

# RENESAS AUTOMOTIVE POWER PRODUCTS

2019.Q3

BIG IDEAS  
FOR EVERY SPACE

# OUTLINE

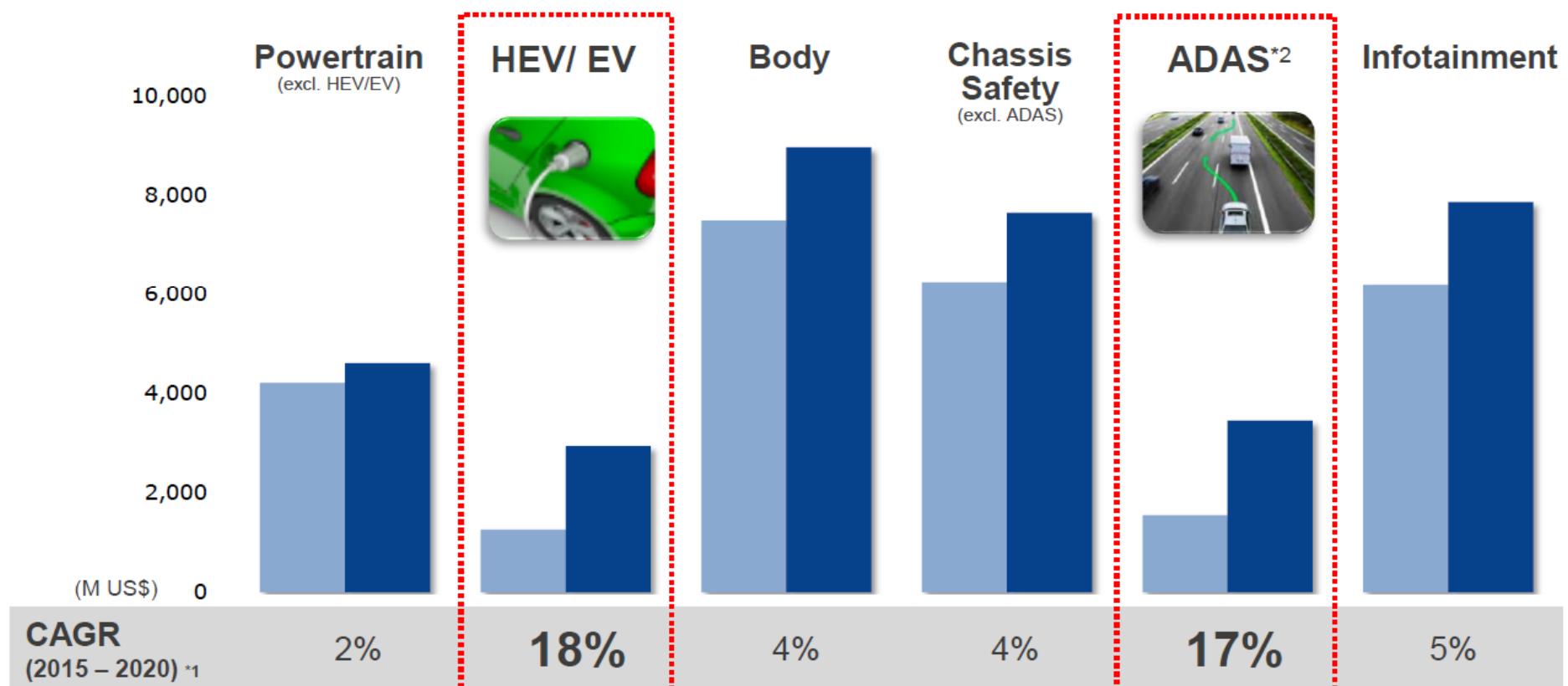
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- Overview of Development/Market Strategy
- Overview & Product Selection Guides
- Product Details
  - Linear Regulators / Battery Chargers
  - Switching Regulators & Controllers
  - Display Products

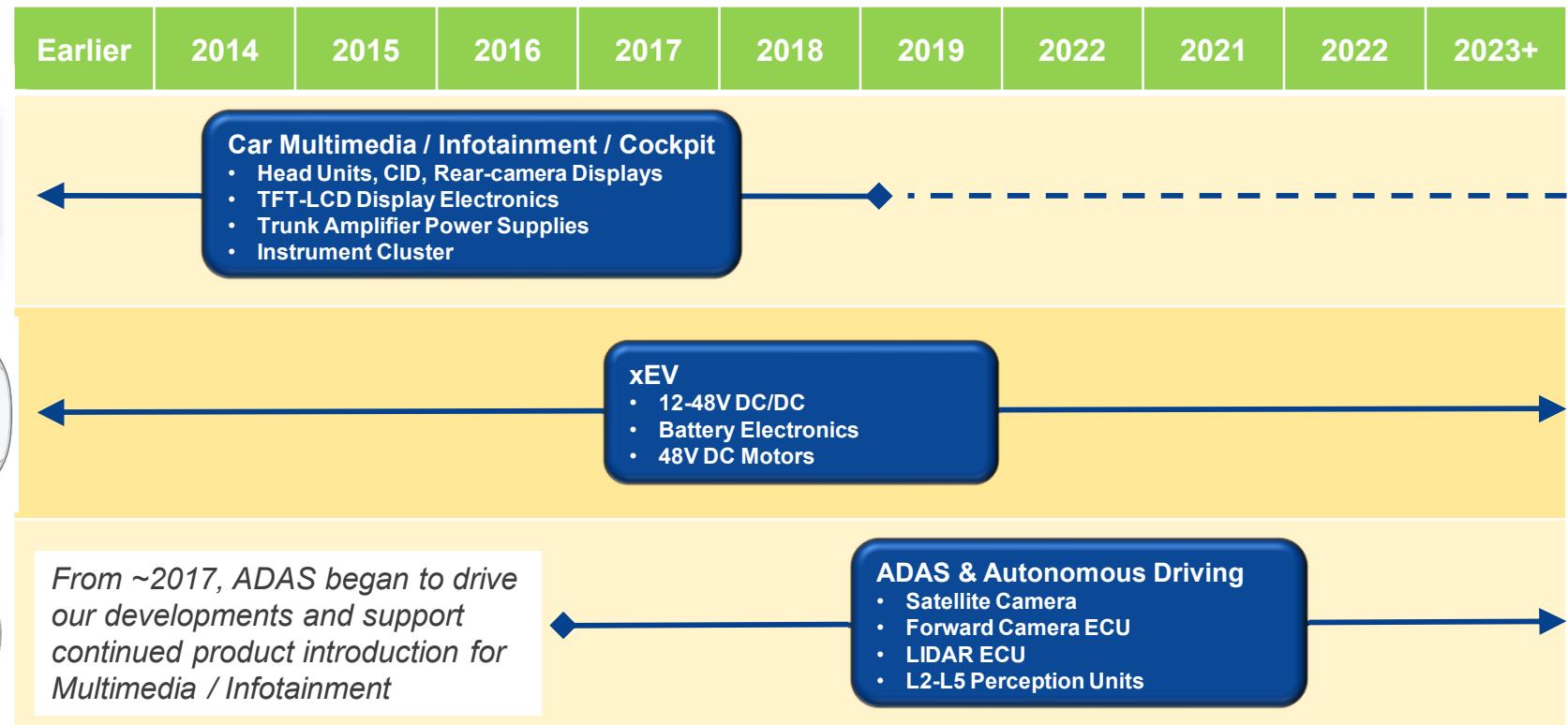
# DEVELOPMENT STRATEGY

# FOCUS AREAS

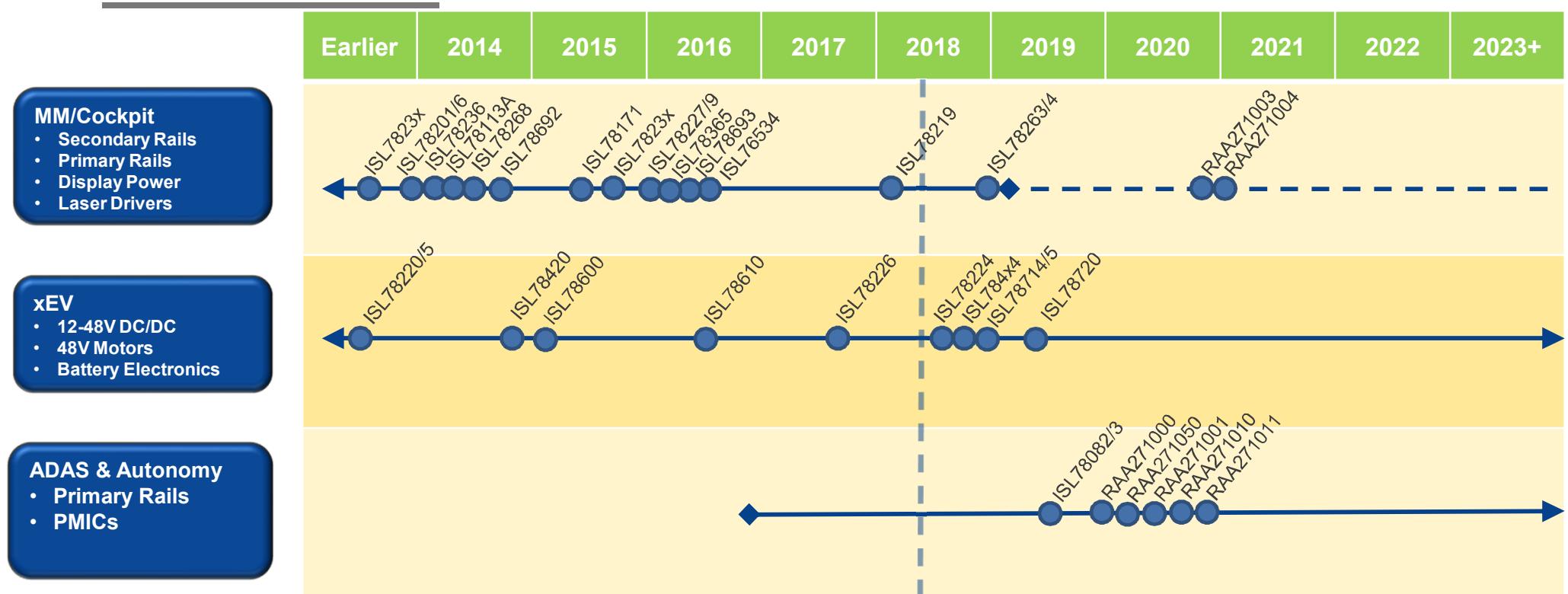
DRIVE AUTOMOTIVE BUSINESS GROWTH BY INVESTING IN GREEN VEHICLE AND AUTONOMOUS DRIVING WITH MASSIVE GROWTH POTENTIAL



# RENESAS (EX-INTERSIL) POWER MANAGEMENT DEVELOPMENT FOCUS



## RENESAS (EX-INTERSIL) POWER MANAGEMENT DEVELOPMENT TIMELINE



# AUTOMOTIVE POWER MARKET DRIVERS

## High Efficiency

- High ambient temperatures require high efficiency to maintain operation within specified junction temperature range.
- Always-on applications require ultra-low quiescent current.
- **Value:** Multi-phase modulation and low RDS-on MOSFETs improve efficiency. Advanced modulators offer highest efficiency buck, boost and buck-boost operation across all load conditions.

## Functional Safety

- Need for systems to comply with ISO-26262 and achieve high ASIL ratings
- **Value:** Advanced PMICs and Regulators offer solutions validated to achieve system safety goals and ASIL ratings up to ASIL D.

## Increased Integration

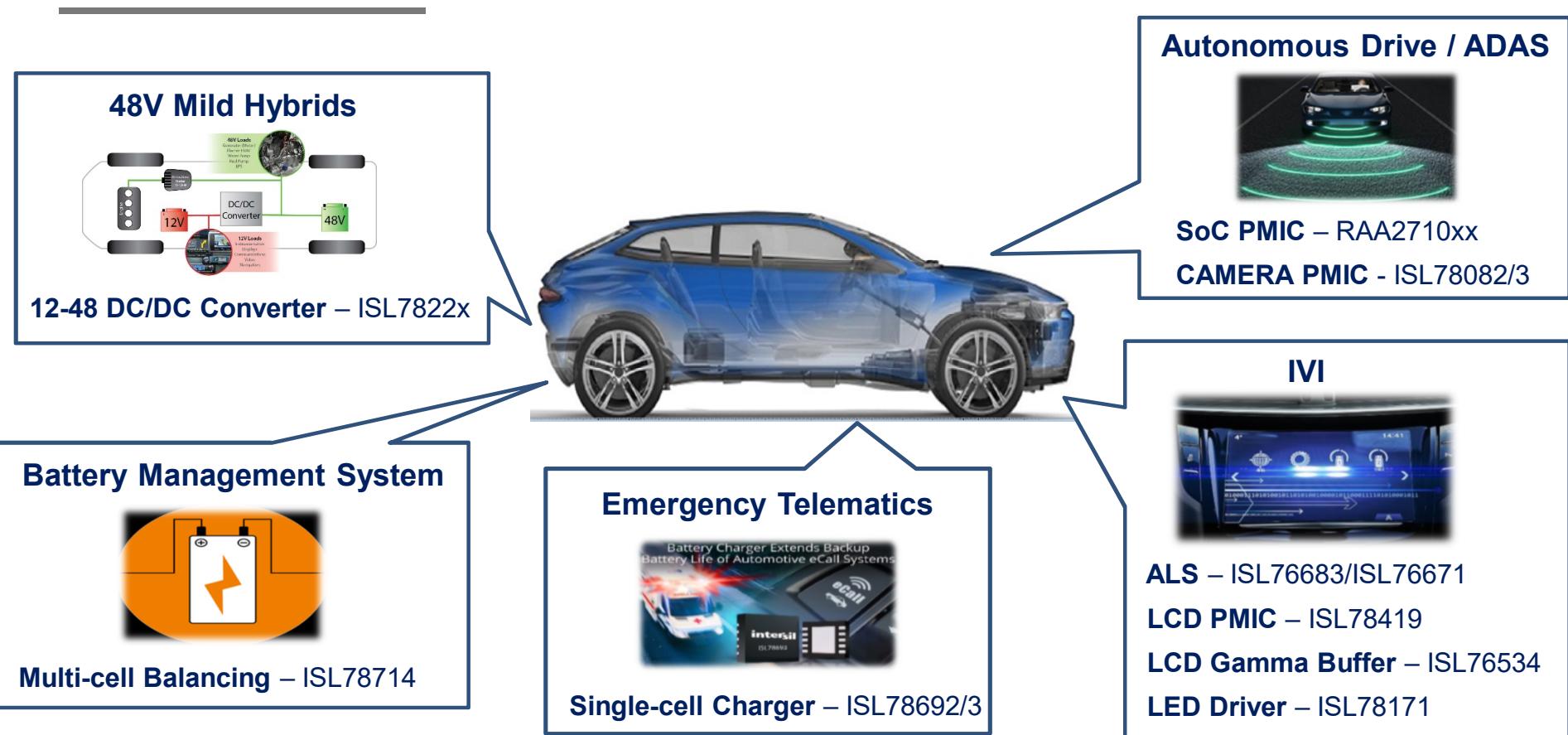
- Increasing system complexity in smaller space (Increasing # of rails).
- Higher system power with SoCs, MCUs, and higher voltages with introduction of 48V board net.
- **Value:** Continued integration and size reduction through multi-rail controllers and PMICs. Advanced control loops to increase transient performance and reduce BOM.

## Ease of Use

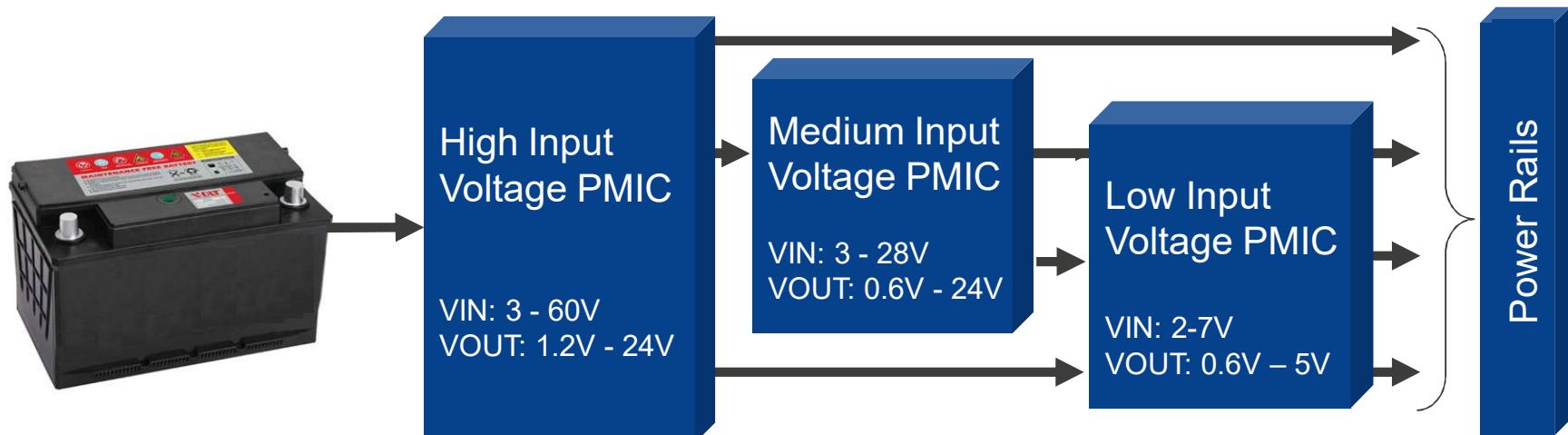
- Customers are deploying to market faster to gain competitive edge
- **Value:** Turn-key solutions and reference designs with higher integration and value-add feature; Simple, low BOM count controllers, switching regulators, power stages and PMICs.

# OVERVIEW AND SELECTION GUIDES

# APPLICATION OVERVIEW



# STANDARD AUTOMOTIVE POWER PRODUCT OVERVIEW



## High Voltage PMIC

Load dump protection  
Double battery protection  
Cold crank operation  
Low quiescent current

## Medium Voltage PMIC

Multi-output  
High integration  
Low EMC  
High efficiency

## Low Voltage PMIC

Tiny footprint  
Accurate  
Low noise  
High efficiency

## All Automotive PMIC

TS16969, AECQ100, Different temperature grades (85° C, 105° C, 125° C, etc.),  
Special packaging (exposed leads or QFN, exposed pads or non-exposed pads).

# RECOGNIZING RENESAS'S AUTO GRADE PARTS

**Every AEC-Q100 qualified product is issued a unique part number**

- Allows us to more fully manage the production flows used for the devices
- Assures only auto certified partners are used (TS16949 etc.)

**We use the following component nomenclature for automotive products**

- ISL76xxx for general purpose analog
- ISL77xxx for other analog
- **ISL78xxx for power products**
- Future Auto Power Devices: RAA271xxx ; xxx=000 to 499
- Future Auto BMS Devices: RAA271yyy ; yyy= 500 to 999

# AUTOMOTIVE POWER OVERVIEW

All Products are Qualified for Vehicle Use

- AEC-Q100 Qualified, Grades 1-3, PPAPs available upon request

## General Power (DC/DC) Management Devices

- Linear Regulators
- Switching Regulators
- Switching Controllers
- MOSFET Drivers

## Display-Related Devices

- TFT-LCD Display PMICs
- LED Backlight Drivers
- Programmable Gamma Buffer
- Ambient Light Sensors

## Special-Purpose Power Devices

- Laser Diode Drivers
- Single-cell Battery Chargers
- Multi-cell Balancing Management IC

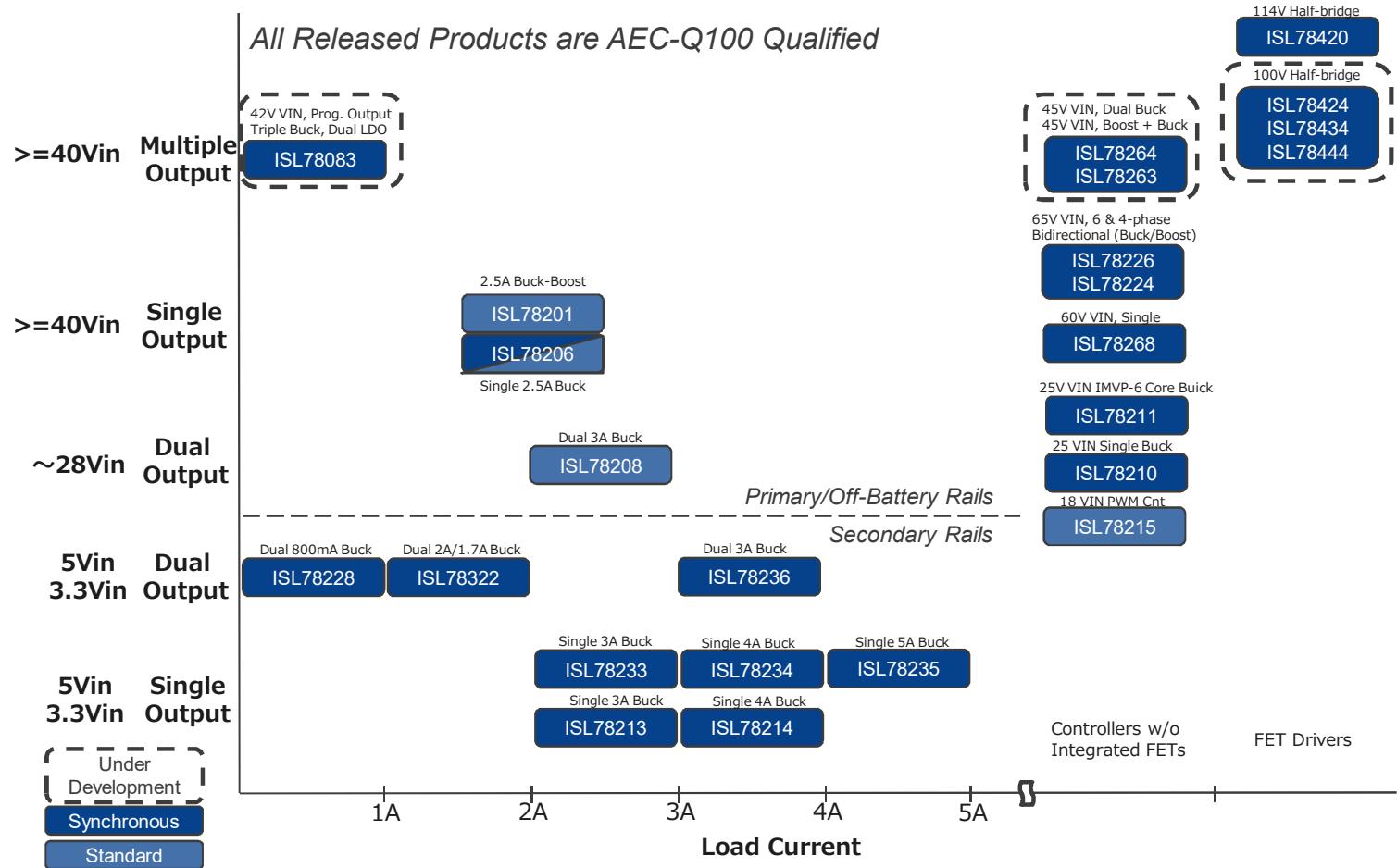
# AUTOMOTIVE POWER PARAMETRIC SEARCH

The screenshot shows a web browser displaying the Renesas Parametric Search page. The URL is [https://www.renesas.com/us/en/search/parametric-search.html?category=param\\_1030255&columns\[0\]=part\\_name&columns\[1\]=MaxBootstrapSupplyVoltage&columns\[2\]=BiasVoltageMax&columns\[3\]=PeakPullUpCurrent&columns\[4\]=PeakPullDownCurrent&columns\[5\]=TurnOnPropagationDelay&columns\[6\]=TurnOffPropagationDelay&columns\[7\]=RiseTime&columns\[8\]=FallTime&columns\[9\]=InputLogicLevel&columns\[10\]=ChargePump&columns\[11\]=QualificationLevel&columns\[12\]=CanSam&columns\[13\]=PartName&columns\[14\]=MaxBootstrapSupplyVoltage&columns\[15\]=BiasVoltageMax&columns\[16\]=PeakPullUpCurrent&columns\[17\]=PeakPullDownCurrent&columns\[18\]=TurnOnPropagationDelay&columns\[19\]=TurnOffPropagationDelay&columns\[20\]=RiseTime&columns\[21\]=FallTime&columns\[22\]=InputLogicLevel&columns\[23\]=ChargePump&columns\[24\]=QualificationLevel&columns\[25\]=CanSam](https://www.renesas.com/us/en/search/parametric-search.html?category=param_1030255&columns[0]=part_name&columns[1]=MaxBootstrapSupplyVoltage&columns[2]=BiasVoltageMax&columns[3]=PeakPullUpCurrent&columns[4]=PeakPullDownCurrent&columns[5]=TurnOnPropagationDelay&columns[6]=TurnOffPropagationDelay&columns[7]=RiseTime&columns[8]=FallTime&columns[9]=InputLogicLevel&columns[10]=ChargePump&columns[11]=QualificationLevel&columns[12]=CanSam&columns[13]=PartName&columns[14]=MaxBootstrapSupplyVoltage&columns[15]=BiasVoltageMax&columns[16]=PeakPullUpCurrent&columns[17]=PeakPullDownCurrent&columns[18]=TurnOnPropagationDelay&columns[19]=TurnOffPropagationDelay&columns[20]=RiseTime&columns[21]=FallTime&columns[22]=InputLogicLevel&columns[23]=ChargePump&columns[24]=QualificationLevel&columns[25]=CanSam).

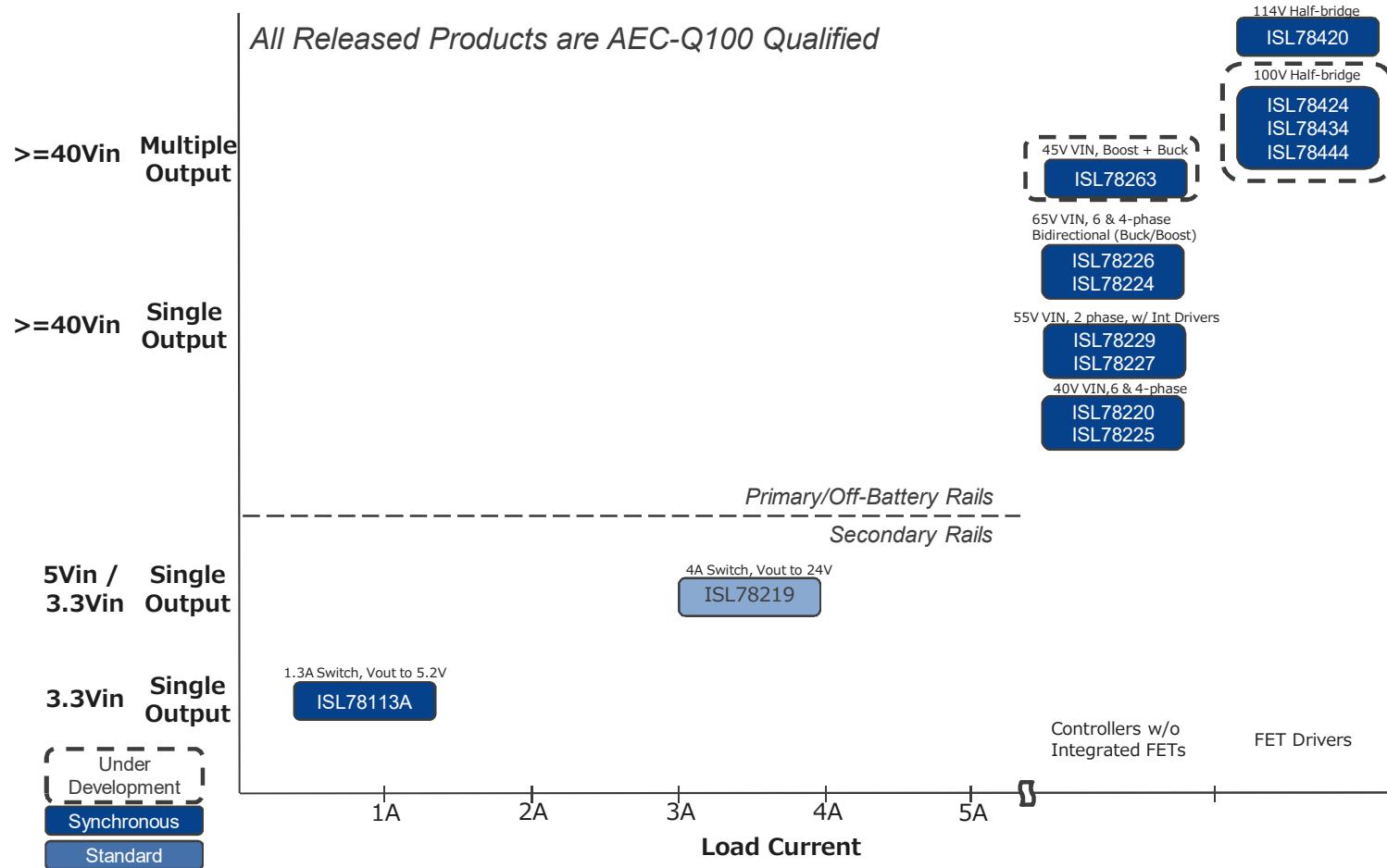
The page title is "Parametric Search". The navigation bar includes links for News, Investors, Parametric Search, Sign in, and Americas. The main content area shows a search results table for "Automotive / Power Management" parts. The search filters are set to "Half, Full Bridge and Three Phase Drivers". The table columns include Part Name, Max Bootstrap Supply Voltage (V), V<sub>Bias</sub> (max) (V), Peak Pull-up Current, Turn-On Propagation Delay (ns), Rise Time, Fall Time, Input Logic Level, Charge Pump, Qualification Level, and Can Sam. A single result for part ISL78420 is listed, matching all specified parameters.

