INDUSTRIAL POWER MANAGEMENT

Rugged, high-performance power solutions for demanding environments

2023.12

PROVIDING SOLUTIONS FOR TODAY'S COMPLEX POWER NEEDS

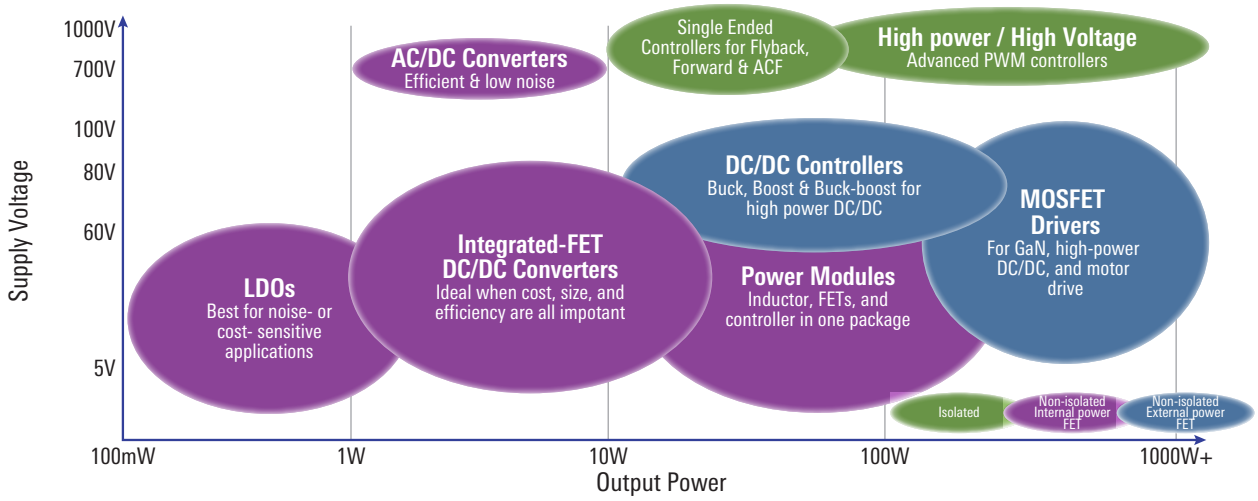
INDUSTRIAL POWER

Contents

Complete Power Solutions

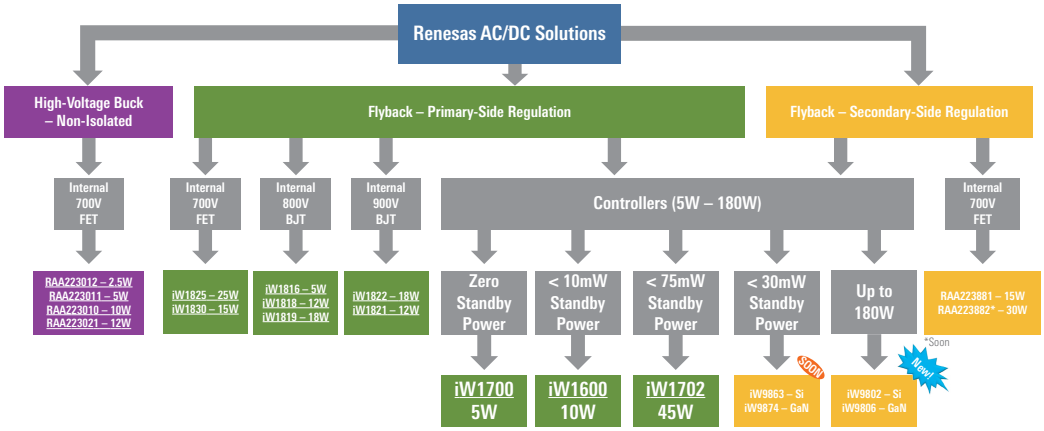
Renesas offers a complete portfolio of high-performance power solutions for processor, controller, DSP, FPGA, CPLD, DDR memory, and other loads in your system. Whether you need standard linear regulators, highly flexible DC/DC converters, or fully integrated power modules, our products are tailored to meet your design challenges.

FROM MILLIWATTS TO KILOWATTS, WE CAN SUPPORT YOUR APPLICATION



AC/DC POWER CONVERSION

AC/DC Product Solutions



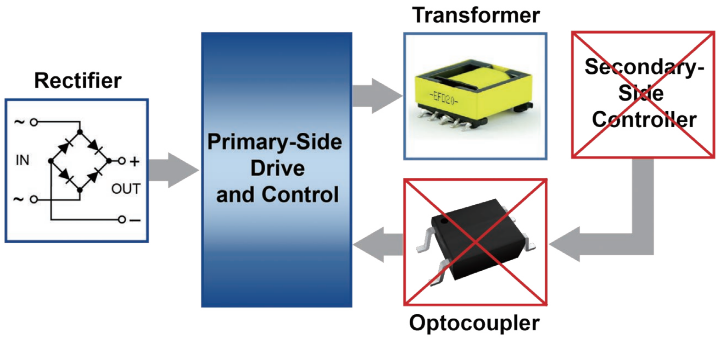
AC/DC Non-Isolated High-Voltage Buck Converters

Product	Typical Output Power (max.)	Power Supply Topology	No-Load Standby Power	Driver Type	Key Features	Package
RAA223012	2.5W	Non-Isolated Buck & Flyback	< 10mW	Integrated 700V MOSFET	Low EMI, no audible noise, supports 3.3V or 5V output directly - no second-stage LDO needed	TSOT23-5, SOIC-8
RAA223011	5W	Non-Isolated Buck & Flyback	< 10mW	Integrated 700V MOSFET	Low EMI, no audible noise, supports 3.3V or 5V output directly - no second-stage LDO needed	TSOT23-5, SOIC8-7, SOIC-8
RAA223010	10W	Non-Isolated Buck & Flyback	< 15mW	Integrated 700V MOSFET	Low EMI, no audible noise, supports 3.3V or 5V output directly - no second-stage LDO needed	SOIC8-7
RAA223021	12W	Non-Isolated Buck & Flyback	< 20mW	Integrated 700V MOSFET	Low EMI, no audible noise, supports 3.3V or 5V output directly - no second-stage LDO needed	SOIC8-7

- Non-isolated buck makes AC/DC design easy
  - Eliminates power transformer
- Also supports isolated flyback topologies
- Renesas' Quiet Light-Load PFM Mode
  - No audible noise, even at light load
- Low standby power: 5 to 30mW
- Low EMI (conducted and radiated)
- Supports 3.3V or 5V output directly
  - No second-stage LDO needed

PrimAccurate™ Digital Primary-Side Regulation Technology

- Patented digital primary-side control technology
  - Provides highly accurate voltage and current control
- Uses digital compensation loop – no external compensation required
- Reduced BOM count enables higher MTBF
  - Eliminates secondary-side feedback and regulation components
  - Lower total BOM count yields higher reliability

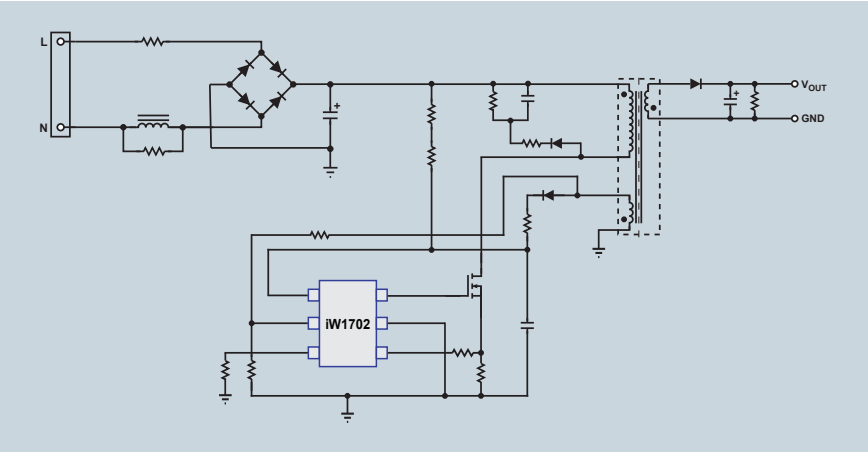


AC/DC *PrimAccurate*™ Primary-Side Isolated Flyback Controllers

Product	Typical Output Power (max.)	Power Supply Topology	No-Load Standby Power	Driver Type	Key Features	Package
iW1700	5W	Primary-side flyback	< 5mW	BJT	Zero Power standby (<5mW)	SOT23-6
iW1600	10W	Primary-side flyback	< 10mW	BJT	Ultra-low standby (<10mW)	SOT23-6
iW1702	45W	Primary-side flyback	< 75mW	MOSFET	Cost effective solution; option for input OVP	SOT23-6

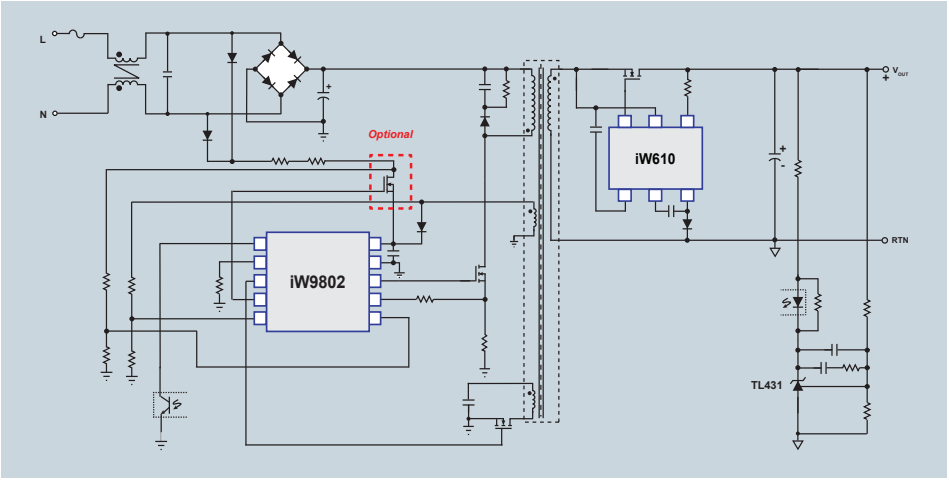
iW1702 – 45W *PrimAccurate™* Primary-Side Isolated Flyback Controller

