

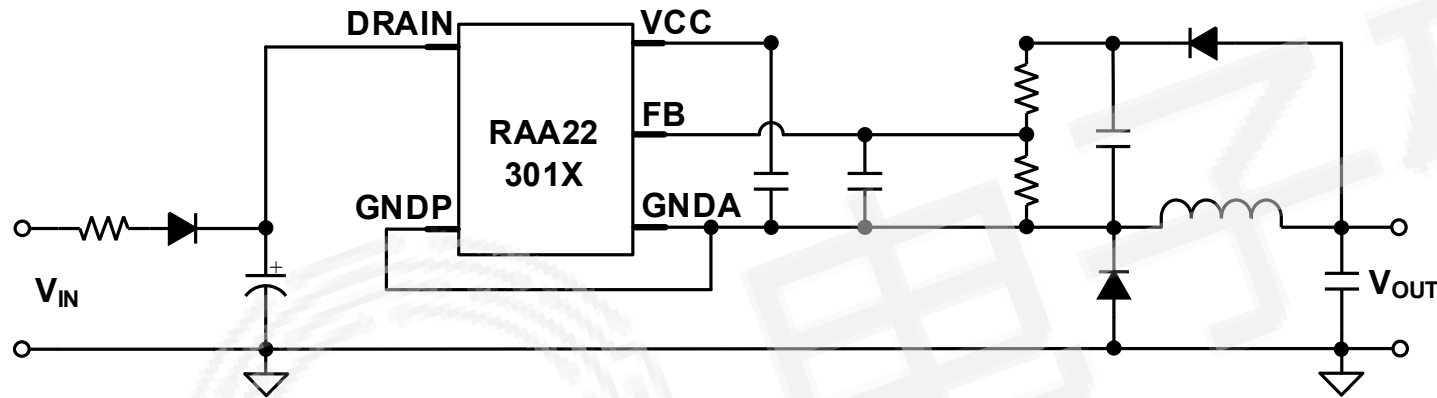
700 V Buck Regulator RAA22301x/2x

RENESAS HIGH VOLTAGE BUCK FAMILY

Industrial Power and Analog Product Line
Renesas Electronics Corporation

BIG IDEAS
FOR EVERY SPACE

RAA22301X FAMILY: NON-ISOLATED 700V AC-DC BUCK REGULATORS



Key values:

- Low standby power of ~10mW
- Configurable - Low standby power or smallest output capacitor
- No audible noise
- Support direct 5V or 3.3V output without extra LDO
- High reliable full protection features

NO AUDIBLE NOISE & LOW EMI ROOT CAUSE

Competitors' Burst Mode

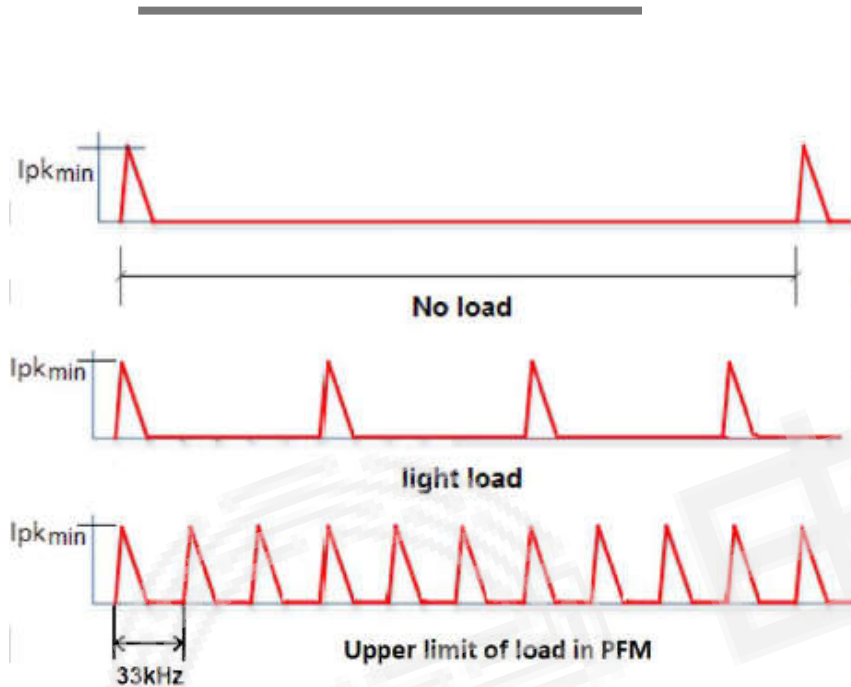


Renesas PFM Mode

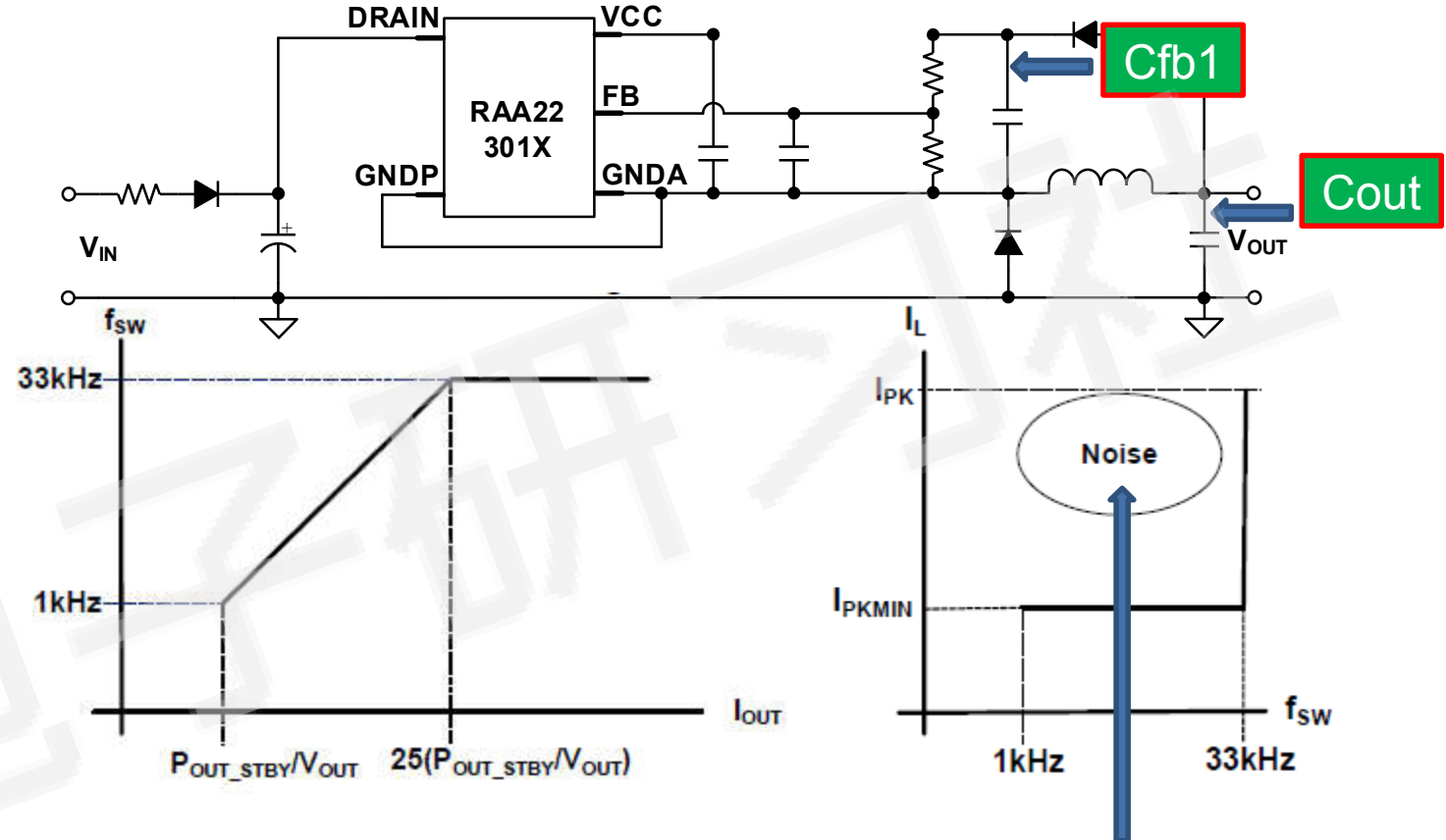


- Competitors use burst mode at light load, create subharmonic content which might become audible and deteriorates EMI
- To minimize audible acoustic energy, Renesas uses:
 - Constant off time mode **AT FULL LOAD** operating above any audible frequency range
 - PFM **AT LIGHT LOAD** that operates with smallest I_{pk} (peak inductor current)
- Renesas PFM has no subharmonic components, so audible noise is reduced with better EMI at light load

OPERATION MODE EXPLAINED IN HIGH LEVEL



- Cfb1 programs pulse frequency at no load to get either ultra low light load power or very small C_{out}
- I_{peak} stays at I_{pk-min} during PFM operation

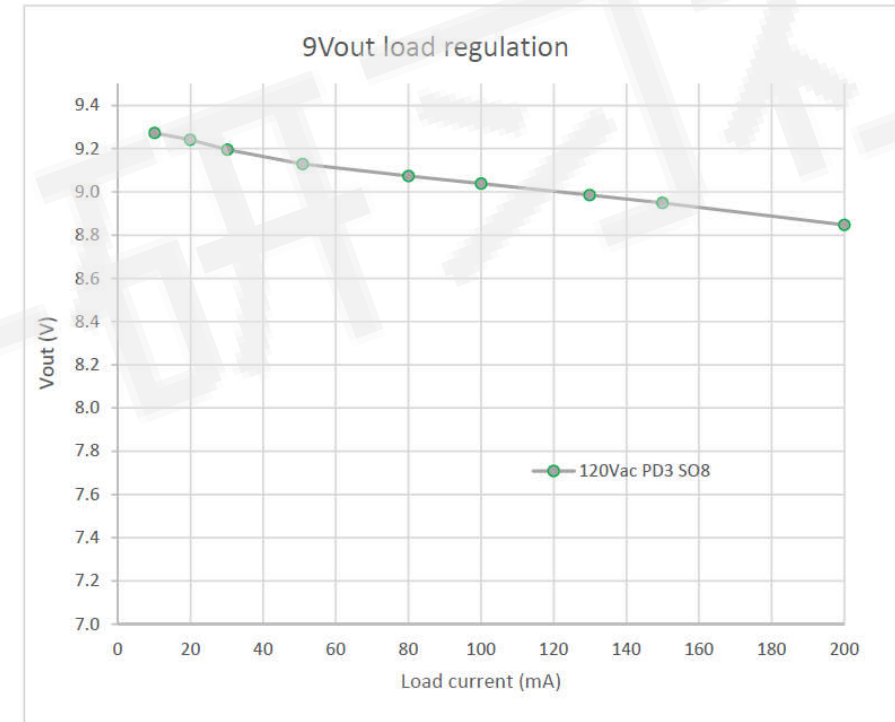


- During light load, when I_{out} increases, the frequency increases until hit peak of 33kHz
- During light load, I_{peak} stays I_{pk-min} so audible noise is negligible
- When frequency is pseudo-fixed at peak load, it's always above audible noise range

RAA223011 PERFORMANCE: LOAD AND LINE REGULATION

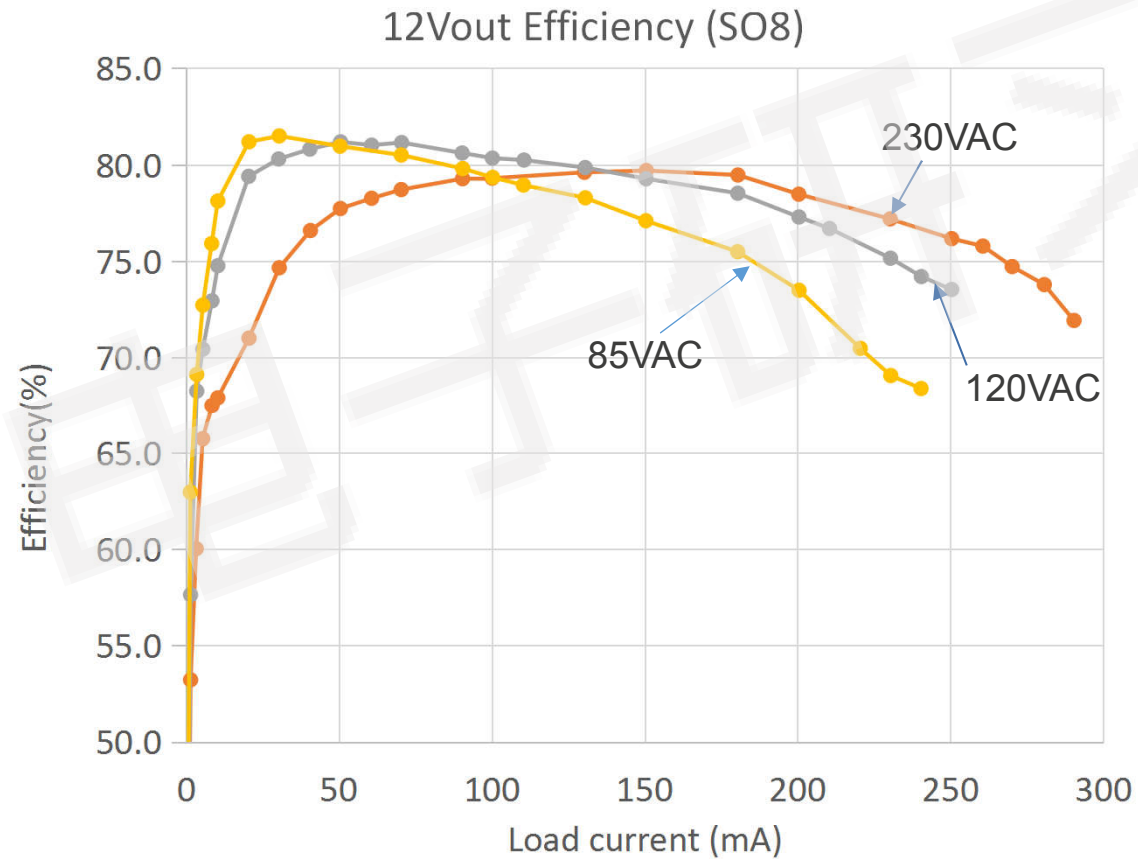


- Accurate load regulation at wide line input



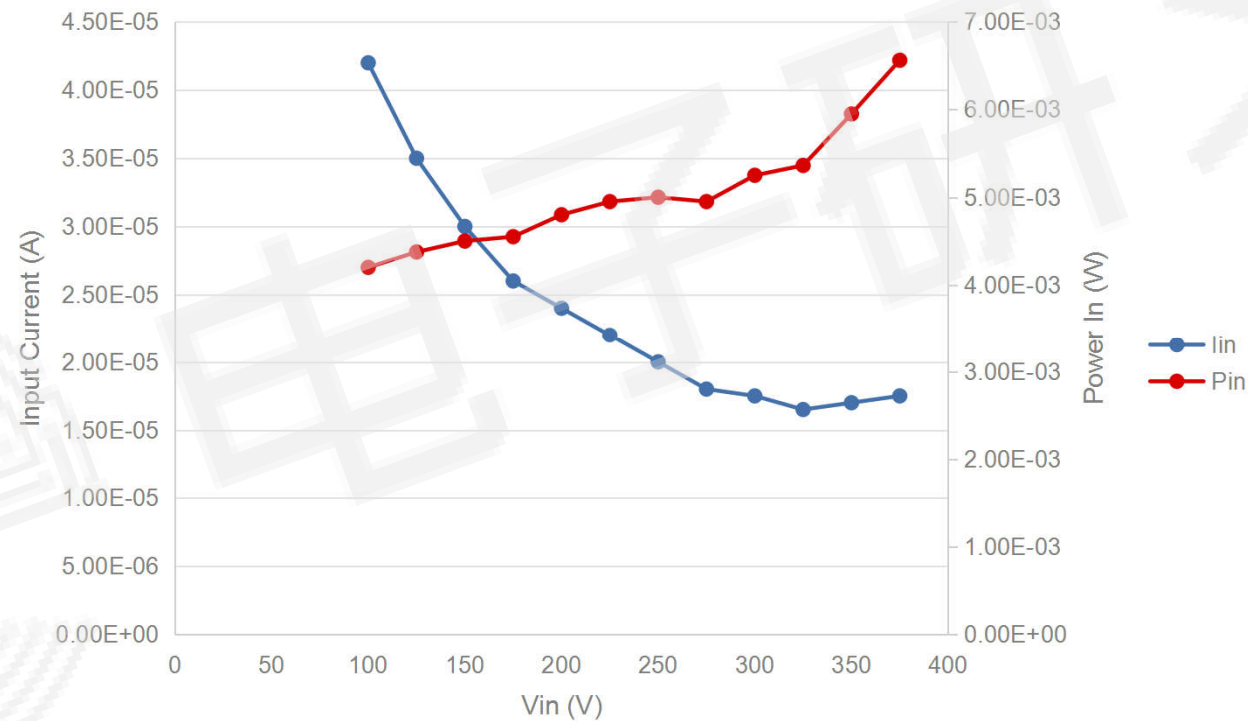
- Accurate load regulation with wide load current change