Parametric search Link

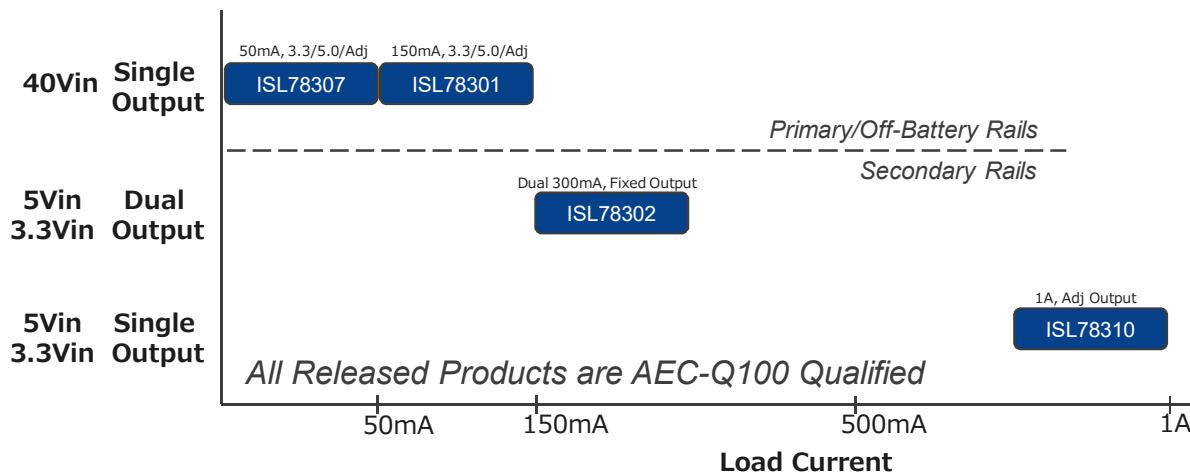
# STEP-DOWN SELECTION GUIDE



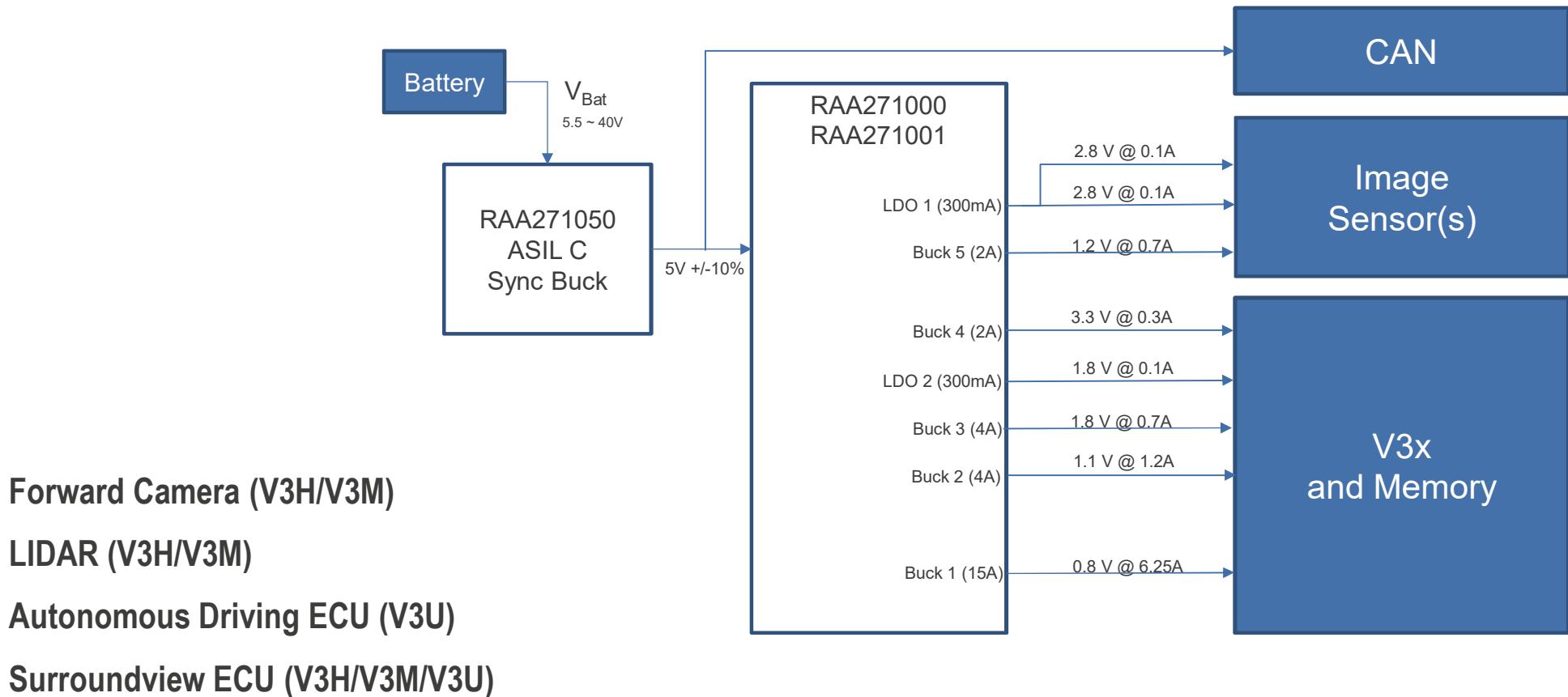
# STEP-UP SELECTION GUIDE



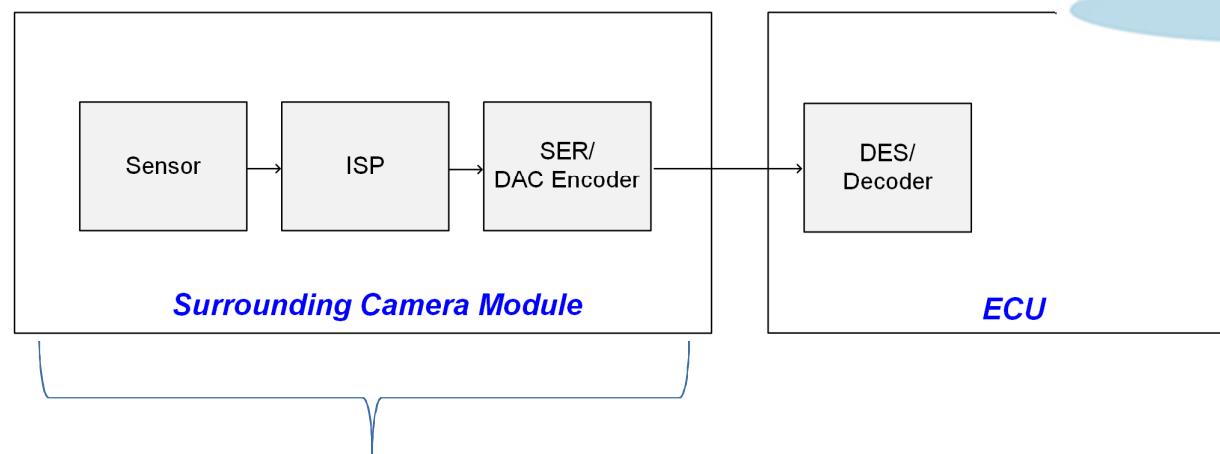
# LDO LINEAR REGULATOR SELECTION GUIDE



# V3X ADAS SYSTEMS



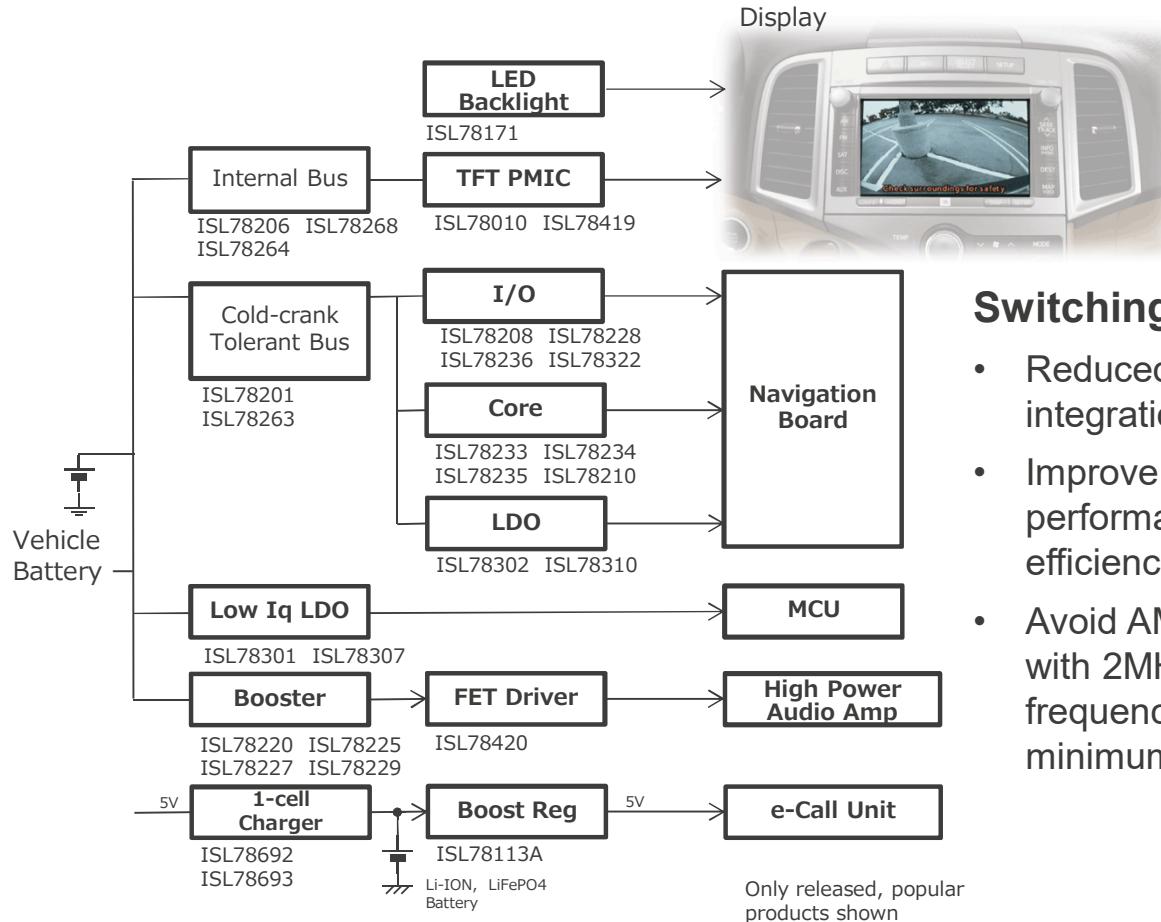
# SIDE AND REAR CAMERAS



ISL78082 & ISL78083 PMICs to supply Imager + ISP + SERDES/AHL Encoder

- Typically satellite and rear-view cameras, forward cameras without local vision processing
- Total power requirements up to 2.5W

# EXAMPLE INFOTAINMENT POWER TREE



## Switching Reg Benefits

- Reduced PCB area with integration/feature set
- Improve thermal performance with high efficiency
- Avoid AM-Band Interference with 2MHz switching frequency and guaranteed minimum on-times

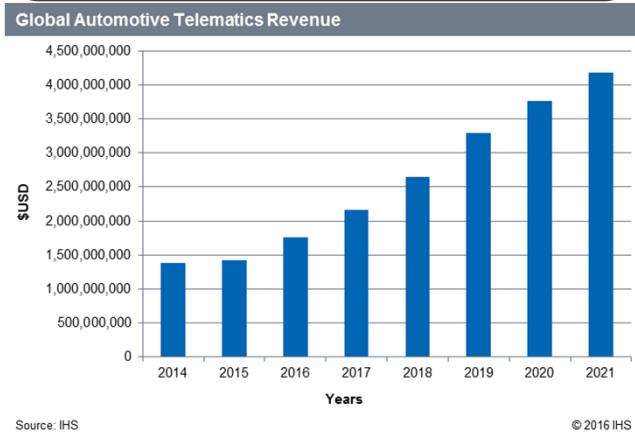
# E-CALL / EMERGENCY TELEMATICS

Legislation to mandate eCall in Europe by late 2017 will drive CAGR of 34% in telematics shipments through 2020

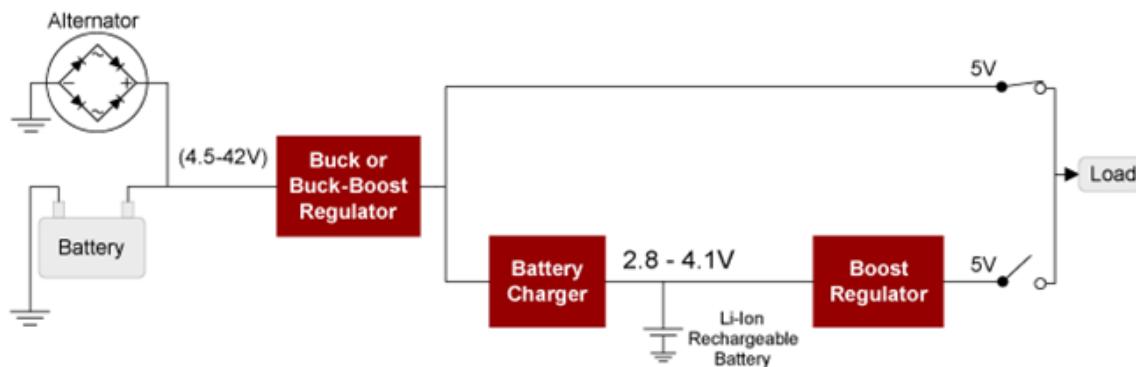
Emergency telematics systems are an emerging application for backup battery chargers in automobiles

## Devices:

- [ISL78201](#): 42V 2.5A Boost-Buck
- [ISL78206](#): 42V 2.5A Buck
- [ISL78692](#): 4.1V Single-cell charger
- [ISL78693](#): 3.6V Single-cell charger
- [ISL78113A](#): 500mA boost



# BACK-UP BATTERY CHARGER BLOCK DIAGRAM



▼ COLLAPSE ALL

▼ Boost Regulator

Integrated FET Regulators

[ISL78113A](#)

Low Input Voltage and High Efficiency Synchronous Boost Converter with 1.3A Switch

▼ Battery Charger

Single Cell Battery Chargers

[ISL78692](#)

Li-ion/Li-Polymer Battery Charger

▼ Buck or Buck-Boost Regulator

Integrated FET Regulators

[ISL78201](#)

40V 2.5A Regulator with Integrated High-Side MOSFET for Synchronous Buck or Boost Buck Converter

[ISL78206](#)

40V 2.5A Buck Controller with Integrated High-Side MOSFET

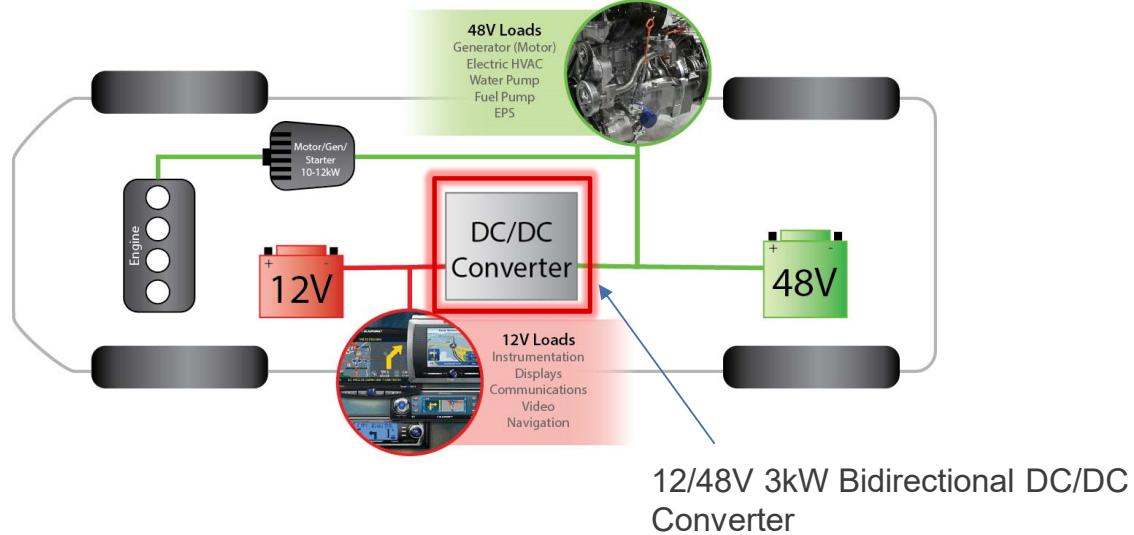
# 48V MILD HYBRIDS WILL HAVE 12V AND 48V BOARD NETS

48V power net being introduced to autos, starting in Europe

- Higher power motors/generators with lighter motors, wiring harnesses
- Li-ion batteries for higher energy density, more charge/discharge cycles

Enables improved start-stop systems, higher power electric loads, conversion of mechanical systems to electrical, and lower vehicle weight

Improves combustion-engine drivetrain, avoids expense of going to high voltage hybrid or fully electric

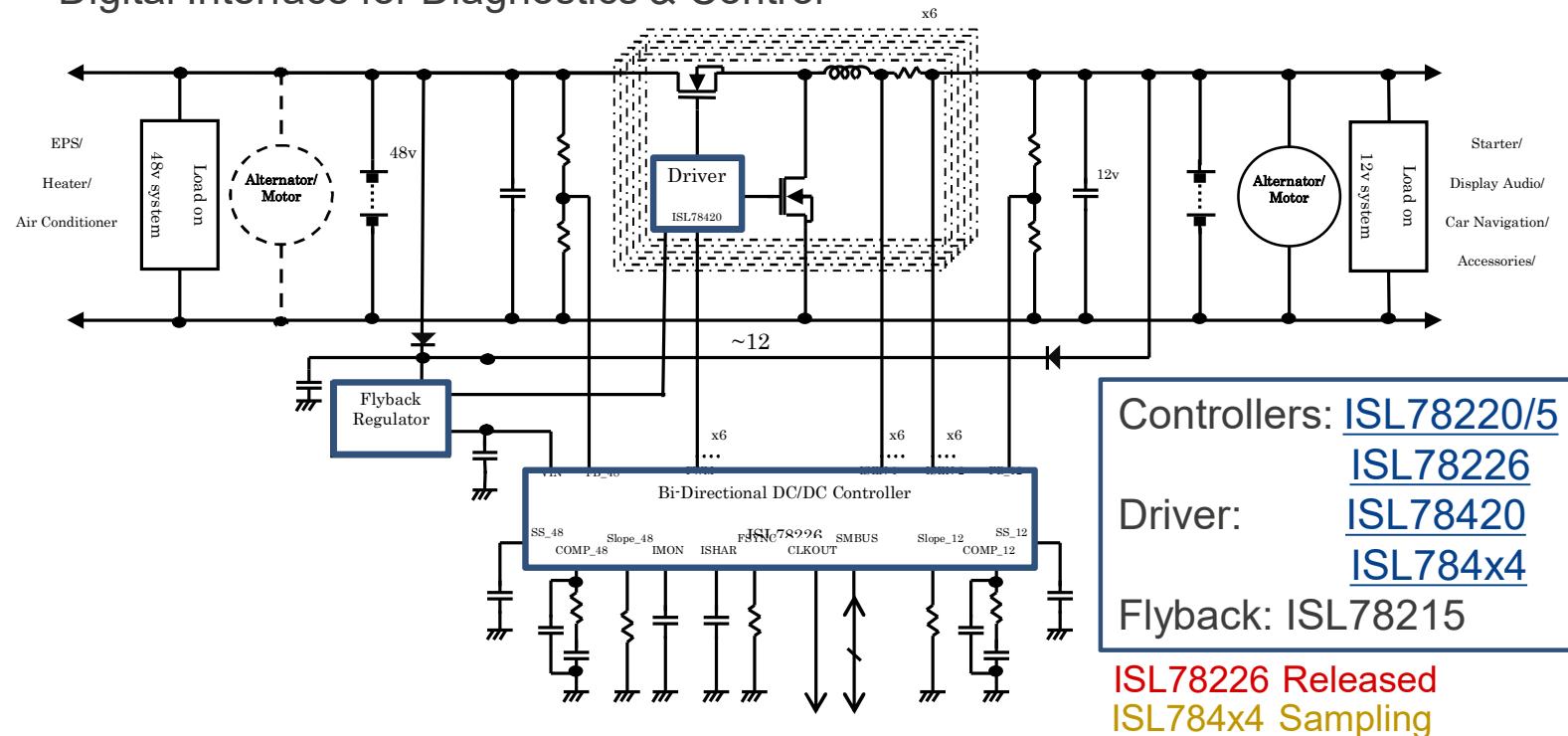


# 12V-48V BI-DIRECTIONAL DC/DC CONVERTER

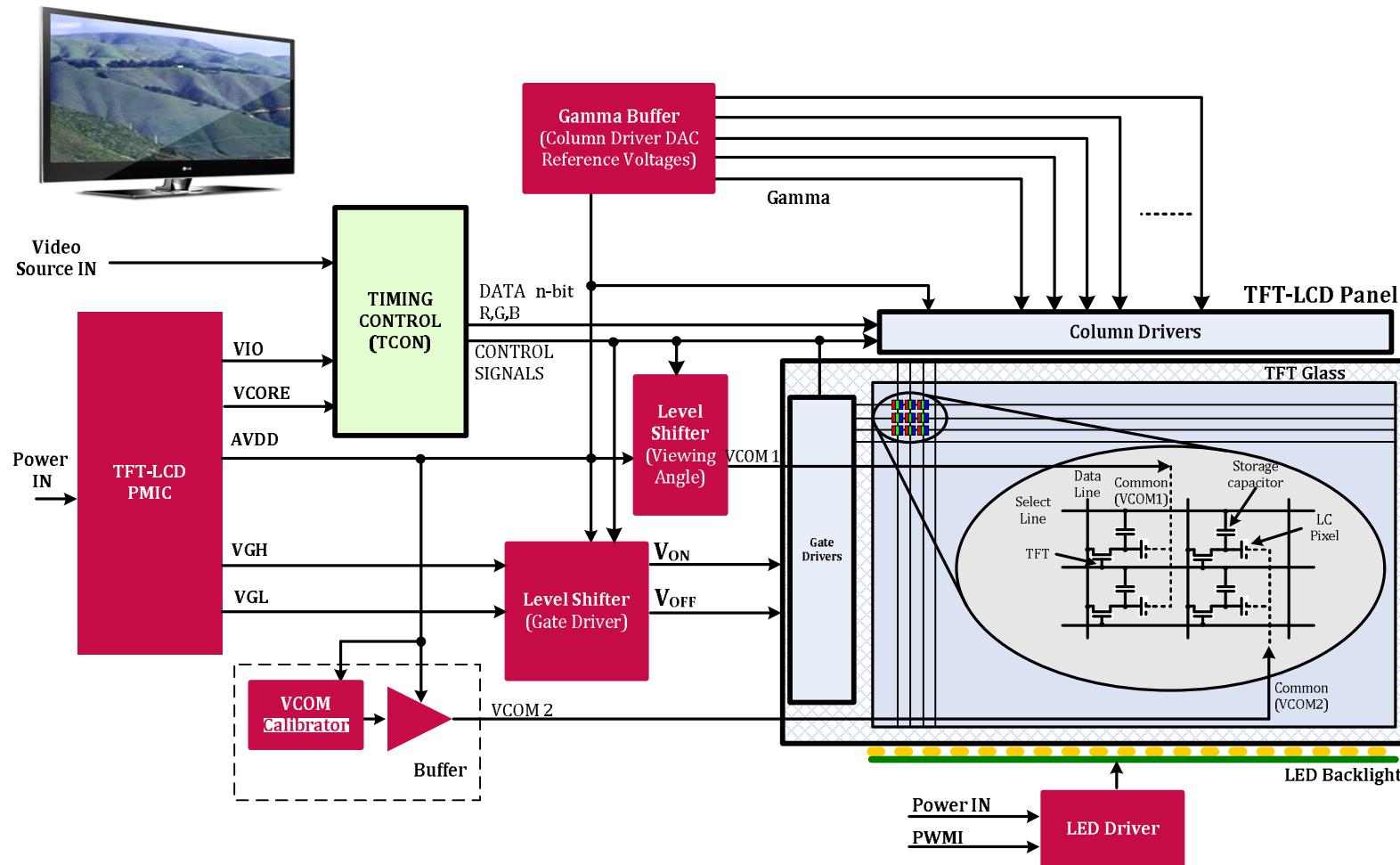
Buck & Boost Controller, 6-phase, Tri-level PWM Output

Constant Current Regulation to Modulate Power Transfer

Digital Interface for Diagnostics & Control



# DISPLAY SYSTEMS



# DISPLAY COMPONENTS

## TFT boost PSU ICs

- Provide multiple supply rails to correctly drive and sequence TFT panels
- [ISL78419](#), [ISL78010](#)

## LED Backlight boost controllers

- Designed to effectively backlight TFT panels
- [ISL78171](#): 6-ch, 50mA High Dimming Ratio LED Backlight Driver

## Gamma buffers

- Designed to tailor the panel transfer function to allow correct color rendering in comparison to video ‘gamma’
- [ISL76534](#): 14-channel Programmable Gamma Buffer w/ internal EEPROM

# ISL76671 – LIGHT TO ANALOG ALS

## Key Features

- Voltage Output
- Spectral Response Similar to Human Eye
- Internally Temperature Compensated
- Package: 2x2.1mm 6-lid ODFN

## Key Specifications

- Light Range: 0.01 to 100 Lux
- Supply Range: 1.8 to 3.0V
- AEC-Q100 Qualified, Grade 2
- $T_A$ : -40 to 105C

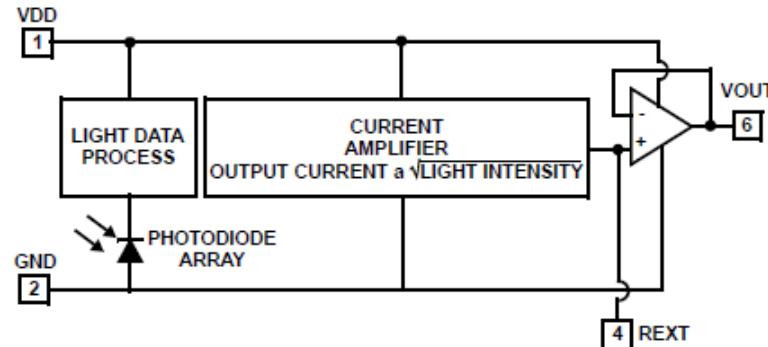


FIGURE 1. SIMPLIFIED BLOCK DIAGRAM

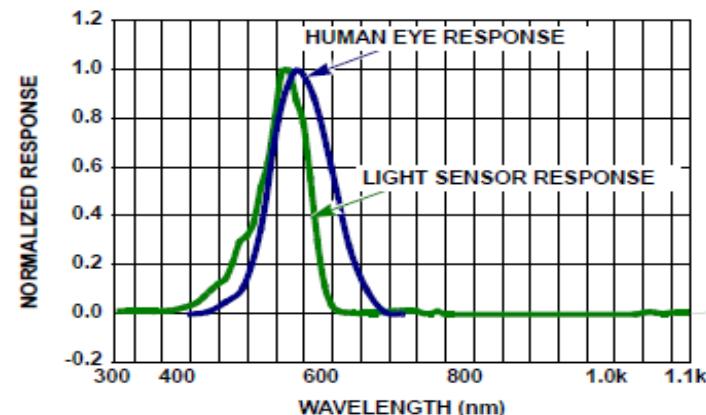


FIGURE 4. SPECTRAL RESPONSE

# ISL76683 – LIGHT TO DIGITAL ALS

## Key Features

- Human eye response with dual PD architecture for IR/UV rejection
- Up to 16-bit, Integrating ADC with 50/60Hz rejection
- I<sup>2</sup>C Interface
- Package: 2x2.1mm 6-lid ODFN

## Key Specifications

- Supply Range: 2.5 to 3.3V
- 4 Programmable Light Ranges (0 to 1k/4k/16k/64k Lux)
- Adjustable sensitivity/resolution
- AEC-Q100 Qualified, Grade 2
- T<sub>A</sub>: -40 to 105C

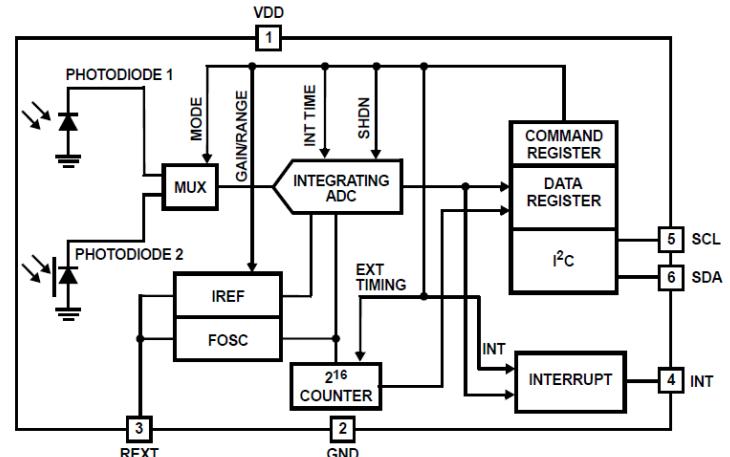


FIGURE 1. BLOCK DIAGRAM

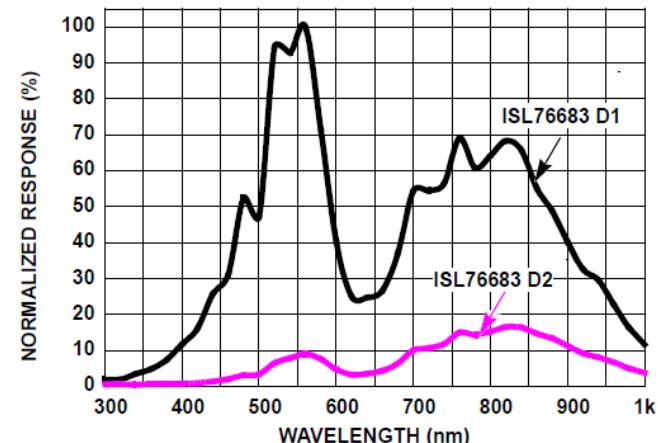
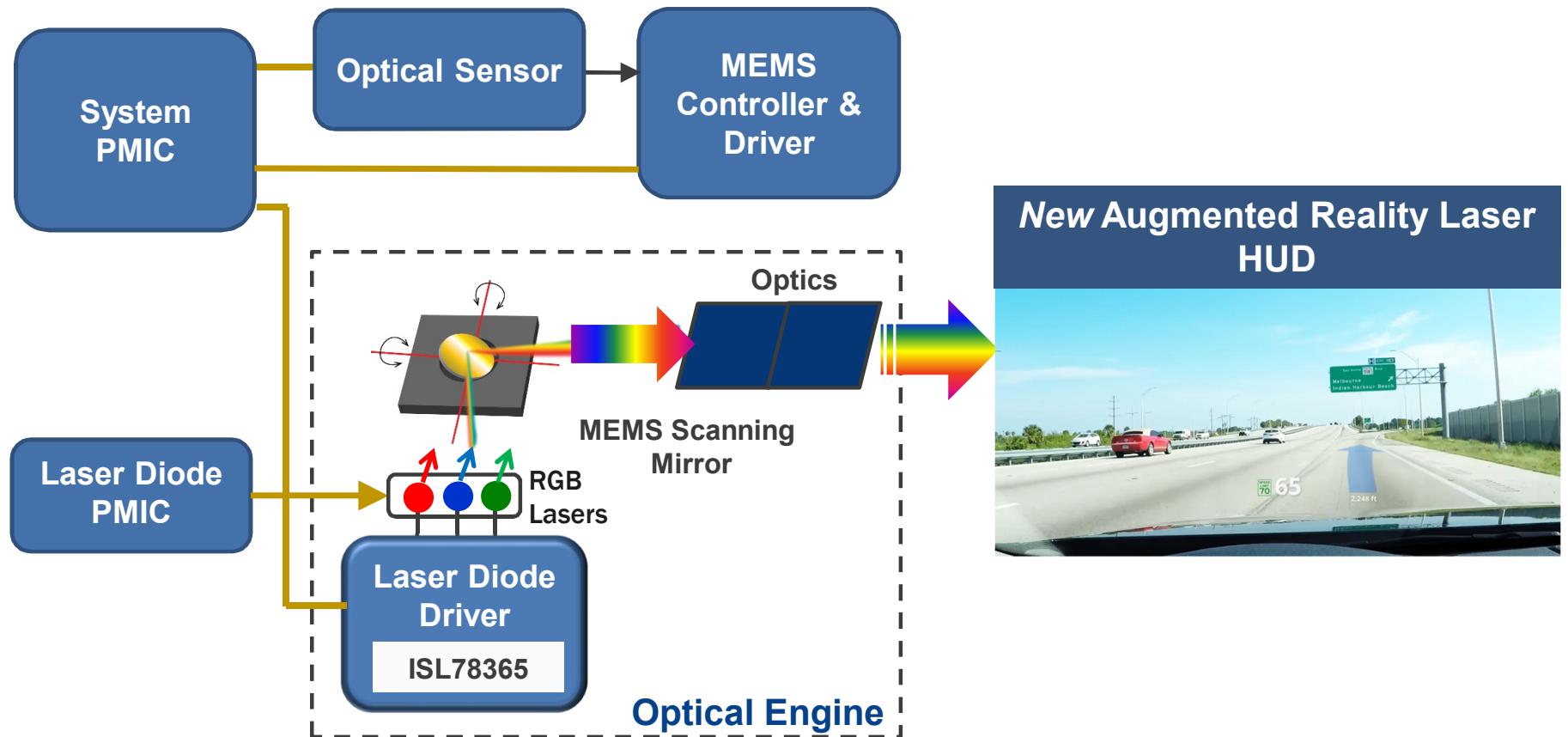