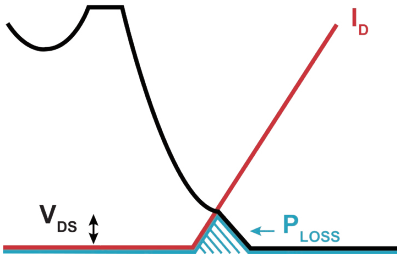
- Quasi-resonant DCM flyback controller
  - 79kHz switching frequency
  - Adjustable light-load mode optimizes for fast transient response and low standby power
    - < 75mW no-load standby power with fast DLR
  - Adaptive multi-mode control
    - High efficiency across all load steps
- Optimized to start into large capacitive loads - 330µF to 6,000µF
- *PrimAccurate™* technology – primary-side regulation
- Optimized for low BOM cost isolated power supplies for appliances, smart meters, smart home applications



High Performance Secondary-Side Regulation Flyback Controllers

Product	Typical Output Power (max.)	Power Supply Topology	No-Load Standby Power	Driver Type	Key Features	Package
iW9802	135W	ZVS Flyback	< 20mW	Silicon FET	High power density ZVS technology	SOIC-10
iW9806	180W	ZVS Flyback	< 20mW	GaN HEMT	High power density ZVS technology; GaN driver	SOIC-10
iW9863	100W	QR Flyback	< 20mW	Silicon FET	Dual-polarity aux winding; adaptive gate drive	SOT23-6
iW9874	100W	QR Flyback	< 75mW	GaN HEMT	Dual-polarity aux winding; GaN driver	SOT23-6





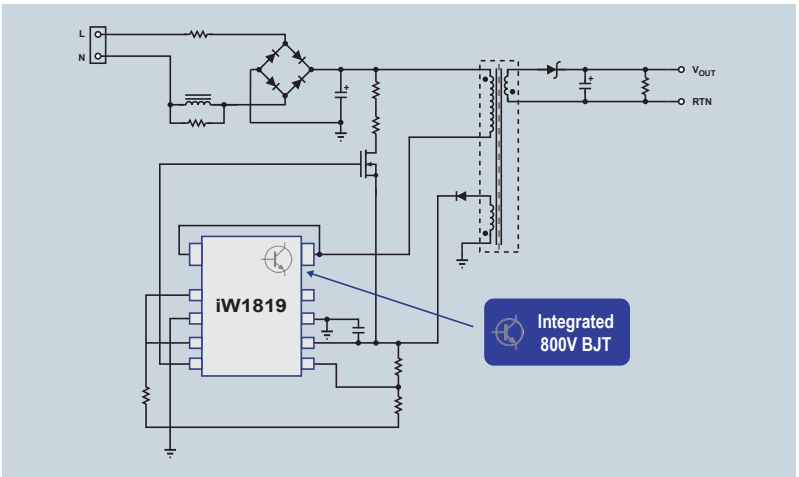
ZVS Flyback Converter V_{DS}

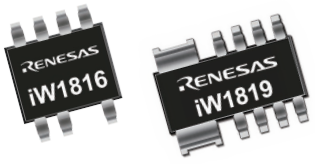
AC/DC *AccuSwitch™* Isolated Flyback Converters

Product	Typical Output Power (max.)	Power Supply Topology	No-Load Standby Power	Integrated Power	Features	Package
iW1816	5W	Primary-side flyback	< 30mW	800V BJT		SO-7
iW1818	12W	Primary-side flyback	< 50mW	800V BJT		PDIP-7
iW1821	12W	Primary-side flyback	< 50mW	1200V BJT	Optimized for high-voltage 3-phase systems	SO-10 Batwing
RAA223181 RAA223182 RAA223183	12W	Secondary-side flyback	< 150mW	900V FET 1000V FET 1000V FET	• Frequency doubling for heavy load operation, up to 12W within 100ms • Valley switching for best efficiency and EMI across full load range • ***CapSaver™*** input OVP – saves input cap cost, shuts off output voltage (RAA223181/2) • ***CapSaver™*** input OVP – saves input cap cost, maintains output regulation (RAA223183) • Single 400V input capacitor for input up to 450VAC	SOIC16-13
iW1820	15W	Primary-side flyback	< 30mW	800V BJT	Optimized for 5V output	SO-10 Batwing
iW1830	15W	Primary-side flyback	< 50mW	700V FET	Optimized for 12V output	PDIP-7
RAA223881	15W	Secondary-side flyback		700V FET	Quasi-resonant switching at full load and PFM at light load for best efficiency and EMI across full load range	PDIP8-7
iW1819	18W	Primary-side flyback	< 30mW	800V BJT		SO-10 Batwing
iW1822	18W	Primary-side flyback	< 30mW	900V BJT	900V high breakdown voltage	SO-10 Batwing
iW1825	25W	Primary-side flyback	< 75mW	700V FET	Configurable light load mode	SO-10 Batwing
SOON RAA223882	30W	Secondary-side flyback		700V FET	Quasi-resonant switching at full load and PFM at light load for best efficiency and EMI across full load range	PDIP8-7

iW1816, iW1819: *AccuSwitch™* AC/DC PWM ICs with Integrated High-Voltage Switch

- PWM controller and 800V BJT in one package
  - iW1816 – 5W output; iW1819 – 18W output
- ***PrimAccurate™*** primary-side regulation eliminates optocoupler
- Isolated flyback power supply topology without adding components
- Optimized to start into high capacitance loads up to 6,000µF
- Meets stringent energy regulations:
  - High light-load and active-mode efficiency
  - < 30mW no-load with fast dynamic load response
- ***EZ-EMI™*** valley mode switching lowers EMI, reduces filtering components size/cost
- Low-cost SOIC-7 package (iW1816)
- Innovative 10-lead SOIC batwing package (iW1819)
  - Provides high-voltage isolation
  - Small footprint, enhanced thermal performance



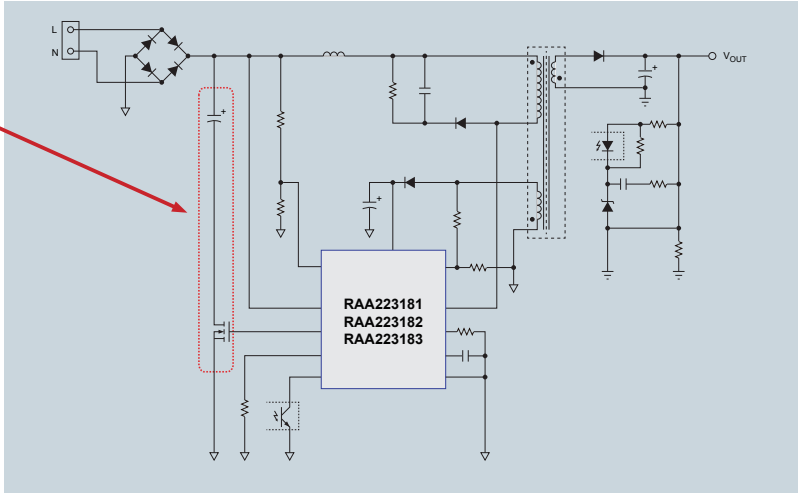


RAA223181/2/3 12W *AccuSwitch™* Isolated Secondary-Side Flyback Converters

- 12W output power, integrated 900V MOSFET (RAA223181)
- 12W output power, integrated 1000V MOSFET (RAA223182/3)
- Very high accuracy secondary-side regulation
- ***CapSaver™*** – single 400V input capacitor for input up to $450V_{AC}$
- Frequency doubling for heavy load operation up to 12W, < 100ms
- Programmable fixed switching frequency, friendly with PLC communication
- Valley switching for best efficiency and EMI across full load range
- Low standby power < 150mW
- Ideal for metering, appliances, smart home power supplies

Renesas' Patent-Pending *CapSaver™* Reduces Cost and Standby Power

- Built-in inrush current limiter
- Eliminates 450V input capacitor to reduce BOM cost
- Eliminates cap balancing resistors
- Always-on output during CapSaver mode - RAA223183



Isolated AC/DC or DC/DC Controllers

Value Proposition:

- High Immunity for transformer signal coupling
- Diode emulation mode for better light load efficiency
- Brick wall OCP protection
- Soft start and soft stop (Supports pre-bias)
- Optimized/adjustable dead time control

Topology Characteristic	Flyback	Forward (two switch)	Active clamp forward	Push-pull	Half-Bridge	Full-Bridge ZVS	Full Bridge (Telecom) Hard SW
Recommended power level	<150W	120W~200W	120- 400W	100W~500W	150W~500W	>400W	>400W
Efficiency	Least ~70-80%	Moderate ~80-90%	High 85~92%	Moderate ~85-93%	High ~95%+	High ~95%+	High ~95%+
Recommended Devices	ISL884X ISL672X	ISL672X	ISL6726	ISL6741	ISL674X	ISL675X	ISL674X
Cost	Least	Low	Low	Low	Medium	High	High
Transfer Function = Vout/Vin	(Ns/Np)*D/(1-D)	(Ns/Np)*D	(Ns/Np)*D	2*(Ns/Np)*D	(Ns/Np)*D	2*(Ns/Np)*D	2*(Ns/Np)*D
High Input Voltage	Good for bias supply	Good for 2-switch forward	Good	Not recommended	Good	Good	Good
Max. Duty Cycle	< 100%	< 50% (70% with active clamp)	70%	< 50% each	< 50% each	< 50% each	< 50% each
Reference Designs	ISL884X ISL672X	ISL672X	ISL6726	ISL6741	ISL674X	ISL675X	ISL674X