RAA223011 PERFORMANCE: EFFICIENCY



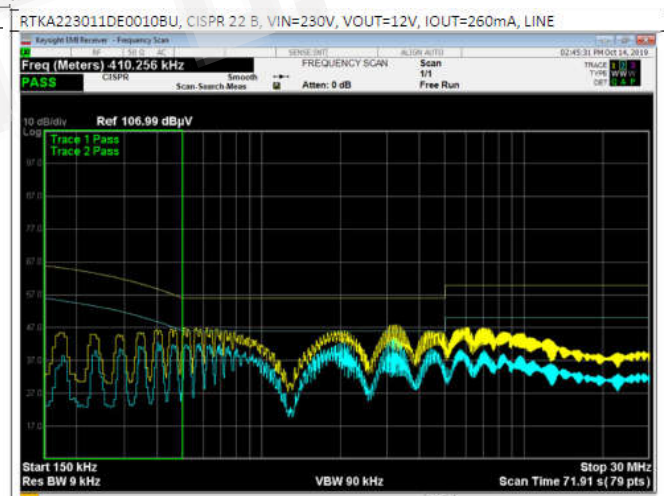
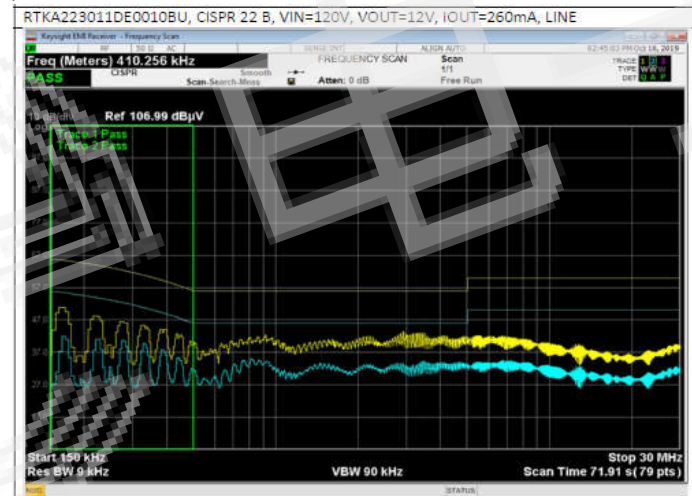
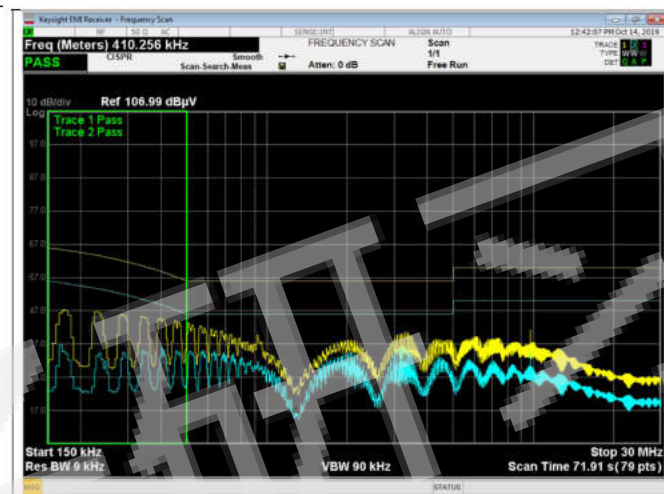
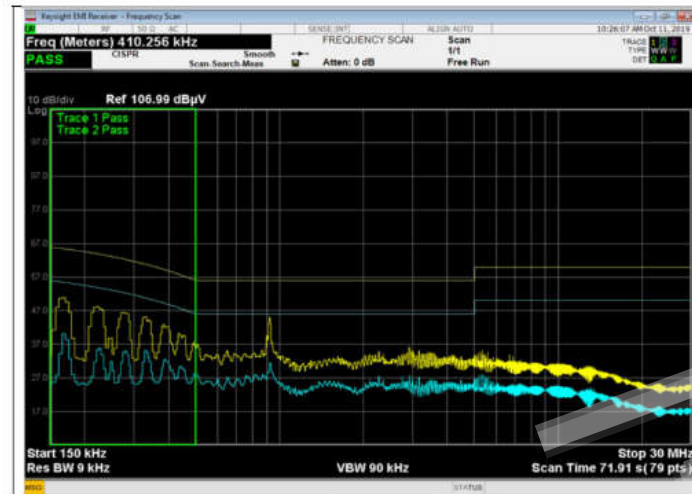
RAA223011 PERFORMANCE: STANDBY POWER

Example shows 7mW standby power at 400VAC



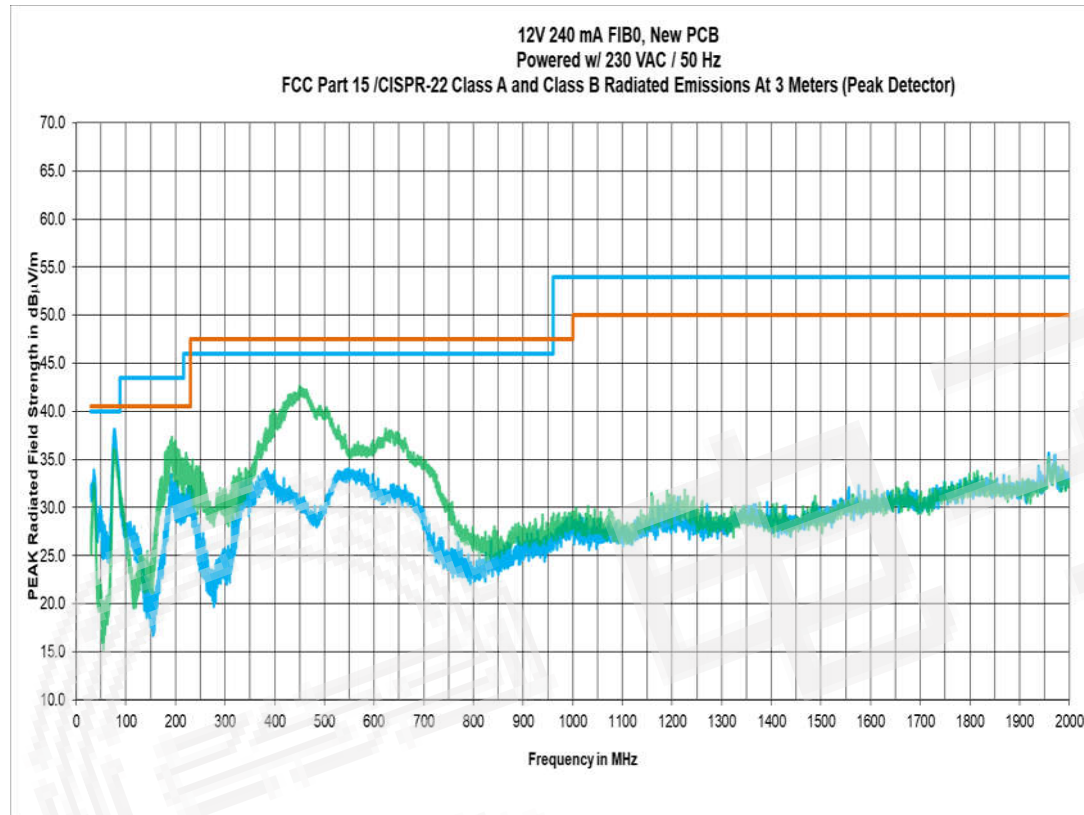
RAA223011 PERFORMANCE: CONDUCTED EMI TEST RESULTS

RTKA223011DE0010BU, CISPR 22 B, VIN=120V&230V, VOUT=12V, IOUT=260mA, LINE & NEUTRAL PLOTS

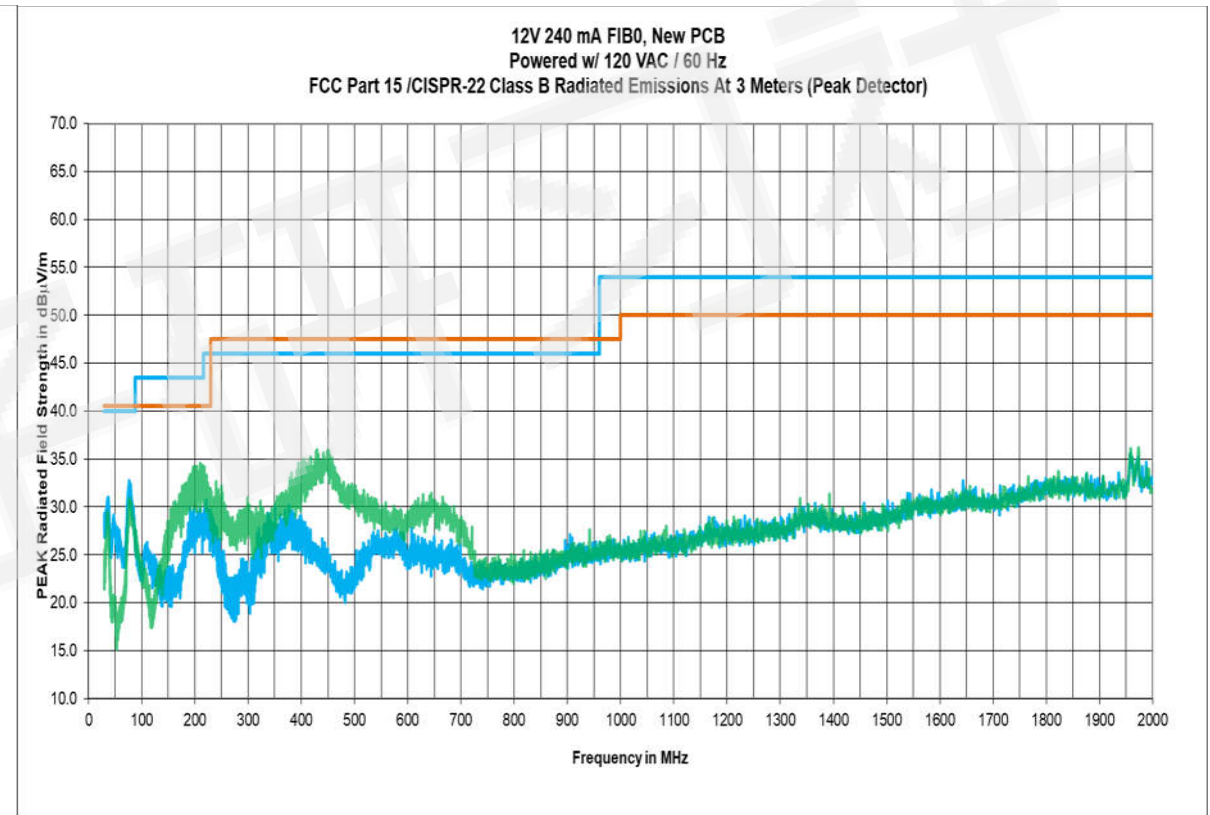


- Extreme low EMI with small input filter size

RAA223011 PERFORMANCE: RADIATED EMI TEST RESULTS



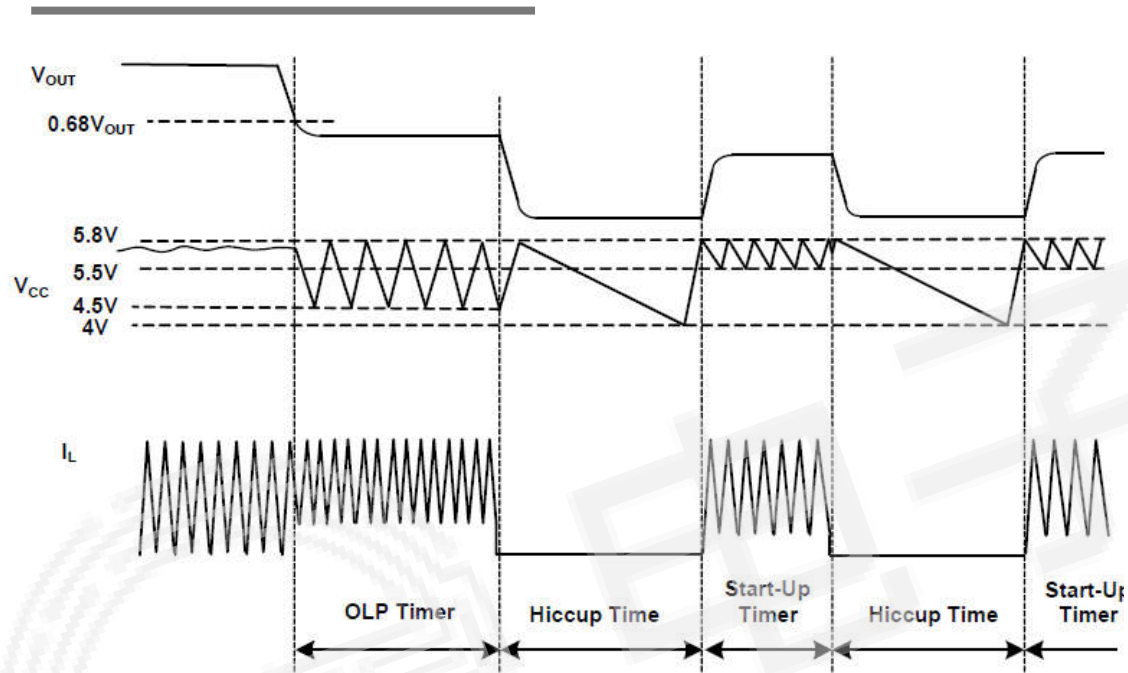
230V



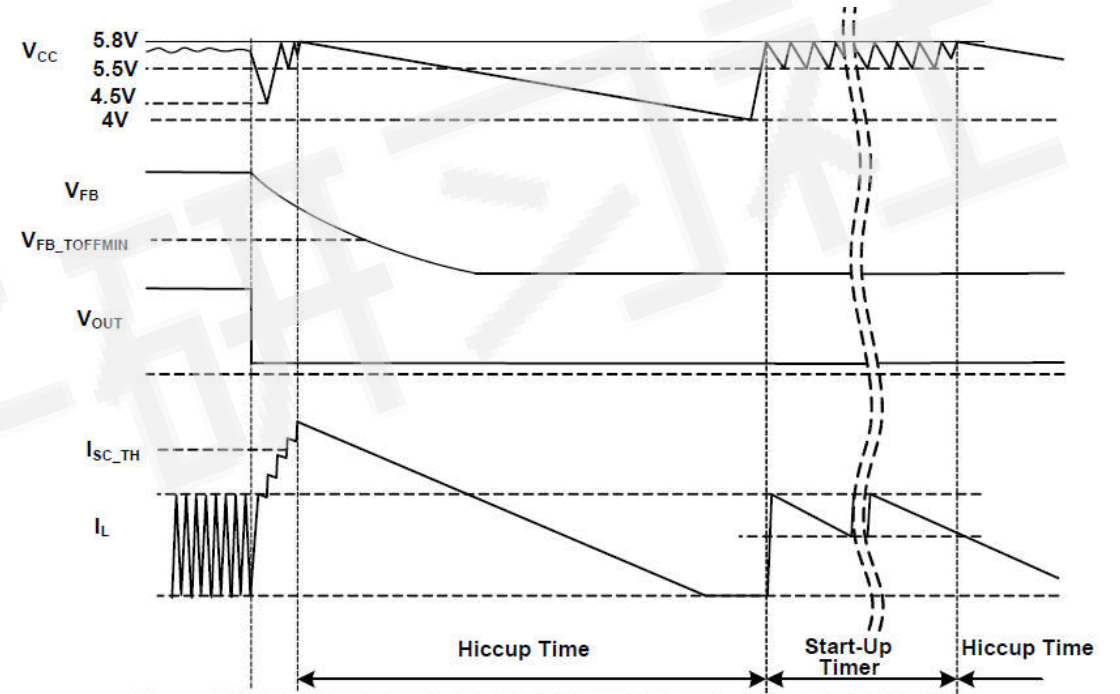
120V

- Extreme low EMI with small input filter size

RAA223011 PERFORMANCE: RELIABILITY- OVERLOAD AND SHORT CIRCUIT PROTECTION



Overload protection with
hiccup restart

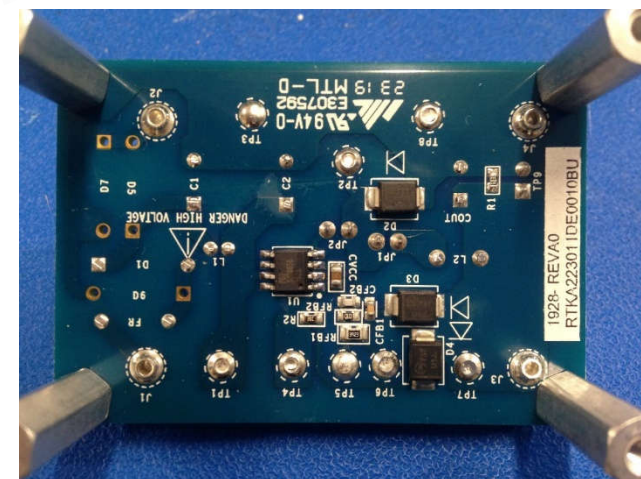


Short circuit protection
with hiccup restart

EVB AND DEMO BOARDS READY TO ORDER – AND MORE TO COME

EVAL Boards			
Orderable boards	Package	Output Voltage	Output current rating
RTK223011DE0000BU	SOT23-5	12	230mA/85Vac 270mA/120Vac 305mA/230Vac
RTK223011DE0010BU	SOIC8	12	235mA/85Vac 260mA/120Vac 270mA/230Vac
DEMO Boards			
RTK223012DR0020BU-1	SOT23	5	150mA
RTK223012DR0010BU-1	SOIC8	5	150mA
RTK223011DR0040BU-1	SOT23	24	170mA/85Vac 200mA/120Vac 220mA/230Vac
RTK223011DR0030BU-1	SOIC8	24	170mA/85Vac 200mA/120Vac 220mA/230Vac
RTK223012DR0050	SOIC8	5V/-5V	150mA
RTK223012DR0060	SOT23	5V/-5V	150mA

More RAA223021 and isolated flyback based EVB are coming soon

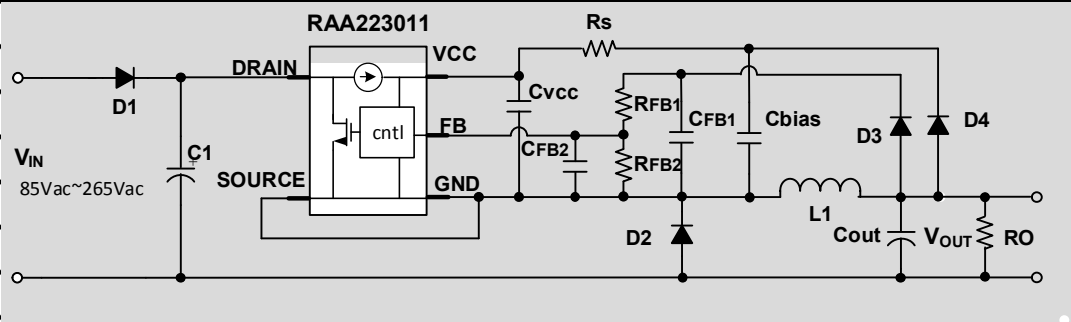


RAA223011 COMPONENT SELECTION AND DESIGN TOOL AVAILABLE AT REQUEST

RAA223011 Component Selection Tool			
Instructions:			
Enter values in the yellow highlighted cells			
Do not change the parameters in red			
Calculation results for specs & components are in green cells			
System Parameters			
Item	Value	Units	Description
Input voltage AC nominal RMS	230	Volt	
Input voltage after rectification	325.22	Volt	Peak value derived from RMS for AC. Set it equal to cell B4 for DC input
output voltage	12	Volt	Output Voltage
load current	0.27	Amp	Affects inductor value
switching inductor ripple max	0.45	Amp	Affects inductor value
Maximum load step	0.05	Amp	Assume di/dt is instant
IC Internal Parameters (do not update unless advised otherwise)			
VFB	2.475	V	Internal to IC
Toffmin (constant off time)	30	μs	IC parameter, to make 30KHz operation in heavy load
standby mode efficiency	0.5	50	Estimated efficiency, this is estimated number
VCC Quiescent current	75	μA	IC parameter, on EC table
DCM Pk inductor current	100	mA	This number is not very accurate, due comparator delay, operation input voltage affecting the current
VCC current during 30K switching	150	μA	IC internal parameter