FIGURE 2. SPECTRAL RESPONSE

# LASER SCAN MEMS PROJECTION FOR HEADS-UP DISPLAYS

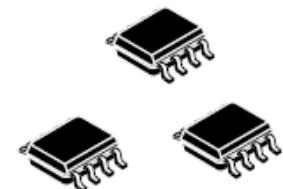
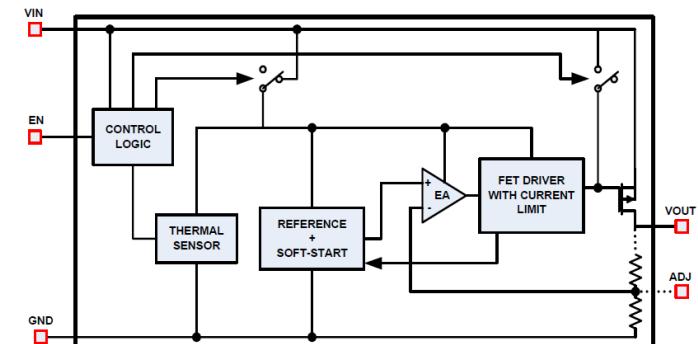


# LINEAR REGULATORS AND BATTERY CHARGERS

# ISL78301/7 – 40V 150MA & 50MA LDOS

- Wide 6V to 40V input eases design by eliminating extra voltage clamping or boost circuitry
  - 40V tolerant enable pin (TTL/CMOS compatible) allows easy control and complete shut-down (5 $\mu$ A)
- Maintains regulation down to 3V ‘cold start/cold cranking’ input voltage
- 18  $\mu$ A quiescent current (typ. for ADJ version)
- 1% voltage accuracy over the -40 to 125°C
- Guaranteed 50/150 mA current for low power MCU/analog applications
- Short circuit, overload & OT protection
- Available in preset 3.3V, 5.0V or adjustable configurations
- 5 & 6kV HBM ESD protection reduces external protection needs
- Exposed Power pad packages - best power dissipation

PN	Iout	Enable	Package
ISL78301	150mA	Yes	14ld HTSSOP
ISL78307	50mA	Yes	8 ld EPSOIC



# ISL78302 – DUAL 300mA LOW IQ HIGH PSRR LDO

- Integrates two 300mA high performance LDO's
  - Input voltage: 2.3V - 6.5V
  - Ultra low  $I_q$ : 20uA/LDO
  - Low dropout voltage: typically 200mV @ 300mA
  - $\pm 1.8\%$  accuracy over all operating conditions
  - PSRR: 90dB @ 1KHz
  - Low output noise: typically 30uVrms @ 100uA(1.5V)
  - Stable with 1-10uF ceramic capacitors
  - Separate enable and POR feature for each LDO
  - Programmable power-on delay on Vout2 (POR2)

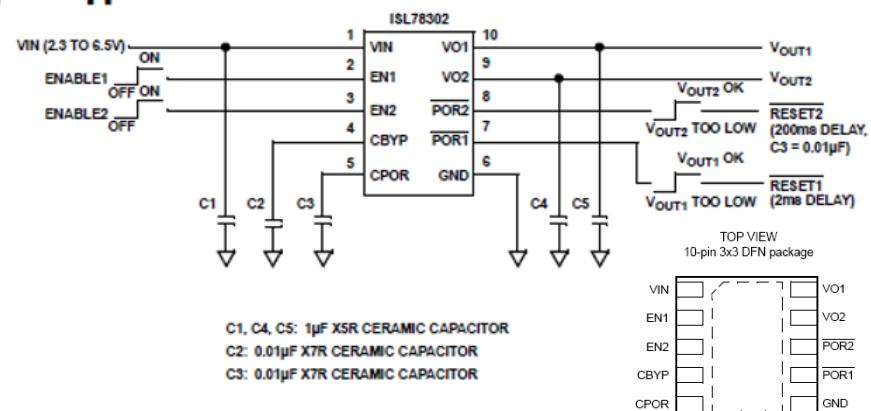
## ISL78302 Vout Options

- 1)  $V_{out1} = 2.5V$ ,  $V_{out2} = 1.5V$
  - 2)  $V_{out1} = 1.5V$ ,  $V_{out2} = 2.5V$
  - 3)  $V_{out1} = 3.3V$ ,  $V_{out2} = 1.5V$
  - 4)  $V_{out1} = 1.5V$ ,  $V_{out2} = 3.3V$
  - 5)  $V_{out1} = 3.3V$ ,  $V_{out2} = 1.2V$
  - 6)  $V_{out1} = 1.2V$ ,  $V_{out2} = 1.8V$
  - 7)  $V_{out1} = 2.5V$ ,  $V_{out2} = 1.2V$
  - 8)  $V_{out1} = 1.8V$ ,  $V_{out2} = 1.2V$
  - 9)  $V_{out1} = 1.25V$ ,  $V_{out2} = 3.3V$

## ISL78302A Vout Options

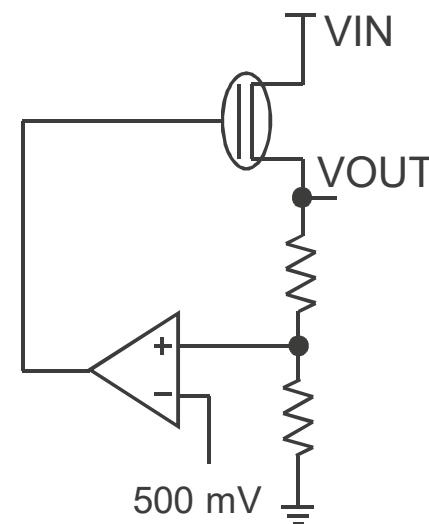
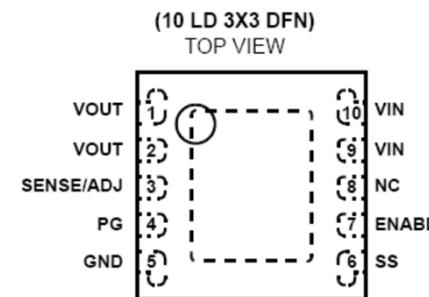
- 1)  $V_{out1} = 3.0V$ ,  $V_{out2} = 3.0V$
  - 2)  $V_{out1} = 2.9V$ ,  $V_{out2} = 2.9V$
  - 3)  $V_{out1} = 2.8V$ ,  $V_{out2} = 3.0V$
  - 4)  $V_{out1} = 2.8V$ ,  $V_{out2} = 2.6V$
  - 5)  $V_{out1} = 2.8V$ ,  $V_{out2} = 1.8V$
  - 6)  $V_{out1} = 2.7V$ ,  $V_{out2} = 1.8V$
  - 7)  $V_{out1} = 1.85V$ ,  $V_{out2} = 2.9V$
  - 8)  $V_{out1} = 1.5V$ ,  $V_{out2} = 2.8V$

## Typical Application



# ISL78310 – 1A OUTPUT PMOS LDO

- Designed for fast load transient response
- Vin from 2.25 to 6V
- Ultra-low dropout voltage 130 mV typ (@1A)
- Tight  $\pm 2\%$  VOUT accuracy
- Adjustable Output Voltage
- 70dB PSRR over full-rated load current
- 90 $\mu$ Vrms low output noise (300Hz to 300kHz)
- Less than 1 $\mu$ A shutdown current
- Ability to set Inrush Current Limit via SS pin
- 10-Ld 3x3 DFN package
- $40^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$



# ISL78692/3 – 4.1/3.6V SINGLE-CELL BATTERY CHARGER

## ISL782692/ISL78693

- 4.1/3.6V Li-Ion Single Cell, Constant Current Charger
- 3x3mm DFN Package

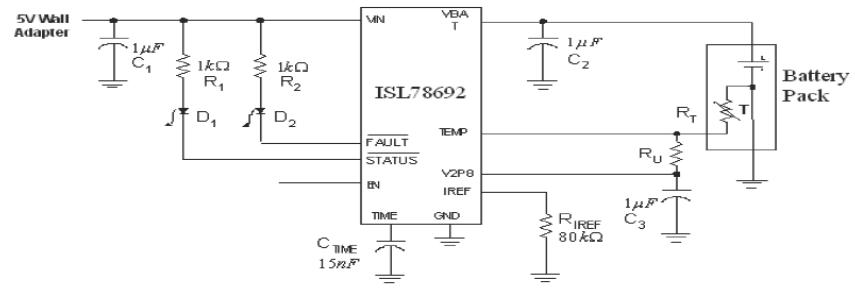
### Primary Application:

- Battery back-up for emergency call systems
- LiFePO<sub>4</sub> Battery (3.2V typ, stop charging at 3.6-3.8V)

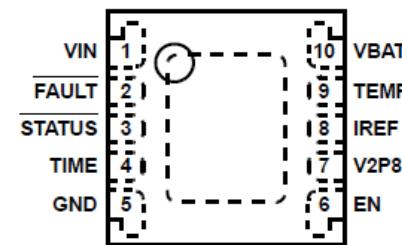
### Key Features

- Up to 1A charging current
- Lowest leakage current from Vbat (3.0uA max vs. 6-50uA from competition)
- Thermal foldback of charging current at 85C

Typical Application Diagram



ISL78692  
(10 LD 3x3 DFN)  
TOP VIEW



# 40V SWITCHING REGULATORS & CONTROLLERS FOR PRIMARY 'OFF-BATTERY' APPLICATIONS

# ISL78224 & ISL78226 OVERVIEW

## Bidirectional Synchronous Controller

- A single controller supports 2, 3, 4, and 6-ph operation
- Controls both buck & boost directions
- Regulates output voltage and inductor current
- Cycle-by-cycle positive and negative current limiting
- Supports forced-synchronous (forced-PWM) or diode-emulation modes for all phases
- Optional automatic phase dropping/adding
- Current monitor output with 2% gain accuracy from 0 to full load
- Digitally programmable average current limit
- Analog or PWM-controlled output voltage tracking, over 4:1 range

## PMBus Communication Port for Configuration and Telemetry

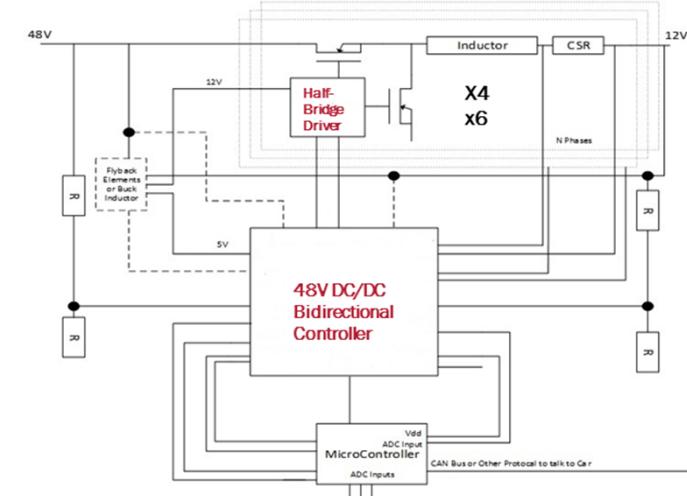
- Detailed status and fault diagnostics
- Programmable fault thresholds, fault responses, operating modes
- Warning and fault interrupt signals

## Integrated Dual-output Flyback Controller

## Integrated Auxiliary 200mA Linear Regulator

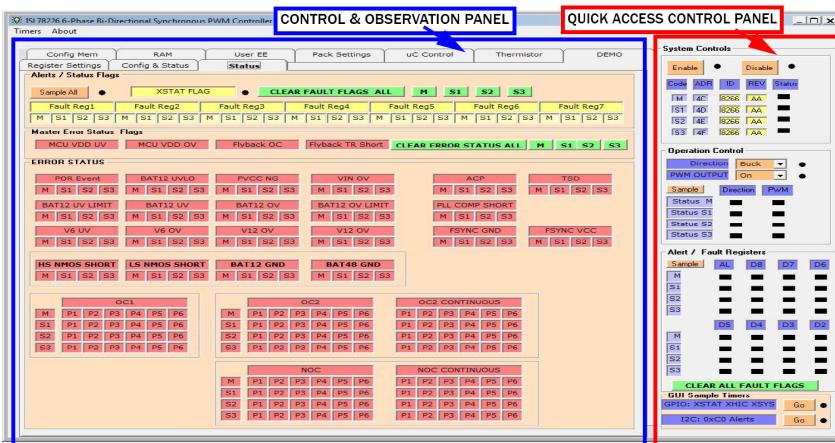
AEC-Q100 Grade 1:  $T_A$ : -40 to 125 C

Package: 10x10mm 64-pin TQFP



# ISL78226 AND ISL78224 EVALUATION BOARDS

3kW 6-phase & 2kW 4-phase 12/48V bidirectional EVB and GUI available



GUI – connects to EVB via USB

These are base designs provided by Renesas @ 500W/phase. These can be easily scaled to accommodate various power levels and phase counts (2 minimum 12 maximum). Renesas provides direct scaling support.



3kW, 6-phase, ISL78226



2kW, 4-phase, ISL78224

# ISL784XX: 100V-BOOT 3A/4A HALF-BRIDGE DRIVERS

## 3A Sourcing / 4A Sinking Half-Bridge Drivers

- Tri-level PWM input or Hi/Li input (opt.)
- Independent source/sink outputs (opt.)
- Adaptive dead-time control with programmable dead-time
- Integrated boot diode

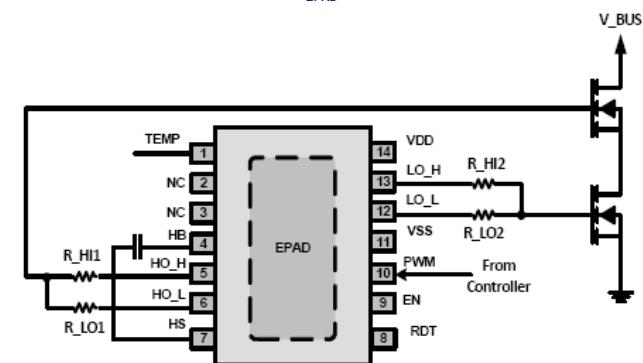
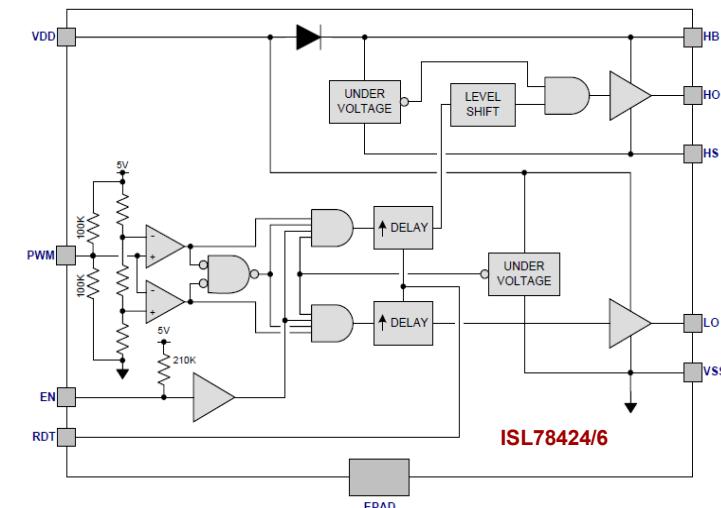
## Voltage Ratings

- Absolute Maximums
  - VDD: 20V
  - HB (Load Dump): 100V
  - HS (Load Dump): = -10 to 86V
- Recommended Max Operating
  - VDD: 8 - 18V
  - Bootstrap Supply, HB (DC): 86V
  - HS (DC): 70V

14-lid HTSSOP, pin-compatible with ISL78420

Ta: -40 to 125C, AEC-Q100 Qualified

- Maximum Operating Junction Temp = 150C



# ISL78220/5 – 40V MULTI-PHASE SYNCHRONOUS CONTROLLERS

## Description

- Multi-phase Boost or Buck configurations
  - ISL78225: 4-phase controller
  - ISL78220: 6-phase controller
- Vin: 5.6 to 40V (Abs Max: 45V)
- Package: 10x10mm, 44-lid EP-TQFP

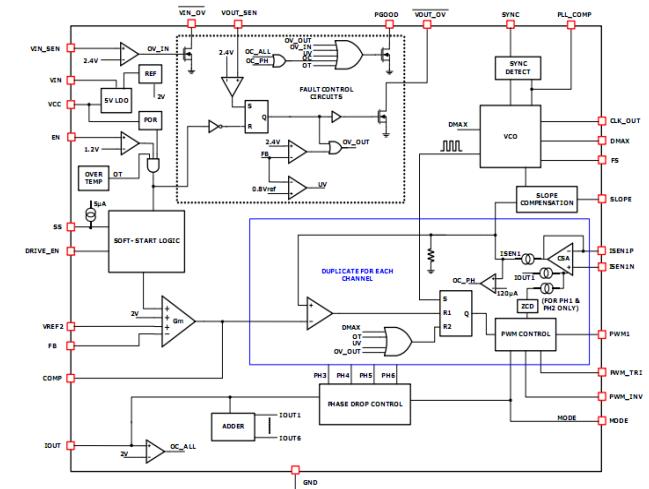
## Key Features

- Peak current mode control with adjustable slope compensation
- Accurate total current monitoring
- 2,3,4 or 6-phase operation with optional automatic phase dropping/ diode emulation/ pulse skipping for high efficiency at light load
- Dedicated Vref2 pin for dynamic output voltage tracking

## Applications

- 200-3000W Trunk Amplifier Supply
- Bi-directional DC/DC (12/48V)
- Start-Stop Voltage Quality Module

## Block Diagram



# ISL78201 – 2.5A 40V BUCK REGULATOR W/ OPTIONAL PRE-BOOST

**Ultra wide input voltage range from 3V to 40V**

- Up to 44V load-dump

**Programmable frequency: 200kHz - 2.2MHz**

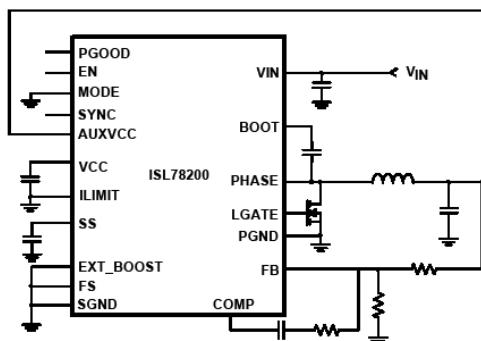
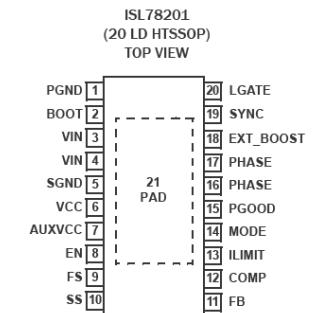
- Frequency synchronization capability

**Supports multiple operating topologies**

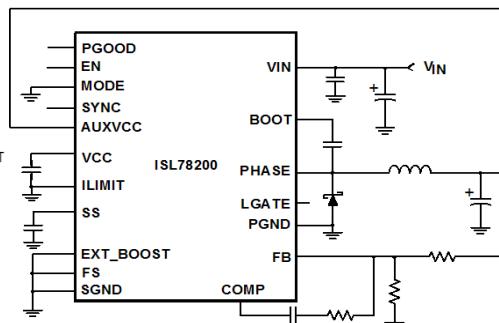
- Synchronous Buck, Asynchronous Buck
- Non-inverting Buck Boost, Two-Stage Boost Buck

**Reliable Over-current Protection**

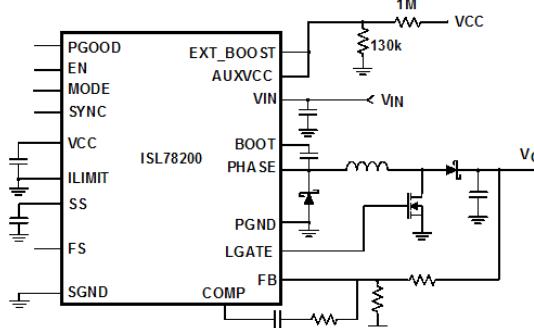
- Temperature compensated current sense
- Cycle-by-cycle current limiting w/ frequency foldback
- Hiccup mode short-circuit protection



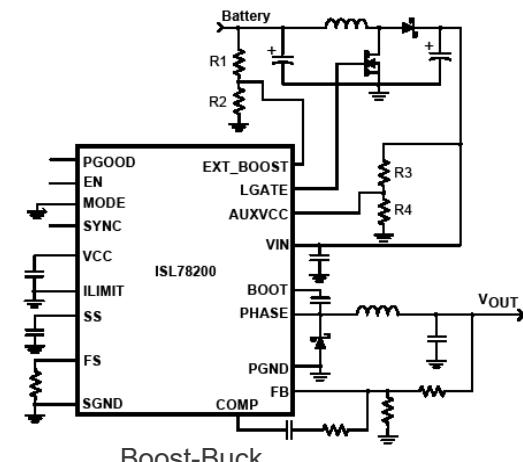
Sync Buck w/ Vcc Switch-over to Vout



Standard Buck w/ Vcc Switch-over to Vout

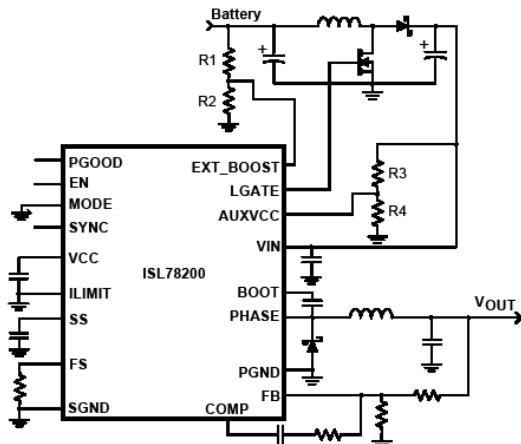


Non-Inverting Buck-Boost

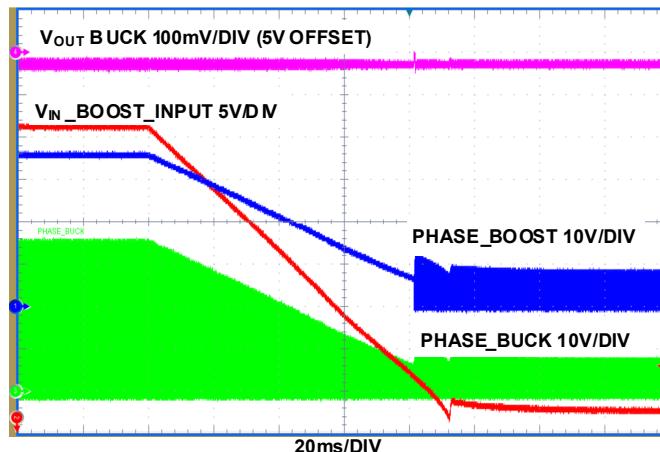


Boost-Buck

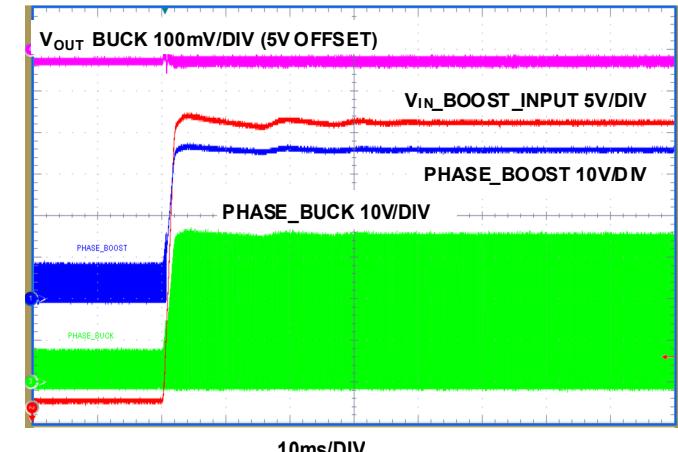
# ISL78201 BOOST BUCK OPERATING EXAMPLES



Boost-buck configuration



Input drops down to 3VDC --  
Overcome cold-crank situations



Input surges from 3V To 36VDC  
Overcome load-dump situations

# ISL78206 – 2.5A SYNCHRONOUS BUCK REGULATOR

- Pin-Compatible with the ISL78201 (Boost – Buck)
- 3V to 40V input range (Up to 44V load-dump)
- Programmable Freq 200kHz - 2.2MHz
- 130mΩ High Side integrated FET with programmable cycle-by-cycle current limit
- Frequency fold back in overcurrent conditions
- Supports synchronous and standard configurations
- 20-ld HTSSOP (TSSOP w/ thermal pad)
- AEC-Q100 Grade 2
  - $T_A$ : -40 to 105 °C
  - $T_J$ : -40 to 125 °C

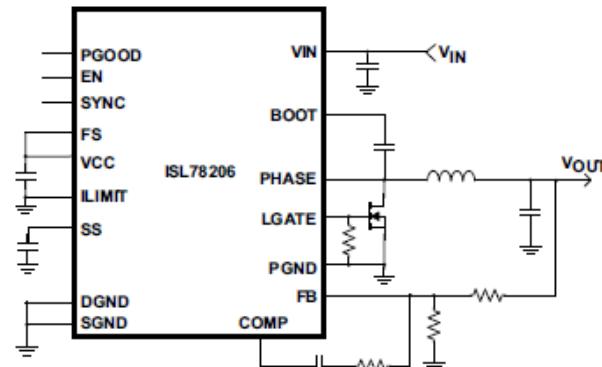


FIGURE 4. TYPICAL APPLICATION SCHEMATIC I - SYNCHRONOUS BUCK

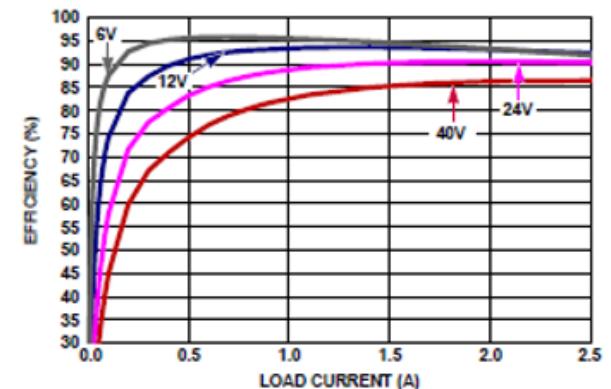


FIGURE 2. EFFICIENCY, SYNCHRONOUS BUCK, 500kHz, V<sub>OUT</sub> 5V,  
 $T_A = +25^\circ\text{C}$

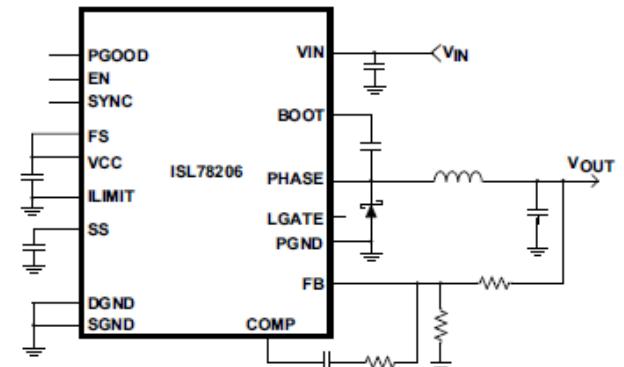


FIGURE 5. TYPICAL APPLICATION SCHEMATIC II - NON-SYNCHRONOUS BUCK

# 18-28V SWITCHING REGULATORS & CONTROLLERS

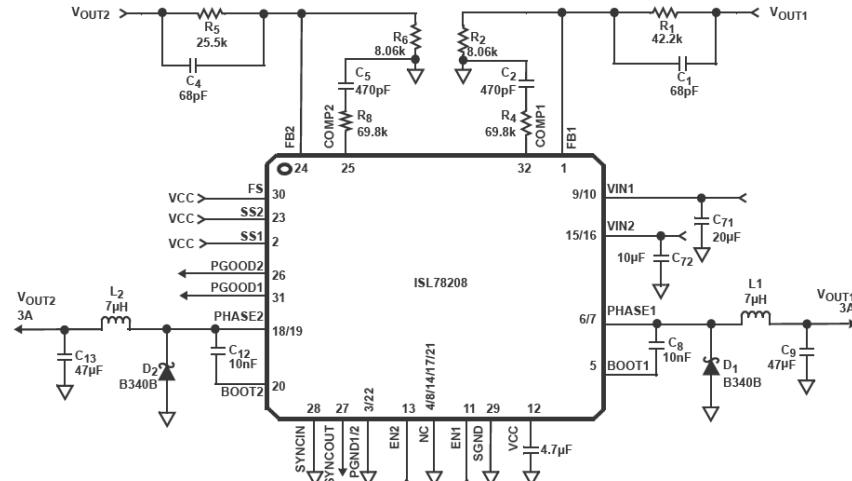
# ISL78208 – 28V SINGLE 6A OR DUAL 3A BUCK REGULATOR