ANALOG CONTROLLERS

High Voltage/High Current for Today's Power Demands
Single-Output Analog Controllers

Part No.	V_{IN} Range (V)	V_{OUT} Range (V)	Package	Topology	Technical Highlights
ISL8130	4.5 to 28	0.6 to Dmax*V_{IN}	20 Ld 4x4 QFN, 20 Ld QSOP	Buck, Boost, SEPIC	Universal controller
ISL8117/A	4.5 to 60	0.6 to Dmax*V_{IN}	16 Ld 4x4 QFN, 16 Ld TSSOP	Buck	Current mode, simplified pin-out, low external components
ISL81401/A	4.5 to 40	0.8 to 40	32 Ld 5x5 QFN	Buck-Boost	Bi-Directional, CV/CC for both input and output
ISL81601	4.5 to 60	0.8 to 60	32 Ld 5x5 QFN, 38 Ld HTSSOP	Buck-Boost	Bi-Directional, CV/CC for both input and output
ISL81801	4.5 to 80	0.8 to 80	32 Ld 5x5 QFN, 38 Ld HTSSOP	Buck-Boost	Bi-Directional, CV/CC for both input and output
SOON ISL81100	4.5 to 100	0.8 to 96	25 Ld 5x5 TQFN	Buck	Current mode, support current sharing operation

80V Dual Phase Buck Controllers for Si and GaN FETs — ISL81802 /ISL81806

Key Features

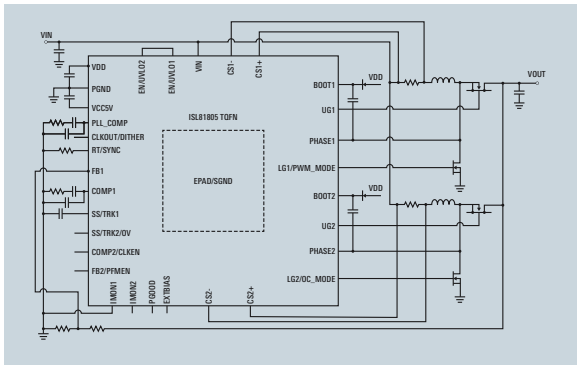
- Integrated CC/CV controller+ driver
- Supports single or dual outputs
- Supports multi-chip paralleling and phase interleaving
- Wide switching frequency: 100kHz to 1MHz
- Selectable mode between PWM/DE/Burst
- Shoot-thru protection, OCP, OVP, OTP, UVP
- ISL81806 with optimized gate drive for GaN FETs

ISL81806 Demo Board
300W,1/16 Brick

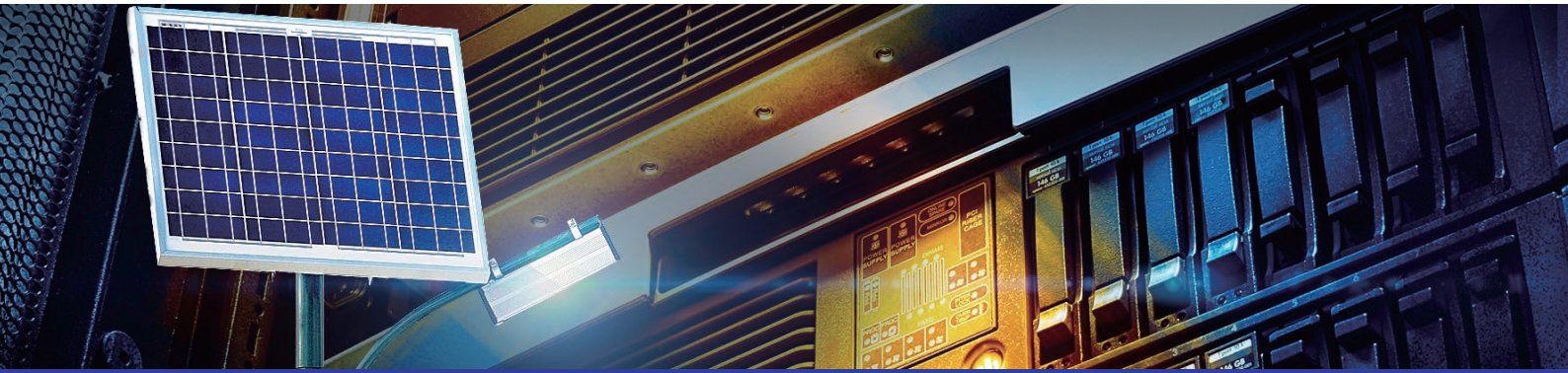
80V Dual Output/Two Phase Boost Controller — ISL81805 /ISL81807

Key Features

- Integrated CC/CV controller+ driver
- Supports single or dual outputs
- Supports multi-chip paralleling and phase interleaving
- Wide switching frequency: 100kHz to 1MHz
- Selectable mode between PWM/DE/Burst
- Shoot-thru protection, OCP, OVP, OTP, UVP
- ISL81807 with optimized gate drive for GaN FETs



Typical Application Diagram



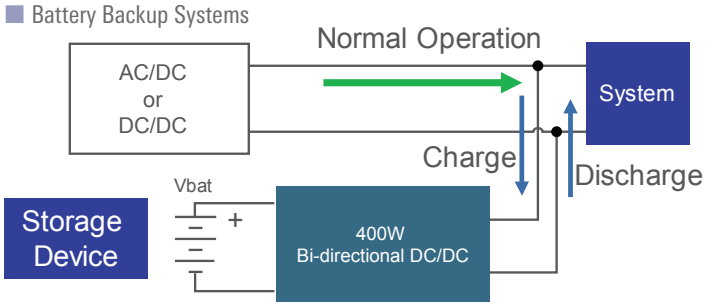
Multi-Outputs and Multiphase Analog Controllers

Output	Part No.	Status	V_{IN} Range (V)	V_{OUT} Range (V)	Package	Topology	Technical Highlights
Dual	ISL81802	Released	4.5 to 80	0.8 to 76	32 Ld 5x5 TQFN 38 Ld HTSSOP	Buck	MOSFET controller
	ISL81806	Released	4.5 to 80	0.8 to 76	32 Ld 5x5 TQFN	Buck	GaN controller
	ISL81805	Released	4.5 to 80	5 to 80	32 Ld 5x5 TQFN	Boost	MOSFET controller
	ISL81807	Released	4.5 to 80	5 to 80	32 Ld 5x5 TQFN	Boost	GaN controller
Up to 12-phase	ISL8126	Released	3.0 to 26.5	0.6 to Dmax*V_{IN}	32 Ld 5x5 QFN	Buck	Current sharing up to 12 phase

ISL81801 80V BI-DIRECTIONAL BUCK-BOOST Controller

Industry's FIRST bi-directional 80V buck-boost controller

- CV/CC for both input and output
- Wide programmable frequency: 100KHz to 600KHz (SYNC to 2MHz)
- Current sharing for parallel operation
- Supports on-the-fly settings change including the current flow
- High reliability with OVP, OCP, OTP, UVLO protection
- Sense both positive and negative inductor peak current



Bidirectional Buck-Boost Controllers

Outputs	Part No.	V_{IN} Range (V)	V_{OUT} Range (V)	Output Current Max (A)	I_Q	POR	SYNCH Capability	External Bias	Control Type	Package Type
Single	ISL81401/A	4.5 to 40	0.8 to 40	Current sharing	3 µA	Yes	Yes	Yes	Current Mode	32 Ld 5x5 QFN
	ISL81601	4.5 to 60	0.8 to 60	Current sharing	3 µA	Yes	Yes	Yes	Current Mode	32 Ld 5x5 QFN, 38 Ld HTSSOP
	ISL81801	4.5 to 80	0.8 to 80	Current sharing	2.7 µA	Yes	Yes	Yes	Current Mode	32 Ld 5x5 QFN, 38 Ld HTSSOP

*Current sharing means current sharing with phase interleaving.