RAA223011 COMPONENT SELECTION AND DESIGN TOOL IS READY

25	Calculations		
26			
27	Ripple on CFB1	0.85 Volt	This along with "standby power" determines the no-load regulation point
28	Standby Power Requirement	7 mWatt	This and "Ripple on CFB1" affect the zero load regulation point. Use 7mW for RAA223011 & '021
29	D2 and D3 mismatch factor	0.4 Volt	This affects the max load regulation point. Use 0.4V for recommended diodes
30	Choose RFB2	100 kΩ	Select this value. 100kOhms is a reasonable value.
31	RFB1	401.0101 KΩ	Calculated component value
32	L1	1 mH	Calculated component value
35	Dummy resistor R0	62.52714 KΩ	Calculated component value
39	Switching frequency at no load	0.624054 KHz	
40	Switching period at no load	1.602426 ms	
41	FB pin ripple	0.169657 Volt	
42	CFB1	0.226225 μF	Calculated component value
43	COUT, Minimum Cout (bulk)	472.254 μF	Calculated component value
44	Rs, Bias Resistor branch	41.33333 Kohm	Calculated component value
46	Output voltage at no load	12.85 Volt	
48			
49	D1, D3: 1N4007	1N4007	
50	D2: MURS160T3	MURS160T3	
51	D4: ES1J	ES1J	
52	CVCC	1 μF	
53			

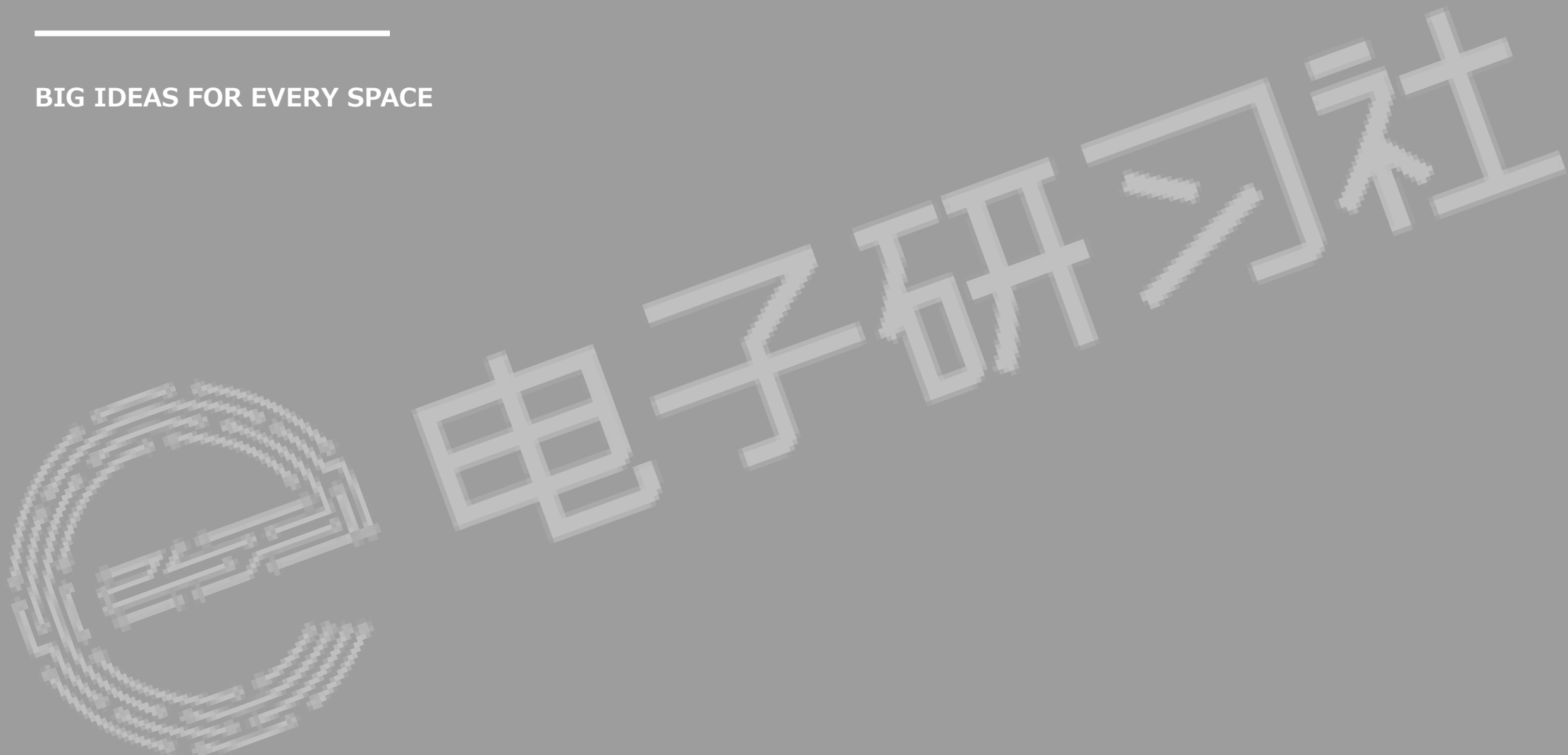


TARGET MARKET 2: WHITE GOODS AND SMALL APPLIANCES



- Appliances are getting smarter and have MCU-based controls & displays
 - Toasters, coffee makers, alarms, water heaters, fan control, humidifier, induction cooker...
 - Fridge, washer, dryer, HVAC... (some white goods require isolation)
 - Most offline motor drives & inverters require bias power from AC

BIG IDEAS FOR EVERY SPACE



ISL81801

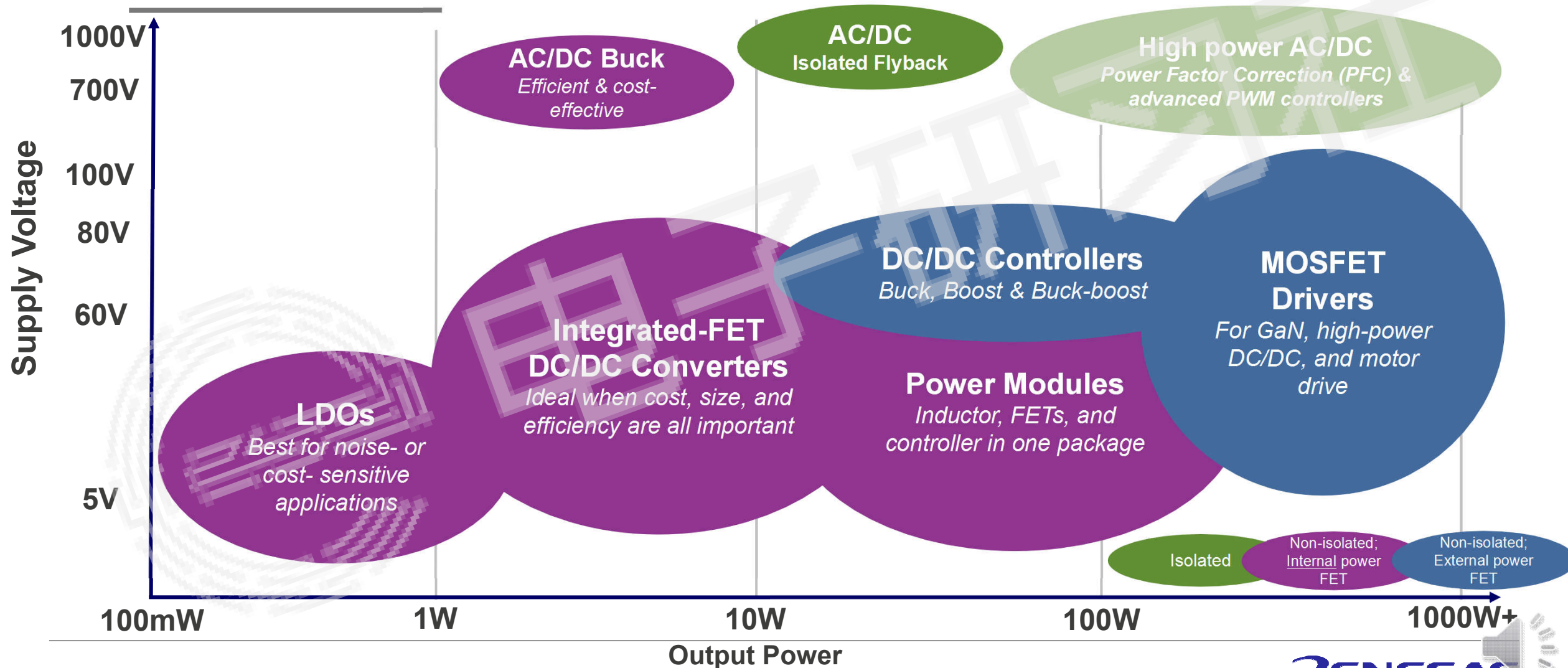
RENESAS HIGH VOLTAGE BUCK-BOOST CONTROLLER FAMILY

Industrial Power and Analog Product Line
Renesas Electronics Corporation

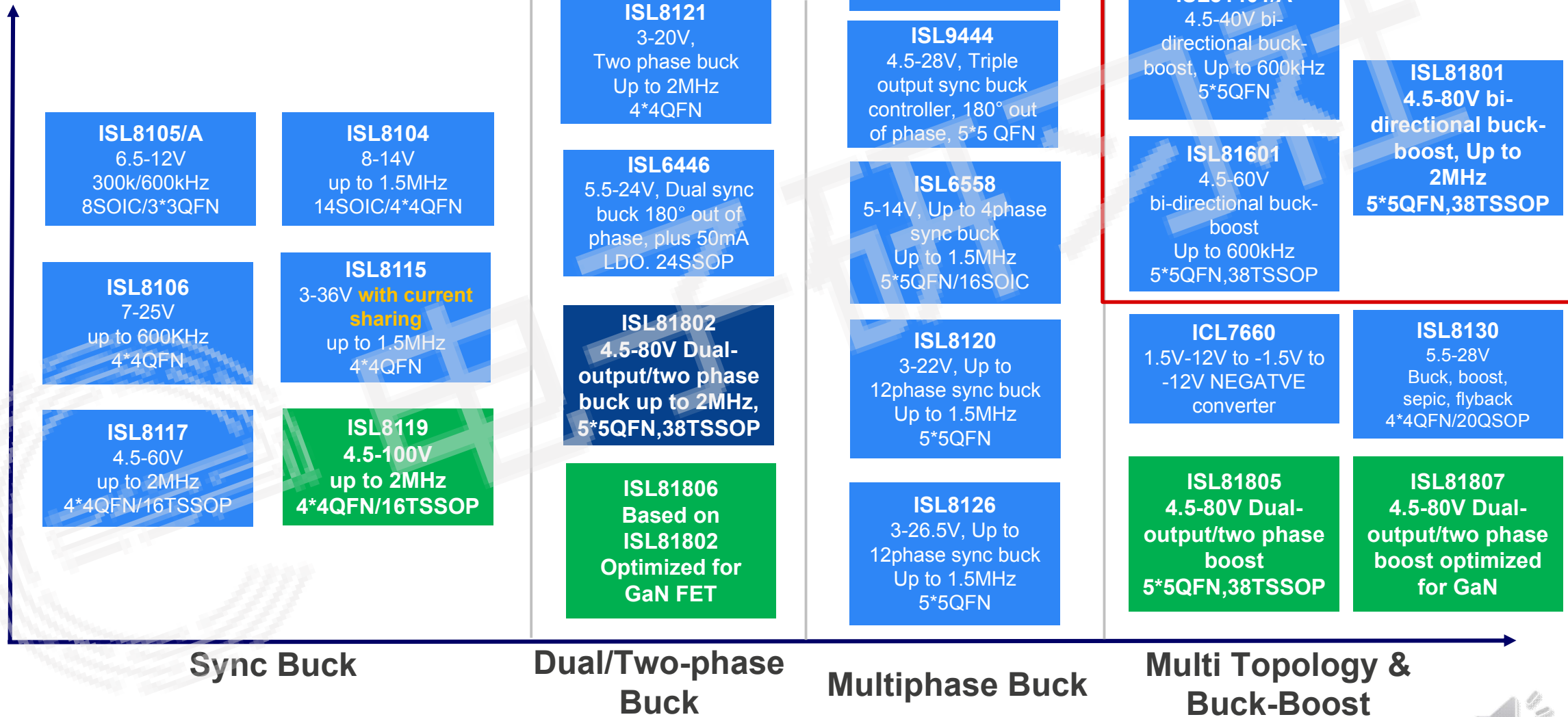
BIG IDEAS
FOR EVERY SPACE

RENESAS FULL MENU OF POWER SOLUTIONS

FROM MILLIWATTS TO KILOWATTS, WE CAN SUPPORT YOUR APPLICATION



RENESAS INDUSTRIAL POWER DCDC CONTROLLER SOLUTIONS



Released

Sampling

Under Design

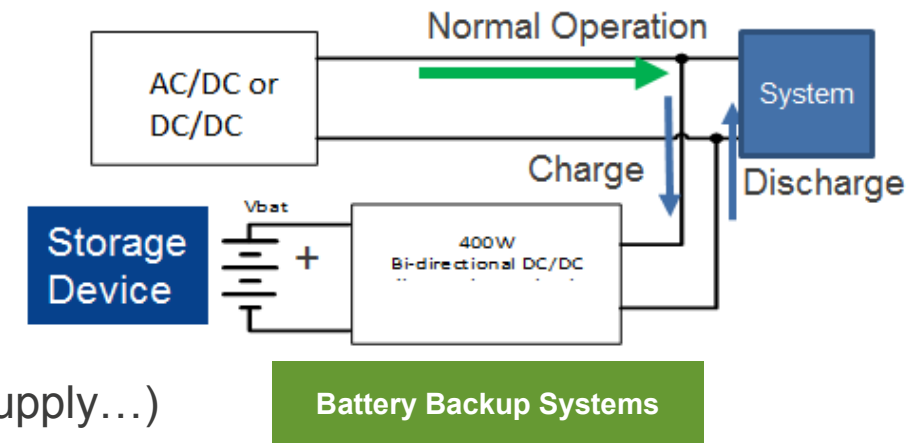
BIG IDEAS FOR EVERY SPACE



TARGET MARKETS AND APPLICATIONS

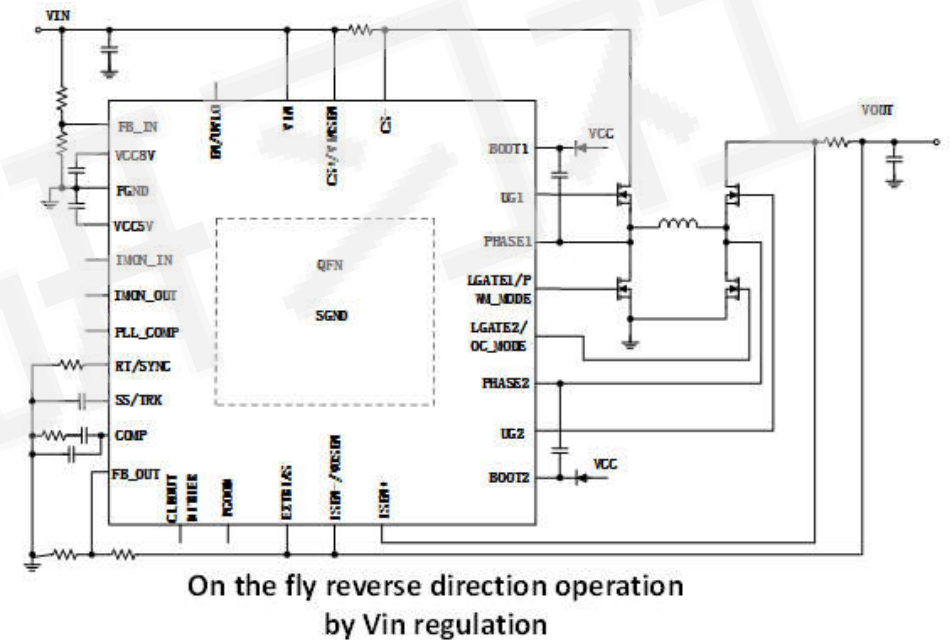
Buck-Boost means V_{in} can be higher or lower than V_{out} (buck for higher input, boost for lower)

- Wide V_{in}
 - Battery and supercapacitor applications (power tools, E-scooters, portable electronics...)
 - Inductive kick causing voltage overshoot (automotive, motor drives)
 - Less regulated input (solar, wind, long cables)
 - One-fit-all Industrial applications with various optional power bus (5V, 12V, 24V...)
- Wide V_{out}
 - USB PD with configurable output voltage
 - Battery chargers with wide output battery voltage
- Dual or Multiple power sources
 - An equipment get power fed from different voltage rails (48V telecom backup, supercapacitor storage, hybrid power supply...)