## Basic Features

- Wide Input Supply Voltage Range: 4.5 – 28V (30V abs max)
- Output Voltage Range: 0.8 – 24V
- Package – 32 Ld. 5x5mm WFQFN

## Differentiating Features

- 3A Guaranteed Output Current per Channel
- 180° Out-of-Phase Operation
- Output Current Sharing Capability
- $F_{\text{switch}}$ : 500kHz (default) or 300kHz to 2MHz Adjustable
- Synchronization to External Clock – 360kHz to 2MHz
- Independent EN and PGOOD for both Channels
- Internal 5ms Soft-Start or Externally Adjustable Soft-Start



# ISL78210 – TINY FOOTPRINT PWM CONTROLLER

- Wide input voltage range: 3.0 to 25.0V
- Wide output voltage range: 0.5 to 3.3V
- Output load up to 30 A
- High performance Intersil R3 PWM modulator
- $\pm 0.75\%$  regulation accuracy
- 300kHz PWM frequency in continuous conduction
- Integrated high current MOSFET driver and Schottky boot-strap diode
- External compensation affords optimum control loop tuning
- Automatic diode emulation mode for highest light-load efficiency
- UV/OV/OC/OT fault protections w/ PGOOD indicator
- 2.6x1.8mm 16-lid µTQFN

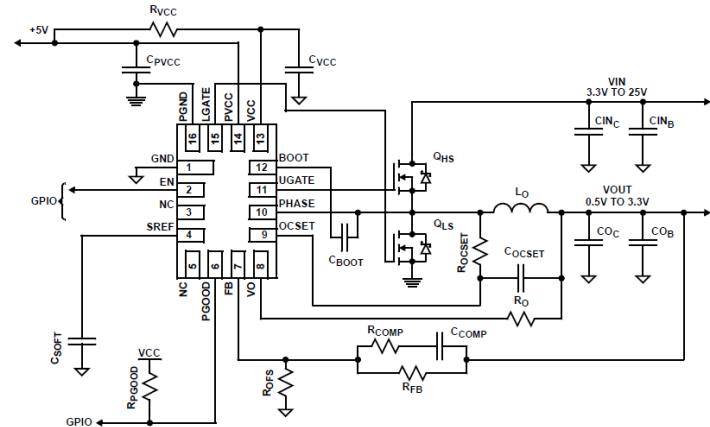
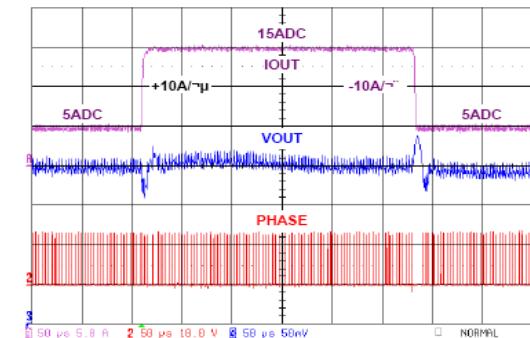


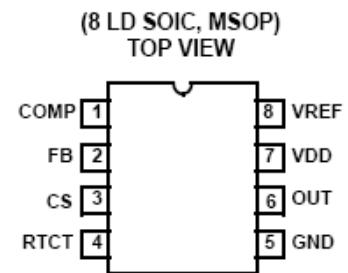
FIGURE 2. ISL78210 APPLICATION SCHEMATIC WITH DCR CURRENT SENSE



CCM LOAD TRANSIENT RESPONSE  
VIN = 12.6V, VOUT = 1.0V

# ISL78215 – 18V CURRENT MODE PWM CONTROLLER

- 1A MOSFET Gate Driver
- 60µA Start-up Current, 100µA Maximum
- 25ns Propagation Delay Current Sense to Output
- Fast Transient Response with Peak Current Mode Control
- Adjustable Switching Frequency to 2MHz
- 20ns Rise and Fall Times with 1nF Output Load
- Trimmed Timing Capacitor Discharge Current for Accurate dead-time/Maximum Duty Cycle Control
- High Bandwidth Error Amplifier
- Tight Tolerance Voltage Reference Over Line, Load, and Temperature
- Tight Tolerance Current Limit Threshold
- Max Duty Cycle: 50%
- Rising UVLO: 7.0V



# SECONDARY RAIL POWER (VIN <6V)

# SECONDARY RAIL POWER QUICK GLANCE

**EMBEDDED POWER SUMMARY**

Part	Description	V <sub>IN</sub> (V)	I <sub>OUT</sub> (A)	V <sub>OUT</sub> (V)	I <sub>Q</sub> ( $\mu$ A)	f <sub>SW</sub> (MHz)	Comments
ISL78210	30A high performance PWM controller	3.3 to 25	30	0.5 to 3.3	1 in shutdown	0.3	Power good, programmable soft-start, $\pm 0.75\%$ Vout tolerance, diode emulation mode, R3 technology for rapid transient response.
ISL78211	Single phase core regulator with IMVP-6TM	5	2	0.300 to 1.500	1 in shutdown	0.33	7-bit VID code programs output in 12.5mV increments. User programmable switching frequency, current sense through DCR & Rsense.
ISL78213	3A, 1MHz Sync DC/DC regulator	2.8 to 5.5	3	0.8 to 5	45	1	Power good, sync to 4 MHz, soft-start, pre-biased o/p, current mode control
ISL78214	4A, 1MHz Sync DC/DC regulator	2.8 to 5.5	4	0.8 to 5	45	1	Power good, sync to 4 MHz, soft-start, pre-biased o/p, current mode control
ISL78228	Dual 800mA Sync DC/DC regulator	2.8 to 5.5	2 x 0.8	2x 0.6 to 5	50	2.25	Power good, sync to 4 MHz, soft-start, pre-biased o/p, current mode control
ISL78233	3A, 2MHz Sync DC/DC regulator	2.7 to 5.5	3	0.8 to 5	80	2	Contact factory
ISL78234	4A, 2MHz Sync DC/DC regulator	2.7 to 5.5	4	0.8 to 5	80	2	Contact factory
ISL78235	5.3A, 2MHz Sync DC/DC regulator	2.7 to 5.5	5.3	0.8 to 5	80	2	Contact factory
ISL78302	Dual 300mA LDO	2.3 to 6.5	2 x 0.3	3.3, 2.5, 1.8, 1.5, 1.2	55	N/A	8 output combinations. Independent Enable and POR pins, soft-start & staged turn-on.
ISL78302A	Dual 300mA low noise LDO	2.3 to 6.5	2 x 0.3	3, 2.9, 2.8, 2.7, 2.6, 1.85, 1.8, 1.5	55	N/A	8 output combinations. Independent Enable and POR pins, soft-start & staged turn-on. Low noise and 80dB PSRR.
ISL78310	1A high performance LDO	2.2 to 6	1	0.8 to 5	12 in shutdown	N/A	Power good, adjustable in-rush current limit, 130mV dropout at full load, programmable soft-start, $\pm 1.8\%$ Vout tolerance.
ISL78322	2/1.7A Sync DC/DC regulator	2.8 to 5.5	2 & 1.7	2x 0.6 to 5	55	2.25	Power good, sync to 4 MHz, soft-start, pre-biased o/p, current mode control, 180° out of phase switching reduces EMI.

# SWITCHING REGULATORS

# ISL78113A – 0.5A SYNCHRONOUS BOOST W/ OUTPUT DISCONNECT

## Synchronous boost converter with adjustable output voltage

- Input voltage range: 0.8V to 4.7V
- Output current: Up to 500mA continuous ( $V_{BAT} = 3.0V$ ,  $V_{OUT} = 5.0V$ )
- Output disconnect during shutdown
- 2.0 MHz switching allows use of tiny Ls & Cs
- Forced-PWM operation under all load conditions
- Low quiescent current: 20 $\mu$ A (Typical)
- Logic control shutdown ( $I_Q < 1\mu A$ )
- 1.2V EN high logic
- Tiny 8-lead 2x2mm DFN

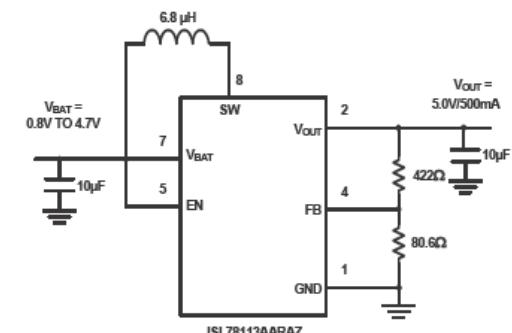


FIGURE 1. TYPICAL APPLICATION

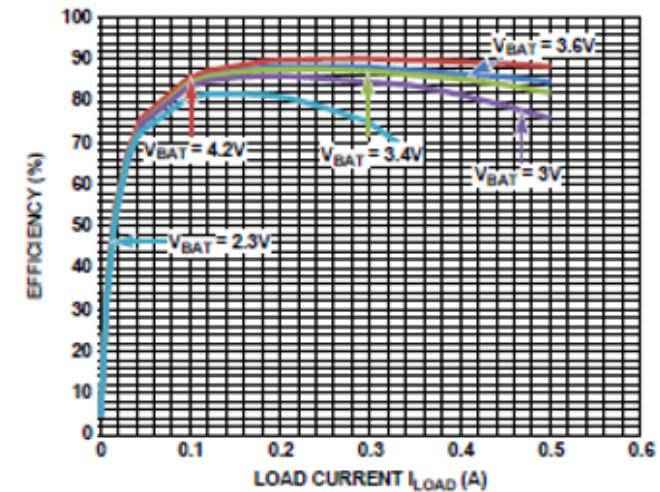


FIGURE 2. EFFICIENCY vs LOAD CURRENT

# ISL78233/4/5 – 3 TO 5A SYNCHRONOUS BUCK REGULATORS

Pin compatible family of 3 to 5A, 2MHz sync switchers

- Vin: 2.7 to 5.5V
- Packages: 3x3mm 16-lid TQFN ( $\theta_{JA}=43\text{ }^{\circ}\text{C/W}$ )  
5x5mm 16-lid WQFN ( $\theta_{JA}=34\text{ }^{\circ}\text{C/W}$ )

2MHz switching frequency

- Externally synchronization up to 4MHz
- 100ns (max) minimum on-time supports wide step-down ratio
- Optional PFM mode for light load efficiency improvement

Soft-start: fixed internal or adj. external

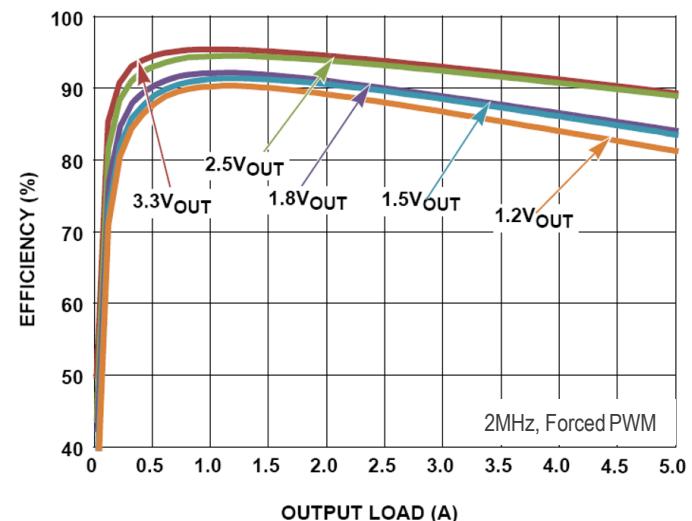
- 1ms or externally adjustable with capacitor
- Start-up with pre-biased output

Full protection: OCP, OVP, OTP, UVLO

Soft-stop output discharge during disable

Device	3x3 Temp Range (°C)	5x5 Temp Range (°C)
ISL78233	-40 to 125	
ISL78234	-40 to 125	
ISL78235	-40 to 105	-40 to 125

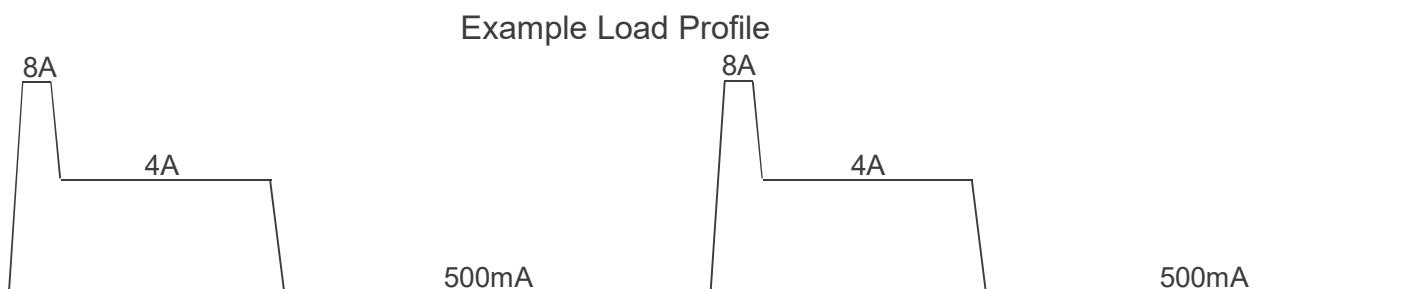
EFFICIENCY vs LOAD (5V<sub>IN</sub>; SYNC = VDD)



# ISL78235-R5668 – 12A/5A SYNCHRONOUS BUCK REGULATOR

## 12A Peak / 5A Continuous Synchronous Buck Regulator

- Includes same feature set from ISL7823x family
- High Peak Current Limit (12A, typ) to support short load bursts for GPUs
- Package: 3x3mm 16-ld TQFN ( $\theta_{JA}=43\text{ }^{\circ}\text{C/W}$ )
  - Pin-compatible with standard ISL78233/4/5
- AEC-Q100 Grade 3: -40 to 85C



# ISL78236 –DUAL 3A /SINGLE 6A SYNCHRONOUS BUCK REGULATOR

## Standard Features

- Input Voltage: 2.7V to 6.0V
- Output Voltage: 0.8V to Vin
- Dual 3A or Single 6A Outputs
- Package : 4x4mm 24-QFN
- Ambient Temp: -40 to 105 °C

## Tiny Solution w/ up to 95% Efficiency

- Fewer External Components
  - 3A Output Current per Channel each with Integrated, 50 mΩ HS/LS FETs
  - Internal Current Mode Compensation
- Smaller External Components
  - 2.5MHz Switching Frequency
  - 180° Out-of-Phase Operation

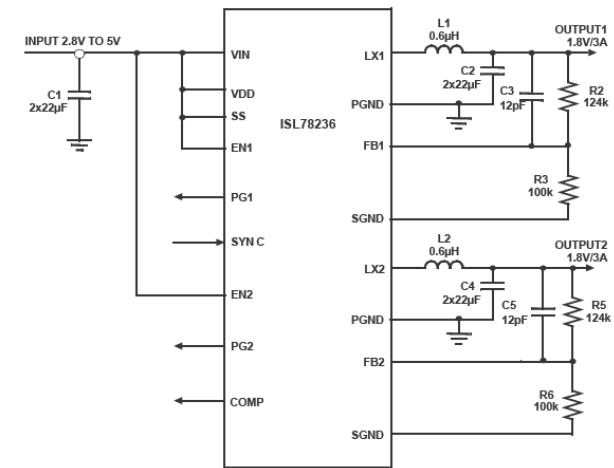


FIGURE 4. TYPICAL APPLICATION DIAGRAM - DUAL 3A OUTPUTS

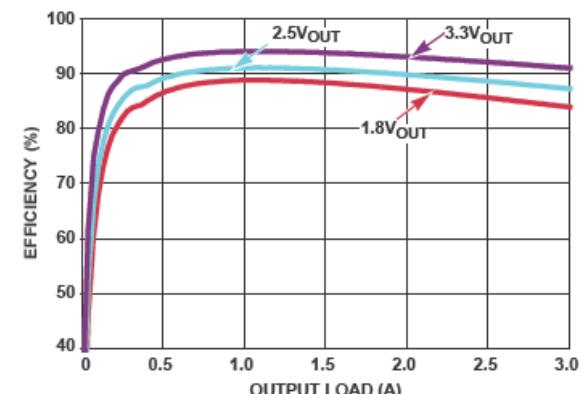
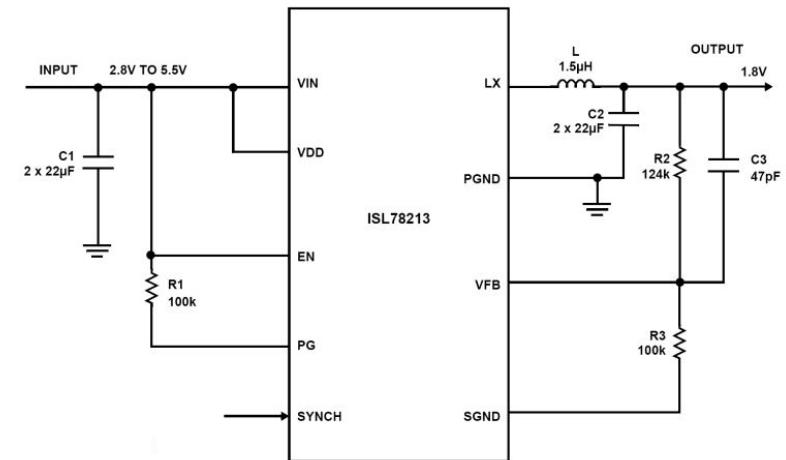


FIGURE 6. EFFICIENCY,  $V_{IN} = 5V$ ,  $T_A = +25^\circ C$

# ISL78213/14 - 3A/4A SYNCHRONOUS BUCK REGULATORS

## Device Parameters

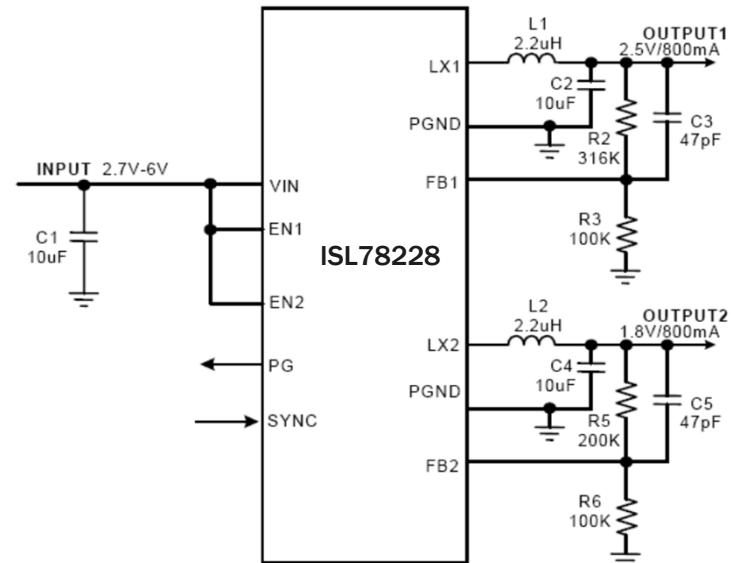
- Vin: 2.7 to 5.5 V
- Vout: 0.8 to Vin V
- ISL78213: 3A Continuous Load Current
- ISL78214: 4A Continuous Load Current
- High Switching Frequency: 1MHz
  - External Synchronization Capability: Up to 4MHz
- Flexible Operation Mode: Selectable PFM/PWM Mode
- Highest Light Load Efficiency: 35 $\mu$ A Quiescent Current (typ)
- Up to 95% Efficiency
- 1ms delayed PGOOD (Power OK) Output, Internal Digital Soft-Start and Regulator Enable Pin
- Start-up in Pre-biased Load
- Peak Current Limiting, Short Circuit Protection Over-temperature
- Package: 16 Ld 4x4mm QFN



# ISL78228 – DUAL 800mA SYNCHRONOUS BUCK REGULATOR

## PFM/PWM Synchronous Buck Regulator with Integrated MOSFETs

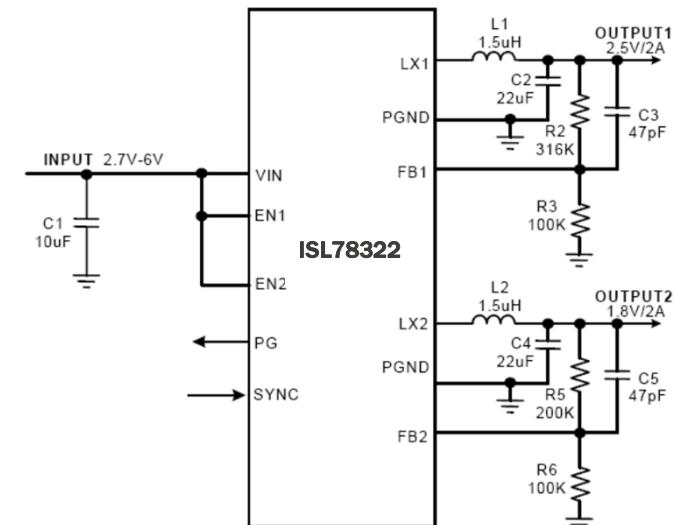
- Vin: 2.7 to 6.0 V
- Vout: 0.6 to Vin V
- 180° Out-of-Phase Operation
- Start-up in Pre-Biased Load
- Internal Current Mode Compensation
- High Switching Frequency – 2.25MHz
- 800mA Guaranteed Output Current per Channel
- Selectable Forced PWM and PFM Mode (Power Save Mode)
- Synchronization to External Clock – Up to 4MHz
- Independent EN and PGOOD for both Channels
- Package – 10 Ld. 3x3 DFN



# ISL78322 – DUAL 2A/1.7A SYNCHRONOUS BUCK REGULATOR

## PFM/PWM Synchronous Buck Regulator with Integrated FETs

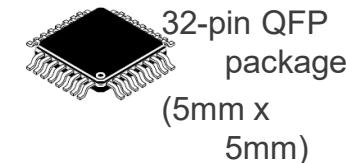
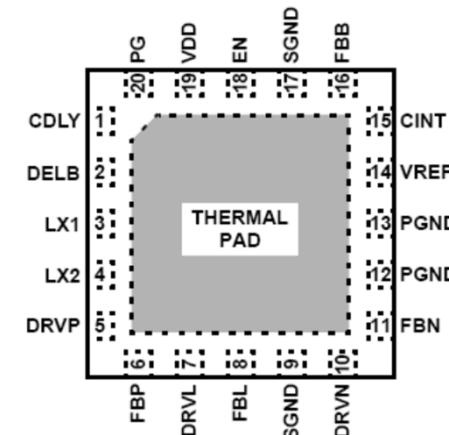
- Input Supply Voltage Range: 2.7V to 6V
- Output Voltage Range: 0.6V to Vin
- 2A/1.7A Output Current/Channel
- 180° Out-of-Phase Operation
- Selectable Forced PWM and
  - PFM Mode (Power Save Mode)
- Synchronization to External Clock – Up to 4MHz
- Independent EN and PGOOD for both Channels
- Internal Current Mode Compensation
- Start-up in Pre-Biased Load
- Package – 12 Ld. 4 x 3 mm DFN



# DISPLAY PRODUCTS

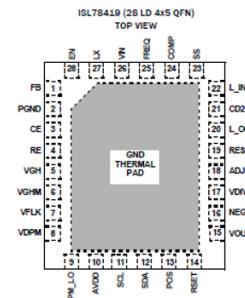
# ISL78010 – TFT/LCD POWER SUPPLY

- Multiple output regulators for automotive TFT-LCDs
- High performance boost regulator with integrated FET
  - Up to 20V, 2A Switch output current
  - Current mode control
  - 1% accuracy on boost output
  - 92% efficiency
- Dual positive LDO & Single negative LDO
- Programmable sequence delay
- Configurable fault protection features
- User selectable start-up sequences & internal soft start
- $T_A$ : -40 to 105 °C

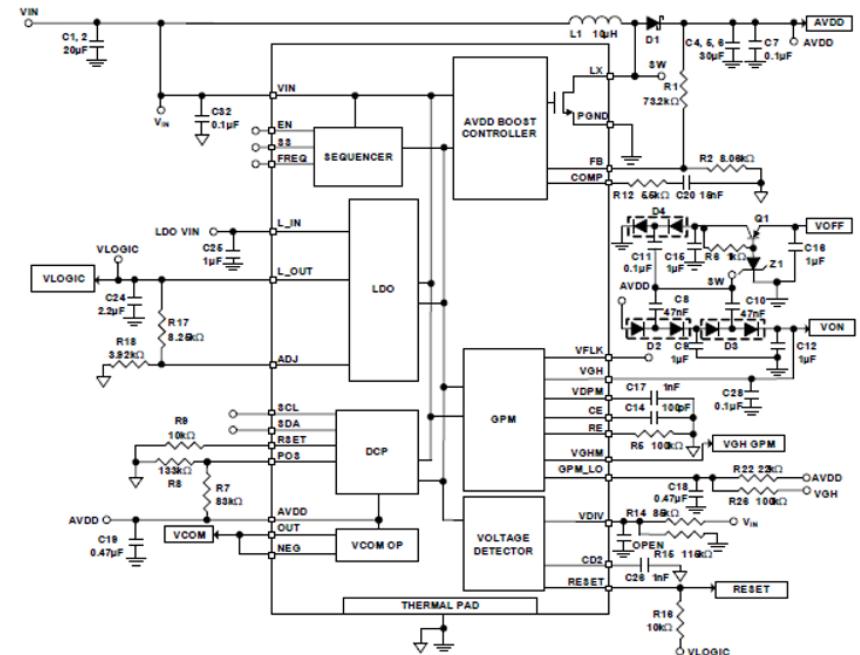


# ISL78419 LCD PSU WITH INTEGRATED VCOM CALIBRATOR

- Input Voltage Range: 2.7V to 5.5V Input
- 1.5A Integrated Boost for Up to 15V AVDD
  - 600 / 1200 kHz switching frequency selectable
- VON / VOFF driven by boost switching
- LDO for Vlogic channel
- Integrated Gate Pulse Modulator
- Reset signal generated by supply monitor
- Integrated VCOM Amplifier
- 7-bit Digitally controlled potentiometer for VCOM calibrator with NVM
  - I<sup>2</sup>C serial interface, address: 0101000, MSB left
  - Wiper position stored in 7 bit nonvolatile memory and recalled on power-up
  - Endurance, 1,000 data changes per bit
- UVLO, UVP, OVP, OCP, and OTP Protection
- 28-ld 4x5mm TQFN



**Application Diagram**



# ISL78171 – 6-CH X 50mA LED DRIVER WITH ULTRA-HIGH DIMMING RATIO AND PHASE SHIFT CONTROL

## Compact & versatile backlight solution

- Integrated boost converter to reduce BOM and PCB
- Six adjustable precision current sinks
- PMBus/I2C Interface for programmability and diagnostics

## High efficiency boost converter with in-rush current limiting

- 4.5V to 26.5V input with max 40V output
- Selectable switching frequency: 600/800/1200kHz

## Six programmable precision current sinks, up to 50mA per string

- Channel-to-channel matching:  $\pm 0.7\%$
- Gang channels together for higher current per string

## Ultra-high dimming ratio over 60,000:1

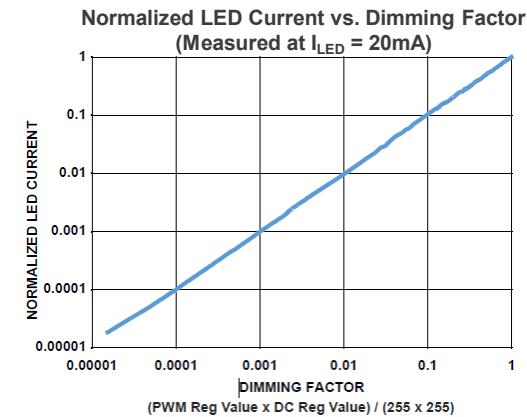
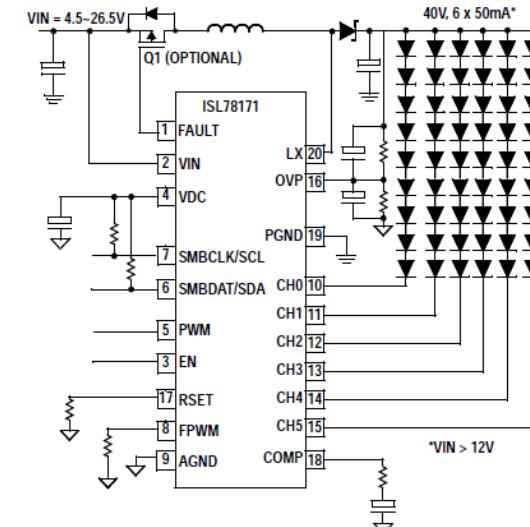
- DC Dimming via PMBus: 8-bit (255:1)
- PWM Dimming with Phase Shift: 8-bit (255:1)
- Direct PWM Dimming: down to 350ns on-time (14,000:1)
- Hybrid Dimming: DC + PWM, 16-bit (>60,000:1)

## Extensive fault detection/protection

- String open/short, OV, OT, output short circuit/in-rush protection

20 Ld 4mmx3mm QFN package

AEC-Q100 Grade 2,  $T_A$ : -40 to 105 °C



# ISL76534 – 14-CH NON-VOLATILE PROGRAMMABLE GAMMA + VCOM

## 14 Gamma References

- 10-bit Resolution
- 60mA Max Output Current
- 5V/ $\mu$ s slew rate

## Vcom Calibrator

- 10-bit Resolution
- 100mA Max Output Current
- 5V/ $\mu$ s slew rate

## Supplies

- Analog (AVDD): 6.3 to 19 V
- Amp (AVDD\_AMP): 4.5 to AVDD
- Digital (DVDD): 2.25 to 3.6 V
- Typ Quiescent Power: 12mW @ 8V

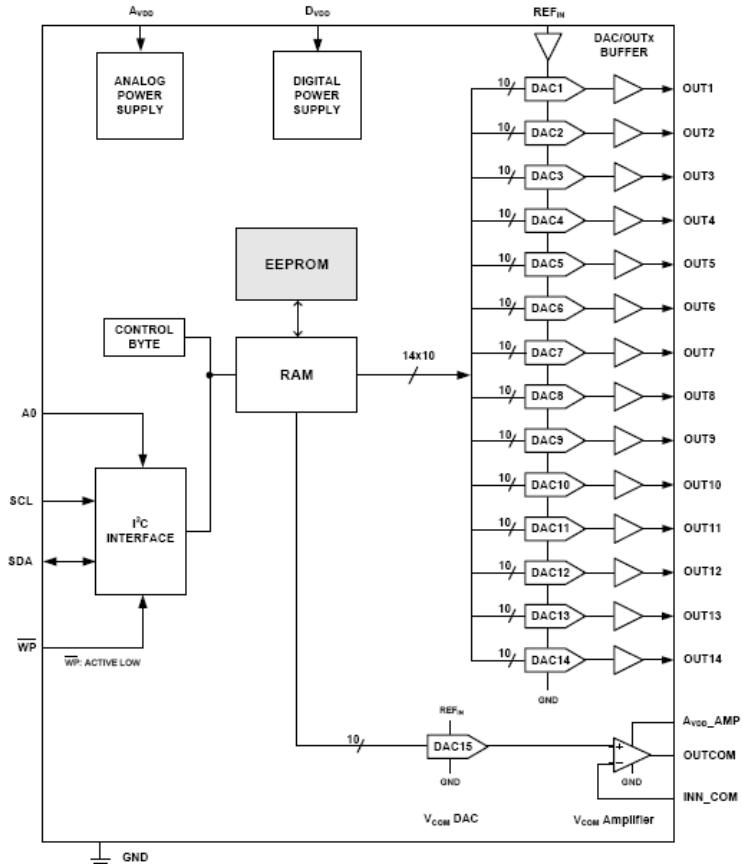
High-endurance non-volatile memory (NVM) (10k writes)