SWITCHING REGULATORS

Wide V_{IN} Coverage

Benefits and Key Features

Robust & Reliable Performance

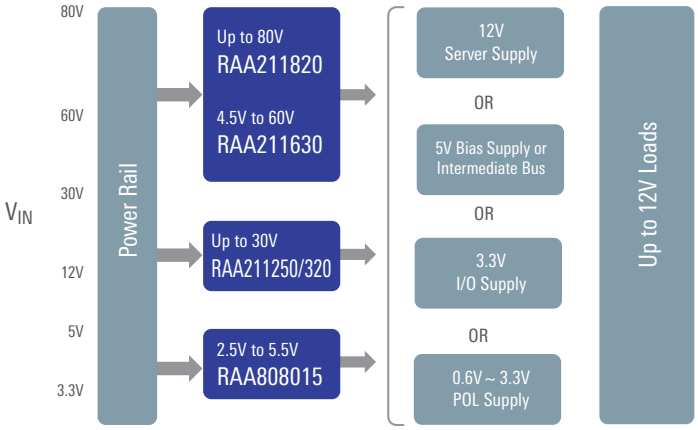
- P_{GOOD}, Enable, adjustable soft-start
- Extensive protection (OCP, OVP, OTP, SCP)
- External frequency synchronization

High Integration

- Integrated HS/LS FETs
- Internal compensation

Target Applications

- High Voltage single board system
- Industrial power system
- Battery powered devices
- Telecommunication base station
- POLs for high performance DSPs, FPGAs, ASICs, and microprocessor

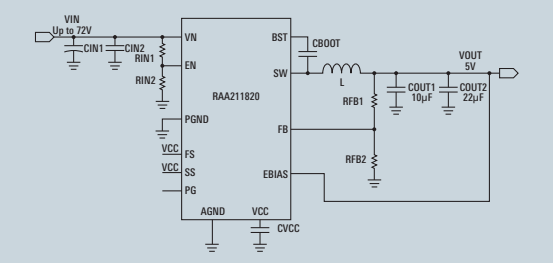


RAA211xxx — New 24V to 75V Sync Buck Regulator Family – Wide V_{IN} Range

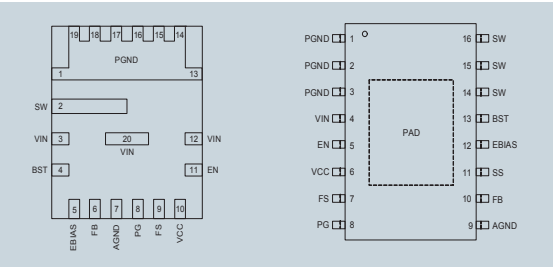
Common Feature

- Integrated high-performance MOSFETs
- Programmable, fixed switching frequency up to 800kHz
- High efficiency light-load operation
- IC can be biased from its own output to improve efficiency
- Power Good, Soft Start, and Enable functions

Part No.	V_{IN} Range	Rdson (High/Low) QFN	Rdson (High/Low) HTSSOP	IOUT	Package
RAA211250	4.5V to 30V	70mΩ/25mΩ	115mΩ/40mΩ	5A	20 Ld 3.5x4 QFN 16 Ld HTSSOP
RAA211450	4.5V to 42V	75mΩ/25mΩ	115mΩ/40mΩ	5A	
RAA211630	4.5V to 60V	110mΩ/40mΩ	155mΩ/55mΩ	3A	
RAA211820	4.5V to 75V	155mΩ/80mΩ	200mΩ/95mΩ	2A	
RAA211835	4.5V to 75V	155mΩ/NA	200mΩ/NA	3A	

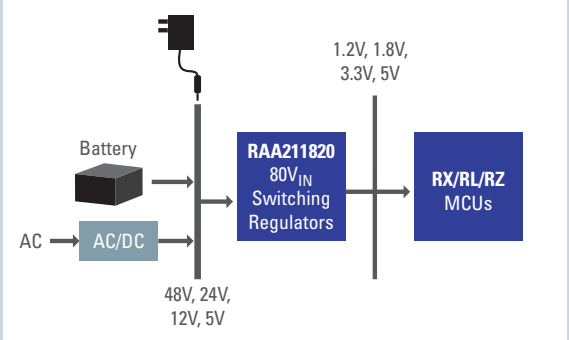


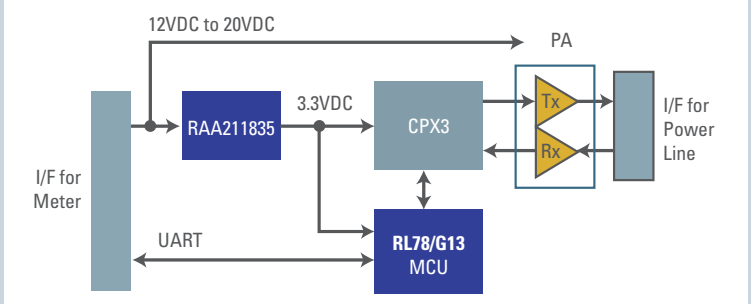
Typical Application Diagram



QFN3.5 x 4 & HTSSOP-16 Package Options

Using 80V Sync Buck Regulator Family to Power MCUs





E-meter System Diagram

RAA211230 24V, 3A Synchronous Buck Regulator

Key Features

- 24V operating max rating is designed for up to 19V nominal input with 20% derating headroom
- Current-mode CoT modulator for excellent transient response
- Small TSOT23-6 package minimizes BOM & cost
- Common footprint to minimize supply chain risk

RAA211233 24V, 3A Synchronous Buck Regulator

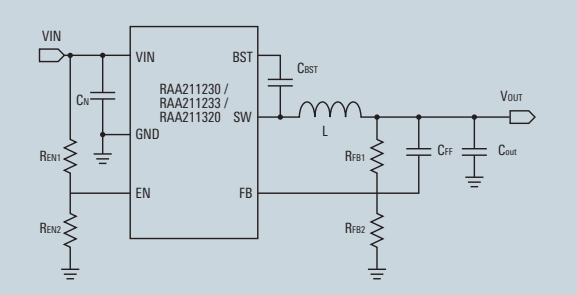
Key Features

- High switching frequency up to 1.4MHz
- PFM for light load operation
- Comprehensive protection: UVLO, OCP, OUVP, OTP

RAA211320 30V, 2A Synchronous Buck Regulator

Key Features

- 4.5V to 30V input, 2A sync buck regulator, 400µA typ Iq
- Frequency 450kHz
- PFM for light load operation
- Comprehensive protection: UVLO, OCP, OUVP, OTP



Part No.	VIN Range	IOUT	FB & Acc	Rdson (High/Low)	Fsw (Hz)	Control Mode	Package
RAA211230	4.5V to 24V	3A	0.765V±0.015V	85mΩ/45mΩ	500K	CoT	TSOT23-6
RAA211233	4.5V to 24V	3A	0.6V±0.012V	85mΩ/45mΩ	1.4M		
RAA211320	4.5V to 30V	2A	0.765V±0.015V	150mΩ/75mΩ	450K		

TSOT23-6
2.9 x 2.8 mm

2.5V-6V Synchronous Buck Regulators

Part No.	Status	I_{OUT} (max) (A)	# of Outputs	V_{IN} Range (V)	V_{OUT} Range (V)	PFM	Ext Comp	Sync	Fsw (Hz)	FB & accuracy	Package
ISL8088	Released	0.8	Dual	2.75 to 5.5	0.6 to V_{IN}	Y	N	Y	2.25M, Sync 4M	0.6±0.01V	10 Ld 3x3 DFN
RAA808013	Released	3	Single	2.7 to 5.5	0.6 to V_{IN}	Y	N	N	1.5M	0.6±0.012V	6 Ld TSOT23
RAA808015A/B	Released	5	Single	2.7 to 5.5	0.6 to V_{IN}	Y/N	N	N	1.8M	0.6±0.012V	8 Ld QFN 2x2.5
ISL80019/A	Released	1.5	Single	2.7 to 5.5	0.6 to V_{IN}	Y	Y	N	1M/2M	0.6±0.005V	8 Ld 2x2 TDFN
ISL80015/A	Released	1.5	Single	2.7 to 5.5	0.6 to V_{IN}	N	N	N	1M/2M	0.6±0.006V	8 Ld 2x2 TDFN
ISL8022	Released	2/1.7	Dual	2.7 to 5.5	0.6 to V_{IN}	Y	N	Y	2.25M, Sync 8M	0.6±0.01V	12 Ld 4x3 DFN
ISL8002/A	Released	2	Single	2.8 to 5.5	0.6 to V_{IN}	Y	Y	N	1M/2M	0.6±0.005V	8 Ld 2x2 TDFN
ISL8002B	Released	2	Single	2.7 to 5.5	0.6 to 4	Y	N	N	2M	0.6±0.005V	8 Ld 2x2 TDFN
ISL80020/A	Released	2	Single	2.7 to 5.5	0.6 to V_{IN}	N	N	N	1M/2M	0.6±0.006V	8 Ld 2x2 TDFN
ISL8033/A	Released	3/3	Dual	2.85 to 6	0.8 to V_{IN}	N	N	Y	1M/2.5M, Sync 6M	0.8±0.01V	24 Ld 4x4 QFN
ISL8036/A	Released	3/3	Dual	2.85 to 6	0.8 to V_{IN}	N	N	Y	1M/2.5M, Sync 6M	0.8±0.01V	24 Ld 4x4 QFN
ISL80030/A	Released	3	Single	2.7 to 5.5	0.6 to V_{IN}	N	N	N	1M/2M	0.6±0.006V	8 Ld 2x2 DFN
ISL80031/A	Released	3	Single	2.7 to 5.5	0.6 to V_{IN}	Y	N	N	1M/2M	0.6±0.006V	8 Ld 2x2 DFN
ISL8023/A	Released	3	Single	2.7 to 5.5	0.6 to V_{IN}	Y	Y	Y	1M/2M	0.6±0.005V	16 Ld 3x3 TQFN
ISL8024/A	Released	4	Single	2.7 to 5.5	0.6 to V_{IN}	Y	Y	Y	1M/2M	0.6±0.005V	16 Ld 3x3 TQFN
ISL8025/A	Released	5	Single	2.7 to 5.5	0.6 to V_{IN}	Y	Y	Y	500K~4M/1M~4M	0.6±0.005V	16 Ld 3x3 TQFN
ISL8026/A	Released	6	Single	2.5 to 5.5	0.6 to V_{IN}	Y	Y	Y	500K~4M/1M~4M	0.6±0.006V	16 Ld 3x3 TQFN
ISL8016	Released	6	Single	2.7 to 5.5	0.6 to V_{IN}	Y	Y	Y	500K~4M, Sync 4M	0.6±0.006V	20 Ld 3x4 QFN
ISL8018	Released	8	Single	2.7 to 5.5	0.6 to V_{IN}	Y	Y	Y	500K~4M, Sync 4M	0.6±0.006V	20 Ld 3x4 QFN