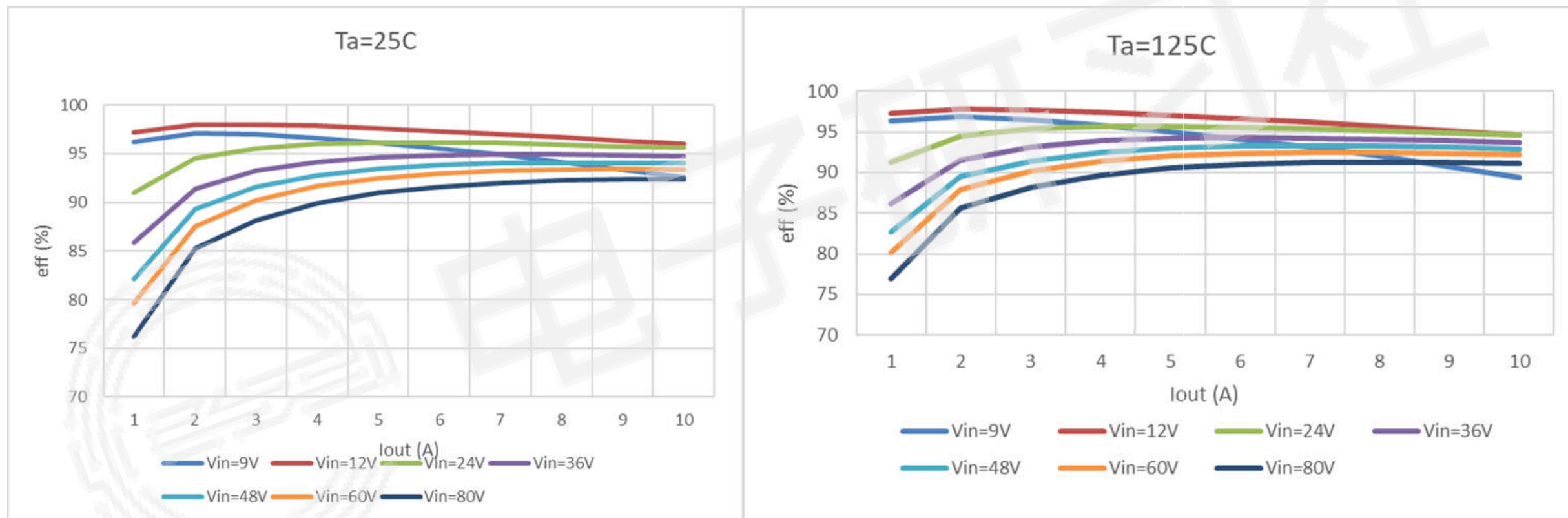
ISL81401 / ISL81601/ ISL81801: 40V/ 60V / 80V **BI-DIRECTIONAL** BUCK-BOOST CONTROLLER

- Industry's FIRST bi-directional buck-boost controller
 - CV/CC for both input and output
 - Dual feedback loop at input and output
- Flexible
 - Wide programmable frequency: 100KHz to 600KHz
 - Interleaved current sharing for parallel operation
 - Supports on-the-fly settings change including the current flow
- Reliable
 - OVP,OCP,OTP,UVLO, soft start
 - Sense both positive and negative inductor peak current

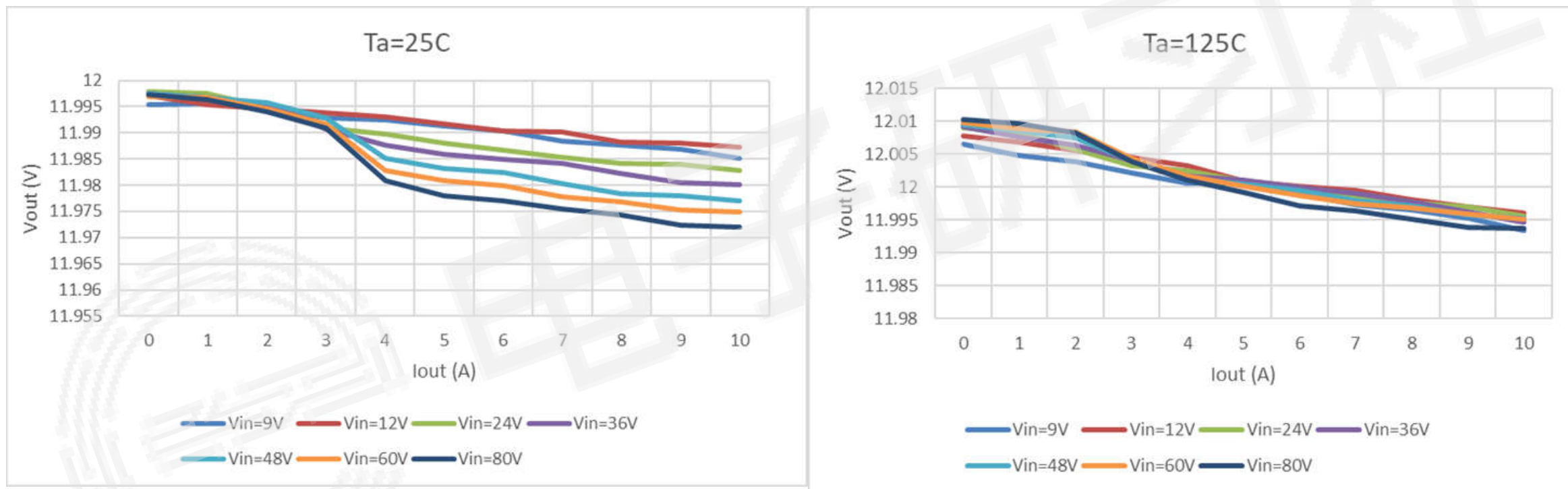


5*5QFN and 38TSSOP

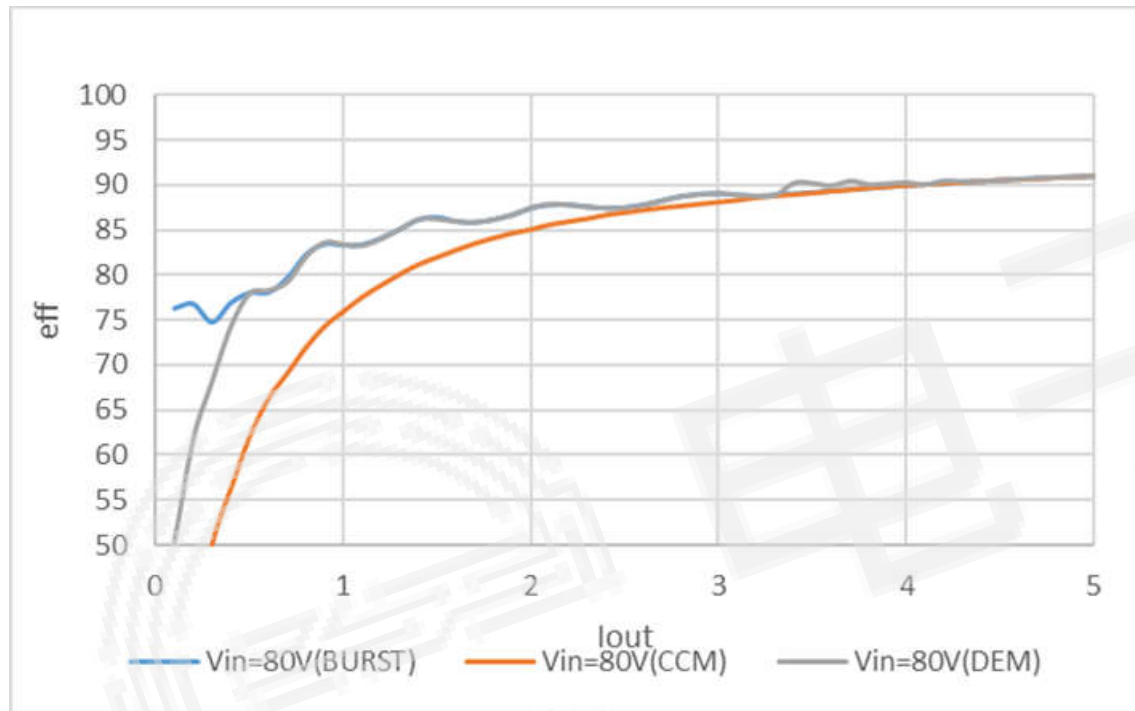
ISL81801: HIGH EFFICIENCY ACROSS WIDE INPUT, WIDE LOAD CURRENT @ 12V, AND WIDE TEMPERATURE RANGE



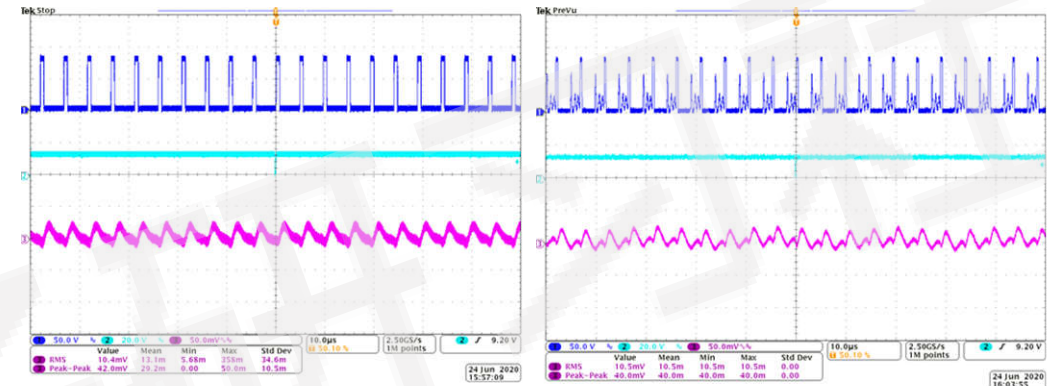
ISL81801: TIGHT LOAD REGULATION < 0.5% ACROSS WIDE INPUT RANGE, WIDE LOAD RANGE AND WIDE TEMPERATURE RANGE



ISL81801 WITH CONFIGURABLE OPERATION MODES FOR BEST EFFICIENCY OR BEST OUTPUT RIPPLE

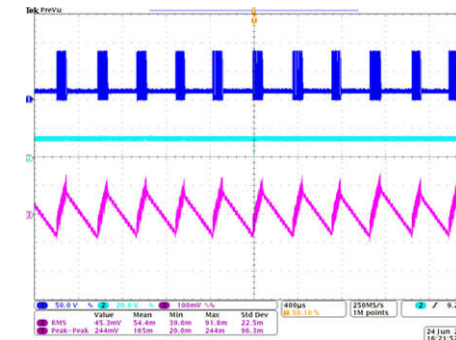


Burst mode achieves higher efficiency at light load, also results in higher output ripple



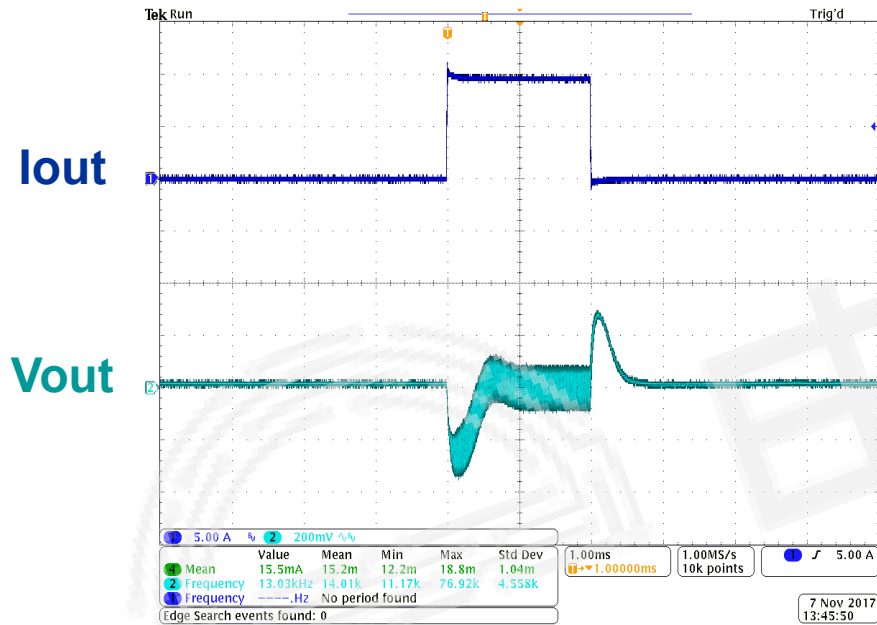
CCM 80V input
12V1A output
Ripple = 42mV

DEM 80V input
12V1A output
Ripple = 40mV

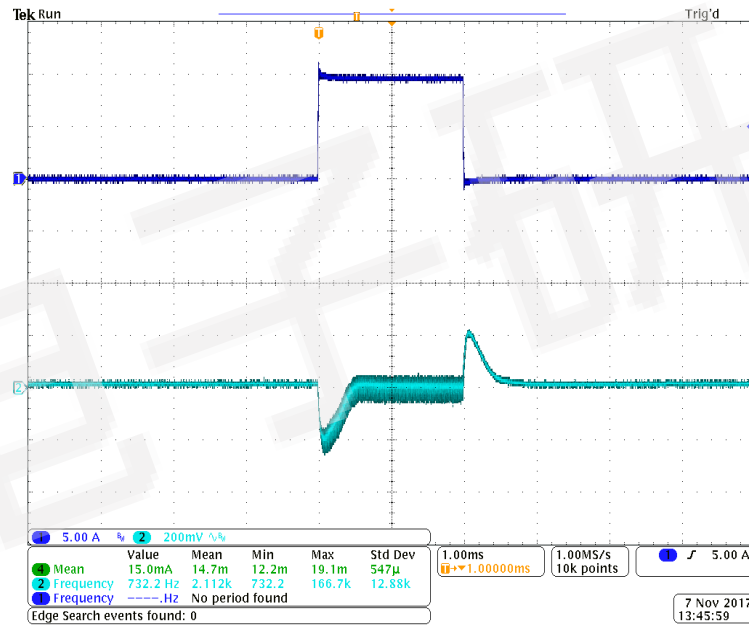


Burst 80V input
12V1A output
Ripple = 244mV

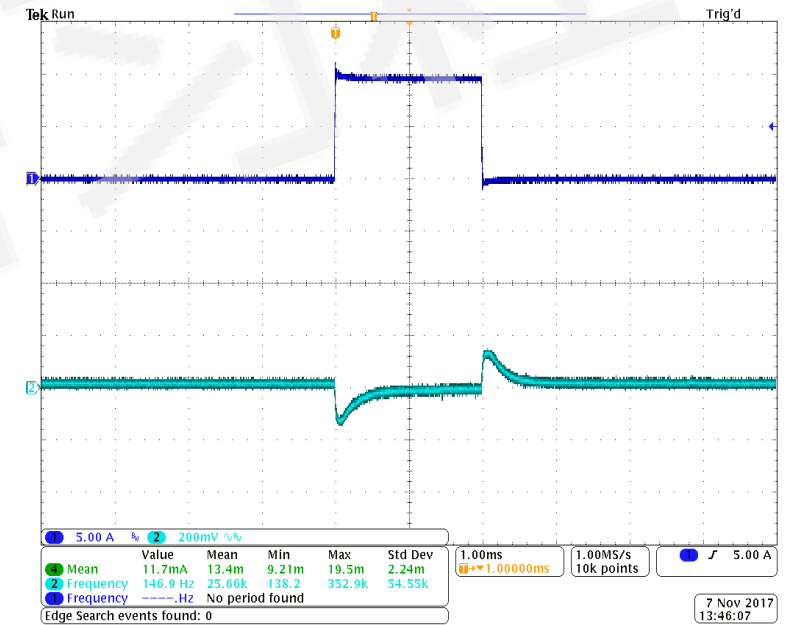
ISL81801: EXTRA SOFT VOUT RESPONSE WITH CONSTANT VOLTAGE LOAD STEP



Vin=9 V Vout=12V Iout=0-10A
Ripple within 300mV

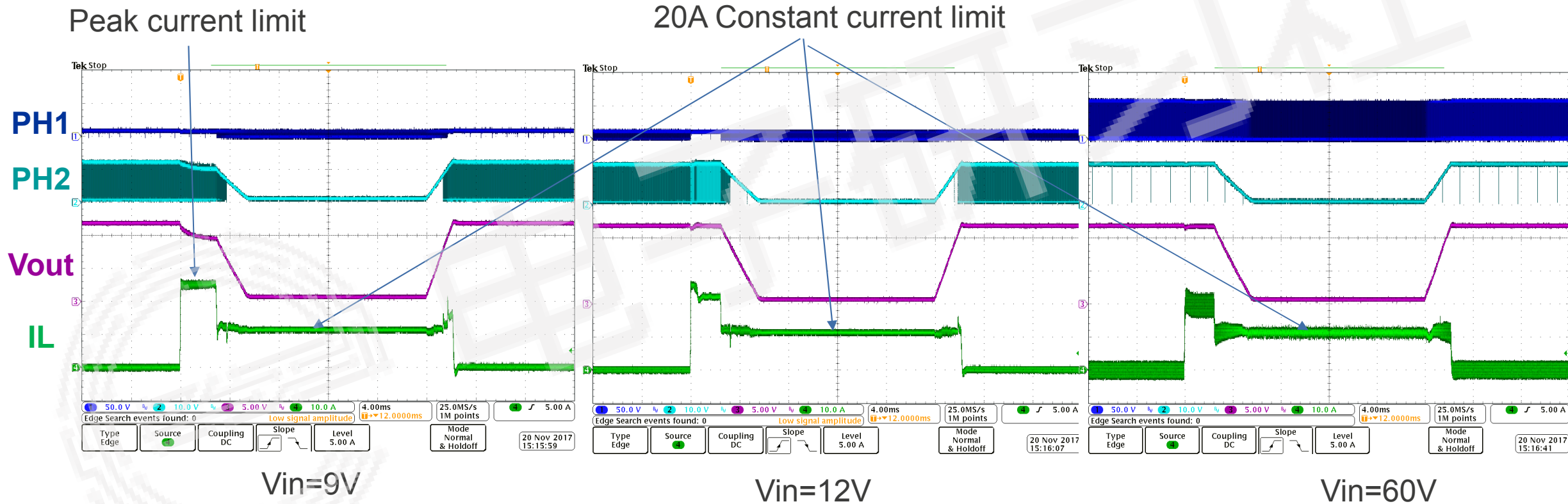


Vin=12V Vout=12V Iout=0-10A
Ripple within 200mV



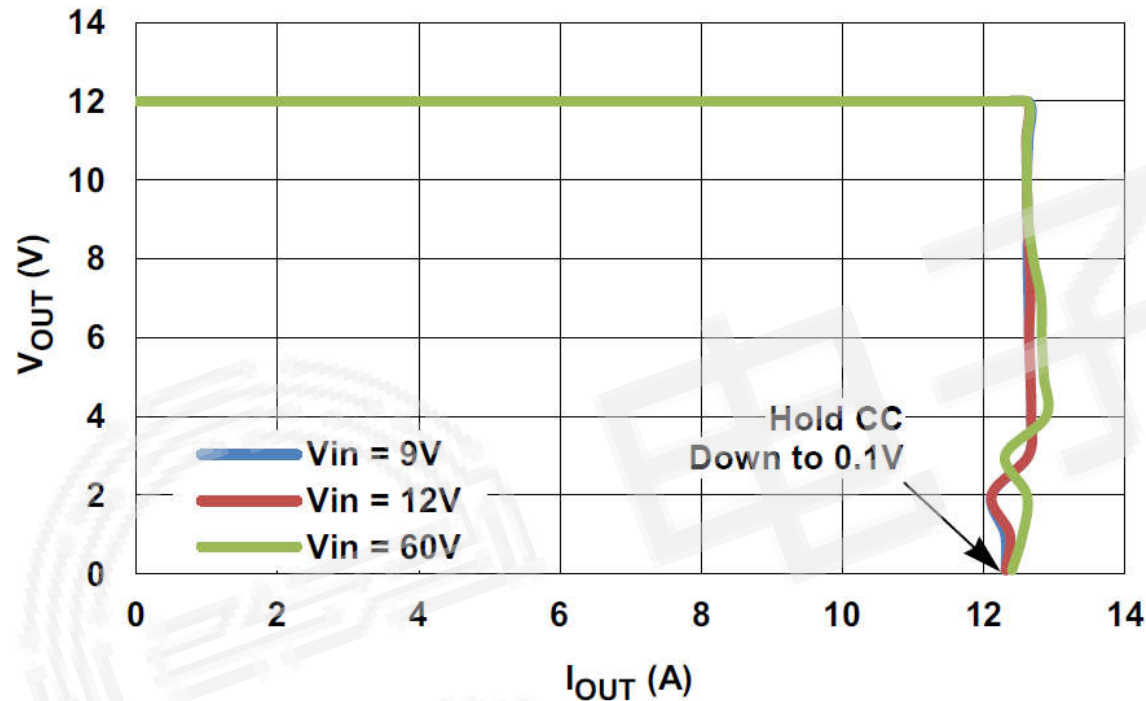
Vin=24V Vout=12V Iout=0-10A
Ripple within 150mV