## I<sup>2</sup>C Interface

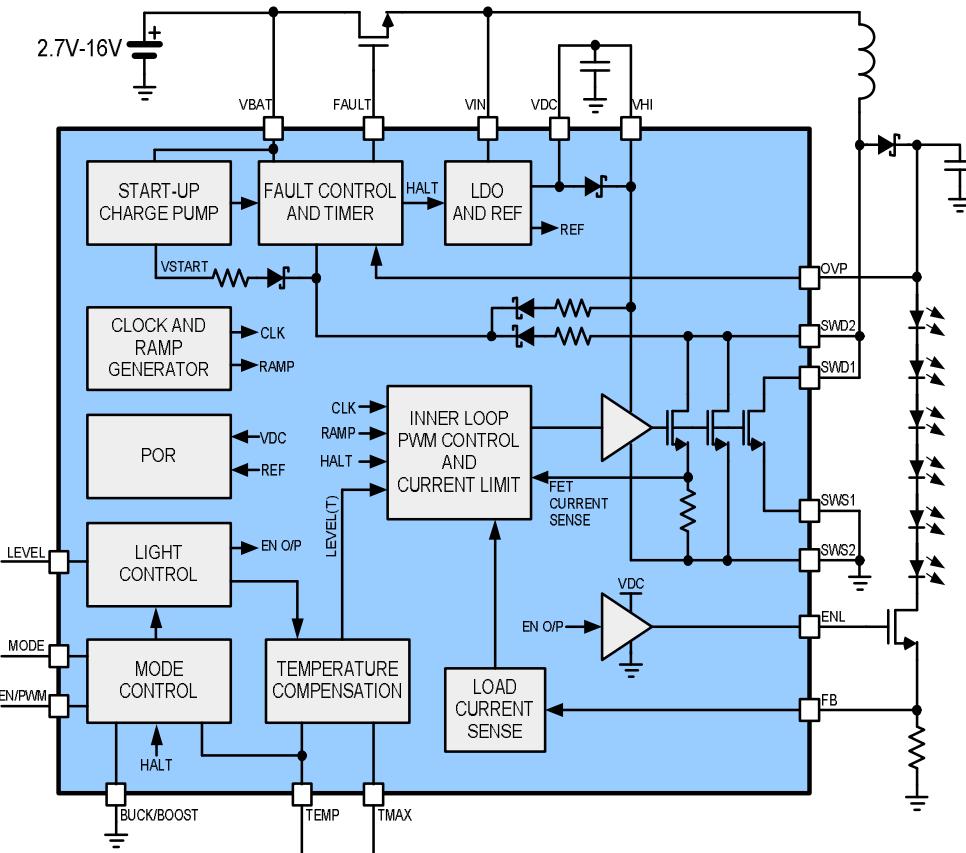
28-LD 4x5mm TQFN Package

Temp: -40 to 105°C

Block Diagram



# ISL78100 - VERSATILE HBLED DRIVER



## Features

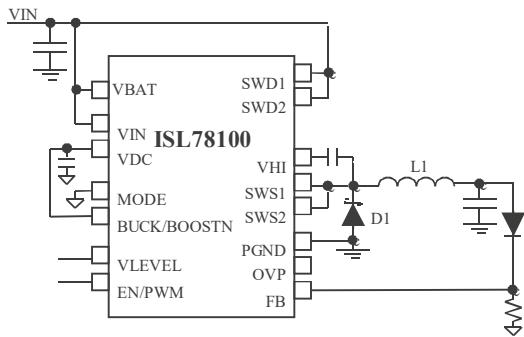
- Drives 1-8 high-power LEDs in series, up to 32V
- 2.7V to 16V input voltage range
- Boost, Buck, or Buck/Boost Configurations
- 3A integrated FET
- Automotive load dump protection
- Light output temperature compensation
- LED over-temperature protection
- LED disconnect switch
- PWM/analog light level
- Small, 20 lead QFN package
- 20-Id 4x4mm QFN

## Applications

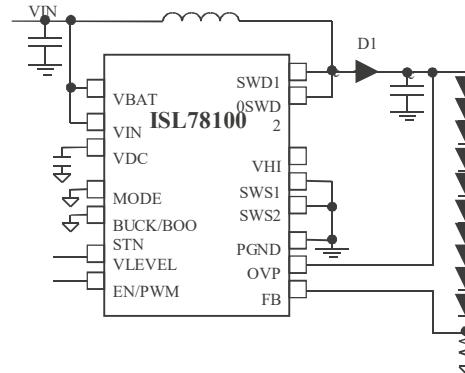
- DC/DC Portable Lighting
- LED flashlight
- Offgrid Lighting
- Portable Projector
- Automotive lighting
  - Display backlighting

# ISL78100 FLEXIBLE DC-DC HBLED DRIVER

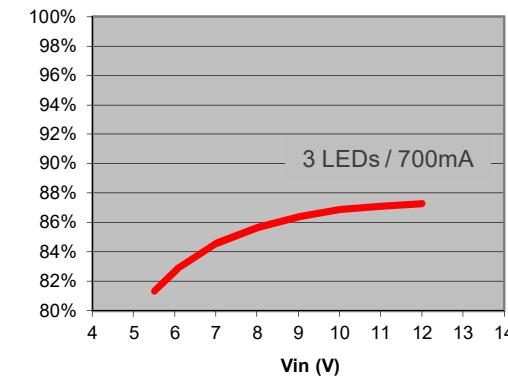
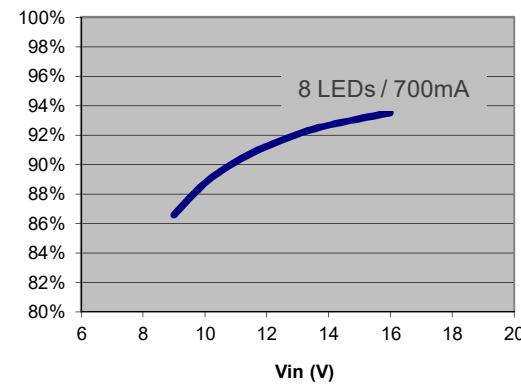
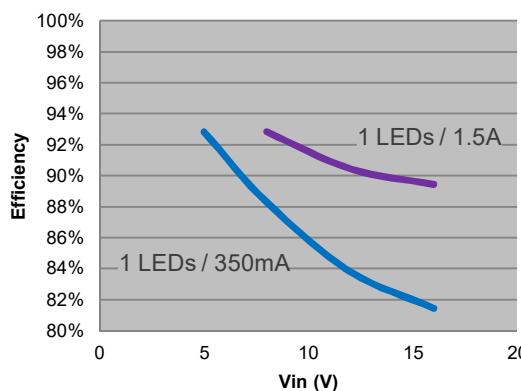
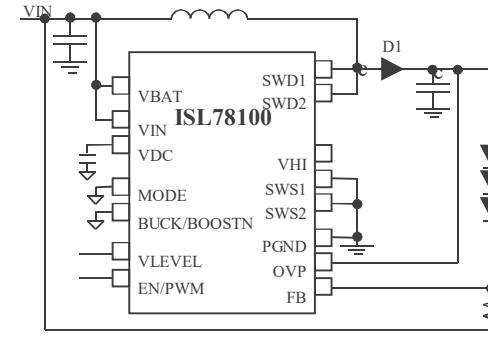
Buck



Boost



Buck/Boost  
(Load-Return-to-Input)



# ISL76671 – LIGHT TO ANALOG ALS

## Key Features

- Voltage Output
- Spectral Response Similar to Human Eye
- Internally Temperature Compensated
- Package: 2x2.1mm 6-lid ODFN

## Key Specifications

- Light Range: 0.01 to 100 Lux
- Supply Range: 1.8 to 3.0V
- AEC-Q100 Qualified, Grade 2
- $T_A$ : -40 to 105C

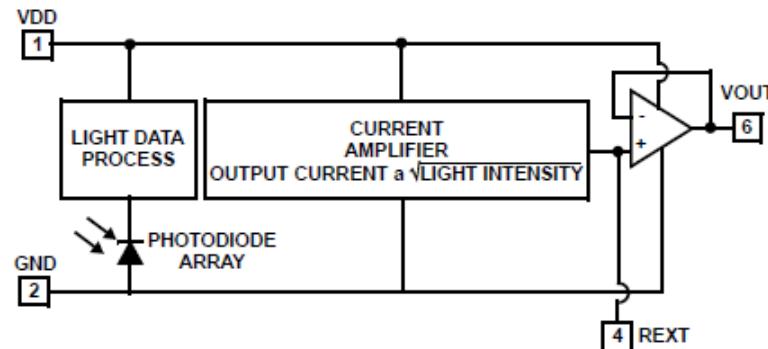


FIGURE 1. SIMPLIFIED BLOCK DIAGRAM

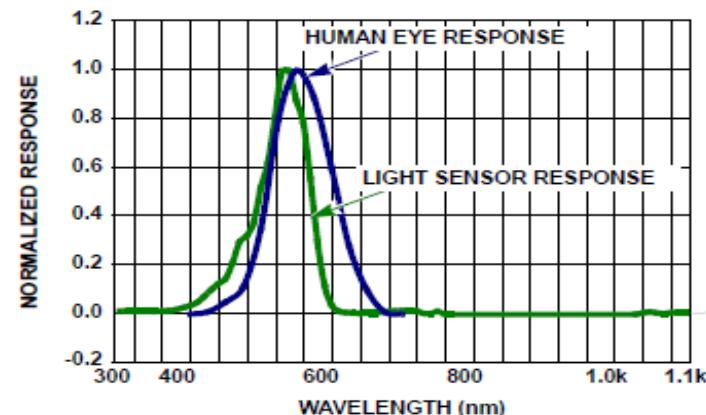


FIGURE 4. SPECTRAL RESPONSE

# ISL76683 – LIGHT TO DIGITAL ALS

## Key Features

- Human eye response with dual PD architecture for IR/UV rejection
- Up to 16-bit, Integrating ADC with 50/60Hz rejection
- I<sup>2</sup>C Interface
- Package: 2x2.1mm 6-lid ODFN

## Key Specifications

- Supply Range: 2.5 to 3.3V
- 4 Programmable Light Ranges (0 to 1k/4k/16k/64k Lux)
- Adjustable sensitivity/resolution
- AEC-Q100 Qualified, Grade 2
- T<sub>A</sub>: -40 to 105C

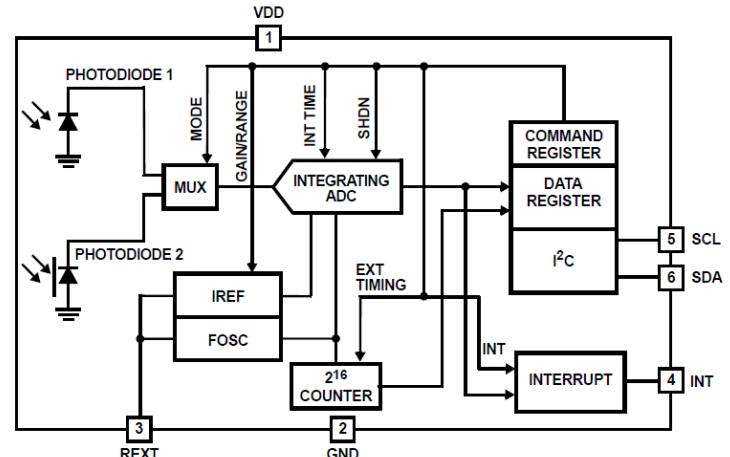


FIGURE 1. BLOCK DIAGRAM

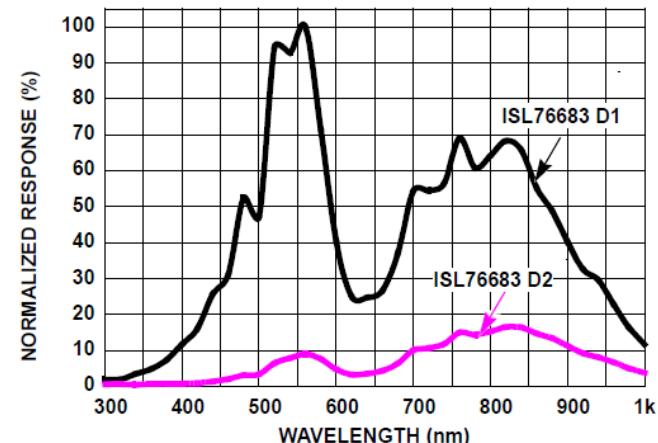
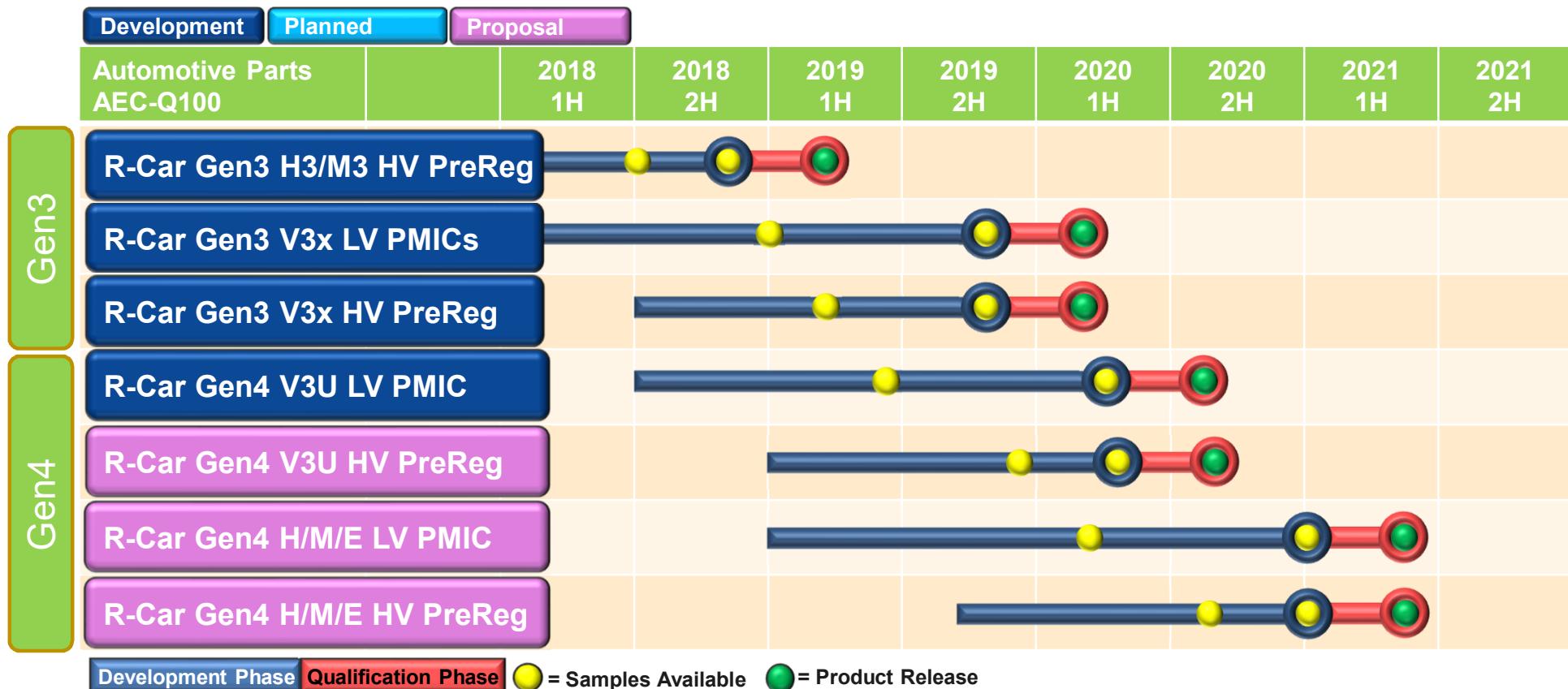


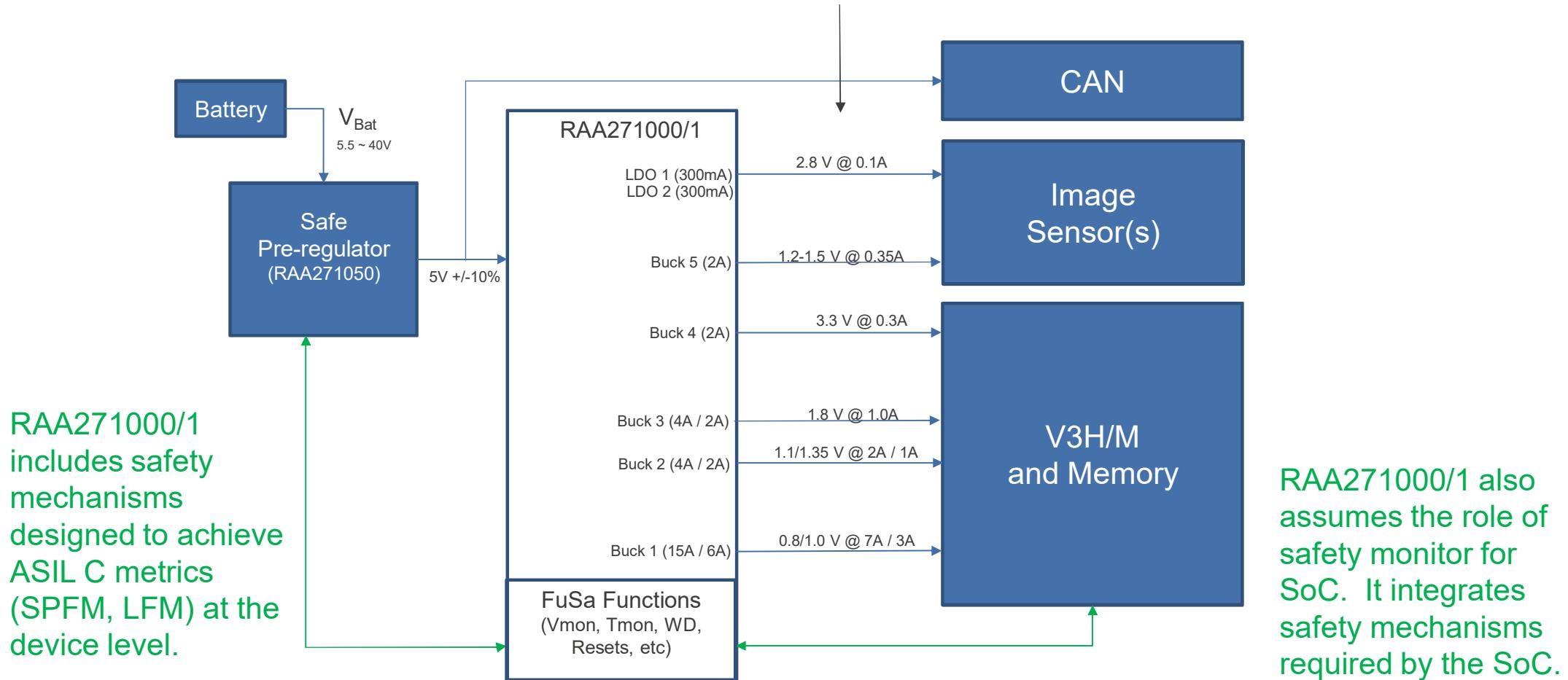
FIGURE 2. SPECTRAL RESPONSE

# SOC PMIC INTRODUCTION

# RENESAS SOC POWER MANAGEMENT DEVELOPMENT STRATEGY



# V3X EXAMPLE SYSTEM



# RAA271000: V3X SAFE PMIC WITH 15A CORE SUPPLY

Vin = 2.7 – 5.5V

Switching Frequency: 2.2 MHz

## 5 High Efficiency Synchronous Buck Regulators

- 1 High Current Core Regulator, max 15A
- 4 Low Current Regulators, 2x2A, 2x4A max
- DVFS for Core Regulator, <=80mV/µs, SPI, I2C or GPIO

## 2 Low Drop-Out Linear Regulators, Drop-out: 200mV @ 200mA @ 3V

Configuration/Control via SPI or I2C, w/ End-to-End Protection

## 2 User GPIO

## ASIL C Functional Safety for IC (up to ASIL D System-level)

- Independent monitoring and protection
- Integrated 12-bit SAR ADC, up to 5V input
  - OT, output UV/OV, SoC core monitor
  - Up to 16 external inputs (w/ ext. mux)
- Challenge/response watchdog timer
- Dual temperature monitors
- SoC error pin monitors
- Dual secondary shut-down paths
- Built-in SoC activation support
- Safe-state state machine w/ 3 programmable outputs

AEC-Q100 Grade 1,  $T_A = -40$  to  $125^\circ\text{C}$ ,  $T_J = -40$  to  $150^\circ\text{C}$

Package: 4.8x8.0mm, 60-ball FCBGA, 0.8mm pitch,  $\theta_{JA} \sim 25 \text{ C/W}$

## One Time Programmable Items

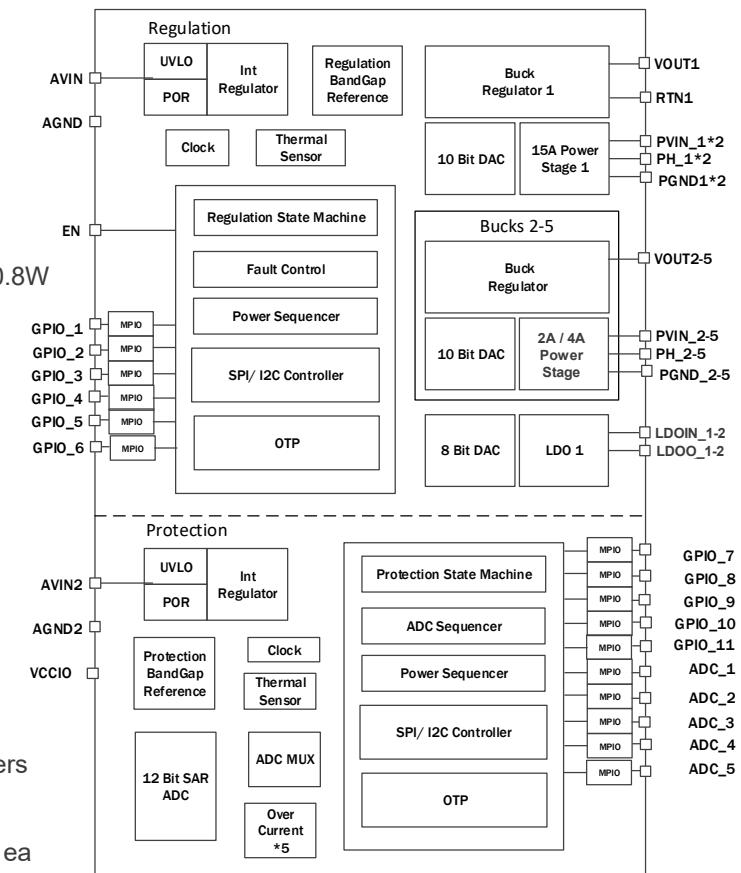
- Output Voltage
- Output Current Limit
- Power-on Delays
- GPIO Configuration

## Example Use-case Power Losses

- Vin=5V,  $T_J = 150^\circ\text{C}$ ,  $F_{sw}=2.2\text{MHz}$ ,  $P_{out} \sim 10.8\text{W}$
- 3.3V @ 0.5A = 0.125W
- 2.8V @ 0.1A (x2) = 0.1W (0.05W each)
- 1.8V @ 0.8A = 0.175W
- 1.2V @ 0.7A = 0.135W
- 1.1V @ 1.2A = 0.230W
- 0.8V @ 6.25A = 0.825W
- Total Power Loss = 1.6W
- $T_J$  Rise =  $P_d = 25\text{C/W} * 1.6\text{W} = 40\text{C}$
- $T_{A\_MAX} = 150^\circ\text{C}-40^\circ\text{C} = 110^\circ\text{C}$

## BOM Components

- Inductors: 120nH for Vcore, 470nH for others
- $C_{out}$  Vcore (0.8V) =  $4 \times 47\mu\text{F}$
- $C_{out}$  Others (1.1/1.2/1.8/3.3V) =  $1 \times 22\mu\text{F}$ , ea
- $C_{out}$  LDOs =  $1\mu\text{F}$ , each



# RAA271001: V3X SAFE PMIC WITH 6A CORE SUPPLY

V<sub>in</sub> = 2.7 – 5.5V

Switching Frequency: 2.2 MHz

## 5 High Efficiency Synchronous Buck Regulators

- 1 High Current Core Regulator, max 6A
- 4 Low Current Regulators, max 2A each
- DVFS for Core Regulator, <=80mV/µs, SPI, I2C or GPIO

## 2 Low Drop-Out Linear Regulators, Drop-out: 200mV @ 200mA @ 3V

Configuration/Control via SPI or I2C

## ASIL C Functional Safety for IC (up to ASIL D System-level)

- Independent Monitoring and Protection
- Integrated 12-bit SAR ADC, up to 5V Input
  - OT, Output UV/OV, SoC Core Monitor
  - Up to 16 external inputs (using ext. mux)
- Challenge/response watchdog timer
- Dual temperature monitors
- SoC error pin monitors
- Dual secondary shut-down paths
- Built-in SoC activation support
- Safe-state State Machine

AEC-Q100 Grade 1, T<sub>A</sub> = -40 to 125°C, T<sub>J</sub> = -40 to 150°C

Package: 4.8x7.2mm, 54-ball FCBGA, 0.8mm pitch, θ<sub>JA</sub> ~ 25 C/W

## One Time Programmable Items

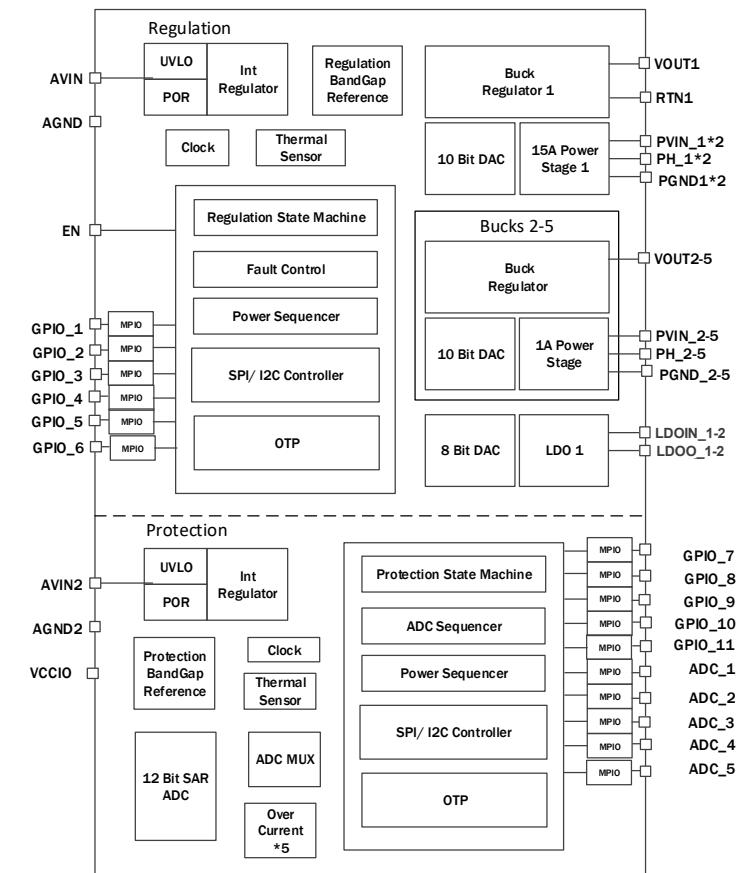
- Output Voltage
- Output Current Limit
- Power-on Delays
- GPIO Configuration

## BOM Components

- Inductors: 330nH for Vcore, 470nH for others
- C<sub>out</sub> Vcore (0.8V) = 2 x 22uF
- C<sub>out</sub> Others (1.1/1.2/1.8/3.3V) = 1 x 22uF, each
- C<sub>out</sub> LDOs = 1uF, each

## Example Use-case Power Losses

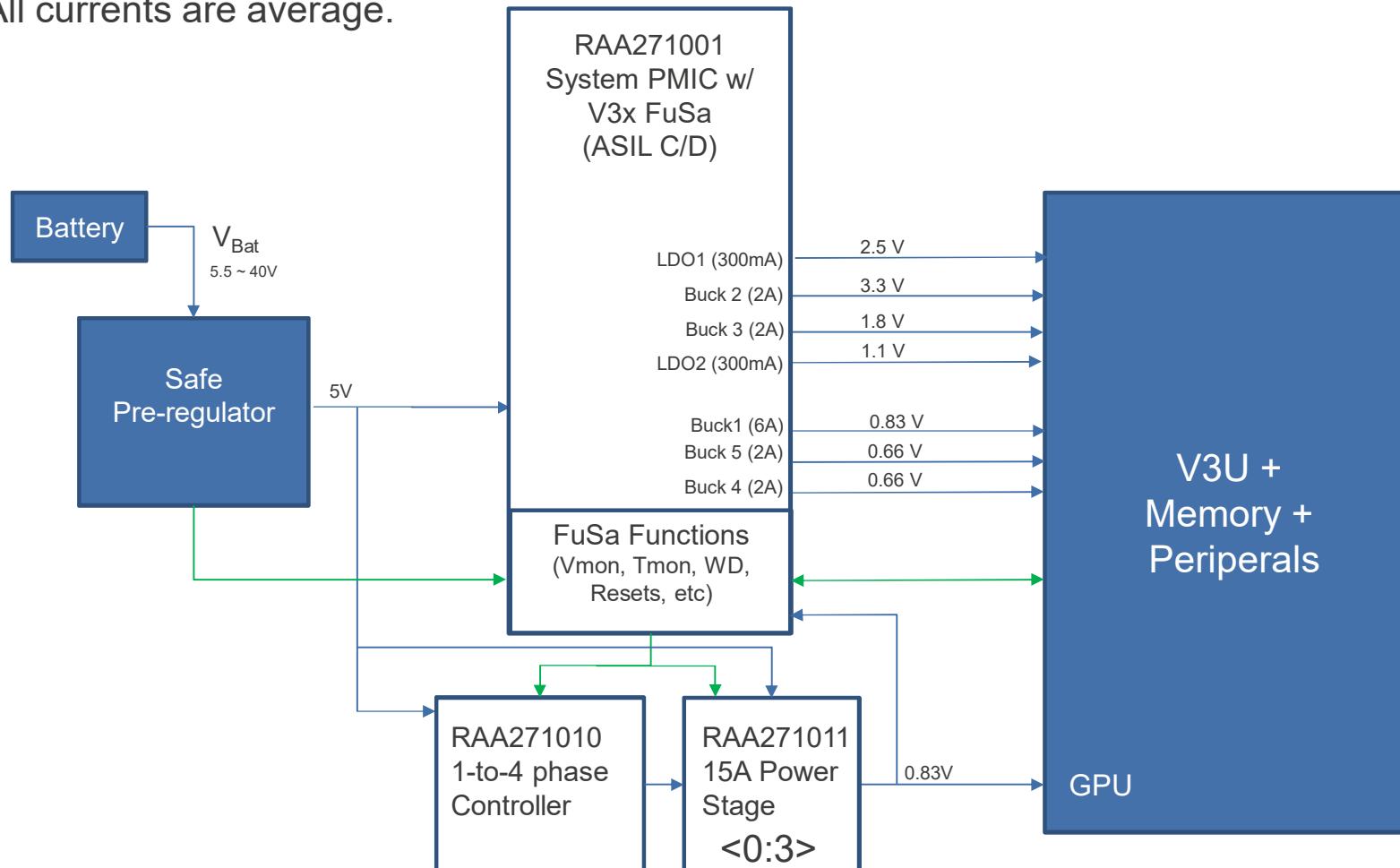
- V<sub>in</sub>=5V, T<sub>J</sub> = 150C, F<sub>sw</sub>=2.2MHz
- 3.3V @ 0.2A = 0.090W
- 1.8V @ 0.2A = 0.080W
- 1.35V @ 1.0A = 0.220W
- 1.20V @ 0.35A = 0.090W
- 1.03V @ 4.4A = 0.560W
- Total Power Loss = 1.040W
- T<sub>J</sub> Rise = P<sub>d</sub> = 25C/W \* 1.04W = 26C
- T<sub>A\_MAX</sub> = 150C-26C = 124C



# RAA271010/RAA271011

# V3U-AD POWER SOLUTION – 4-PHASE CORE SUPPLY + RAA271001 PMIC

All currents are average.