Up to 18V Synchronous Buck Regulators

Part No.	Status	I_{OUT} (max)	# of Outputs	V_{IN} Range	V_{OUT} Range	Fsw (Hz)	I_Q (typ)	Package
ISL85003/A	Released	3A	Single	4.5V to 18V	0.8V to Dmax*V_{IN}	500K, Sync 2M	3.2 mA	12 Ld 3x4 DFN
ISL85005/A	Released	5A	Single	4.5V to 18V	0.8V to Dmax*V_{IN}	500K, Sync 2M	3.2 mA	12 Ld 4x3 DFN
ISL85009	Released	9A	Single	3.8V to 18V	0.6V to Dmax*V_{IN}	300K or 600K, Sync 1M	3 mA	15 Ld 3.5x3.5 TQFN
ISL85012	Released	12A	Single	3.8V to 18V	0.6V to Dmax*V_{IN}	300K or 600K, Sync 1M	3 mA	15 Ld 3.5x3.5 TQFN
ISL85014	Released	14A	Single	3.8V to 18V	0.6V to Dmax*V_{IN}	300K or 600K, Sync 1M	3 mA	15 Ld 3.5x3.5 TQFN

Up to 30V Synchronous Buck Regulators

Part No.	Status	I_{OUT} (max)	# of Outputs	V_{IN} Range	V_{OUT} Range	Fsw (Hz)	I_Q (typ)	Package
RAA211230	Released	3A	Single	4.5V to 24V	0.765V to Dmax*V_{IN}	500K	400 µA	TSOT23-6
RAA211233	Released	3A	Single	4.5V to 24V	0.6V to Dmax*V_{IN}	1.4M	400 µA	TSOT23-6
RAA211320	Released	2A	Single	4.5V to 30V	0.765V to Dmax*V_{IN}	500K	400 µA	TSOT23-6
RAA211250	Released	5A	Single	4.5V to 30V	0.8V to 90%*V_{IN}	200K~800K	90 µA	20 Ld 3.5x4 QFN, 16 Ld HTSSOP
ISL85033	Released	3A	Dual	4.5V to 28V	0.8V to Dmax*V_{IN}	300K~2M	1.2 mA	28 Ld 4x4 TQFN

Up to 40V Synchronous Buck Regulators

Part No.	Status	I_{OUT} (max)	# of Outputs	V_{IN} Range	V_{OUT} Range	Fsw (Hz)	I_Q (typ)	Package
ISL85412	Released	150 mA	Single	3.5V to 40V	0.6V to Dmax*V_{IN}	700K	50 µA	8 Ld 3x3 TDFN
ISL85413	Released	300 mA	Single	3.5V to 40V	0.6V to Dmax*V_{IN}	700K	50 µA	8 Ld 3x3 DFN
ISL85415	Released	500 mA	Single	3V to 36V	0.6V to Dmax*V_{IN}	300K~2M	80 µA	12 Ld 4x3 DFN
ISL85418	Released	800 mA	Single	3V to 40V	0.6V to Dmax*V_{IN}	300K~2M	80 µA	12 Ld 4x3 DFN
ISL85410	Released	1A	Single	3V to 40V	0.6V to Dmax*V_{IN}	300K~2M	80 µA	12 Ld 4x3 DFN
ISL854102	Released	1.2A	Single	3V to 40V	0.6V to Dmax*V_{IN}	300K~2M	80 µA	12 Ld 4x3 DFN
ISL85403 (Buck or Buck-Boost)	Released	2.5A	Single	3V to 40V	0.8V to Dmax*V_{IN}	200K~2.2M	300 µA	20 Ld 4x4 QFN
RAA211450	Released	5A	Single	4.5V to 42V	0.8V to 90%*V_{IN}	200K~800K	90 µA	20 Ld 3.5x4 QFN, 16 Ld HTSSOP

Up to 80V Synchronous Buck Regulators

Part No.	Status	I_{OUT} (max)	# of Outputs	V_{IN} Range	V_{OUT} Range	Fsw (Hz)	I_Q (typ)	Package
RAA211630	Released	3A	Single	4.5V to 60V	0.8V to 90%*V_{IN}	200K~800K	90 µA	20 Ld 3.5x4 QFN, 16 Ld HTSSOP
RAA211650	Released	5A	Single	4.5V to 60V	0.8V to 90%*V_{IN}	200K~2.5M	16.5 mA	28 Ld 4x5 QFN
RAA211651	Released	5A	Single	4.5V to 60V	0.8V to 90%*V_{IN}	565K	19 µA	28 Ld 4x5 QFN
RAA211820	Released	2A	Single	4.5V to 75V	0.8V to 90%*V_{IN}	200K~800K	90 µA	20 Ld 3.5x4 QFN, 16 Ld HTSSOP

Up to 80V Non-Synchronous Buck Regulators

Part No.	Status	I_{OUT} (max)	# of Outputs	V_{IN} Range	V_{OUT} Range	Fsw (Hz)	I_Q (typ)	Package
RAA211605	Released	500 mA	Single	4.5V to 60V	0.6V to Dmax*V_{IN}	450K	300 µA	TSOT23-6
RAA212831	Released	500mA	1 buck + 2 LDOs	4.5V to 72V	1.25V to 24V	350K	325 µA	SOIC-8
RAA212832	Released	500mA	1 buck + 2 LDOs	4.5V to 72V	12V	350K	325 µA	SOIC-8
RAA211835	Released	3A	Single	4.5V to 75V	0.8V to 90%*V_{IN}	200K~800K	90 µA	20 Ld 3.5x4 QFN, 16 Ld HTSSOP
RAA211412	Released	1A	Single	5.8V to 45V	0.8V to Vin-3	630K	300 µA	6 Ld SOT23
RAA211403/5	Released	300mA	Single	7V to 40V	3.3V/5V	500K	3.5 µA	5 Ld SOT23
RAA211803/5	Released	300mA	Single	7V to 80V	3.3V/5V	500K	5.5 µA	5 Ld SOT23

MEMO

LOW DROPOUT REGULATORS (LDO)

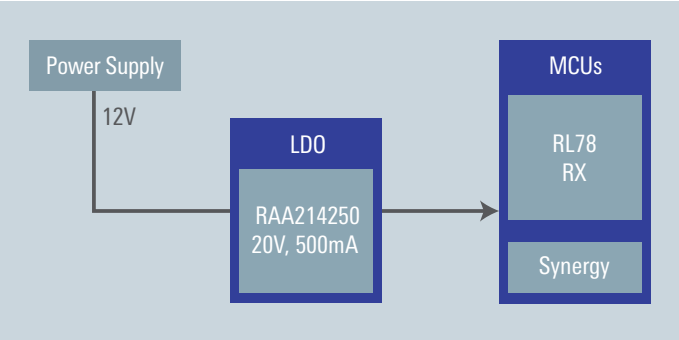
High Performance LDOs

RAA214250 20V Wide Input Voltage Range, 500mA Linear Regulator

The RAA214250 is a Cost-effective power for Renesas RA, RL78, Synergy, and RX MCUs

Key Features

- Efficient
- Low 50µA supply current for high light-load efficiency
- ENABLE pin shuts down output to save power
- Reliable
- Approved for use with all modern Renesas MCUs
- Stable with no load, so it can power an MCU in HALT or SLEEP mode

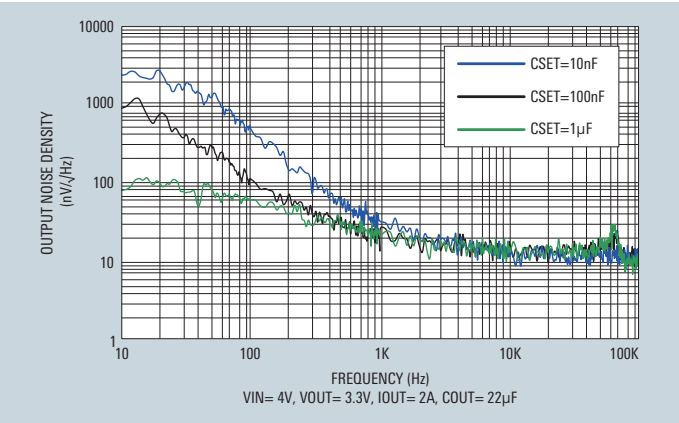


RAA214020 LOW NOISE LDO FOR SENSITIVE CIRCUITRY

New ultra-low noise LDOs minimize phase noise & jitter in high-performance applications

Excellent Noise Performance

- Low Spot Noise Spectral Density: 82nV/Sqrt Hz @ 10Hz
- Low Integrated Noise: 4.54uV RMS from 10Hz-100kHz
- Very high PSRR @ 2A load current: Freq=10kHz=80dB
- Vin = 2.7V to 5.5V, Vout=0.9V to Vin-dropout
- Low dropout of 500mV max @ 2A, over temperature