ISL81601: EXTRA SOFT VOUT RESPONSE WITH CONSTANT CURRENT LOAD STEP AT ANY INPUT

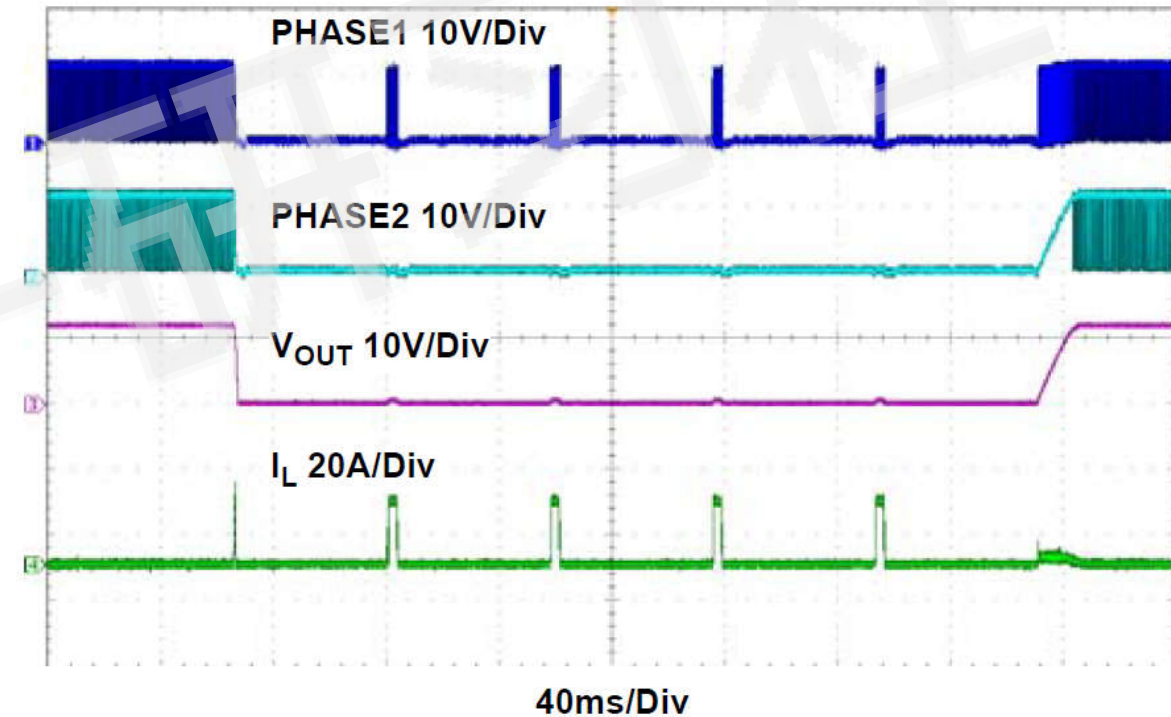


Apply and Remove a 20A CC Load

ISL81601: TRUE CONSTANT CURRENT REGULATION OR OPTIONAL HICCUP AT OCP



Constant Current OCP
(low ripple, low noise)

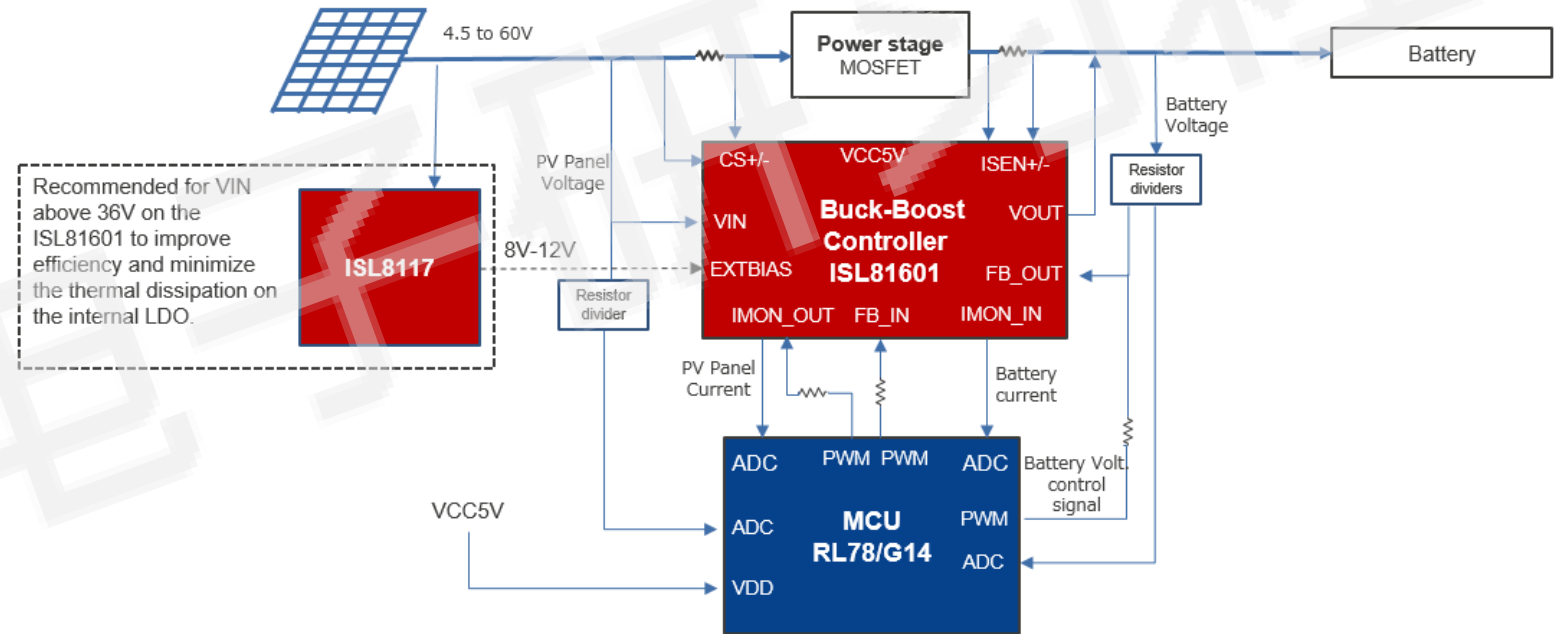


Hiccup OCP
(high ripple, high efficiency)

SOLAR BATTERY CHARGER: PROJECT OVERVIEW

Key Features

- Buck-boost converter, allowing PV volt lower or higher than V_{battery} .
- Wide Vin & Vout output range, up to 60/80V
- MPP tracking function of solar panel based on P&O method
- Battery charger function (CC/CV).
- Full protections on input/output volt/current/temp, reverse polarity/current, over-charge/over-discharge.
- Optional: GUI with Solar/battery status, instruction/input

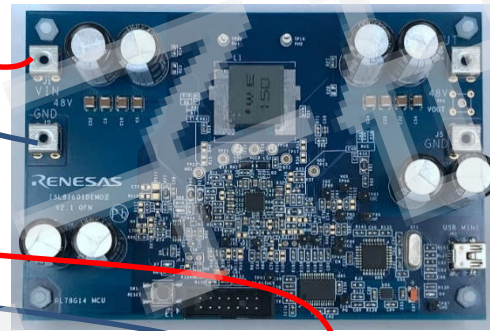


SOLAR BATTERY CHARGER DEMO SETUP

DC source



Battery/Super Cap



Demo board
available upon
request

E-load



Renesas IC used:

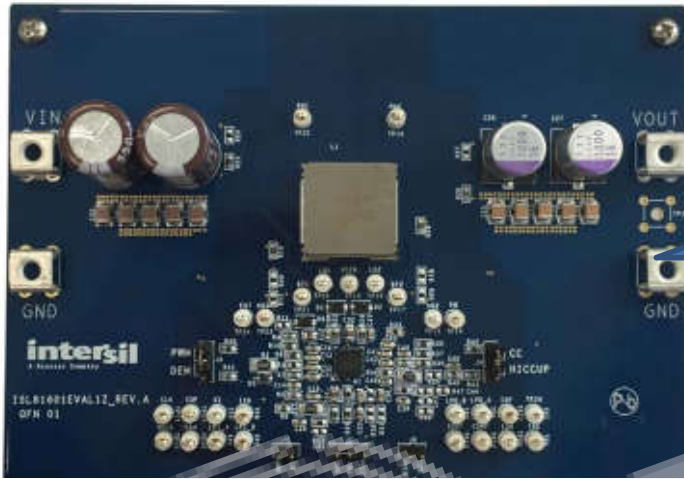
ISL81601/801: Bidirectional buck-boost

ISL28213: Dual opamp

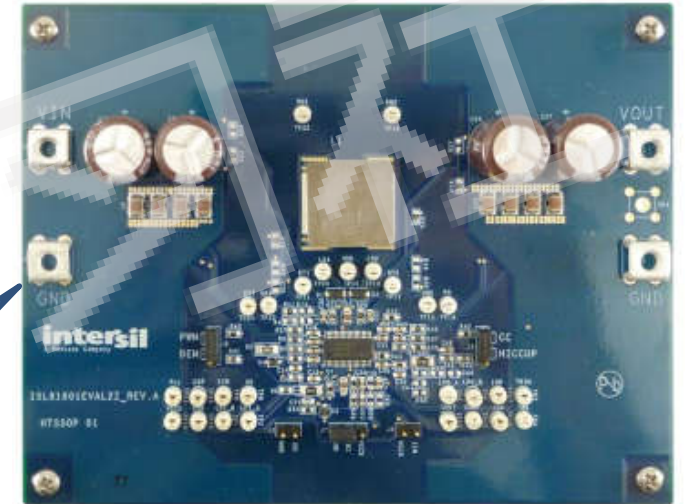
ISL80510: 5V1A LDO

RL78G14: low power 16bit MCU

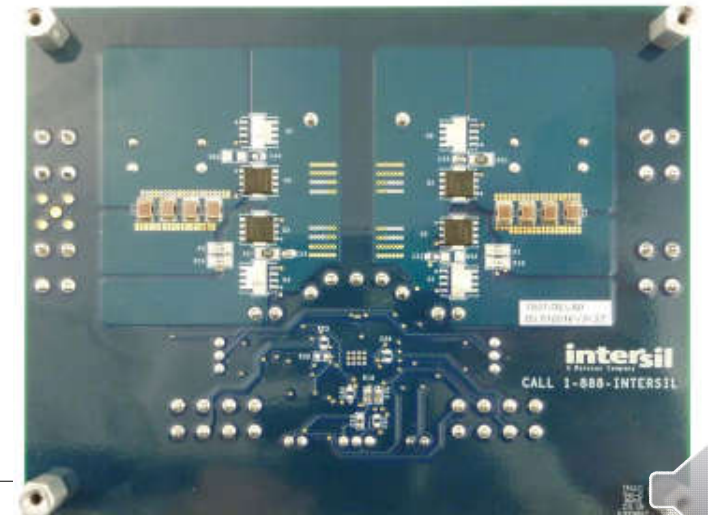
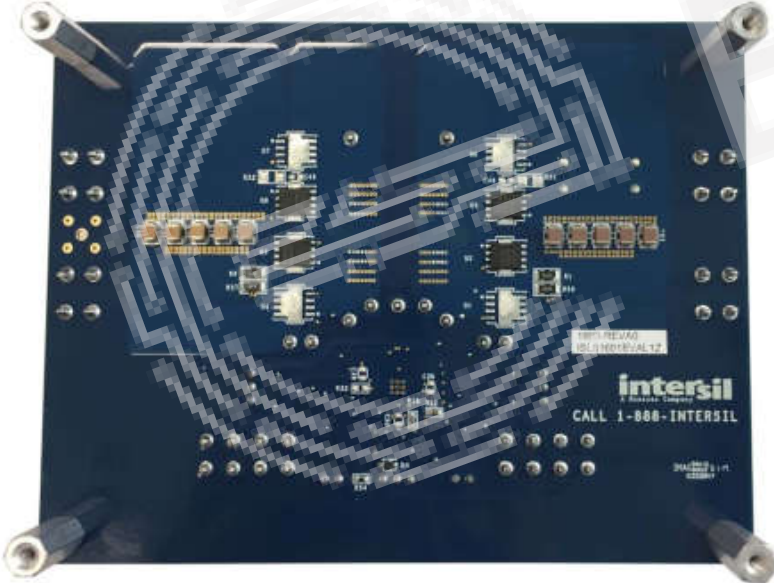
ISL81801 EVALUATION BOARDS AVAILABLE FOR EVALUATION



ISL81801EVAL1Z
9V~60V >>> 12V@10A
120W

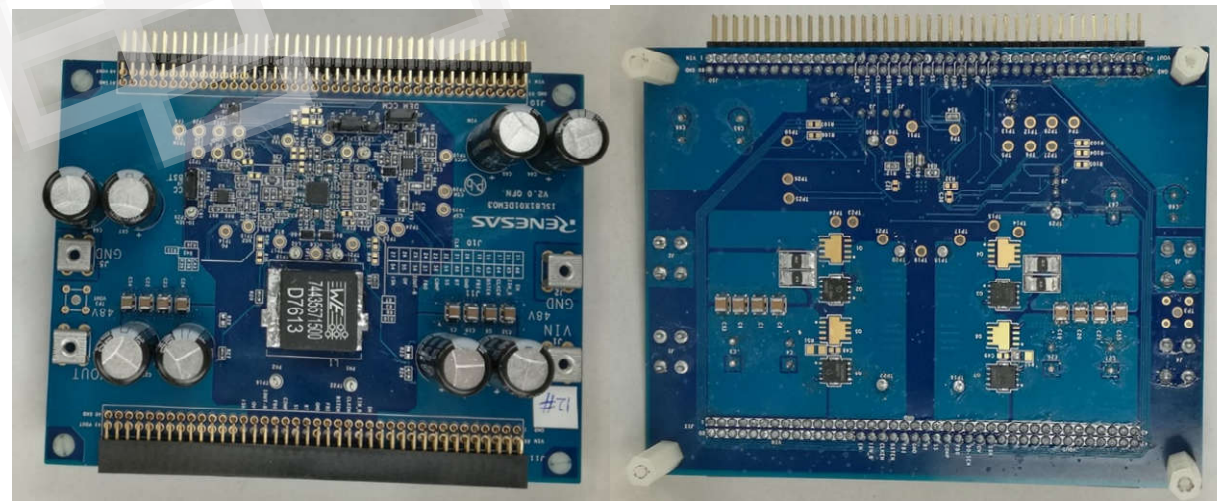


ISL81801EVAL2Z
32V~60V >>> 48V@5A
240W

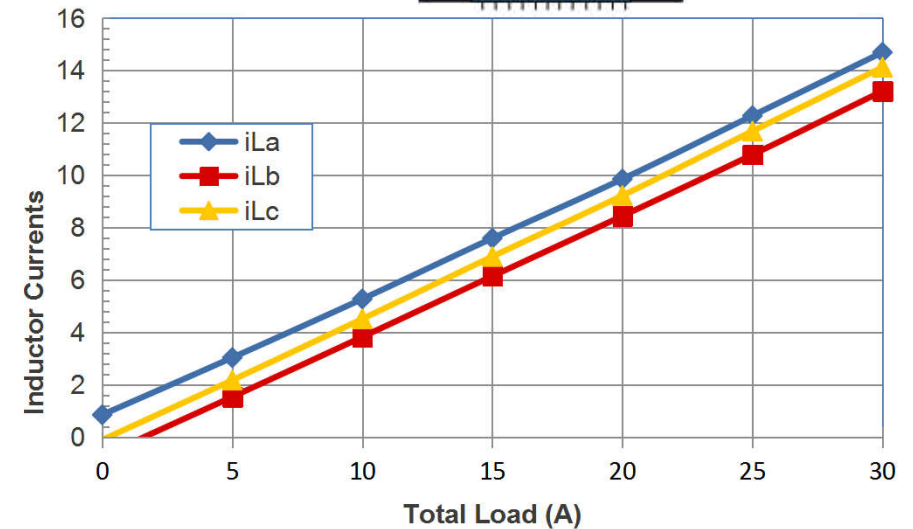
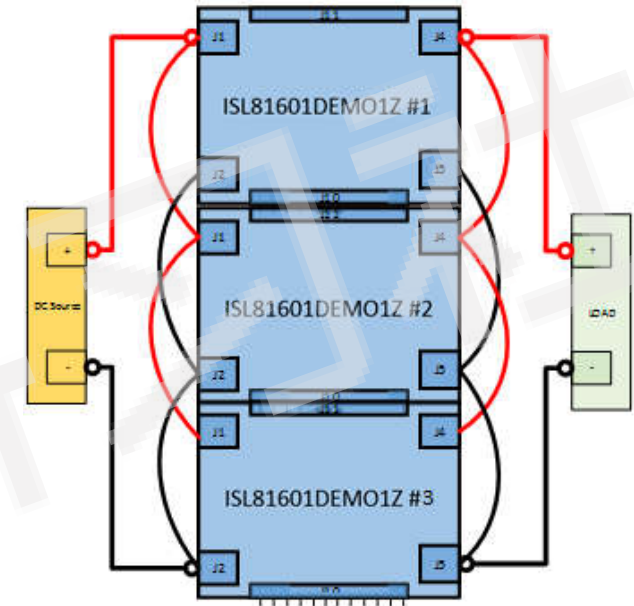
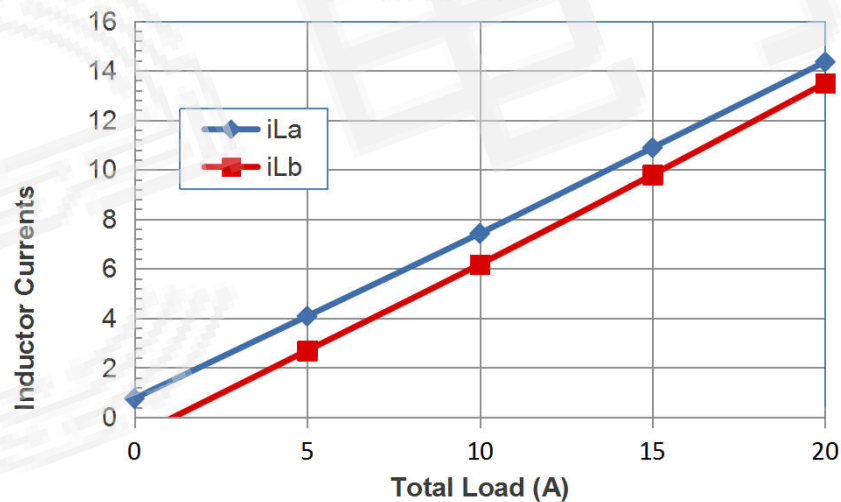
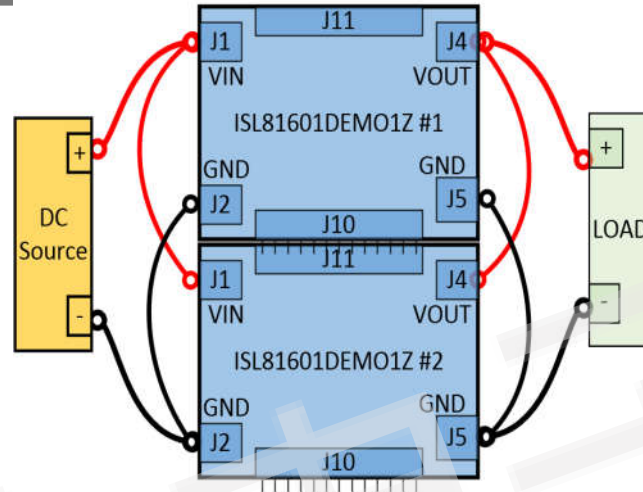