# RAA271010/RAA271011: V3U SCALABLE CORE RAIL

Vin = 2.5 – 5.5V

Switching Frequency: 2.2 MHz

Configuration/Control via SPI or I2C

High Efficiency Multiphase Synchronous Buck Controller

- R5 switching architecture for fast transient response.
- Controller supports 1-to-4 Phases
- Power stage can be reused and replaced, as needed
- High current core regulator, max 60A
- DVFS, <=80mV/μs, SPI, I2C or GPIO
- Fixed frequency, spread spectrum, option for EMI sensitive environments

ASIL D Development Process

- FuSa Monitoring performed off-chip

Power Stage is Customizable based on SoC Demands

- V3U Target: 15A (4x = 60A peak)

AEC-Q100 Grade 1, T<sub>A</sub> = -40 to 125C, T<sub>J</sub> = -40 to 150C

Package:

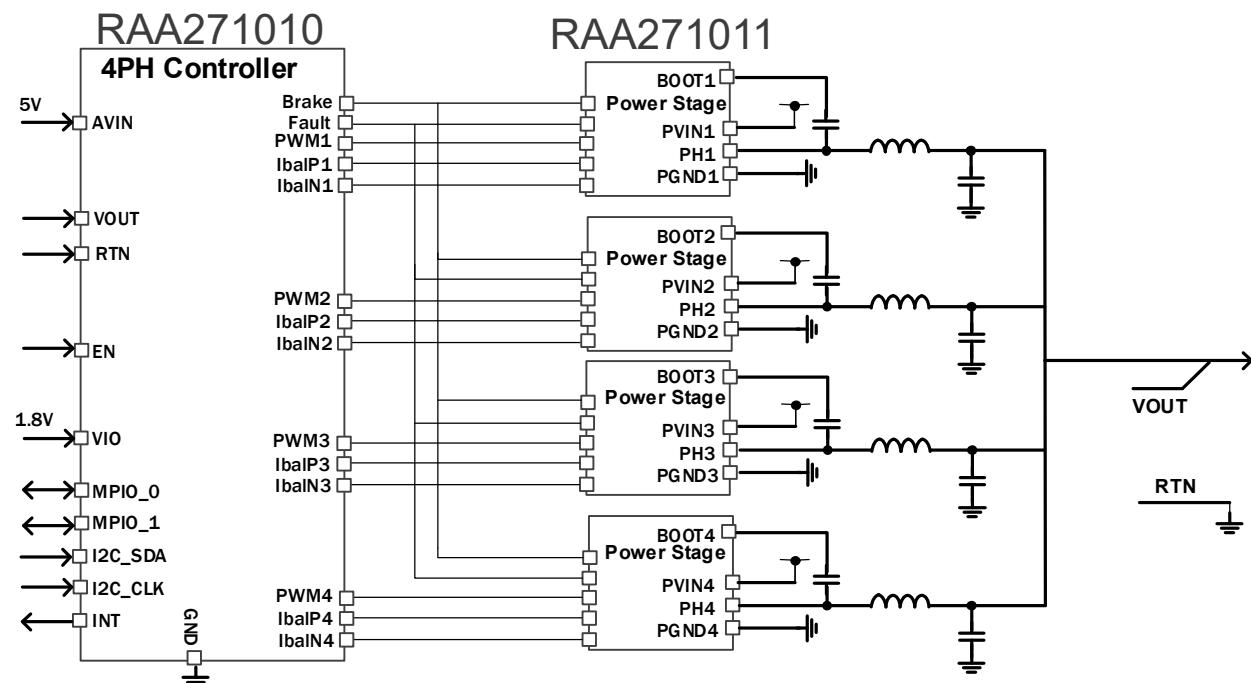
- RAA271010 Controller: 24 pin 4x4mm SC-QFN,
- RAA271011 Power Stage: 3.2x3.2mm FCOL QFN

## One Time Programmable Items

- Output Voltage
- Output Current Limit
- Power-on Delay
- GPIO Configuration

## BOM Components

- Inductors: 90nH per phase
- Cout on Vcore 0.83V = 490uF



# RAA271050

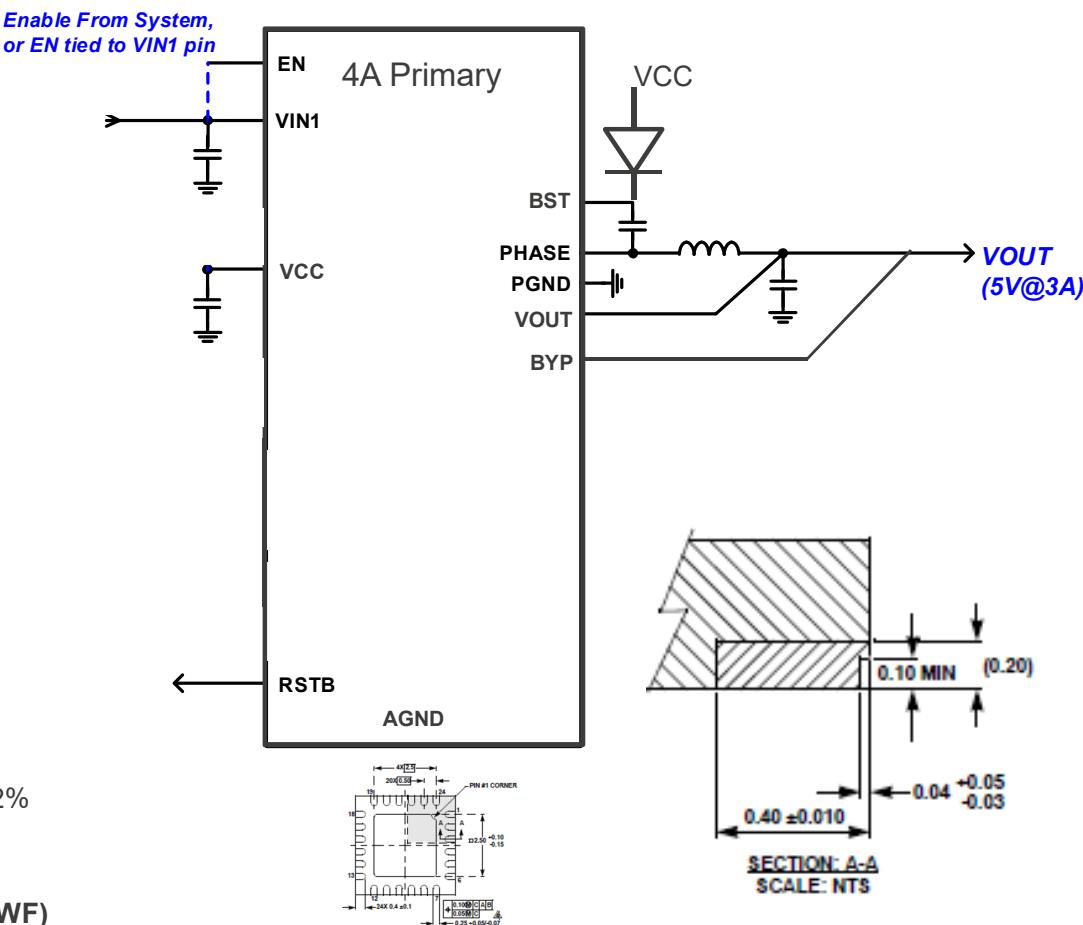
# RAA271050 4A ASIL C MONITORED PRIMARY

## High Efficiency Monolithic Synchronous Buck Regulator

- 4A core rail with integrated NMOS HS & LS switches
- Vin = 4.5-42V
- Vout = 5.0V/3.3V (internally programmed)
- Switching Frequency: 2.2MHz
- Spread Spectrum (Pseudo-Random, programmable variation, 1/2/3%)
- Factory configurable soft-start time
- HV EN Pin (42V Max)
- 12V->5V Efficiency, 2.2MHz: 93% Peak, 90% @ 2A
- DC Regulation +/- 2% (max over temp)
- Forced-PWM operation
- Minimal external components:
  - Integrated FETs
  - Integrated FB divider
  - No Isense resistor
  - Internal compensation
- External Bias (BYP) for improved efficiency
- Short-circuit Protection
- Output discharge when disabled (150ms)
- Initial startup time (including any BIST) completes in under 15ms
- ASIL C Functional Safety (*ASIL D Development Process*)
- Independent Monitoring and Protection, +/- 2% Tolerance at +/- 6, 8, 12%
- BIST of all safety features at startup

AEC-Q100 Grade 1,  $T_A$ : -40 to 125C,  $T_J$ : -40 to 150C

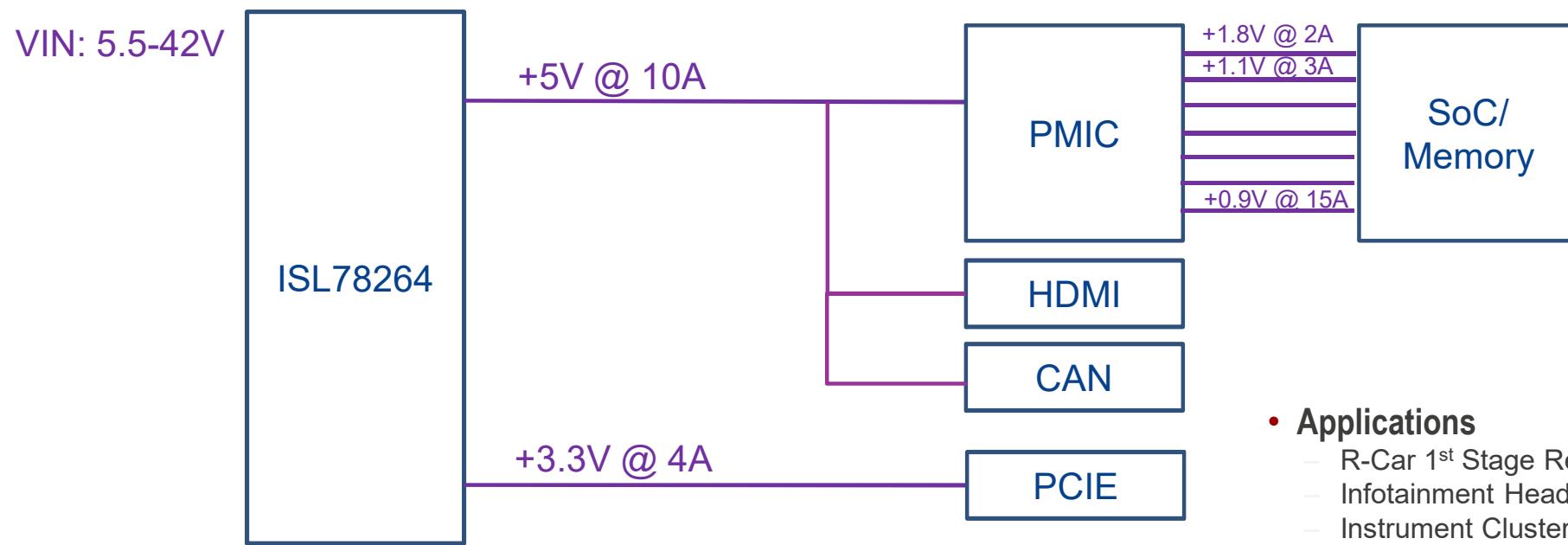
4x4mm 24ld Step-cut QFN with Optically Inspectable Solder Joints (WF)



# ISL78264

# ISL78264 DESIGNED INTO V3H REFERENCE DESIGN (CONDOR) & H3 “SMALL-SIZE MODULE” (REPLACES MAX16933)

Power Diagram



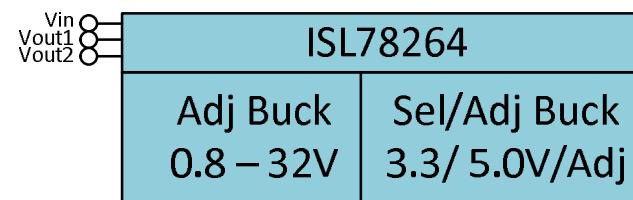
- **Applications**

- R-Car 1<sup>st</sup> Stage Regulator
- Infotainment Head-Unit
- Instrument Cluster
- Surround View ECU

# ISL78264 – 45V DUAL SYNCHRONOUS BUCK CONTROLLER

Sampling Now!

- **Key Features**
  - Controller 1
    - Selectable 3.3, 5.0V or Adj. 0.8 - 5.0V
    - Integrated feedback
    - Low-I<sub>q</sub> for Always-on
  - Controller 2
    - Adjustable output, 0.8 – 32V
    - LS switch to disconnect the feedback resistor network if disabled.
  - VIN (startup) Range: 4.5 (5.5) to 40.0V
  - Low Quiescent Current Operation
  - Adjustable Switching Frequency
  - Optional Spread Spectrum
  - External Synchronization
  - Four Integrated 2A 5V Nch FET Drivers
  - Protection: Vin UVLO, OCP, OTP
  - Package: 32-WFQFN
  - Temp: -40 to 125C (Grade 1)

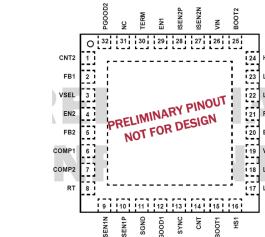


## • Key Specifications

- F<sub>sw</sub>: 200kHz to 2.2MHz
- I<sub>q</sub> (1-Contr): 6µA (typ)
- T<sub>min-on</sub>: 60ns (max)
- T<sub>min-off</sub>: 60ns (max)
- Driver Sourcing Current: 2A peak
- Driver Sinking Current: 3A peak
- Spread Spectrum Range: +/- 6%
- V<sub>ref</sub> = 0.8V (+/- 1%)
- Shutdown Current < 5µA (max)
- Industry leading duty-cycle range supports warm crank requirement for start-stop at 2MHz switching frequency.

## • Value Proposition

- Supports soft-start (warm crank down to 6V @ 2MHz without requiring pre-boost)
- Reduces size and cost of external components
- Reduces complexity of meeting EMI specs

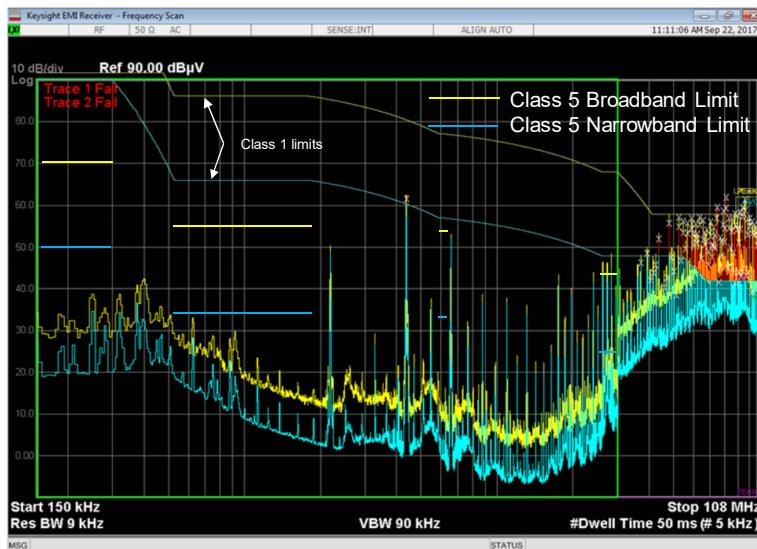


AEC-Q100 Grade 1  
5x5mm  
32-WFQFN

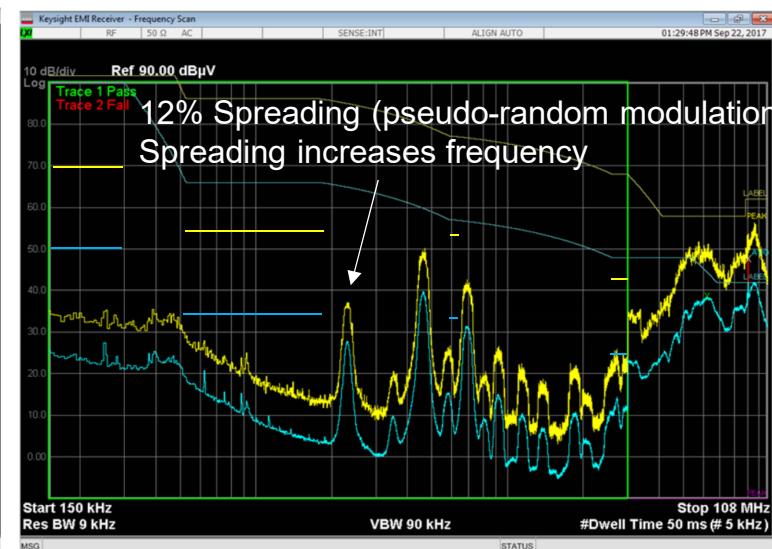
# SPREAD SPECTRUM EVALUATION

**FS = 2.2MHz, CH1 = 5.0V @ 10A, CH2 = 3.3V @ 10A**

Spread Spectrum Off



Spread Spectrum On



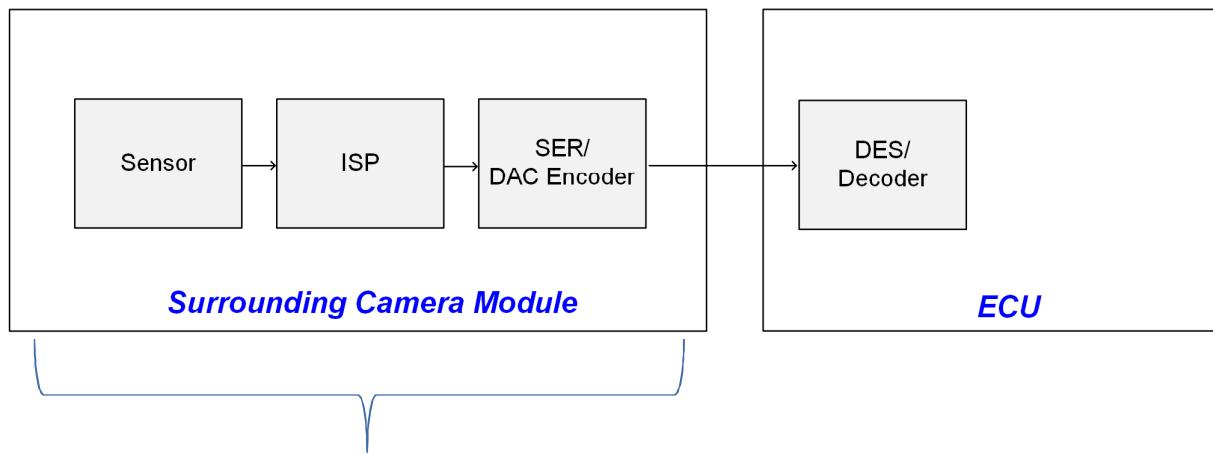
Frequency / Peak Mode	Spread Spectrum Off	Spread Spectrum On	Improvement
1.0 Fs (~2.2MHz)	50 dB $\mu$ V	37 dB $\mu$ V	13 dB $\mu$ V
2.0 Fs (~4.4MHz)	62 dB $\mu$ V	50 dB $\mu$ V	12 dB $\mu$ V
3.0 Fs (~6.6MHz)	53 dB $\mu$ V	43 dB $\mu$ V	10 dB $\mu$ V

# ISL7808X PMIC FAMILY FOR AUTOMOTIVE CAMERAS

OCTOBER 2019



# CAMERA SYSTEM BLOCK DIAGRAM



ISL78082 & ISL78083 PMICs to supply Imager + ISP + SERDES/Encoder

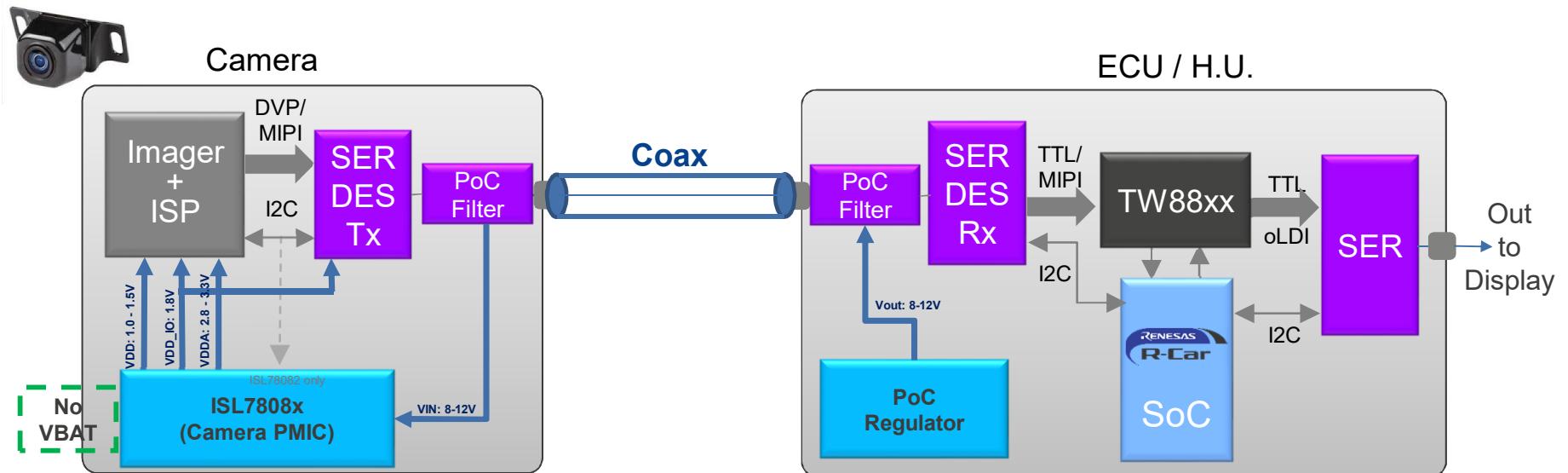
- Typically satellite and rear-view cameras, forward cameras without local vision processing
- Total power requirements up to 2.5W

# ISL7808X AUTOMOTIVE HD CAMERA PMIC FAMILY



# ISL7808X CAMERA PMICS, SERDES USE CASE

ISL78083: Released (MP)  
ISL78082: WS1 Now



## ISL7808x Camera PMICs

- Highest Efficiency
- Best Automotive Features
- Fewest BOM Components

## Automotive Feature Set

- Switching Freq. = 2.2MHz
- Spread Spectrum Clocking
- Load-dump Tolerant 1<sup>st</sup> Buck

## ISL78083

- QM w/ PG Status Pins

## ISL78082

- ASIL B w/ I2C and GPIO

# ISL78083/2 CAMERA PMICS IN AHL USE CASE

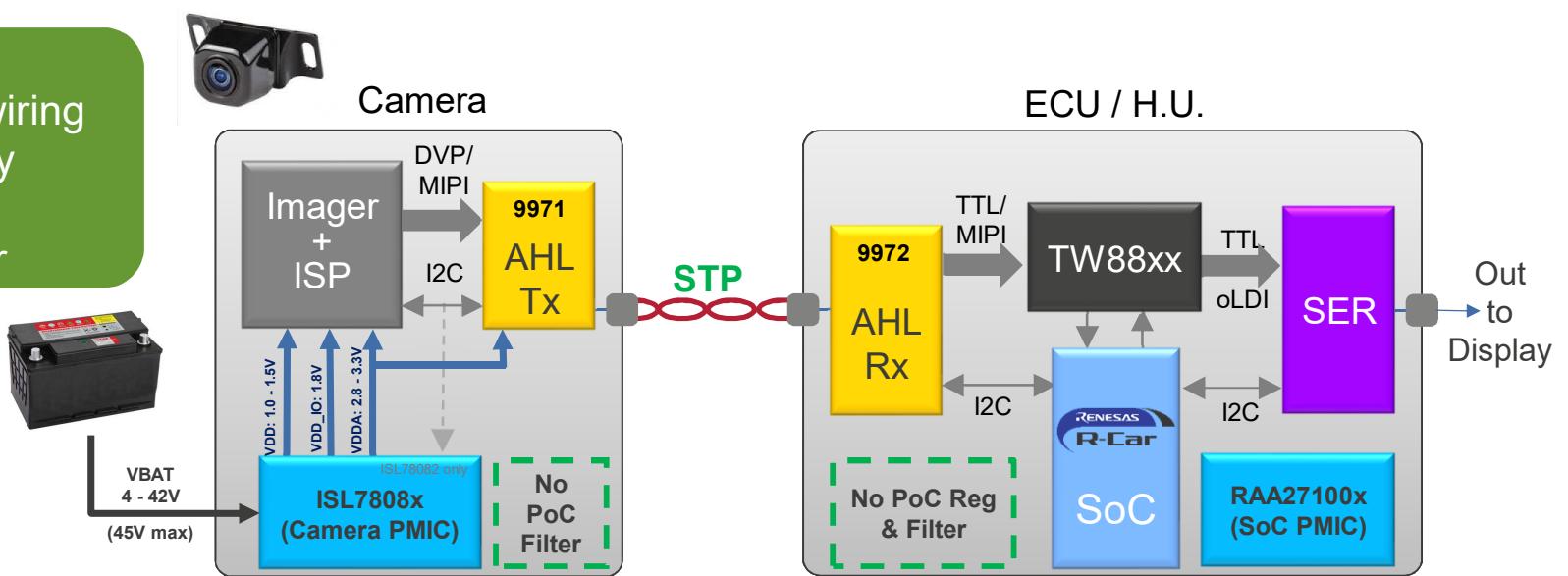
ISL78083: Released (MP)  
ISL78082: WS1 Now

## Advantages of AHL

- Supports low cost STP wiring

## Advantages of VBAT Supply

- Eliminate PoC filters
- Eliminates PoC regulator



## ISL7808x Camera PMICs

- Highest Efficiency
- Best Automotive Features
- Fewest BOM Components

## Automotive Feature Set

- Switching Freq. = 2.2MHz
- Spread Spectrum Clocking
- Load-dump Tolerant 1<sup>st</sup> Buck

## ISL78083

- QM w/ PG Status Pins

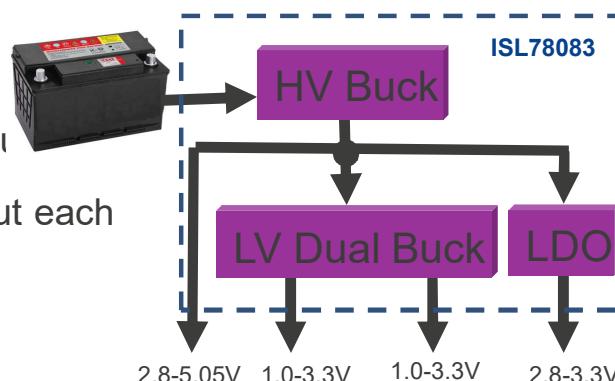
## ISL78082

- ASIL B w/ I<sub>2</sub>C and GPIO

# ISL78083: 42V 4-CH UNIVERSAL POWER SUPPLY FOR AUTOMOTIVE CAMERAS

## Key Functional Blocks

- 1 42V Primary Buck, 750mA Iout
- 2 Secondary Bucks, 750mA Iout each
- 1 Secondary Linear Regulator, 300mA Iout
- 4 Voltage Monitors with 3 PG outputs
- 1 Programmable Reset Output (RSTb)

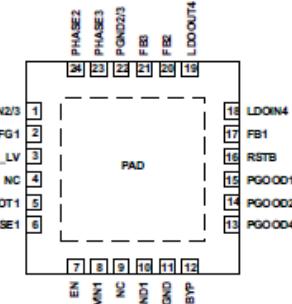
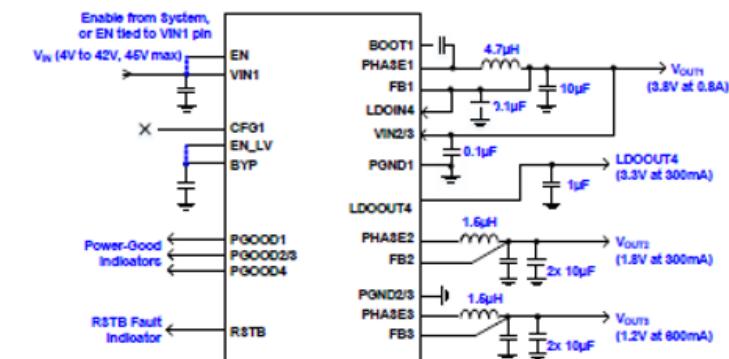


## Internally Programmable Features

- Output voltages, 50mV resolution
- OV/UV supervision thresholds, +/- 4, 6, 8, 12%
- Startup/shutdown sequence
- Startup slew rates
- Startup & shutdown delays
- Spread spectrum (modulation depth, direction)
- Output discharge
- Reset generation