High-Performance LDOs

Part No.	Status	I_{OUT} max (A)	V_{IN} (V)	V_{OUT} (V)	PSRR @1 kHz (dB)	Fixed V_{OUT} Option	Dropout (mV)	Acc. (%)	I_Q (typ)	Package
SOON RAA214035	Sampling	3	2.7 to 5.5	0.9 to 5.5 – dropout	>80	No	500	±2.0	100 µA	5mm x 5mm 20 Ld QFN 3.5mm x 3.5mm 20 Ld QFN
RAA214401	Released	0.15	5.4 to 40	3.3	47	Yes	1550 @ 150mA	±1.0	<3 µA	SOT23
RAA214220	Released	0.15	2.5 to 20	1.23 to 18	>63	No	145 @ 100mA	±2.0	6 µA	SOT23
RAA214250	Released	0.5	2.5 to 20	1.23 to 18	>63	No	350 @ 500mA	±2.0	NA	8Ld DFN3x3/ SOIC
RAA214020	Released	2	2.7 to 5.5	0.9 to 5.5 - dropout	>80	No	500	±2.0	100 µA	10 Ld DFN
RAA214023	Released	2	2.7 to 5.5	0.9 to 5.5 - dropout	>80	No	500	±2.0	100 µA	5mm x 5mm 20 Ld QFN 3.5mm x 3.5mm 20 Ld QFN
ISL80505	Released	0.5	1.8 to 6	0.8 to 5.5	50	No	45 @ 500mA	1.8	2.2 mA	8 Ld 3x3 DFN
ISL80510	Released	1	2.2 to 6	0.8 to 5.5	48	No	130 @ 1A	1.8	2.2 mA	8 Ld 3x3 DFN
ISL80101A	Released	1	2.2 to 6	0.8 to 5	48	Yes	90 @ 1A	1.8	3.0 mA	10 Ld 3x3 DFN
ISL80101-Adj.	Released	1	2.2 to 6	0.8 to 5	58	Yes	130 @ 1A	1.8	3.0 mA	10 Ld 3x3 DFN
ISL80102	Released	2	2.2 to 6	0.8 to 5	55	Yes	81 (@2A,Vout=2.5V)	1.8	7.5 mA	10 Ld 3x3 DFN
ISL80103	Released	3	2.2 to 6	0.8 to 5	55	Yes	120 (@3A,Vout=2.5V)	1.8	7.5 mA	10 Ld 3x3 DFN
ISL80111	Released	1	1 to 3.6	0.8 to 3.3	80	No	27 @ 1A	1.6	3.5 mA	10 Ld 3x3 DFN
ISL80112	Released	2	1 to 3.6	0.8 to 3.3	80	No	53 @ 2A	1.6	3.5 mA	10 Ld 3x3 DFN
ISL80113	Released	3	1 to 3.6	0.8 to 3.3	80	No	75 @ 3A	1.6	3.5 mA	10 Ld 3x3 DFN

Wide Input Voltage Generic LDOs (Focus on Low Quiescent Current)

Part No.	Status	I_{OUT} max (A)	V_{IN} (V)	V_{OUT} (V)	PSRR @1 kHz (dB)	Fixed V_{OUT} Option	Dropout (mV)	Acc. (%)	I_Q (typ)	Package
ISL80410	Released	0.15	6 to 40	2.5 to 12	66	No + EN	295 @ 150mA	±1.0	18 µA	8 Ld EPSOIC
RAA214401	Released	0.15	5.4 to 40	3.3	47	Yes	1550 @ 150mA	±1.0	<3 µA	SOT23-3
RAA214220	Released	0.15	2.5 to 20	1.23 to 18	>63	No + EN	145 @ 100mA	±2.0	38 µA	SOT23-5
SOON RAA214223	Sampling	0.15	2.5 to 20	3.3	>65	Yes + EN	240 @ 150mA	±2.0	96 µA	SOT23-5
RAA214250	Released	0.5	2.5 to 20	1.23 to 18	>63	No + EN	350 @ 500mA	±2.0	68 µA	8Ld DFN3x3/ EPSOIC
SOON RAA214290	Sampling	1	2.5 to 20	1.23 to 18	>62	No + EN	270@ 500mA	±2.0	80 µA	8Ld DFN3x3/EPSOIC
SOON RAA214403	Pre-Released	0.15	3.6 to 40	3.3	47	Yes + EN	<100 @ 10mA	±3.0	<4 µA	SOT23-5 & SOT89-3
SOON RAA214404	Pre-Released	0.15	3.9 to 40	3.6	47	Yes + EN	<100 @ 10mA	±3.0	<4 µA	SOT23-5
SOON RAA214405	Pre-Released	0.15	5.3 to 40	5	47	Yes + EN	<100 @ 10mA	±3.0	<4 µA	SOT23-5 & SOT89-3
SOON RAA214409	Pre-Released	0.15	9.3 to 40	9	47	Yes	<120 @ 10mA	±3.0	<4 µA	SOT89-3

SHUNT REGULATORS

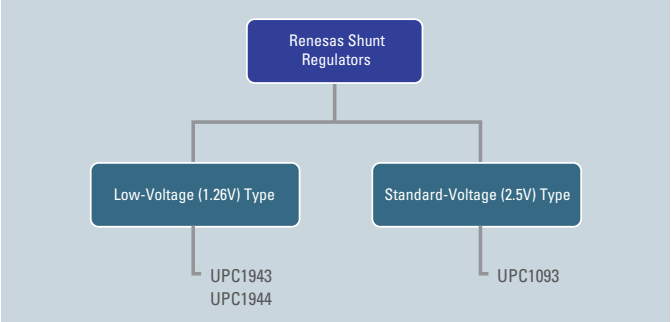
Reference Power Supply ICs

Benefits and Key Features

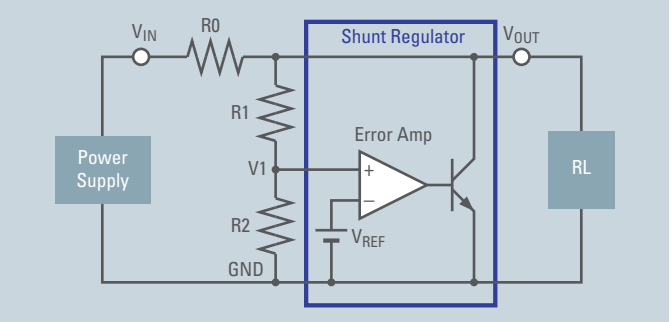
Shunt regulators are the standard reference voltage source widely used by the feedback circuits of switching power supplies and so on. Compared to the Zener diode, which is a discrete product, a shunt regulator has much better voltage precision because voltage control is carried out as an IC.

In addition to its use as a reference power source for amplifier circuits, A/D converters, etc., it is also widely used for feedback circuits of switching regulators.

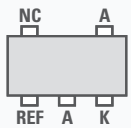
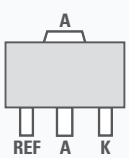
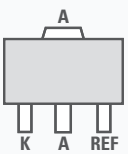
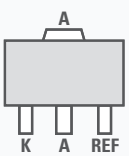
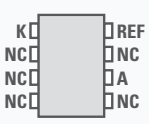
Shunt Regulators Lineup



Shunt Regulator Application



Shunt Regulators

Item		Low-Voltage (1.26V) Type		Standard-Voltage (2.5V) Type		
		UPC1943T	UPC1944T	UPC1093TA	UPC1093T	UPC1093G
Reference voltage	VREF (V)	1.23 (min.) to 1.26 (typ.) to 1.29 (max.)		2.440 (min.) to 2.495 (typ.) to 2.550 (max.)		
Cathode voltage	VKA (V)	24 (max.)		36 (max.)		
Cathode current	IK (mA)	30 (max.)		100 (max.)		
Operating temperature range	TA (°C)	-30 to +85		-20 to +85		
Package	5-pin mini mold(SC-74A)					
	3-pin power mini mold(SC-62)					
	8-pin SOP					

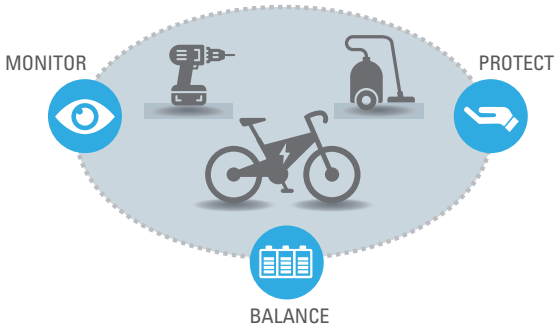
MEMO

BATTERY MANAGEMENT

Management and Protection of Lithium-ion Batteries

Protect, Monitor & Balance Rechargeable Battery Packs

Renesas' Li-ion battery pack monitoring, protection, and balancing ICs are specifically designed to meet the stringent safety, reliability, and performance requirements of portable and battery powered applications such as consumer, industrial, and medical products.



Battery Front End (BFE), Battery Management ICs

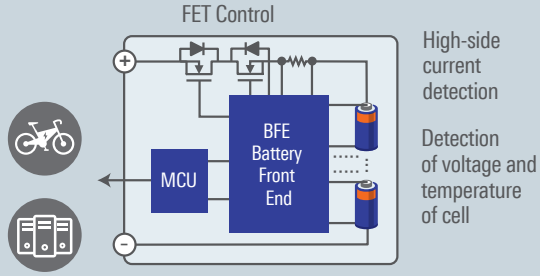
Benefits and Key Features

Protection and Cell Balancing

- Hot plug tolerant
- Over/under voltage
- Charge/discharge current
- FET control when error detected
- Open-wire detection
- Auto-cell balancing

Host Controlled Features

- Current measurement
- Cell voltage measurement
- Pack voltage measurement
- Temperature measurement
- LED indication by GPIO
- Power supply for MCU



BFE Battery Pack System Diagram

RAA489206 Industrial Battery Front End Protects, Monitors, and Balances High Voltage Battery Packs

- Up to 16 cell inputs
- Highly integrated, includes charge pump, high side FET drivers, current measurement, LDO, wake-up logic, internal and external balancing circuits, and LED drivers
- Hot plug tested and proven via random connection trials
- Reference circuit, sample code, and high degree of integration accelerates battery pack design, test and verification

Battery Front End, Multi-Cell Li-Ion Battery Management ICs

Cells	Pack Voltage	Part Number	Cell Balance	Current Sense	Charge/ Discharge FET	Internal ADC	Features	Package
4 to 16	12 to 60V (60V available Q4'2021)	RAA489206	Both Internal and External	Low Side	N-channel, High side and Low side	Yes	LDO, LED Drivers	64QFN
4 to 6	4 to 26.4	ISL94208	Both Internal and External	Low Side	N-channel, Low Side	No	Simplicity, internal cell balancing	32QFN
6 to 14 (and Daisy Chain)	10 to 65	RAA489204	Both Internal and External	No	N/A	Yes	Daisy chain	64TQFP
3 to 8	4 to 36	ISL94202	External	High Side	N-channel, High Side	Yes	High-side current sense, standalone capable	48TQFN

Battery Fuel Gauge ICs (FGIC)

Dedicated one-package solution with MCU and AFE provides an intelligent, programmable system for battery management that constantly monitors and protects the battery.