HIGH POWER PARALLEL-ABLE EVALUATION BOARD

	ISL81801DEMO1Z
Input Voltage	32V to 80V
Switching Frequency	200kHz
Output Voltage	48V
Output Current	10A
Dimensions	130x87x30 mm ³
Efficiency	97.2%@36Vi,FullLoad; 98.5%@48Vi,FullLoad; 98.2%@60Vi,FullLoad;



ISL81801DEMO1Z: PARALLEL OPERATION



BIG IDEAS FOR EVERY SPACE

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电子研习社



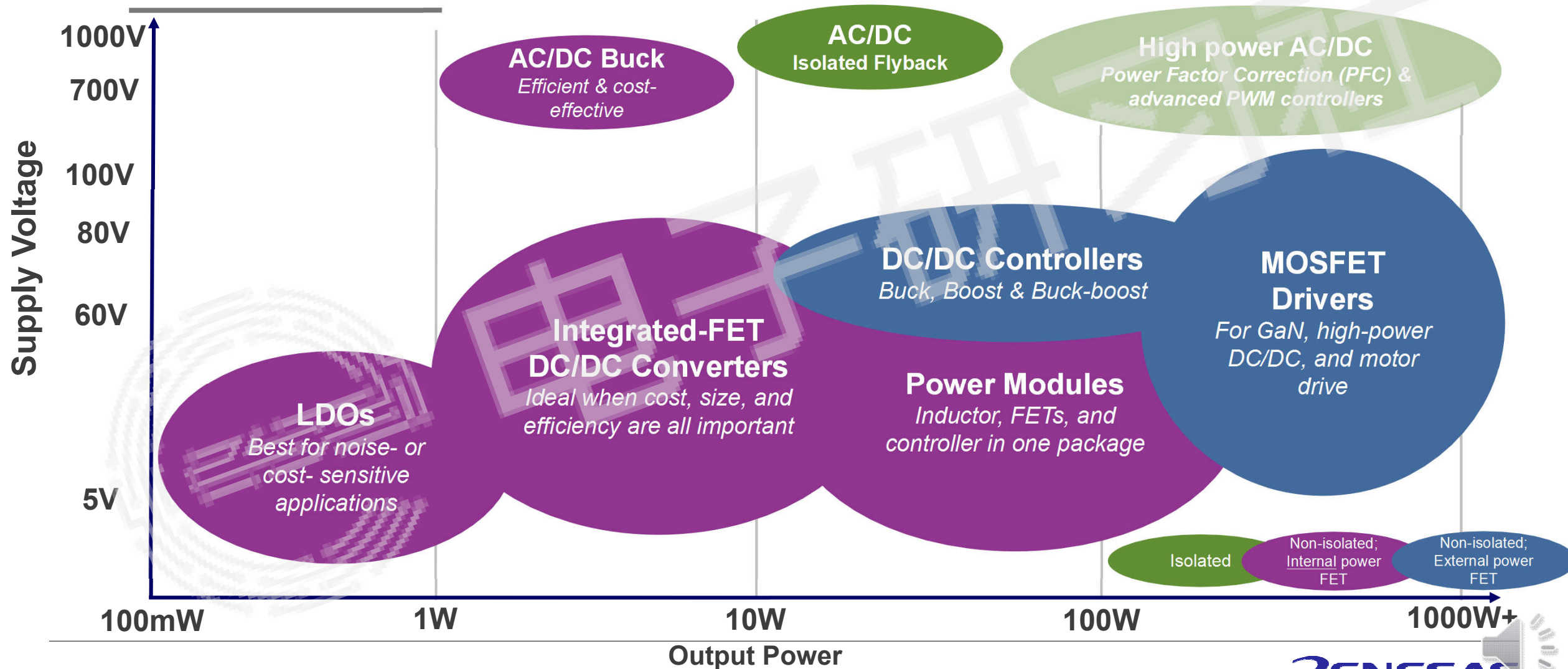
80V DUAL PHASE SYNC BUCK CONTROLLER ISL81802 INTRODUCTION

INDUSTRIAL POWER PRODUCT LINE
IIBU
RENESAS
06/20/2020

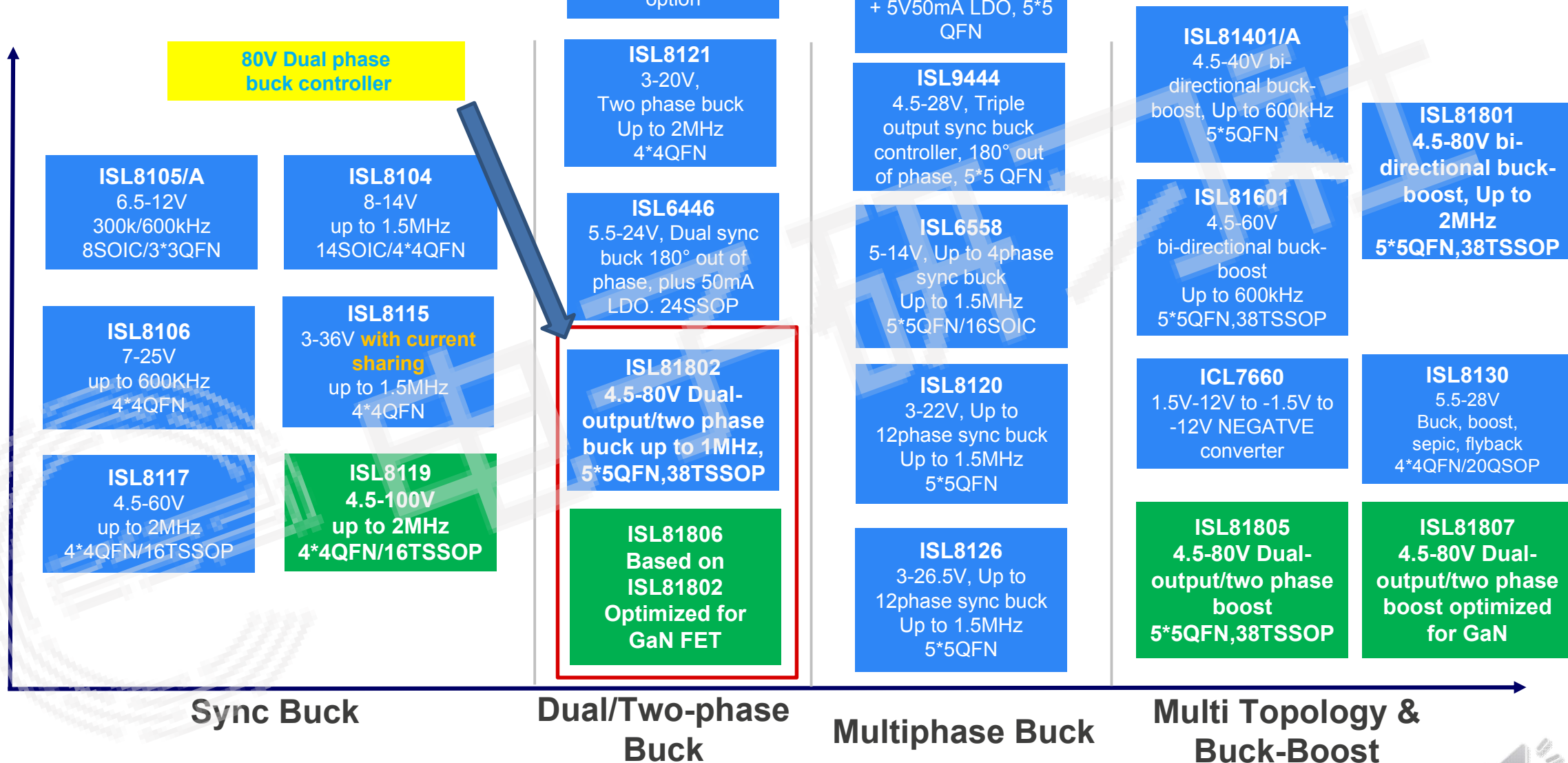
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Released

Sampling

Under Design

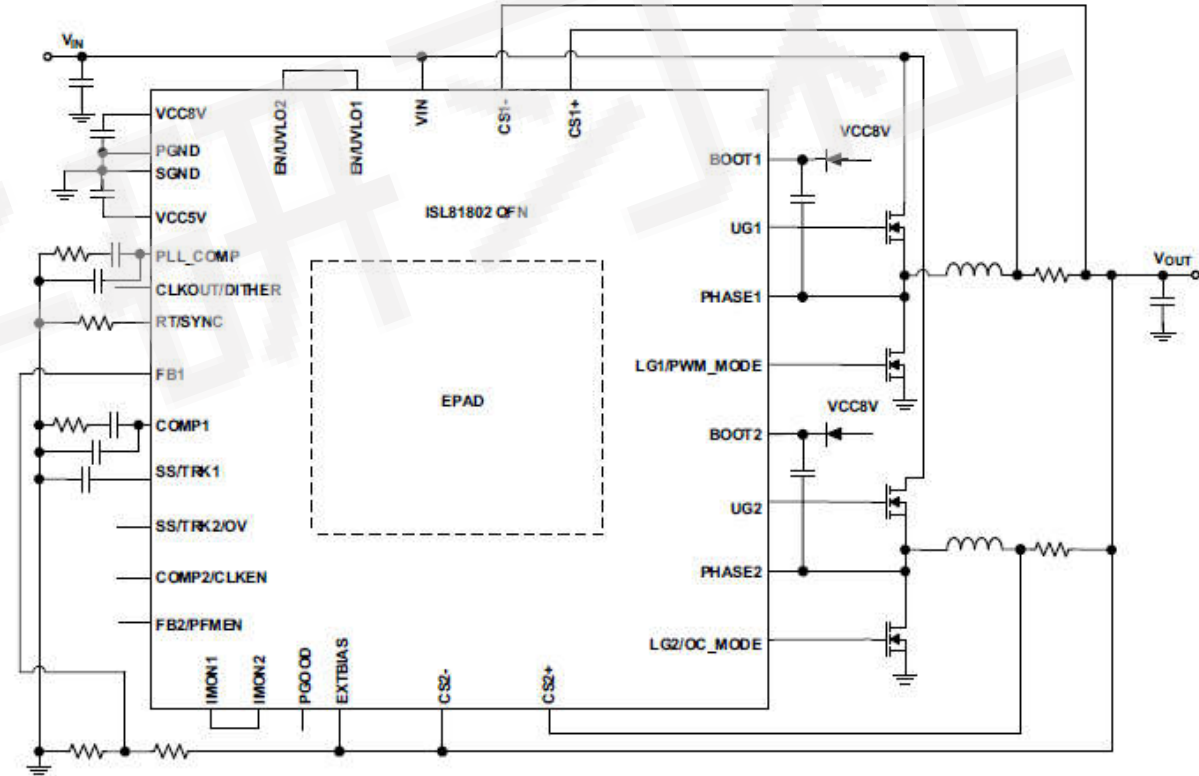
BIG IDEAS FOR EVERY SPACE



ISL81802: 80V DUAL OUTPUT/TWO PHASE CONTROLLER

FEATURES

- Wide Vin range: 4.5V to 80V
- Wide Vout range: 0.8V to 76V
- Dual or Two-phase Buck controller with interleaved outputs
- Integrated CC/CV controller+ driver
- Supports multi-chip paralleling and phase interleaving
- Wide switching frequency: 100Khz to 1MHz
- Current mode with diode emulation and burst mode at light load or Forced PWM mode
- Shoot-thru protection, OCP, OVP, OTP, UVP
- Independent EN and Soft start for each output

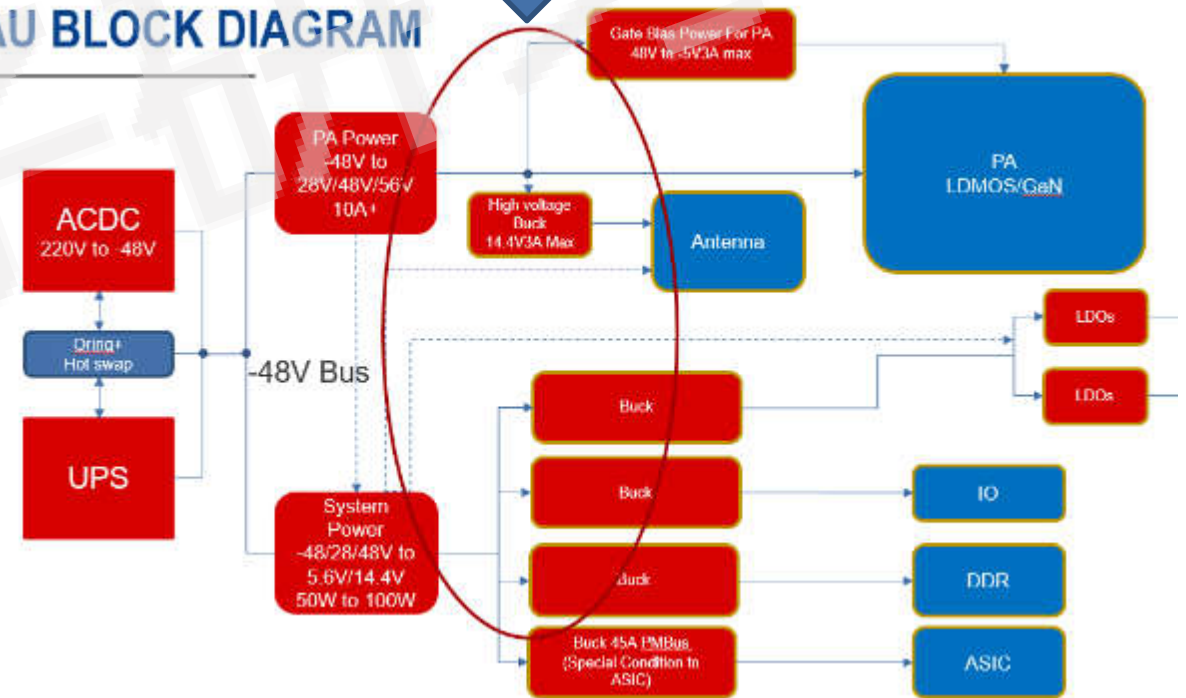


ISL81802 KEY APPLICATIONS

- Telecom non-isolated 48V/56V to 14V/12V/5V conversion
- 48V server, datacom and storage
- Battery and supercapacitor applications
- Aftermarket automotive
- Less regulated input in industrial applications (solar, wind, long cables)
- High current distributed power systems

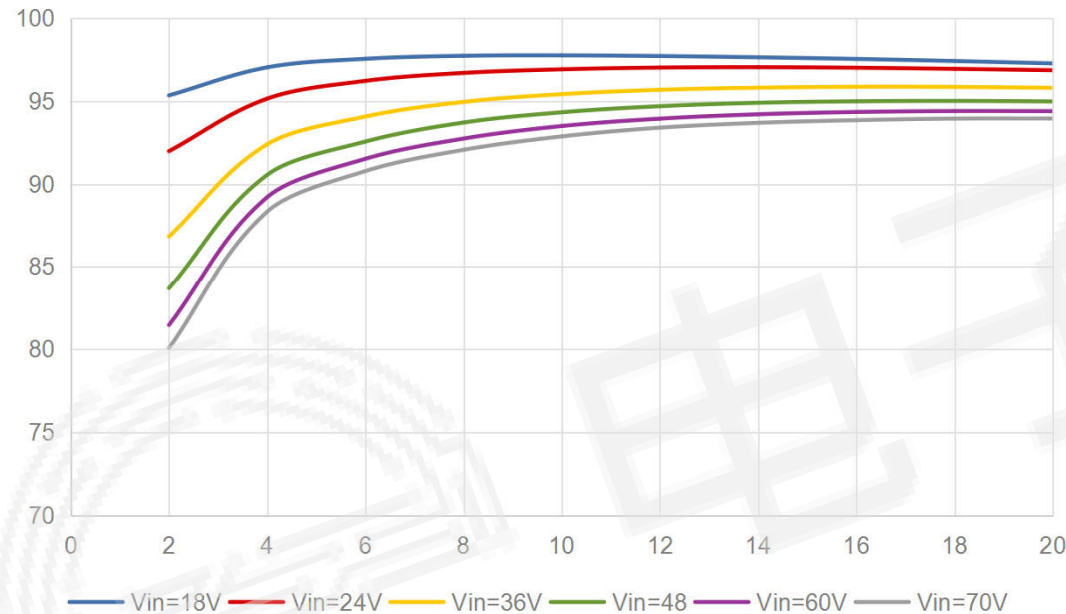
5G uses ISL81802 in AAU/BBU for +48V/+56V to 5.6V/14.4V conversion

AAU BLOCK DIAGRAM



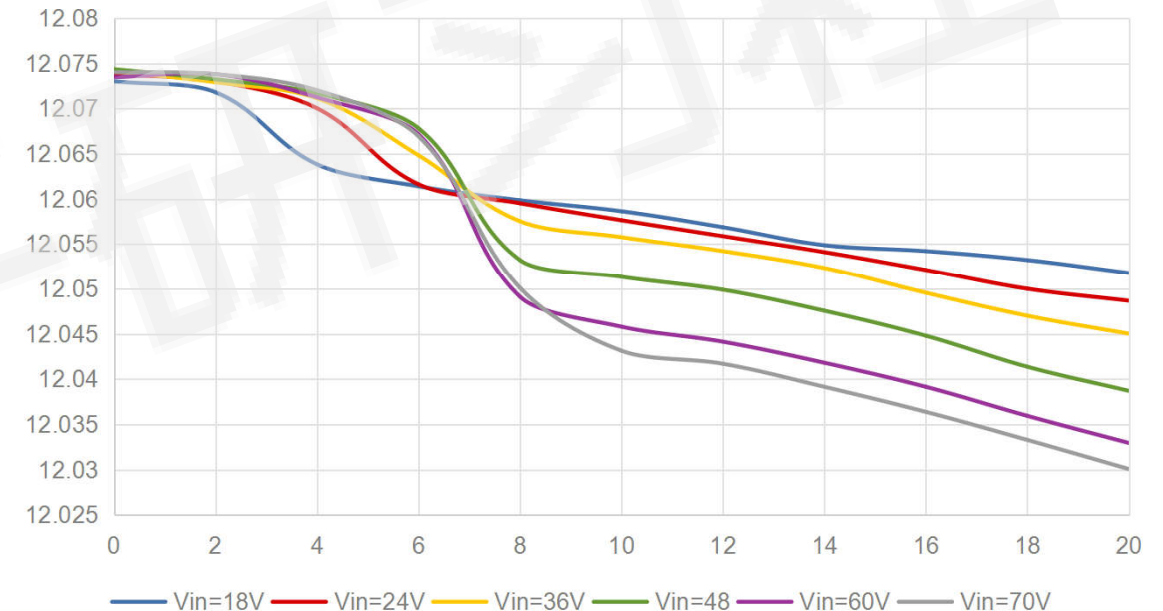
HIGH EFFICIENCY AND TIGHT LOAD REGULATION

