video and support communications through LVDS <ul style="list-style-type: none"> <li>Supporting 24-bit RGB video</li> <li>400 k bit back channel I<sup>2</sup>C connection for multi-touch input</li> </ul> </li> <li>Multi-touch input supported via 400 k bit back channel I<sup>2</sup>C connection</li> <li>Haptic feedback</li> <li>State of art I<sup>2</sup>C/SPI interface LED backlighting controller with dimming ratio of &gt;10,000:1, switching frequency ~ 2.2 MHz, hybrid dimming and safety and fault tolerances/functions</li> <li>Backlight adjustable to inputs <ul style="list-style-type: none"> <li>Ambient light sensor</li> <li>Thermistor inputs on the LCD and the back light to enable thermal protection</li> </ul> </li> </ul> |

### TIDA-00223: Automotive audio I<sup>2</sup>S over Coax class D amplifier

| Description  | Features   |
|--|--|
| <p>This design is an I<sup>2</sup>S/TDM-based, low-cost, easy-to-use alternative to fiber optics/analog copper wire for connecting an automotive (sound) control panel to an output stage/power amplifier. Supporting I<sup>2</sup>S as well as TDM, it is capable of transmitting digital audio signal to 16 independent channels of speakers with each channel output of 80 W at 4 Ω. It also supports bidirectional communication with the control unit or processor via I<sup>2</sup>C, over a single shielded twisted pair (STP) or coaxial.</p> <p>Learn more at: <a href="http://www.ti.com/tool/TIDA-00223">www.ti.com/tool/TIDA-00223</a></p> | <ul style="list-style-type: none"> <li>Wide input voltage range: off battery 6 V to 40 V power supply</li> <li>The design consists of two boards: SAT0084 (FPD-LINK III and audio amplifier) and SAT0085 (600 W power solution)</li> <li>Audio serializer/deserializer support I<sup>2</sup>S and TDM audio for up to 16 audio channels</li> <li>Audio plus bidirectional I<sup>2</sup>C and GPIO control over a single STP or coaxial cable, eliminating the need for a local microcontroller</li> <li>Power over coax to run distributed microphone</li> </ul> |

### TIDA-00159: Automotive eCall reference design

| Description   | Features  |
|---|---|
| <p>This design is for vehicles equipped with eCall systems which has the capability to enable phone calls to an emergency service center in the event of an accident. Customers can accelerate the design of their eCall systems by taking advantage of a complete reference design comprised of analog AEC-Q100 qualified integrated circuits (ICs) from TI. This design creates a robust, low cost solution that is scalable with flexible power operations which allows the system to be powered from the main car battery or the back-up cell battery.</p> <p>Learn more at: <a href="http://www.ti.com/tool/TIDA-00159">www.ti.com/tool/TIDA-00159</a></p> | <ul style="list-style-type: none"> <li>The TPS43330-Q1 pre-boost circuit supports automotive start/stop and boosts back-up battery supply voltage, allowing operation down to 2 V at the input</li> <li>The TAS5421-Q1 delivers 10 W output power at 8 Ω which translates to clear and loud audio</li> <li>The audio amplifier also features integrated diagnostics to increase the safety level</li> <li>The components offered in this system provide load dump protection against input transients up to 40 V</li> <li>Can sustain a 10 to 15 minute phone call in emergency situations</li> </ul> |

### TIDA-00160: Automotive USB charger with linear droop compensation

| Description  | Features  |
|--|---|
| <p>This design provides detailed data for evaluating and verifying a USB charger, which uses a USB charge controller, a buck converter and a shunt amplifier. With the help of the shunt amplifier, the design aims to compensate the effects on Vdroop when the smartphone/tablet is connected to the USB charger using a cable that is roughly two to three meters in length.</p> <p>Learn more at: <a href="http://www.ti.com/tool/TIDA-00160">www.ti.com/tool/TIDA-00160</a></p> | <ul style="list-style-type: none"> <li>Compliance with almost all major smartphone/tablet manufacturers is supported due to programmable current limit up to 3 A, BC 1.2 compliant devices being supported, and D+/D- divider modes of 2.7 V/2.7 V and 1.2 V</li> <li>Drop in and BOM compatible with TPS2543-Q1</li> <li>Supports CDP/SDP auto switch for small industry standard footprint based devices</li> </ul> |