## Key Features

- *Designed to facilitate compact layout*
- 2.2MHz switching frequency with spread spectrum
- 42V primary can connect to battery and eliminate PoC filter
- Internal Compensation



4x4mm 24-SC-QFN  
AEC-Q100 Grade 1

# ISL78083 SWITCHING REGULATOR SPECIFICATIONS

## Common Regulator Specifications

- Current Mode Control, Cycle-by-cycle Current Limit
- Fsw: 2.2MHz with Pseudo-random Spread-spectrum
  - Selectable via OTP for 1%/2%/3%, enable/disable, upward/middle/downward)
- Output Voltage Tolerance (DC regulation): +/- 1.5%
- Output Voltage UV/OV Monitors:
  - Selectable threshold: +/- 4%, 6%, 8%, 12%
  - Tolerance +/- 1.5%
- Protections: Input UVLO, OC, NOC

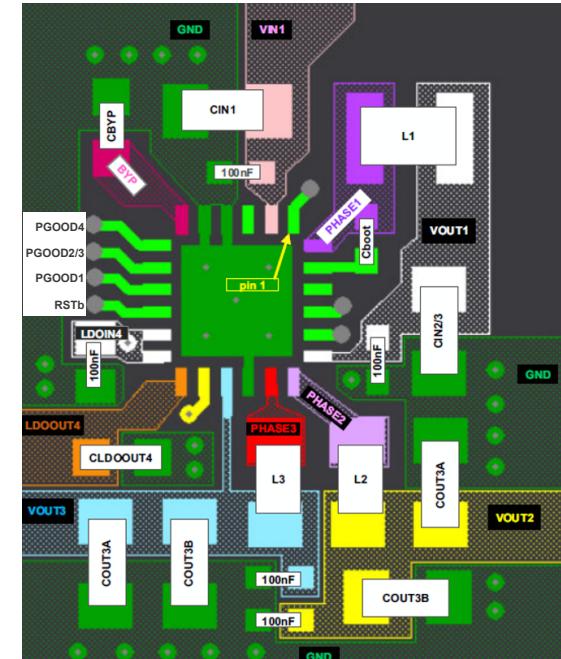
## Buck 2/3 (LV)

- Vout: 1.0...2.55V (50mV resolution), 2.8V, 3.3V
- Iout: 750mA continuous
- Integrated P-ch MOSFET for upper and N-ch MOSFET for lower switch
- Optional output discharge

## LDO4 (LV)

- Vout: 2.8...3.4V, 50mV resolution
- Dropout: 80mV @ 300mA
- Iout: 300mA
- Optional output discharge

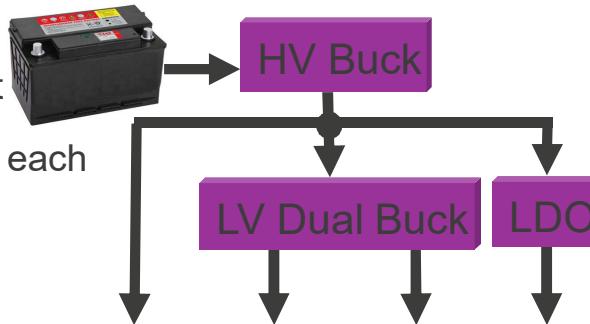
## ISL78082/3 Pin-Compatible PCB Layout



# ISL78082: 42V 4-CH SAFE POWER SUPPLY FOR AUTOMOTIVE CAMERAS

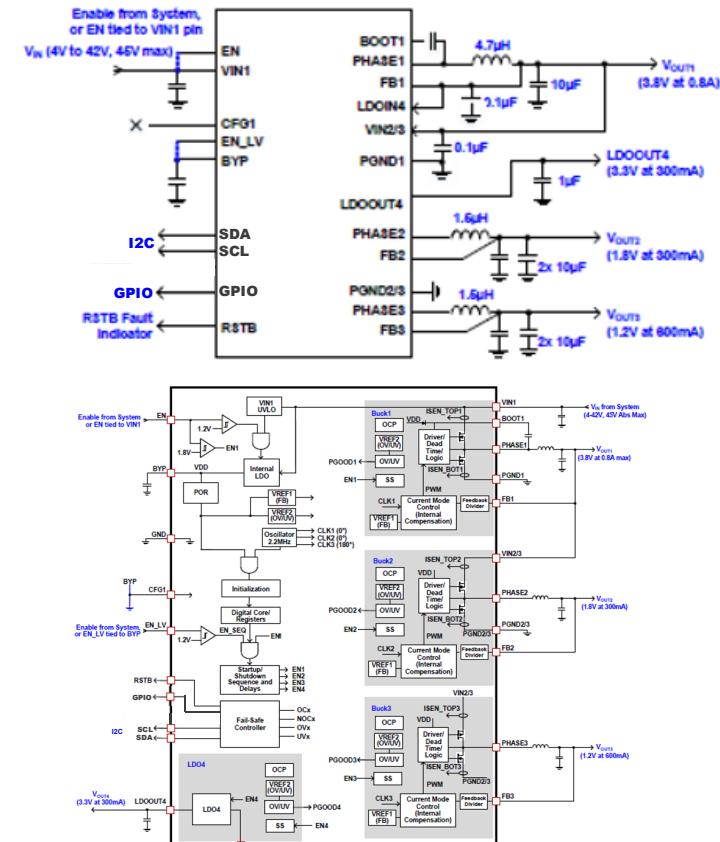
## Key Functional Blocks

- 1 42V Primary Buck, 750mA Iout
- 2 Secondary Bucks, 750mA Iout each
- 1 Secondary Linear Regulator, 300mA Iout
- 4 Voltage Monitors, Window Watch-Dog, I<sup>2</sup>C
- 1 Programmable Reset Output (RSTb)
- 1 Programmable GPIO
- **Key Features**
  - Conforms to ISO-26262 ASIL B Functional Safety
    - Dual Ref, Voltage Monitors, WWDT, OT, BIST, I<sup>2</sup>C w/ CRC



## Internally Programmable Features

- Output voltages, 50mV resolution
- OV/UV supervision thresholds, +/- 4, 6, 8, 12%
- Startup/shutdown sequence
- Startup slew rates
- Startup & shutdown delays
- Spread spectrum (modulation depth, direction)
- Output discharge
- Reset generation



# ISL78082 SWITCHING REGULATOR SPECIFICATIONS

## Common Regulator Specifications

- Current Mode Control, Cycle-by-cycle Current Limit
- Fsw: 2.2MHz with Pseudo-random Spread-spectrum
  - Selectable via OTP for 1%/2%/3%, enable/disable, upward/middle/downward)
- Output Voltage Tolerance (DC regulation): +/- 1.5%
- Output Voltage UV/OV Monitors:
  - Selectable threshold: +/- 4%, 6%, 8%, 12%
  - Tolerance +/- 1.5%
- Protections: Input UVLO, OC, NOC

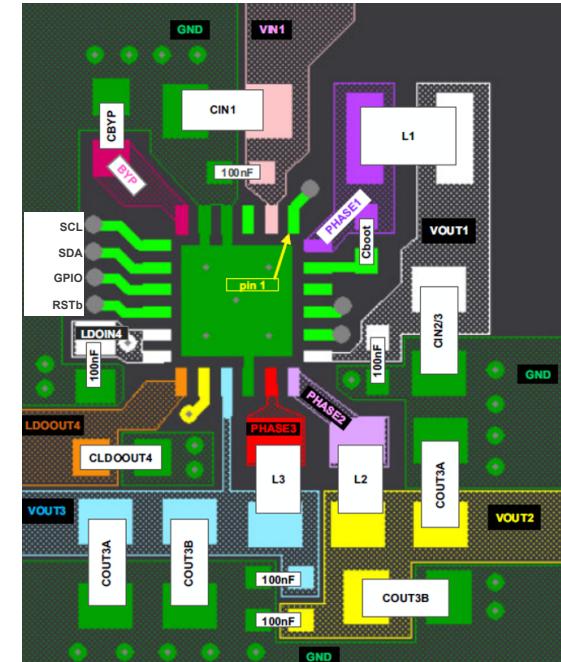
## Buck 2/3 (LV)

- Vout: 0.85...2.1V (50mV resolution), 2.2...2.5 (100mV resolution), 2.8V, 3.3V
- Iout: 750mA continuous
- Integrated P-ch MOSFET for upper and N-ch MOSFET for lower switch
- Optional output discharge

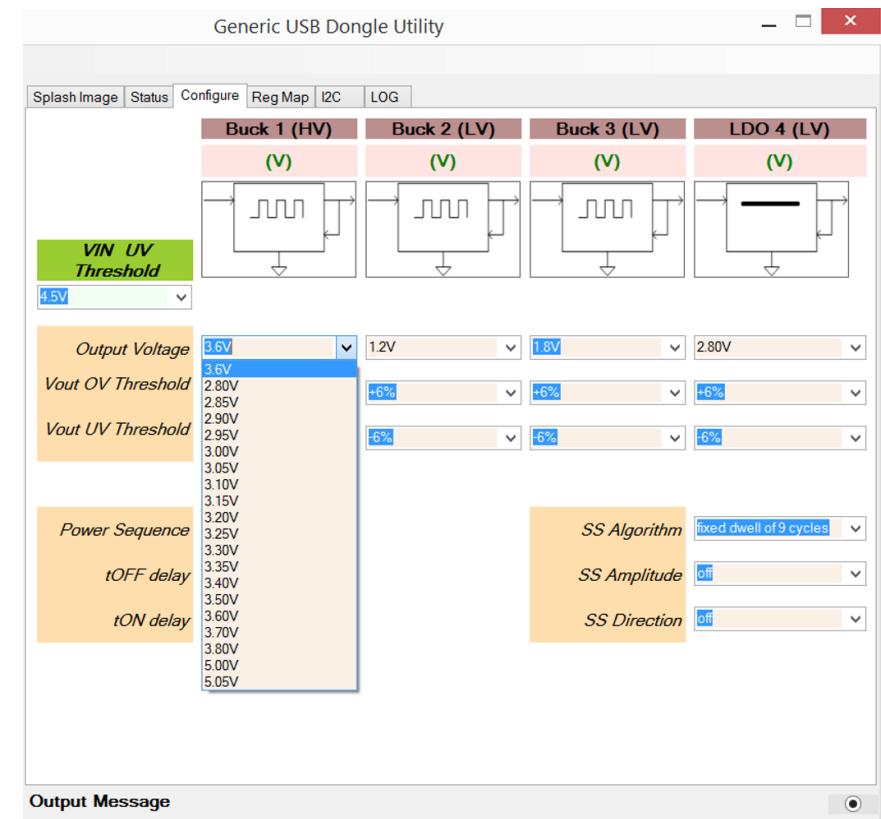
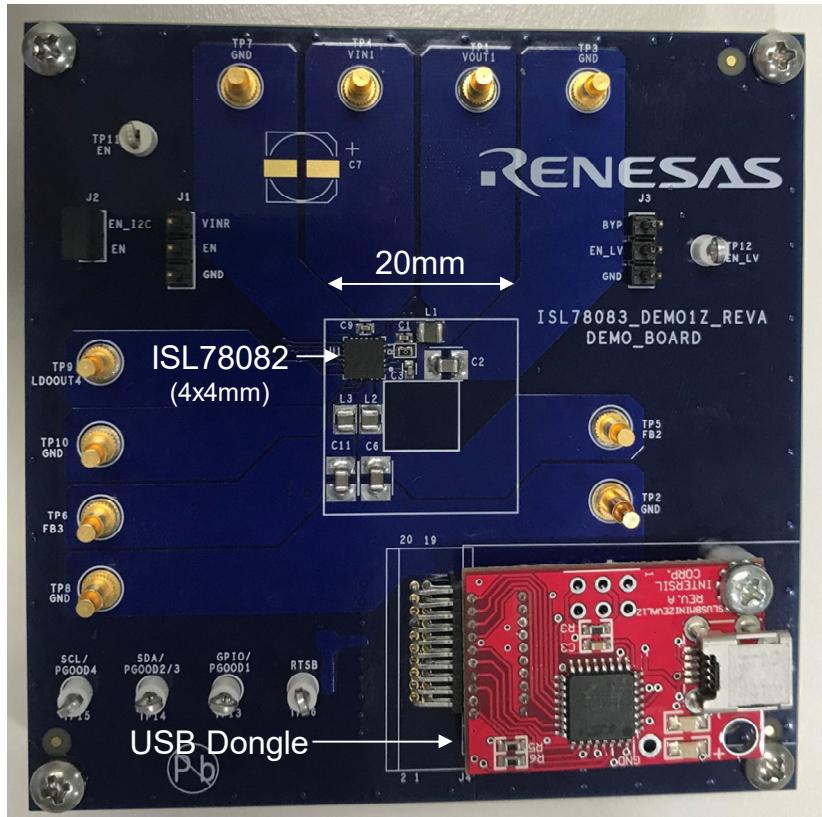
## LDO4 (LV)

- Vout: 2.7...3.0V (50mV resolution), 3.1, 3.2, 3.25, 3.3, 3.35, 3.4V
- Dropout: 80mV @ 300mA
- Iout: 300mA
- Optional output discharge

## ISL78082/3 Pin-Compatible PCB Layout



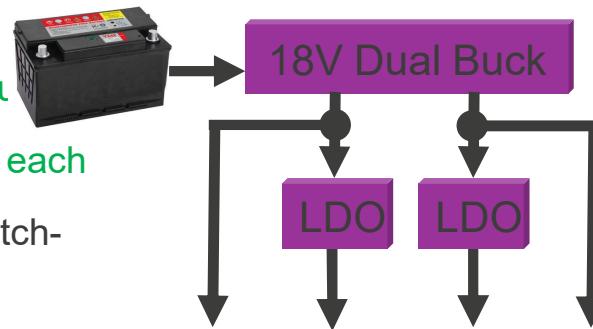
# EVALUATION BOARD WITH GUI TO CONFIGURE ALL OPTIONS



# ISL78081: 18V 4-CH SAFE POWER SUPPLY FOR AUTOMOTIVE CAMERAS

## Key Power Supply Blocks

- 2 18V Primary Bucks, 600mA Iout
- 2 Secondary LDOs, 300mA Iout each
- 4 Voltage Monitors, Window Watch-Dog
- 1 Programmable Reset Output (RSTb)
- 1 Programmable GPIO

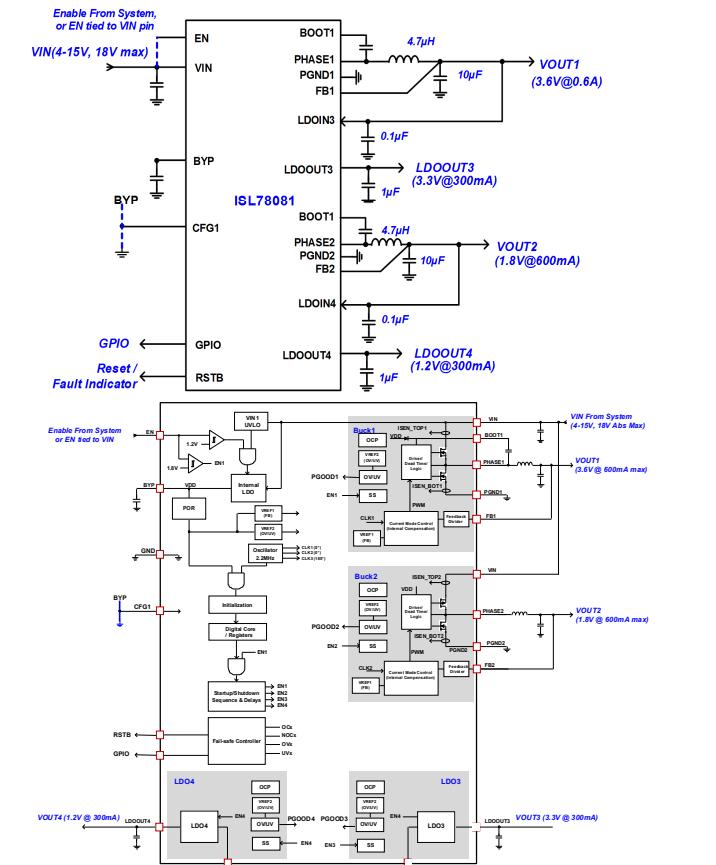


## Internally Programmable Features

- Output voltages, 50mV resolution
- OV/UV supervision thresholds, +/- 4, 6, 8, 12%
- Startup/shutdown sequence
- Startup slew rates
- Startup & shutdown delays
- Spread spectrum (modulation depth, direction)
- Output discharge
- Reset generation

## Key Features

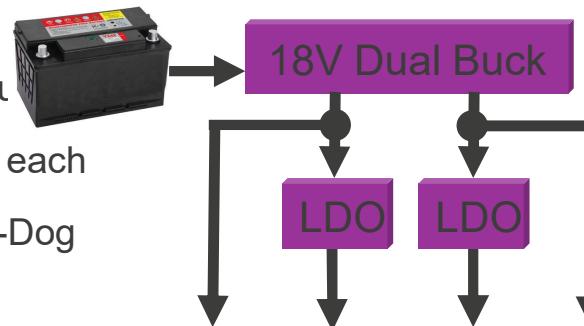
- *Designed to miniaturize Power-over-Coax cameras*
- Conforms to ISO-26262 ASIL B Functional Safety
  - Dual Ref, Voltage Monitors, WWDT, OT, BIST, CRC
- 2.2MHz switching frequency with spread spectrum
- Internal compensation



# RAA271080: 18V 4-CH SAFE POWER SUPPLY FOR AUTOMOTIVE CAMERAS

## Key Power Supply Blocks

- 2 18V Primary Bucks, 600mA Iout
- 2 Secondary LDOs, 300mA Iout each
- 4 Voltage Monitors, QNA Watch-Dog
- 1 Programmable Reset Output (RSTb)
- 1 Programmable GPIO

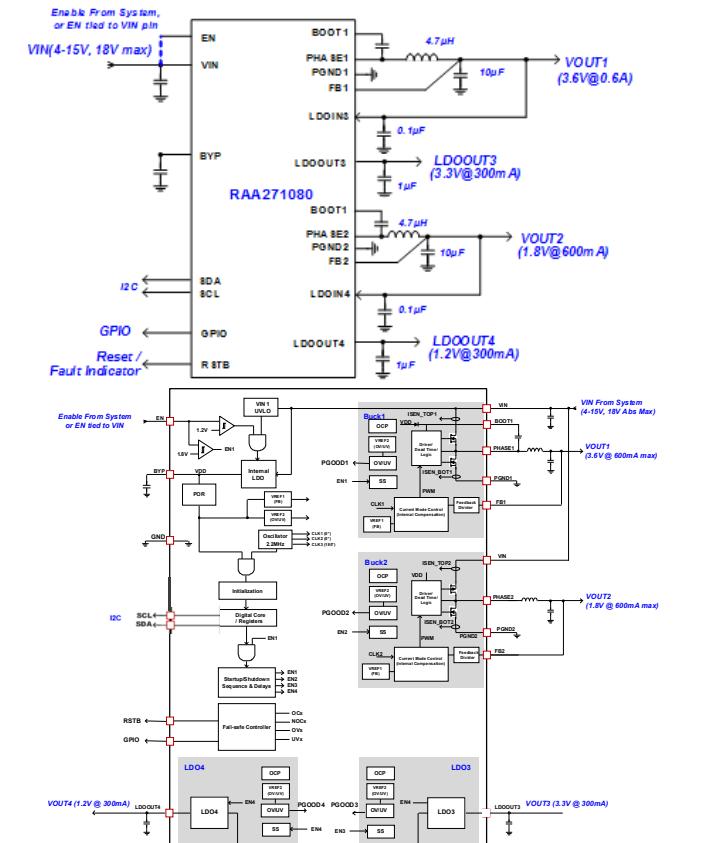


## Key Features

- *Designed to miniaturize Power-over-Coax cameras*
- Conforms to ISO-26262 ASIL D Functional Safety
  - Dual Ref, Dual Temp Sensor, Voltage Monitors, QNA WDT, BIST, I2C w/ CRC
- 2.2MHz switching frequency with spread spectrum

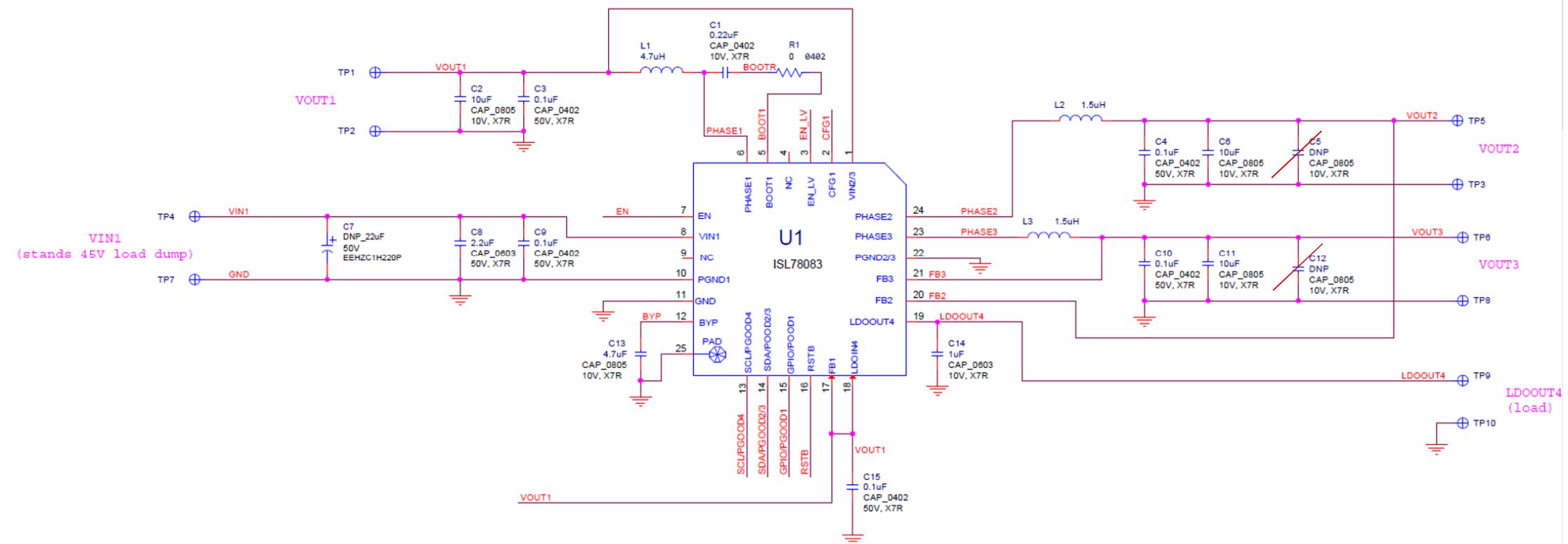
## Internally Programmable Features

- Output voltages, 50mV resolution
- OV/UV supervision thresholds, +/- 4, 6, 8, 12%
- Startup/shutdown sequence
- Startup slew rates
- Startup & shutdown delays
- Spread spectrum (modulation depth, direction)
- Output discharge
- Reset generation

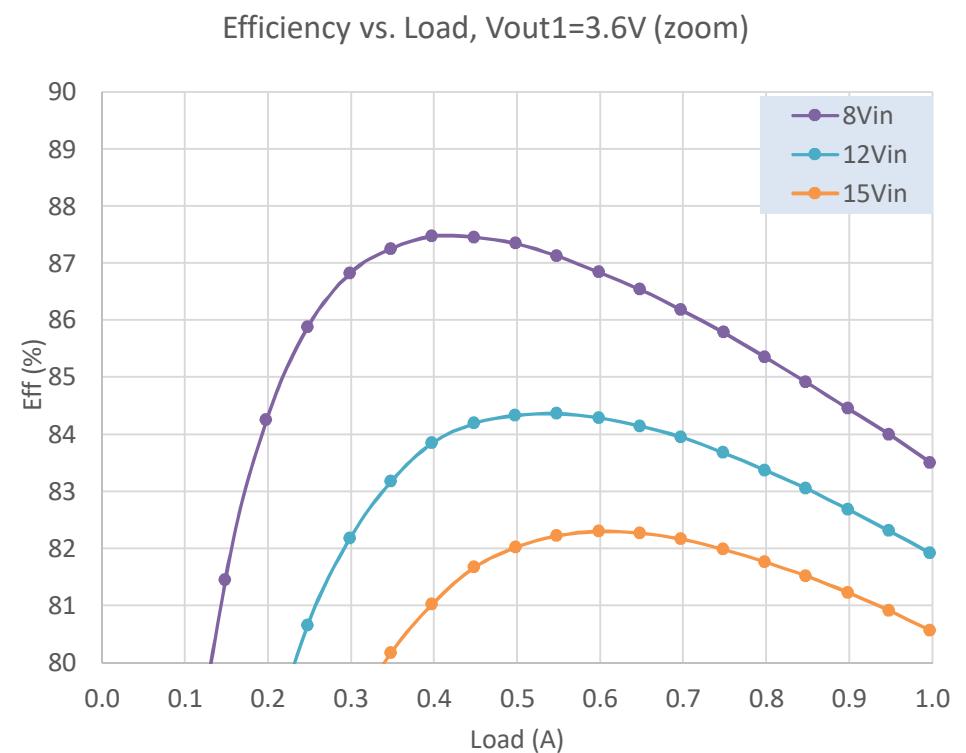
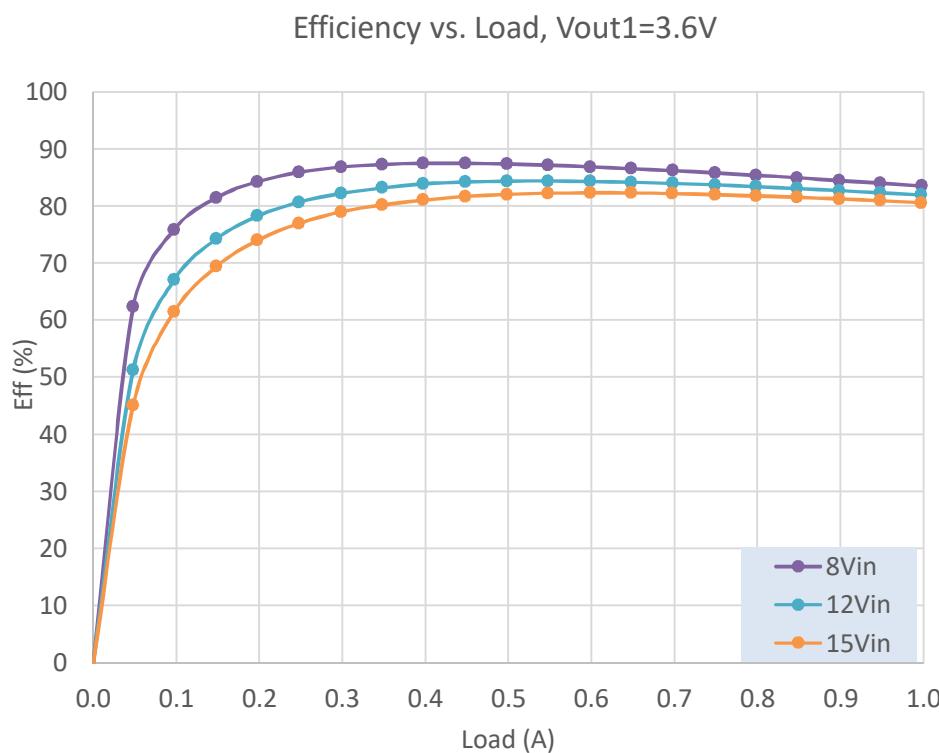


# SELECT ELECTRICAL CHARACTERISTICS (ISL78082/3)

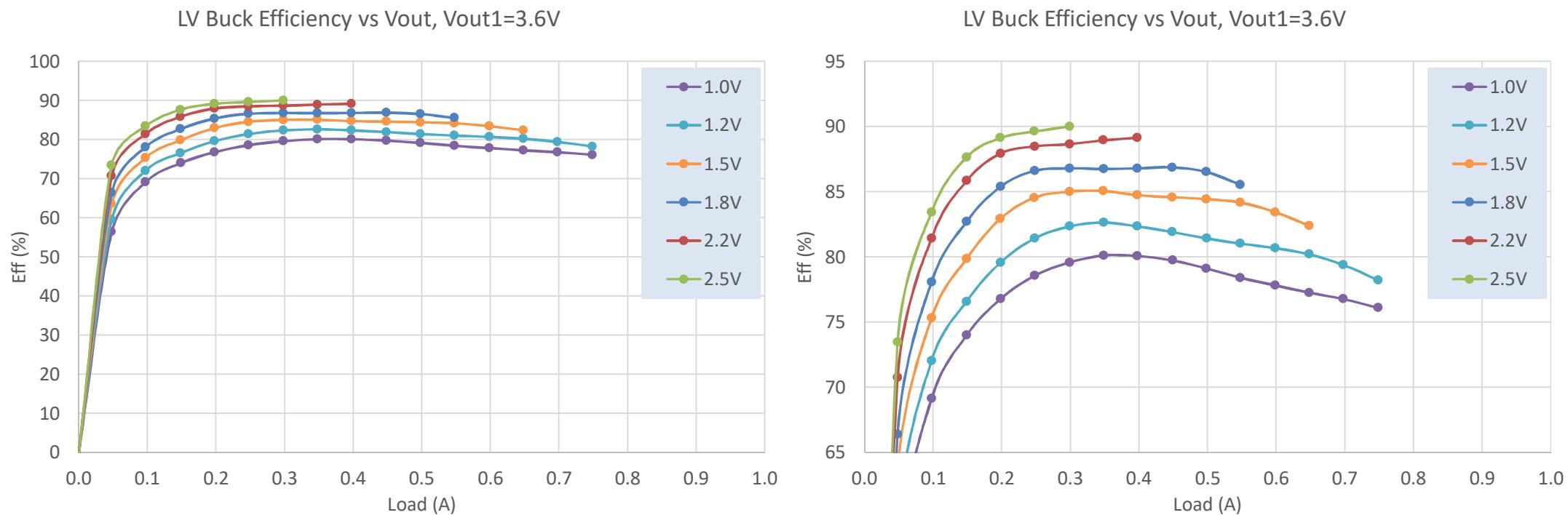
# TYPICAL SCHEMATIC (FROM EVB)