Efficiency @ T-ambient 85C



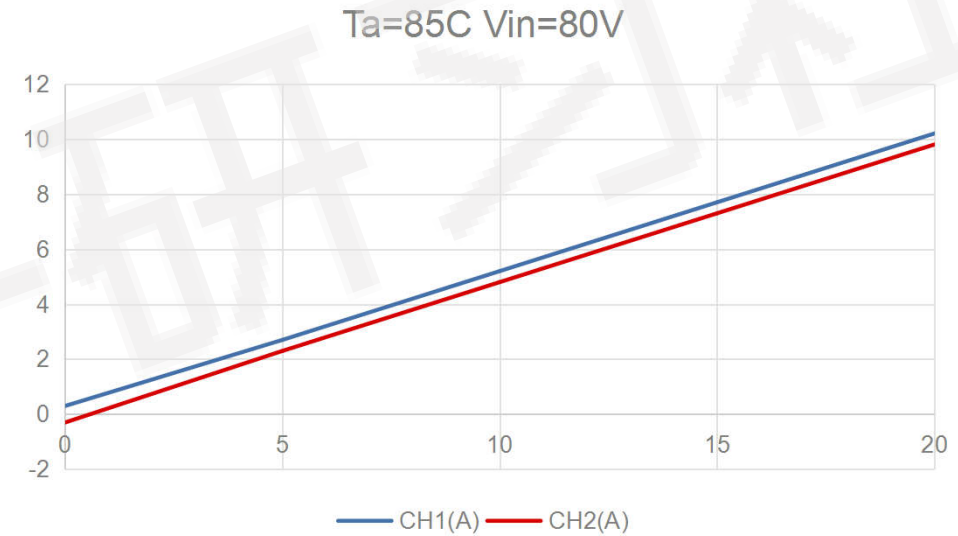
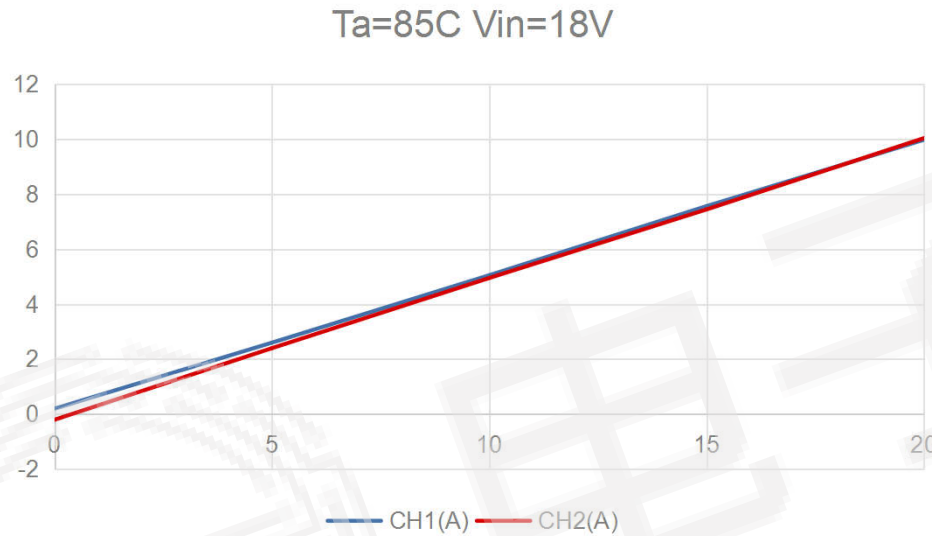
**18V-70V input;
12V output;
High efficiency from 2A to 20A**

Load Regulation @ T-ambient 85C



**18V-70V input;
12V output;
<0.4% regulated difference from 2A to 20A**

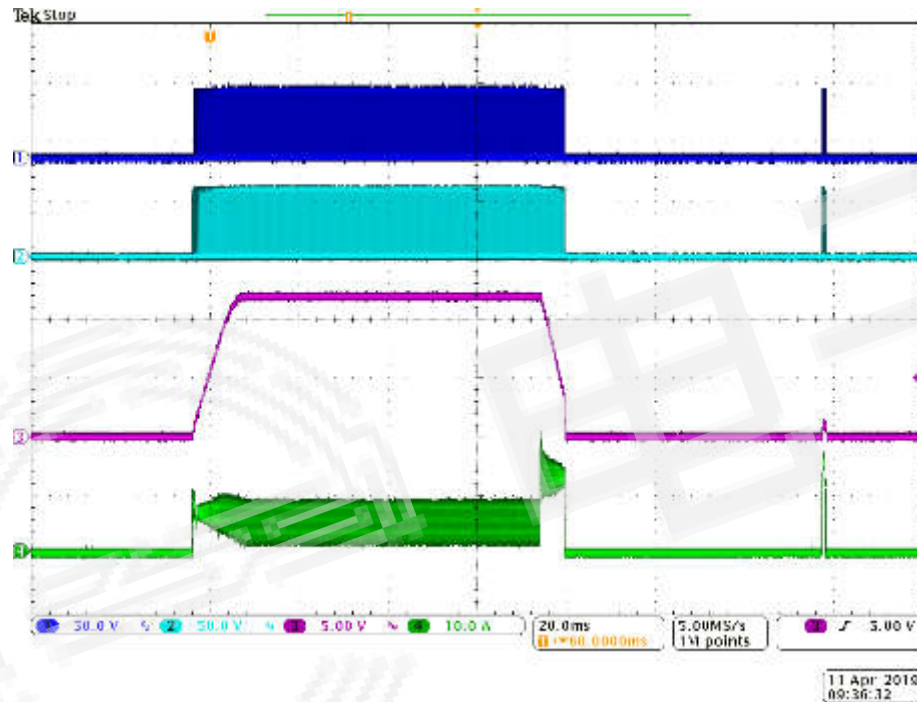
CURRENT SHARING



**Very tight current sharing
under wide input range**

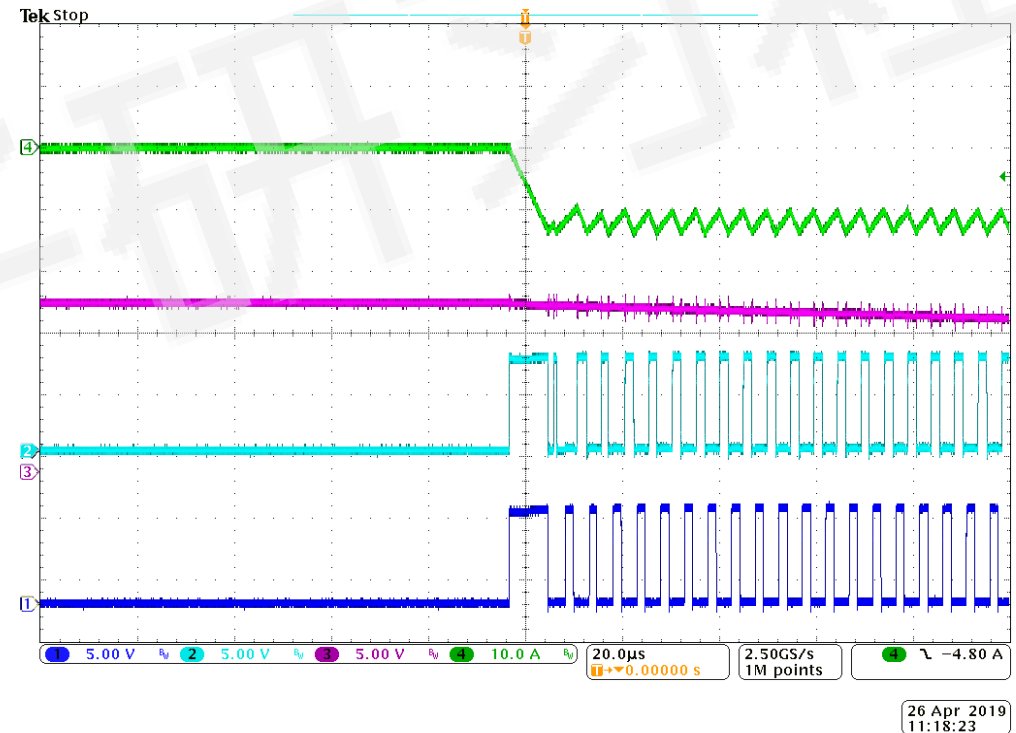
OUTPUT OCP AND OVP WITH HICCUP RESTART

CH1: PH1, CH2: PH2, CH3: VOUT, CH4: IL2



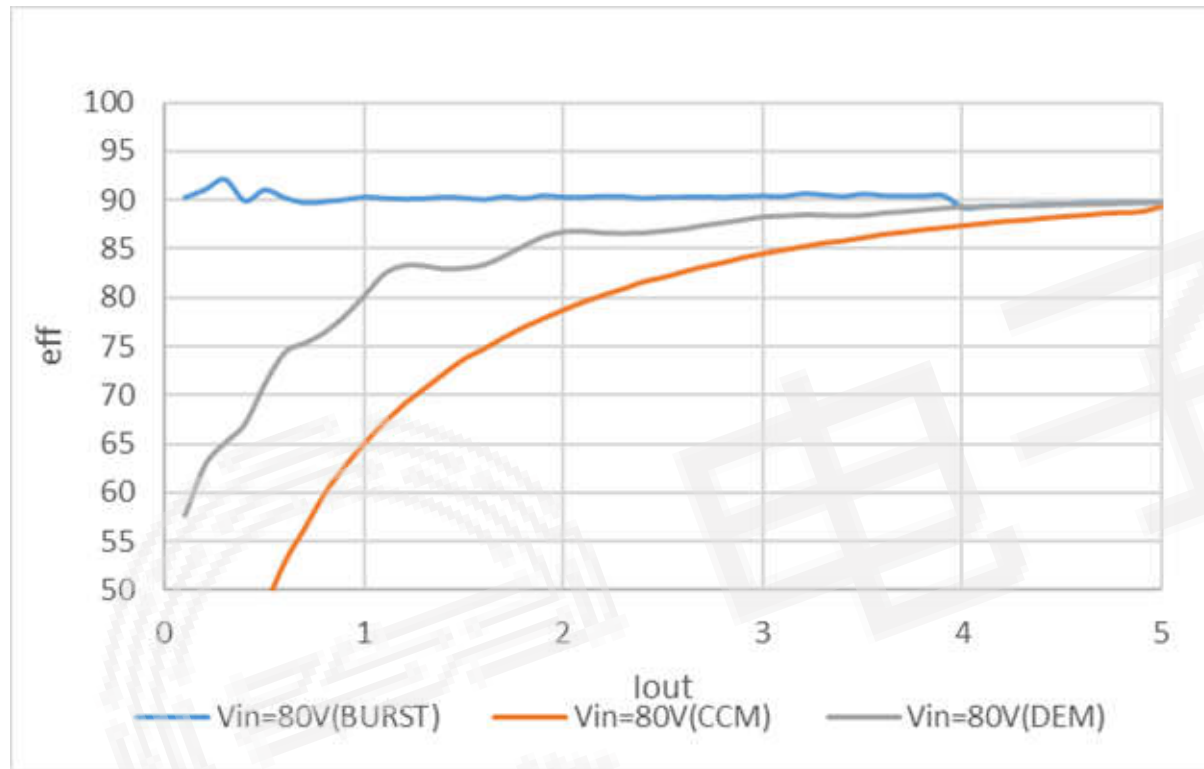
Safe OCP with hiccup restart

CH1: LG1, CH2 : LG2, CH3: VOUT, CH4: IL2

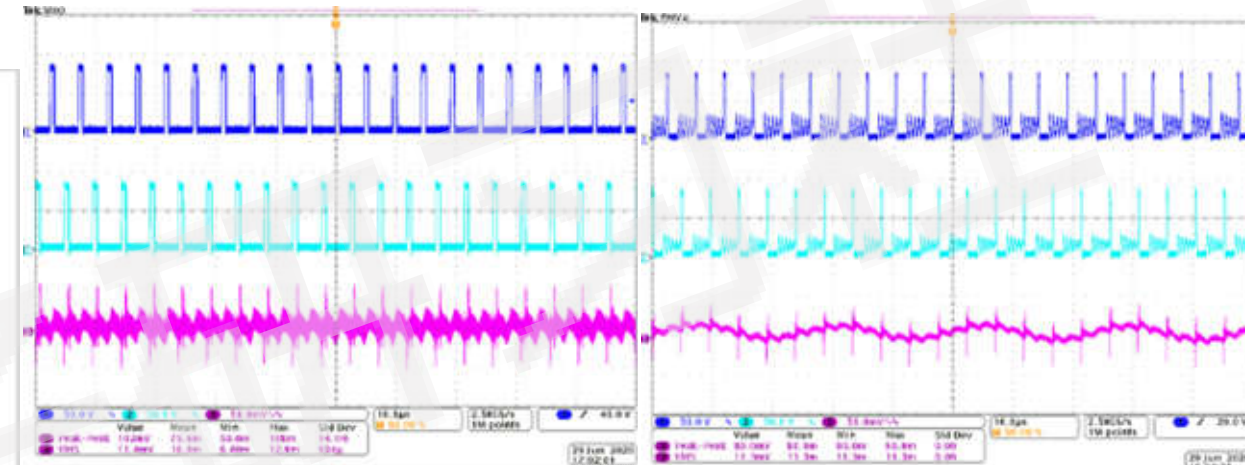


Safe OVP with hiccup restart

ISL81802 WITH CONFIGURABLE OPERATION MODES FOR BEST EFFICIENCY OR BEST OUTPUT RIPPLE

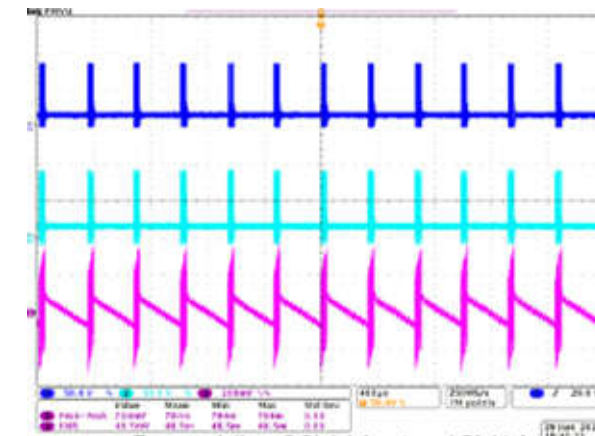


Burst mode achieves higher efficiency at light load, also results in higher output ripple



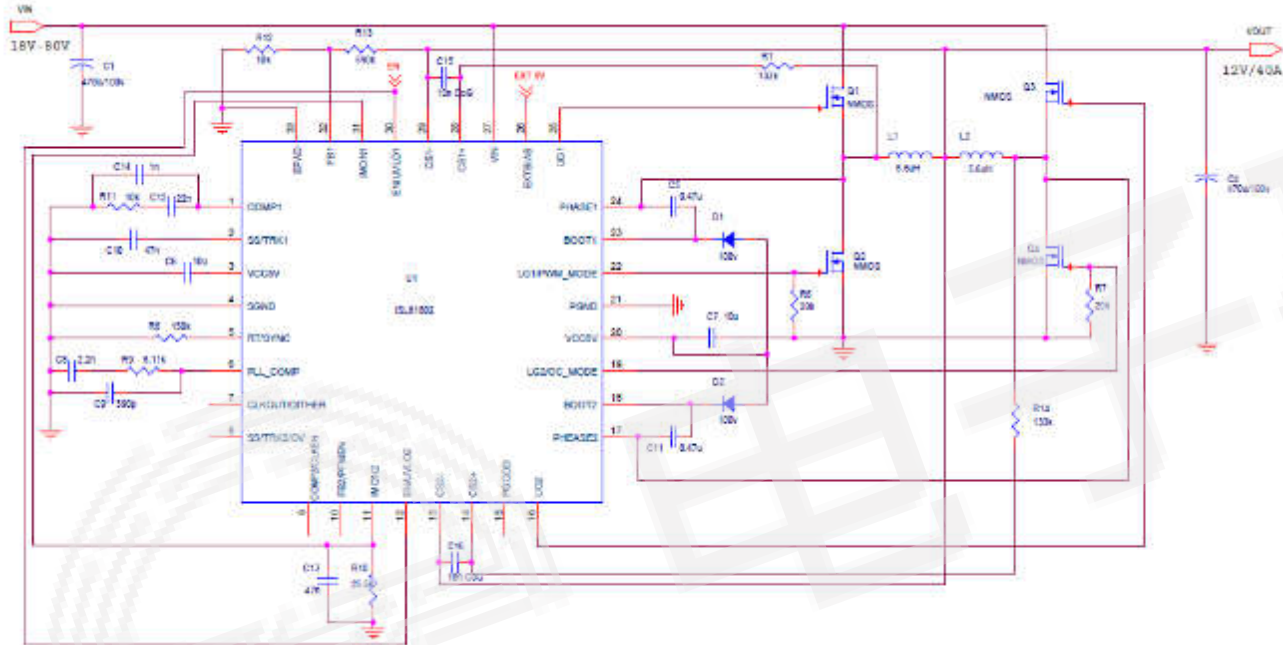
CCM, $V_{in}=80V$, $V_{out}=12V$, $I_{out}=1A$
Ripple = 102mV