### More reference designs

| Infotainment category  | TI design  | Description  |
|------------------------|--|--|
| eCall                  | Automotive eCall Reference Design (TIDA-00159)   | <ul style="list-style-type: none"> <li>TPS43330-Q1 pre-boost circuit supports automotive start/stop and boosts back-up battery supply voltage, allowing operation down to 2 V at the input</li> <li>TAS5421-Q1 delivers 10 W output power at 8 Ω</li> <li>Load dump protection against input transients up to 40 V</li> </ul>  |
| LCD display            | WVGA Digital Video SerDes for Automotive TFT LCD Displays w/ OpenLDI Interface Reference Design (TIDA-00136)     | <ul style="list-style-type: none"> <li>Support WVGA x 60 data rates with OpenLDI Standard (LVDS)</li> <li>FPD-Link II technology with ideal, cost optimized solution for high speed, low power and low EMI</li> <li>Serial bus scheme</li> <li>Built in self-test (BIST) ASIL B applications</li> </ul>  |
|                        | High-Definition (HD) Automotive SerDes w/ OpenLDI Interface over twisted pair for TFT LCD Displays (TIDA-00131)  | <ul style="list-style-type: none"> <li>Support WVGA x 60 data rates with OpenLDI Standard (LVDS)</li> <li>FPD-Link II technology with ideal, cost optimized solution for high speed, low power and low EMI</li> <li>Serial bus scheme</li> <li>Built in self-test (BIST) ASIL B applications</li> </ul>  |
|                        | High Definition (HD) Automotive SerDes w/ 24 Bit RGB Interface over twisted pair for TFT LCD Display (TIDA00132) | <ul style="list-style-type: none"> <li>24 bit parallel RGB interface, supports TFT LCD displays up to 720 p x 60 Hz</li> <li>Bi-directional control channel supporting GPIO and I<sup>2</sup>C</li> <li>Adaptive equalizer auto calibrates for cable length, aging, and over temperature</li> <li>Diagnostic built in self-test (BIST) and pattern generation</li> </ul> |
|                        | Automotive TFT LCD Display Solution (TIDA-00169)   | <ul style="list-style-type: none"> <li>Off battery 4.5 V to 40 V power supply</li> <li>Supporting 24 bit RGB video, 400 k bit back channel I<sup>2</sup>C connection for multi touch input</li> <li>LED backlighting controller with world class dimming and safety and fault tolerances/functions</li> </ul>  |
| USB charging           | Automotive USB Charger with Linear Droop Compensation Reference Design (TIDA-00160)                              | <ul style="list-style-type: none"> <li>Cable compensation up to 3 m</li> <li>Programmable current limit up to 3 A</li> <li>BC 1.2 compliant devices being supported</li> <li>D+/D- divider modes of 2.7 V/2.7 V and 1.2 V</li> </ul>   |
| Audio I <sup>2</sup> S | Digital Audio SerDes Over Twisted Pair or Coax for Remote Automotive Audio Systems (TIDA-00134)                  | <ul style="list-style-type: none"> <li>Supports up to 8 stereo or 16 mono speaker channels with I<sup>2</sup>S and TDM modes</li> <li>Built in self-test (BIST)</li> <li>Adaptive equalizer auto calibrates for cable length, aging, and over temperature</li> </ul>   |
|                        | Automotive Audio I <sup>2</sup> S over Coax Class D Amplifier Reference Design (TIDA-00223)                      | <ul style="list-style-type: none"> <li>Wide input voltage range: off battery 6 V to 40 V power supply</li> <li>The design consists two boards, which are FPD-LINK III audio amplifier, and 600 W power solution</li> <li>Audio serializer/deserializer support I<sup>2</sup>S and TDM</li> </ul>   |
| Application power      | Automotive I.MX6 Quad Core Processor Power Solution (TIDA-00350)   | <ul style="list-style-type: none"> <li>Provide I.MX6 quad core application processor cost competitive discrete power solutions</li> <li>Supports wide V<sub>IN</sub> off battery voltage from 6 V to 42 V</li> <li>Switching frequency &gt;2 MHz to avoid AM band interference</li> </ul>  |

# TI Worldwide Technical Support

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Malaysia 1-800-80-3973  
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Singapore 800-886-1028  
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