# TYPICAL EFFICIENCY OF HV BUCK @ VOUT=3.6V



# TYPICAL EFFICIENCY DATA OF LV BUCK, VIN (HV BUCK VOUT) = 3.6V



# STARTUP / SHUTDOWN WAVEFORMS BY EN

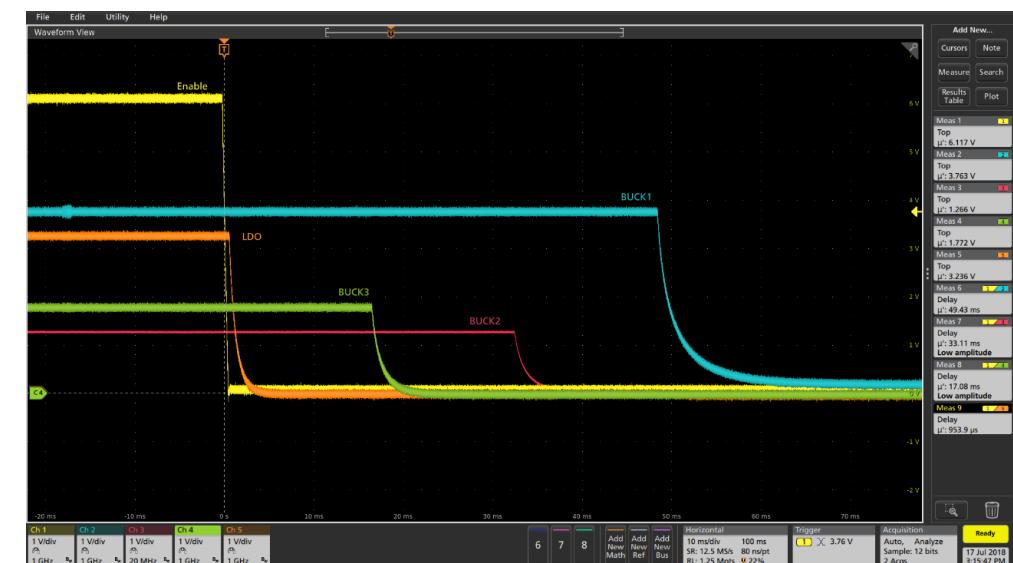
## Programmable Items

- Sequence (LDO first/last of LV Regulators)
- Delay between outputs (0 to 32ms)
- Ramp-rate of each output



## Programmable Items

- Delay between outputs (0 to 32ms)
- LV Output Pull-down On/Off



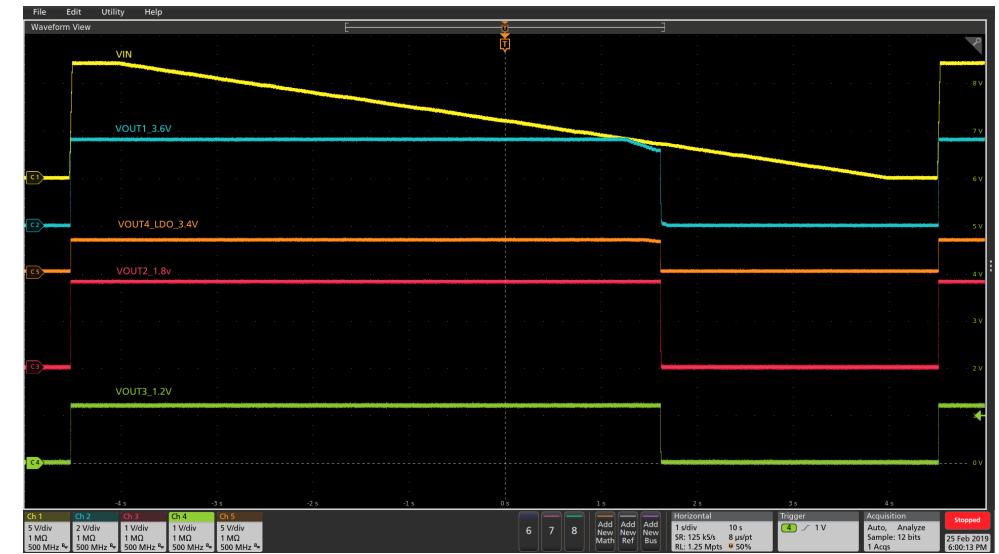
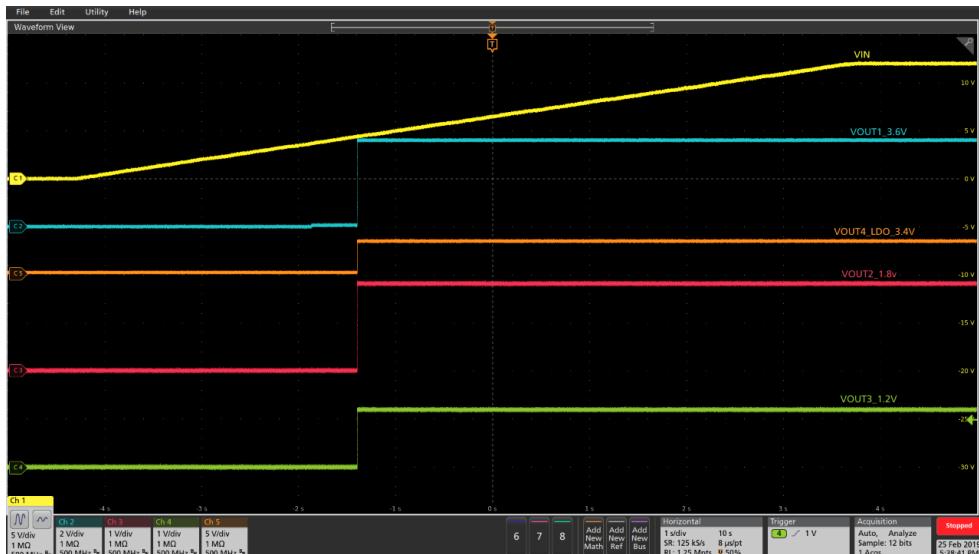
# STARTUP/SHUTDOWN BY VIN

VIN Ramp = 1.6mV / ms

- All regulators have 100-ohm load

VIN Ramp = -1.6mV / ms

- All regulators have 100-ohm load



# ISL78226/4, ISL78424

2<sup>ND</sup> GEN 2.0/3.0KW 12-48V BIDIRECTIONAL DC/DC REFERENCE DESIGN

# ISL78224 & ISL78226 OVERVIEW

## Bidirectional Synchronous Controller

- A single controller supports 2, 3, 4, and 6-ph operation
- Controls both buck & boost directions
- Regulates output voltage and inductor current
- Cycle-by-cycle positive and negative current limiting
- Supports forced-synchronous (forced-PWM) or diode-emulation modes for all phases
- Optional automatic phase dropping/adding
- Current monitor output with 2% gain accuracy from 0 to full load
- Digitally programmable average current limit
- Analog or PWM-controlled output voltage tracking, over 4:1 range

## PMBus Communication Port for Configuration and Telemetry

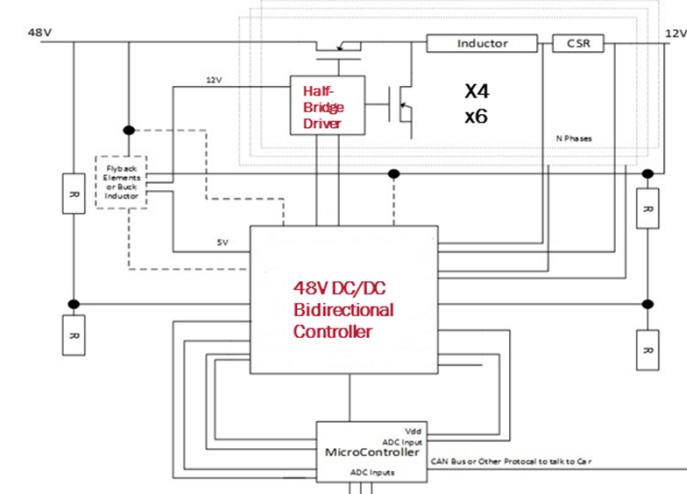
- Detailed status and fault diagnostics
- Programmable fault thresholds, fault responses, operating modes
- Warning and fault interrupt signals

## Integrated Dual-output Flyback Controller

## Integrated Auxiliary 200mA Linear Regulator

AEC-Q100 Grade 1:  $T_A$ : -40 to 125 C

Package: 10x10mm 64-pin TQFP



# ISL784X4

100V, 4A HALF BRIDGE DRIVER WITH TRI-LEVEL INPUT AND ADAPTIVE  
DEAD-TIME CONTROL

# ISL784XX: 100V-BOOT 3A/4A HALF-BRIDGE DRIVERS

## 3A Sourcing / 4A Sinking Half-Bridge Drivers

- Tri-level PWM input or Hi/Li input (opt.)
- Independent source/sink outputs (opt.)
- Adaptive dead-time control with programmable dead-time
- Integrated boot diode

## Voltage Ratings

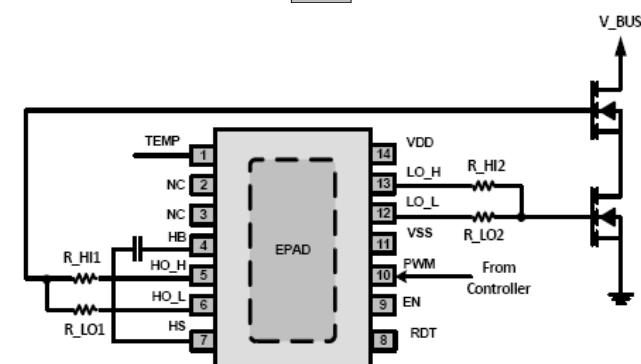
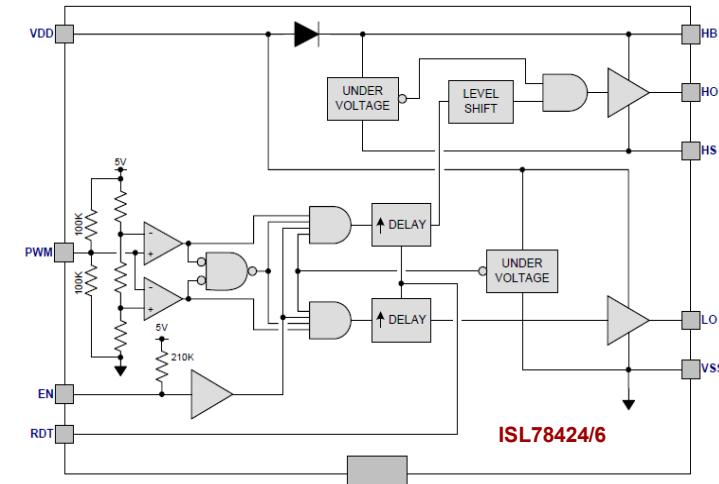
- Absolute Maximums
  - VDD: 20V
  - HB (Load Dump): 100V
  - HS (Load Dump): = -10 to 86V
- Recommended Max Operating
  - VDD: 8 - 18V
  - Bootstrap Supply, HB (DC): 86V
  - HS (DC): 70V

14-1d HTSSOP, pin-compatible with ISL78420

Ta: -40 to 125C, AEC-Q100 Qualified

- Maximum Operating Junction Temp = 150C

Samples Available Now  
Production Release in Q3 2018



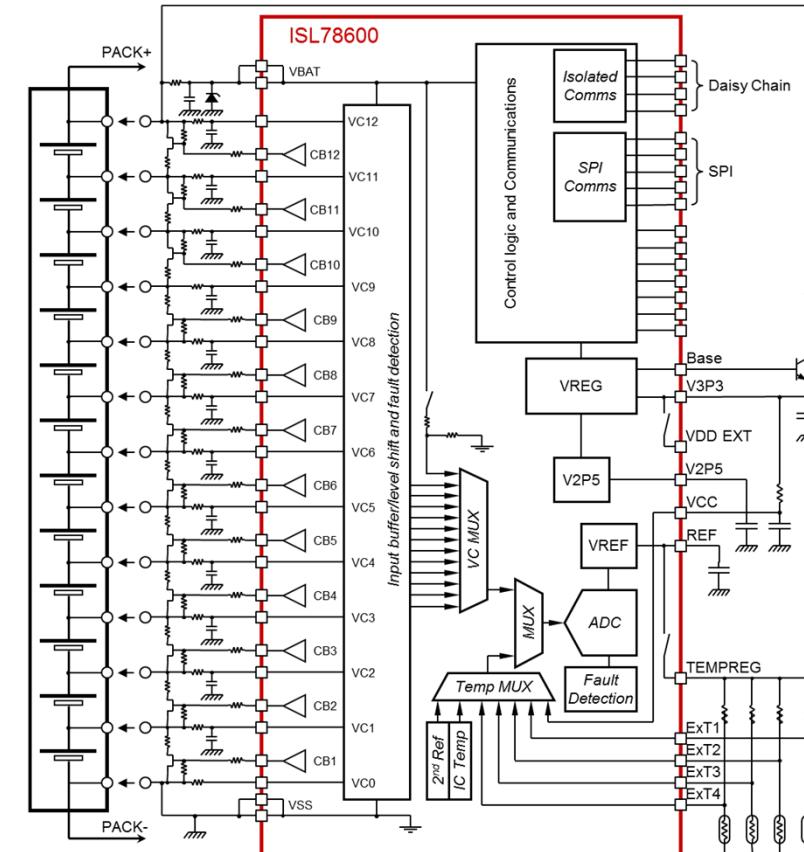
# BMS TECHNOLOGY SOLUTIONS

# ISL78600 – LI-ION BATTERY PACK MANAGER

ISO26262 ASIL C

AEC-Q100

- Up to 12 cell voltage monitors
- Cell voltage measurement accuracy  $\pm 1.5\text{mV}$
- VBAT measurement accuracy  $\pm 100\text{mV}$
- Cell voltage scan rate of 19.5 $\mu\text{s}$  per cell
- Proprietary Daisy Chain communications system
  - Robust EMI performance
  - Excellent system transient resistance
- Extensive integrated diagnostic functions:
  - Cell over and under voltage
  - Over temperature
  - Open cell monitoring wires
  - Open temperature monitoring wires
  - VBAT and VSS connection integrity
  - Voltage reference function
  - Oscillator function
- 64 lead TQFP package

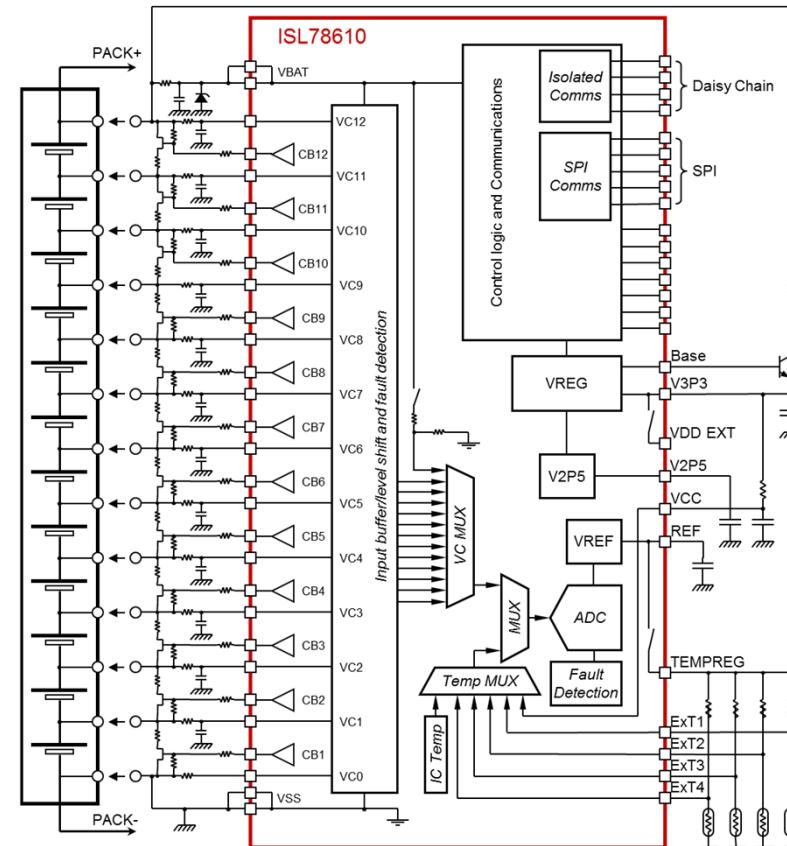


# ISL78610– LI-ION BATTERY PACK MONITOR

ISO26262 ASIL C

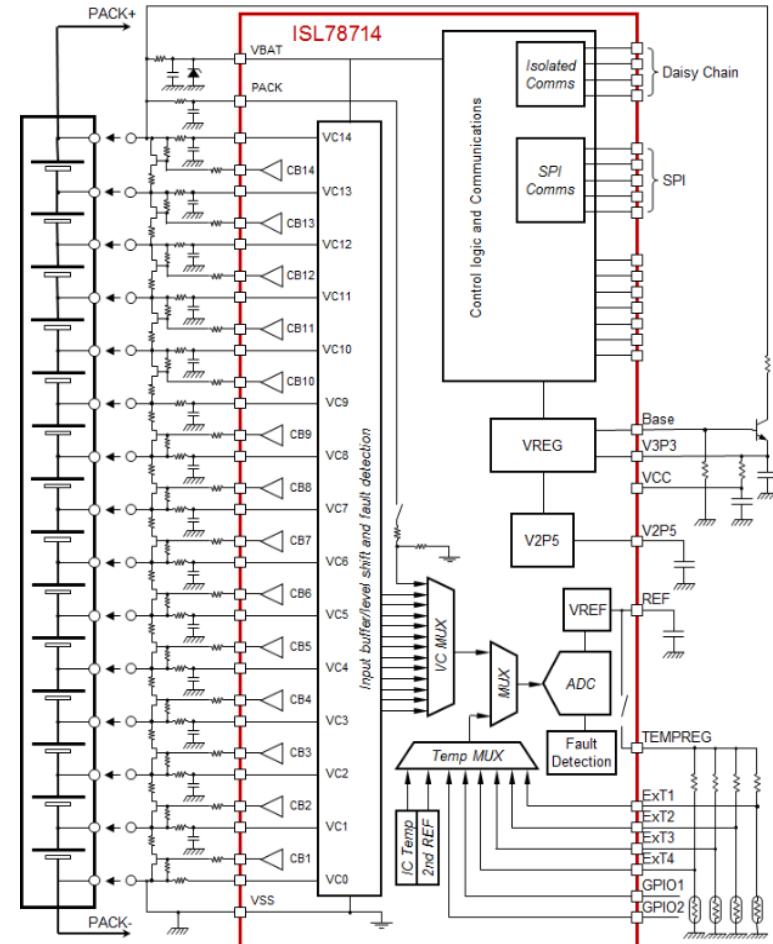
AEC-Q100

- Up to 12 cell voltage monitors
- Cell voltage measurement accuracy  $\pm 10.0\text{mV}$
- VBAT measurement accuracy  $\pm 100\text{mV}$
- Absolute voltage measurement rather than preset levels
- Internal and External temperature monitoring
- Watchdog timer shuts down device if communications is lost
- Proprietary Daisy Chain communications system
  - Robust EMI performance
  - Excellent system transient resistance
  - Capacitive isolation – cost effective
- Integrated system diagnostics for all key internal functions
- 2Mbps SPI
- 64 lead TQFP package

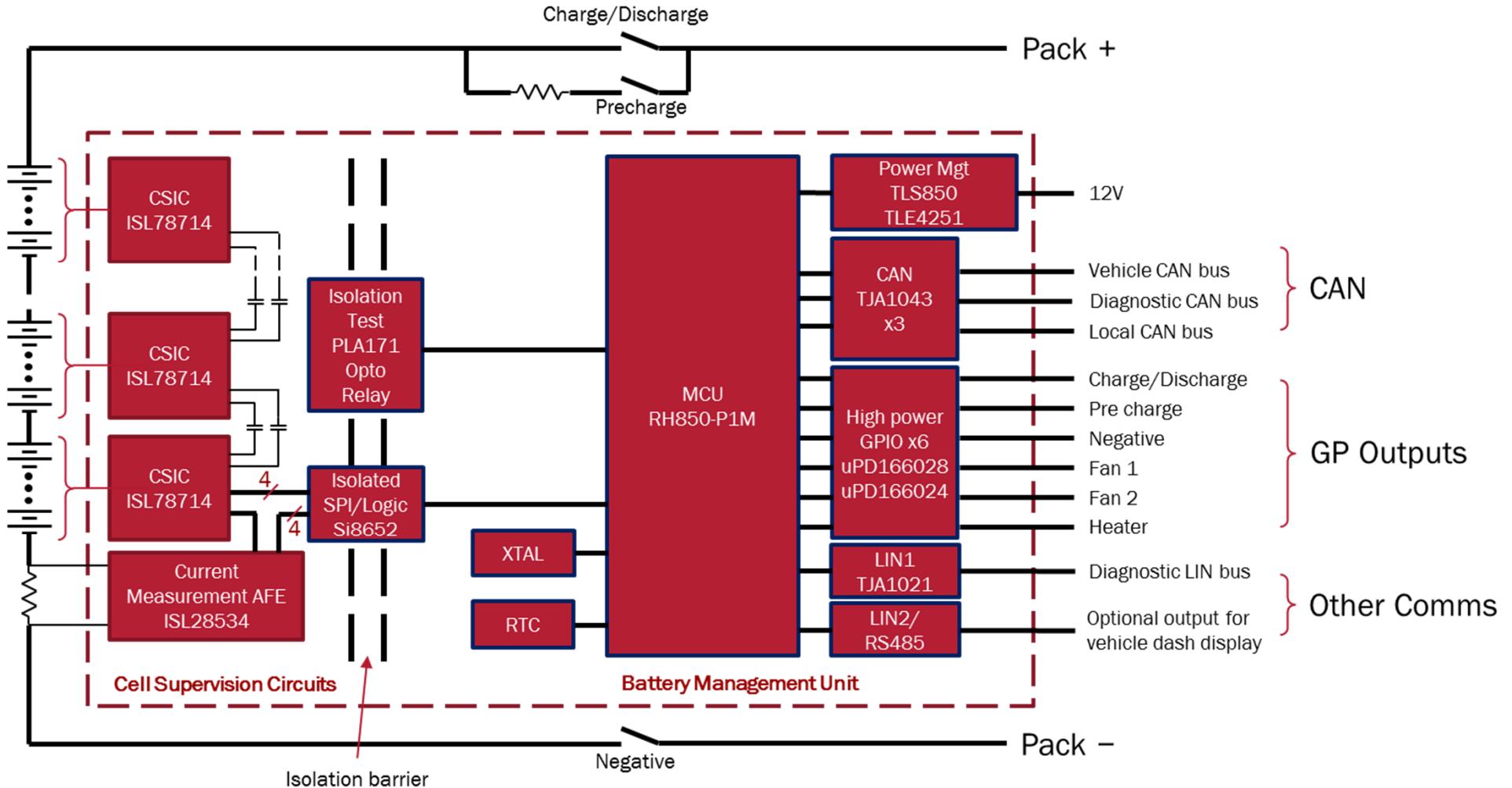


# ISL78714—NEXT GENERATION LI-ION PACK MANAGER

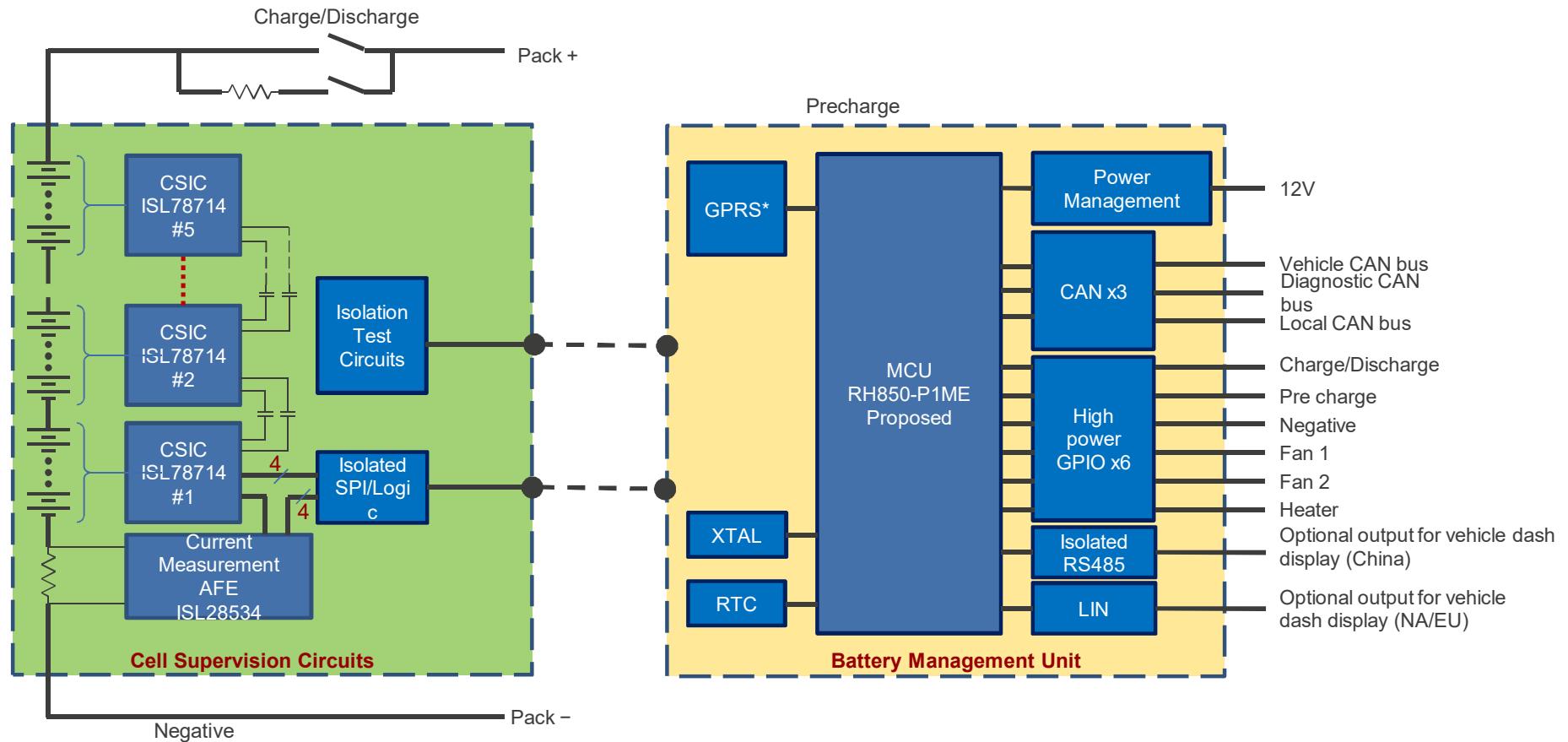
- Up to 14 cell voltages
- Cell voltage measurement accuracy  $\pm 2.0\text{mV}$
- ASIL-C for cell voltage and temperature measurements
- Cell Inputs  $\pm 5\text{V}$  measurement range
- 2x GPIO & 4x Temp Sensor Inputs
- Proprietary Low power high security Daisy chain
  - Capacitor or transformer coupling
  - Robust EMI performance
  - Excellent system transient resistance
- 16b and 32b CRC coverage
- Integrated diagnostic functions:
  - Cell over and under voltage
  - Over temperature
  - Open cell monitoring wires
  - Open temperature monitoring wires
  - VBAT and VSS connection integrity
  - Voltage reference function
  - Oscillator function
- 64 lead TQFP package



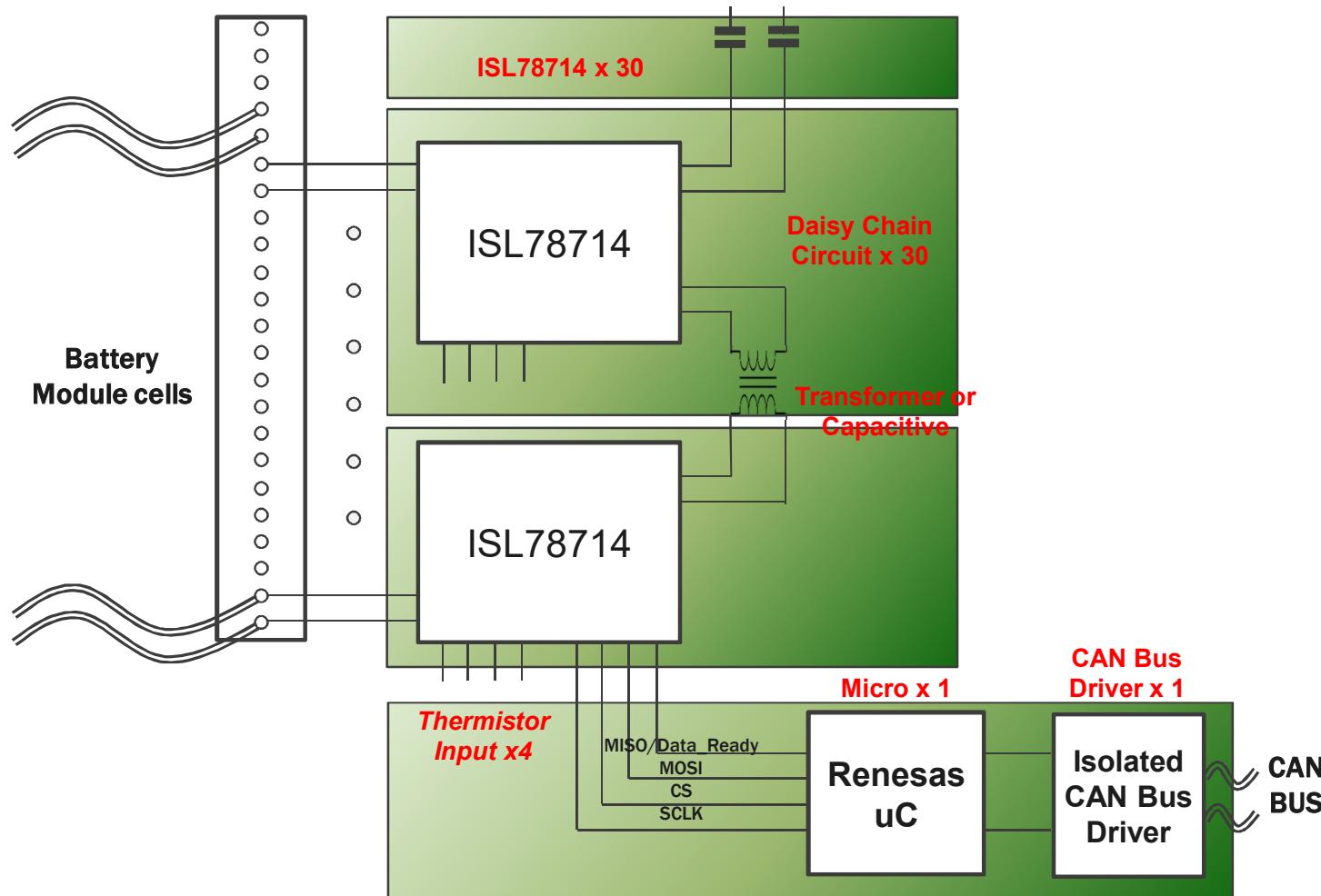
# RENESAS BATTERY MANAGEMENT SYSTEM USING ASIL-C RH850 MCU



# RENESAS BMS – FIRST STAGE DUAL BOARD SOLUTION



# CELL BALANCER BLOCK WITH ISL78714



**BIG IDEAS FOR EVERY SPACE**