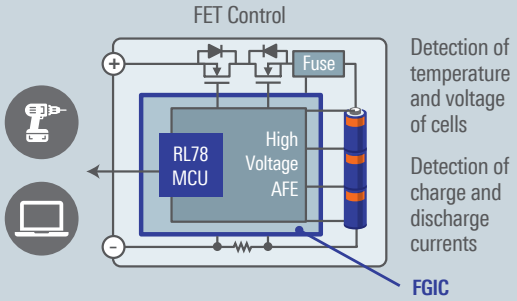
Benefits and Key Features

Safety and Protection Control

- Over/under voltage
- Charge/discharge current
- FET control when error detected
- Chemical fuse control
- Cell balancing

Remaining Capacity Management

- Current/voltage detection
- Precise coulomb counter
- Deterioration detection
- Calculation and learning of battery capacity
- Current/voltage calibration
- Fault detection/history management



FGIC Battery Pack System Diagram

FGIC Block Diagram

Voltage and Current Measurement by Independent A/D Converters

- Current detection: 153 µA/LSB resolution (18-bit ΔΣ 5 mΩ shunt resistor) support for simultaneous measurement with virtually no temperature drift
- Voltage/temperature measurement: 15-bit ΔΣ ADC

High Reliability & High Integration

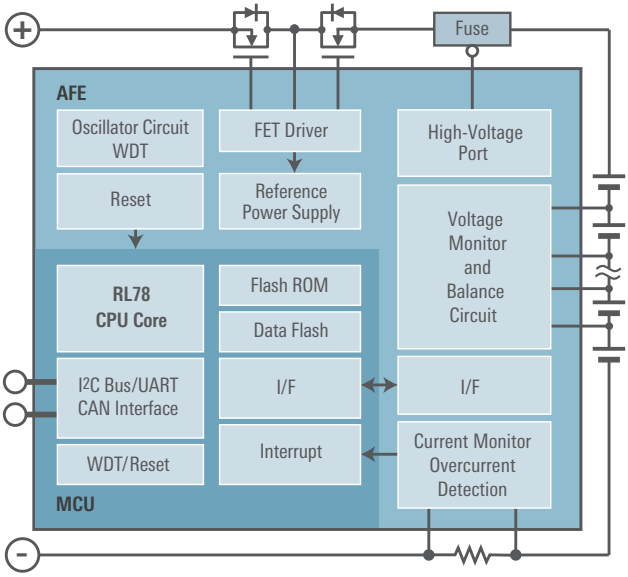
- Built-in FET protection for overcurrent or short circuit conditions
- Redundant fault detection by both MCU and AFE
- Ability to set lifecycle related limits and maintain battery parameter and operation history using data flash guaranteed for 100,000 erase/write cycles
- Integrated CAN interface and RTC (Real Time Clock) circuit for industrial apps; ICs can manage date and time in a single device (RAJ240090 and RAJ240100)

Few Parts, Low System Cost

- Supports large-current discharge with N-channel FET drivers
- Integrated pull-up resistors for thermistor

Extended Battery Life

- Low power mode with consumption of 25 µA or less and cell balance circuit to maximize battery capacity (RAJ240090 and RAJ240100)



Internal Block Diagram of FGIC

Battery Fuel Gauge ICs

Cells	Pack Voltage (V)	Part No.	Flash ROM	RAM	Charge/ Discharge FET Control	Serial I/F	I/O	Features	Package
NEW 1	2 to 5.5	RAA241200	64 KB	4.0 KB	Low side	I²C, UART	7	Very compact package (1.871mm x 2.478mm) Very low power consumption (10 µA)	16WLBGA
NEW 2 to 4	2.2 to 25	RAJ240055	64 KB	4.0 KB	High side	I²C, UART	12	Compact package (4mm x 4mm)	32QFN
		RAJ240057	128 KB	7.0 KB					
2 to 5	4 to 25	RAJ240071	32 KB	1.5 KB	High side	I²C, UART	11	Compact package (4mm x 4mm) 5 cell support	32QFN
		RAJ240075	64 KB	4.0 KB					
3 to 8	4 to 50	RAJ240090	128 KB	7.0 KB	High / Low side	I²C, UART, CAN	31	High voltage tolerance, On-chip CAN, Low power consumption (25 µA)	64LQFP
3 to 10		RAJ240100							
NEW 3 to 7	4 to 40	RAJ240301	64 KB	5.5 KB	Low side	I²C, UART	21	GPIO: I/O x 15, Input x 2, NOD x 2, HVNOD x 2	48QFP
3 to 10	8 to 50	RAJ240310	64 KB	4.0 KB	Low side	I²C, UART	15	Compact package (5mm x 5mm) 10 cell support	40QFN

* Specifications are subject to change without notice.

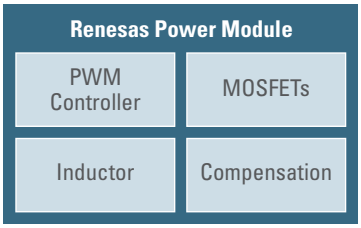
POWER MODULES

Complete Power System

Benefits and Key Features

Easy to Use

- Full integration means less complexity and easier design
- First pass success



Highest Power Density

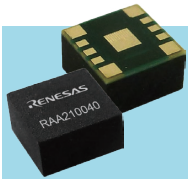
- Power output up to **100W** POL in a single package

Thermally Enhanced Package Technology

- Thermal molding compound allows for even heat distribution
- Large copper pads transfer heat efficiently
- Operates at full load across wide temperature range
- Leaded package allows pin access

Featured Product

- RAA210040 5V, 4A Step-Down DC/DC Mini Module with Integrated Inductor



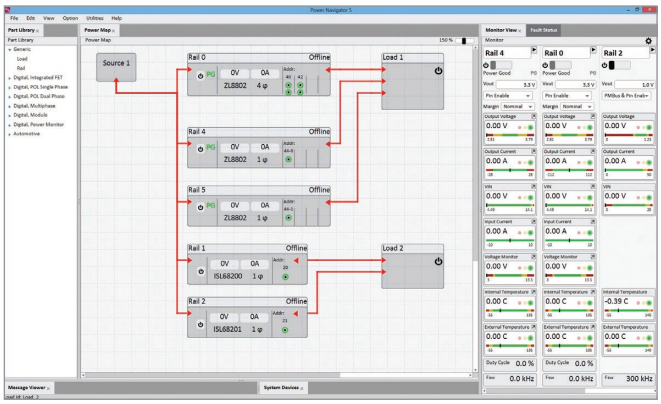
5V, 4A Low-profile Mini Module
for industrial, telecom and medical applications

- RAA210130 12V, 30A Step-Down DC/DC Digital Power Module. 12V, 30A Small Footprint, Digital Power Module for general purpose power for ASIC, FPGA, DSP and memory

Real-Time Telemetry — Dynamic Configuration (Available in Digital Power Modules)

PowerNavigator™ GUI

Allows simple configuration and monitoring of multiple Digital-DC devices using a PC with a USB interface.



Analog Modules

A simple, effective DC/DC power supply solution that integrates necessary power elements in a single package.

Digital Modules

A high-performance DC/DC power supply solution that integrates all power elements in a single package and supports digital communication and configurability for advanced power management techniques. Digitally design with PowerNavigator™ GUI software.

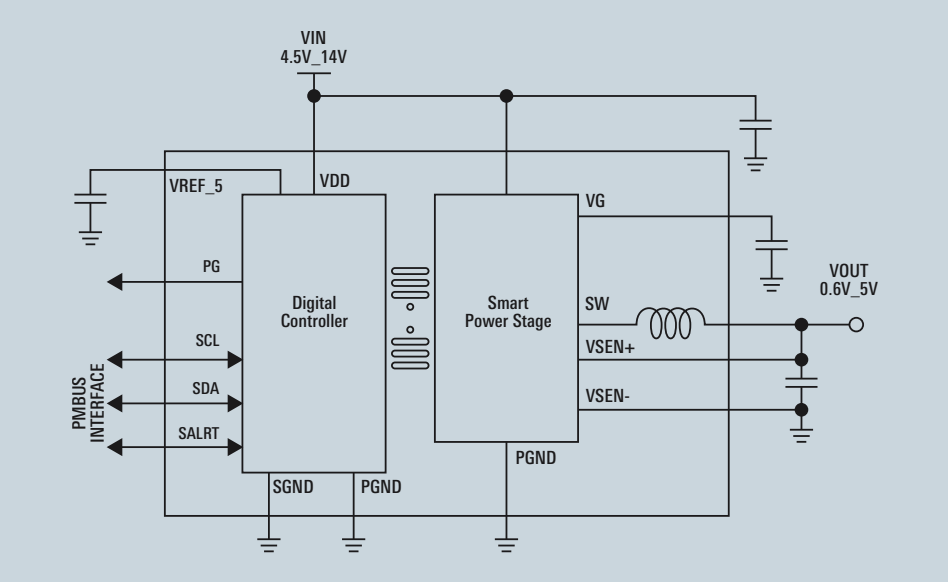
DC/DC POWER MODULES

RAA210130 PMBUS-enabled 15V, 30A Module

High power density supports demanding loads in BGA-POP module

Key Features

- PMBus™ Compliant Controller + Smart Power Stage
- Vin range: 4.75V to 15V, Vout range: 0.45V to 3.3V
- ±0.7% Output Voltage Accuracy over Temperature
- Pin-selectable pre-programmed output voltage options
- "Black box" fault capture & recording
- User-accessible one-time-programmable memory slots



DC/DC Power modules integrated inductor

Part No.	I_{OUT} MAX (A)	Ch	Circuit	V_{IN} (V)	V_{OUT} (V)	Package	PMBus	Molded
RAA210130	30A	1	DC/DC (Step-down)	4.75 to 15	0.45 to 3.3	10mm x 13mm x 7.8mm BGA package	Yes	NO
RRM12120	20A	1	DC/DC (Step-down)	4.75 to 15	0.45 to 3.3	10mm x 13mmx 5.9mm BGA package	Yes	NO
SOON RRM20030	3A	1	DC/DC (Step-down)	4.5 to 20	0.6 to 5	3mm x 2.8mmx 1.7mm dual flat no-lead package	No	YES
RAA210040	4A	1	DC/DC (Step-down)	2.7 to 5.5	0.6 to 5	3mm x 3mm x 1.7mm dual flat embedded laminate package	No	YES
RAA210030	3A	1	DC/DC (Step-down)	2.7 to 5.5	0.6 to 5	3mm x 3mm x 1.1mm dual flat embedded laminate package	No	YES

More power modules are available. To see a complete product list, visit: www.renesas.com.

MOSFET DRIVERS

Industry-Leading Bridge Drivers

HIP2103/04 Family of 60V Bridge Drivers for BLDC and Similar Loads

Optimized for Battery Powered Applications from 5V to 36V

- 60V max rating is suitable for 36V battery applications
- 4.5 UVLO allows operation as low as 5V
- Proprietary sleep mode activation eliminates the need for additional I/O control pins
- Very low I_Q (<10 µA) eliminates the need for a disconnect switch to maintain idle battery life

Integrated Linear Regulators (HIP2104) for External Loads

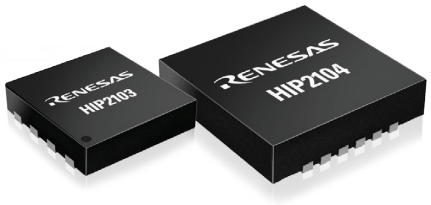
- Reduces external components for lower BOM cost and smaller solution footprint
- 12V output provides gate drive bias
- 3.3V output provides digital controller bias

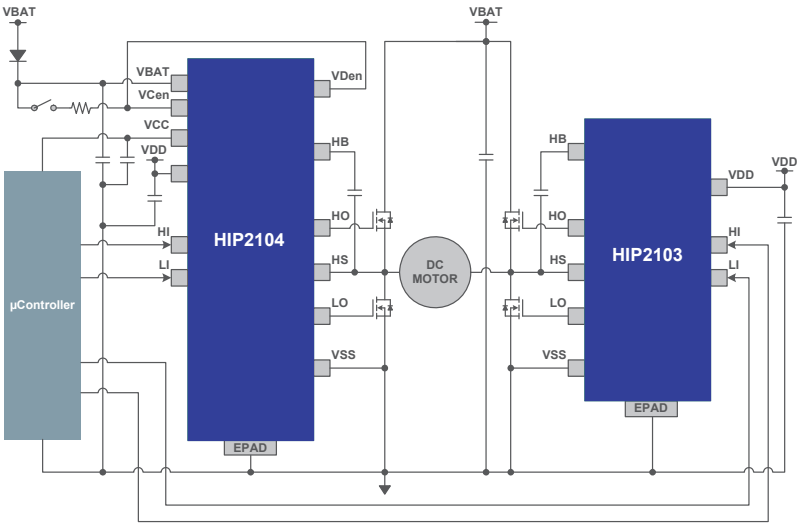
1A Sourcing, 2A Sinking MOSFET Drivers

- Enough drive strength for high speed switching applications
- Enough drive strength for very high MOSFET gate charge

Easy to Configure Half-Bridge, Full-Bridge, and 3-phase

- Small packages allow drivers to be placed next to the bridge FETs





Typical Full-Bridge Application

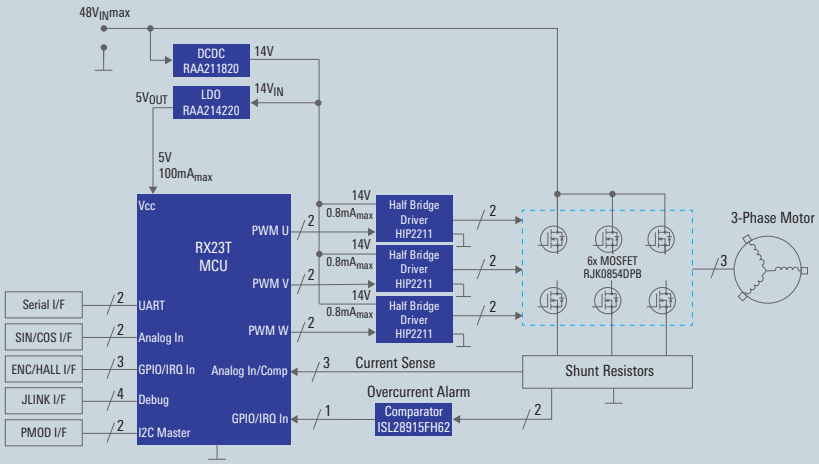
48V BLDC Motor Control – Using 120V HB drivers + DC/DC + LDO + RX23T

Benefits

- Smaller solution size
- Better system efficiency through higher driver current and lower I_Q
- Adaptive dead time eliminates the need for leading-edge delays for shoot-thru prevention, reducing the programming complexity for the controller
- BOM cost saving with integrated current monitor

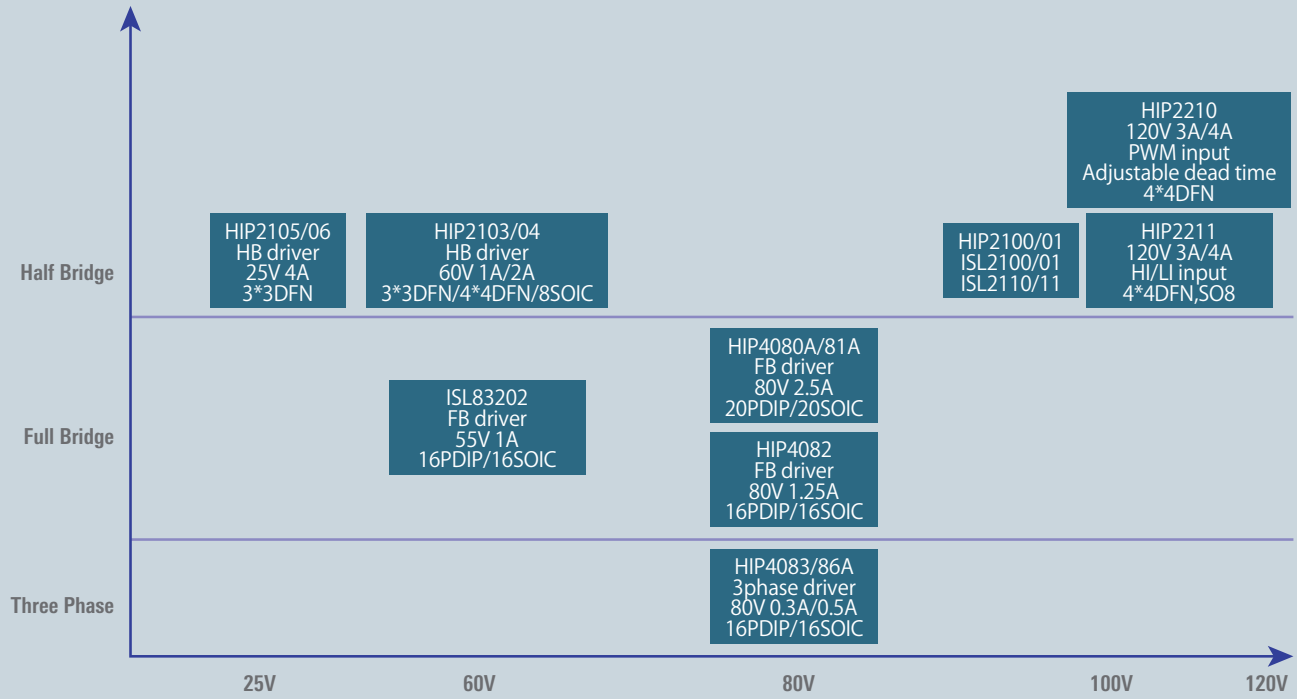
Applications

- Telecom bricks and power supplies
- High power motor control
- Robotics



Full Menu of MOSFET Gate Drivers

BRIDGE FET DRIVERS



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Renesas Electronics Corporation
TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Renesas Electronics America Inc. Milpitas Campus
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics America Inc. San Jose Campus
6024 Silver Creek Valley Road, San Jose, CA 95138, USA
Tel: +1-408-284-8200, Fax: +1-408-284-2775

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 101-T01, Floor 1, Building 7, Yard No. 7, 8th Street, Shangdi, Haidian District, Beijing 100085, China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai 200333, China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, #06-02 Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit No 3A-1 Level 3A Tower 8 UOA Business Park, No 1 Jalan Pengaturcara U1/51A, Seksyen U1, 40150 Shah Alam, Selangor, Malaysia
Tel: +60-3-5022-1288, Fax: +60-3-5022-1290

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338

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