DEM, $V_{in}=80V$, $V_{out}=12V$, $I_{out}=1A$
Ripple = 80mV



Burst, $V_{in}=80V$, $V_{out}=12V$, $I_{out}=1A$
Ripple = 704mV

ISL81802 EVALUATION BOARD ISL81802EVAL1Z

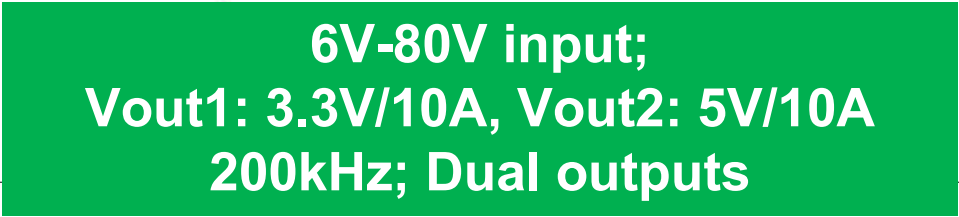


18V-80V input;
12V,40A output;
200kHz; Two phase

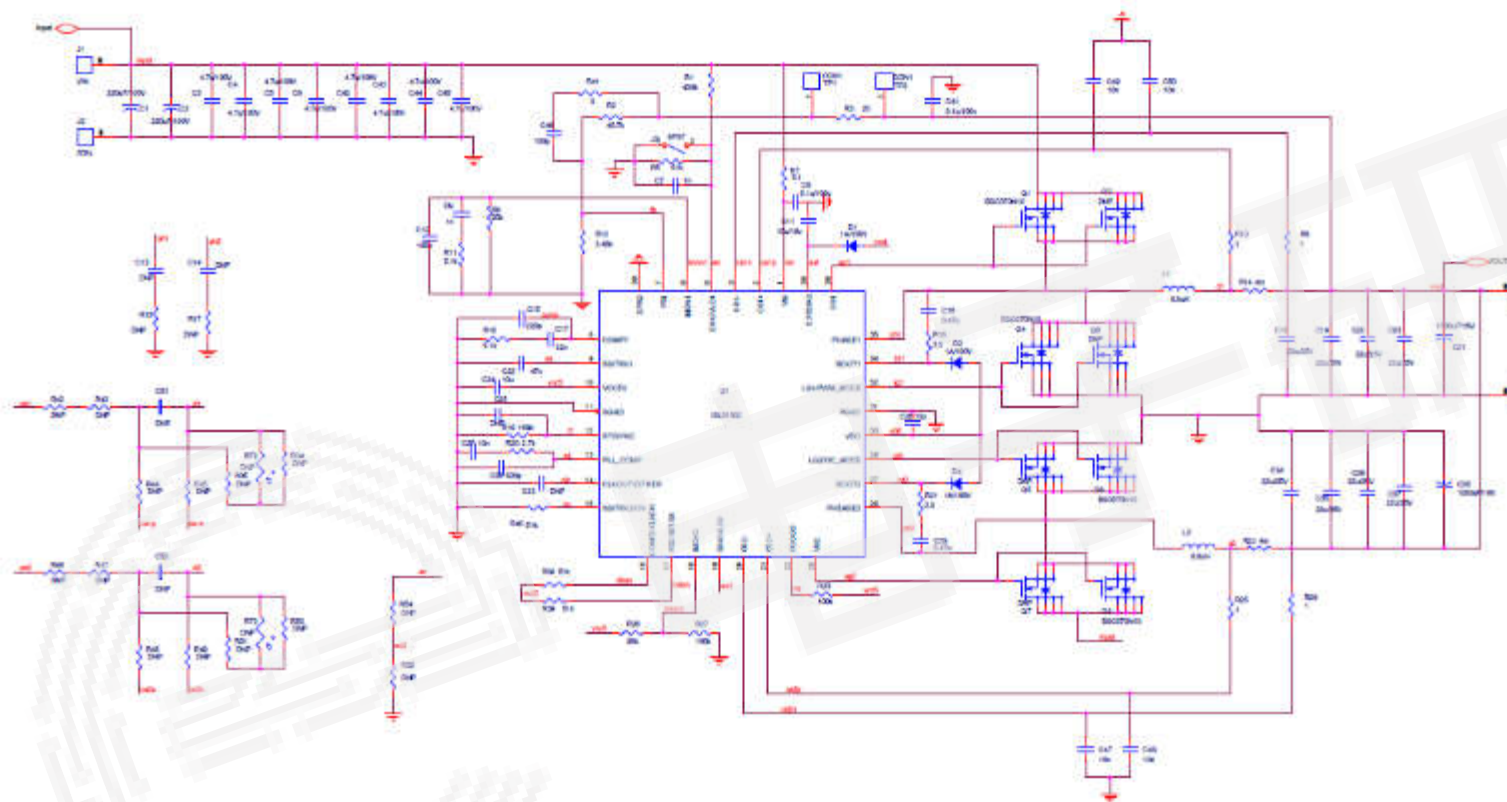
ISL81802 EVALUATION BOARD ISL81802EVAL2Z

The schematic diagram illustrates the ISL81802 evaluation board. The central component is the ISL81802 IC, which is configured for a 6V-80V input and provides two regulated outputs: 5V/10A and 3.3V/10A. The input stage includes a 6V-80V input, a 470µF/100V capacitor (C1), and a 10kΩ resistor (R15). The output stages feature 5V and 3.3V outputs, each with a 5.6µH inductor (L1, L2) and a 220µF/10V capacitor (C4, C7). The board also includes various other components such as resistors (R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R57, R58, R59, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69, R70, R71, R72, R73, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R84, R85, R86, R87, R88, R89, R90, R91, R92, R93, R94, R95, R96, R97, R98, R99, R100) and capacitors (C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C59, C60, C61, C62, C63, C64, C65, C66, C67, C68, C69, C70, C71, C72, C73, C74, C75, C76, C77, C78, C79, C80, C81, C82, C83, C84, C85, C86, C87, C88, C89, C90, C91, C92, C93, C94, C95, C96, C97, C98, C99, C100) to ensure proper operation and stability.

6V-80V input;
Vout1: 3.3V/10A, Vout2: 5V/10A



ISL81802 EVALUATION BOARD ISL81802EVAL3Z



**18V-80V input; 4PHASE
12V,40A output; 200kHz**



BIG IDEAS FOR EVERY SPACE

www.renesas.com

电子研习社



ISL85403/81401

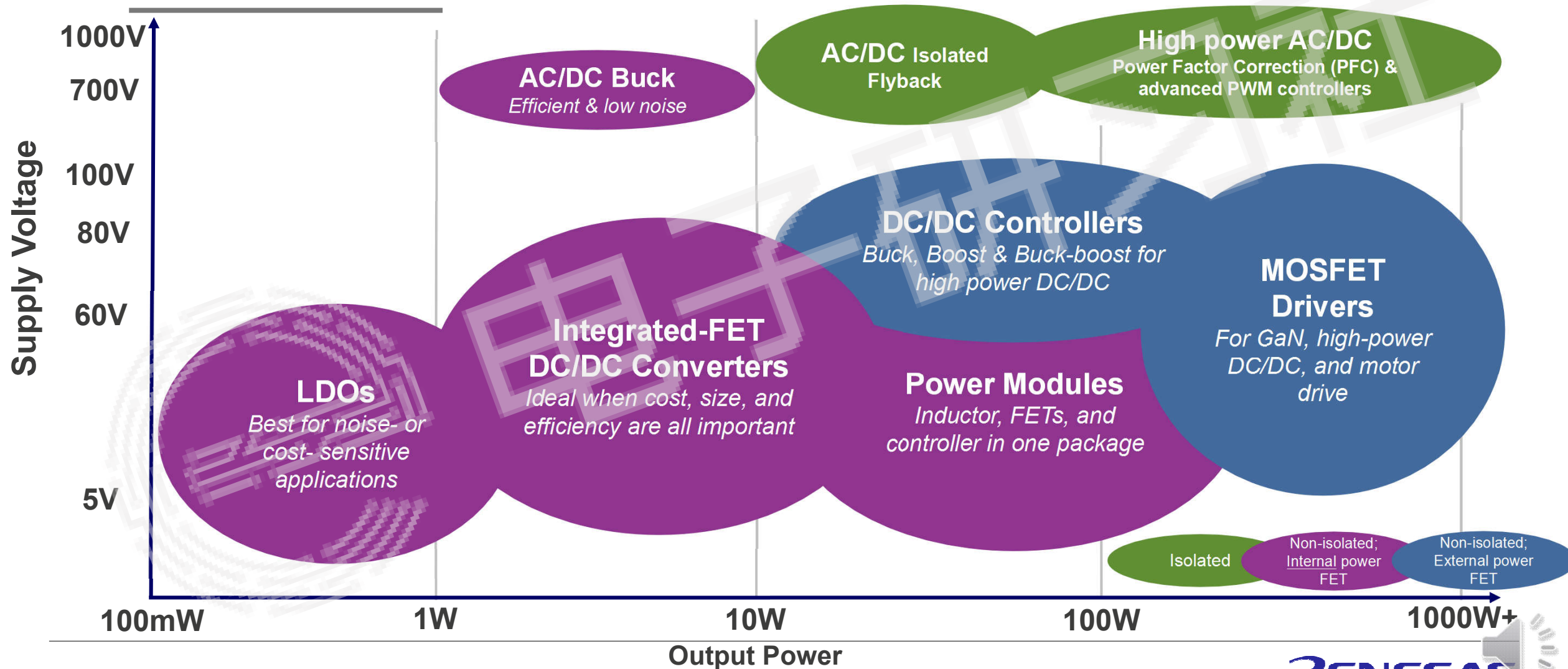
RENESAS SUPER CAP SOLUTIONS

Industrial Power and Analog Product Line
Renesas Electronics Corporation

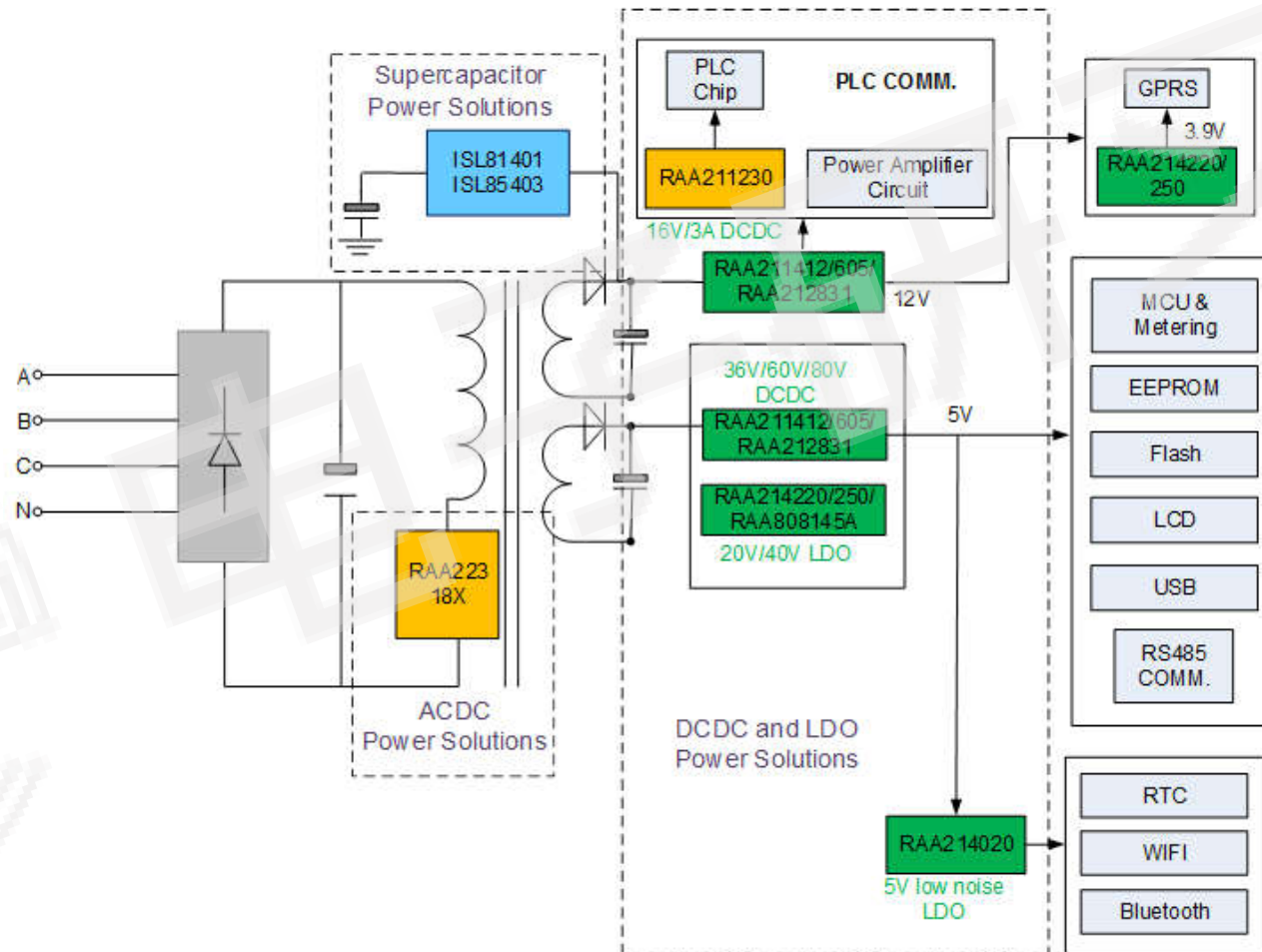
BIG IDEAS
FOR EVERY SPACE

IPA'S FULL MENU OF POWER SOLUTIONS

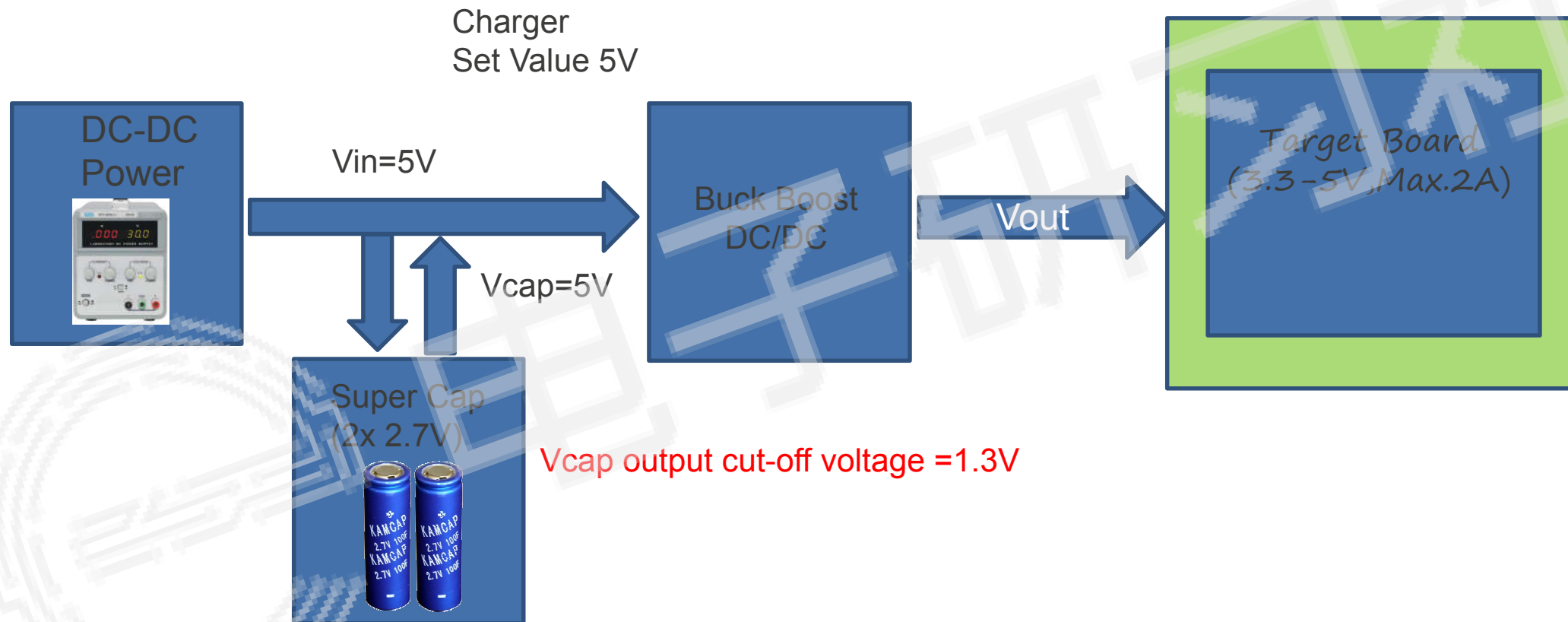
FROM MILLIWATTS TO KILOWATTS, WE CAN SUPPORT YOUR APPLICATION



RENESAS SMART METERS, CONCENTRATORS AND TERMINALS



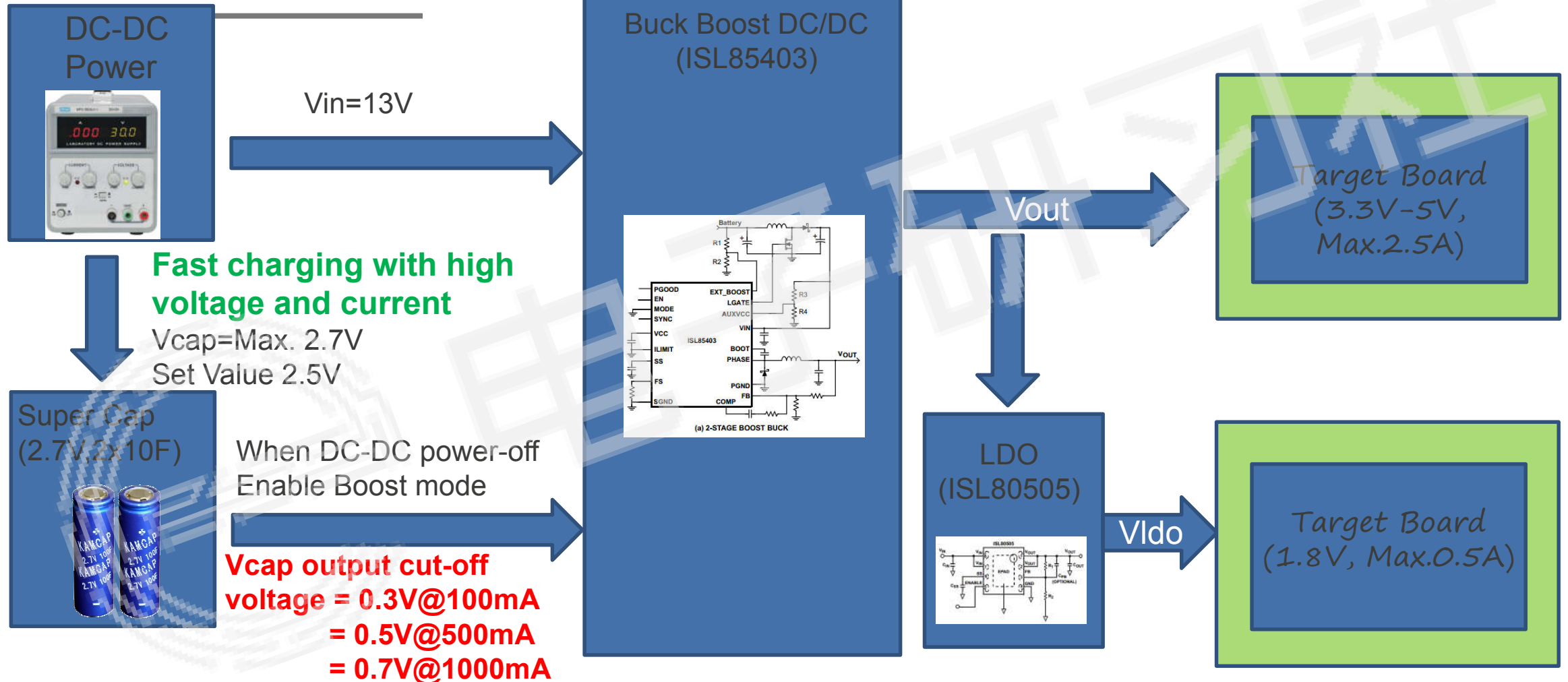
Super capacitor power supply – Current Market Solution



Renesas solution 1

2-Stage Boost Buck converter operation mode :
 $V_{in} = 13V$, $V_{out} = 3.3V-5V @ 2.5A(\text{Max.})$ and $V_{ldo} = 1.8V @ 0.5A(\text{Max.})$.

The minimum voltage of a supercapacitor is as low as 0.3V





ISL85403 – 2.5A REGULATOR WITH INTEGRATED HIGH SIDE FET

SUPPORT 3V-40V INPUT VOLTAGE RANGE FOR BUCK OR BOOST-BUCK OUTPUT

Wide Working Range

- Power input voltage range from 3V to 40V
- Support both step down (buck) or boost+buck outputs
- Up to 2.5A load over full temperature range

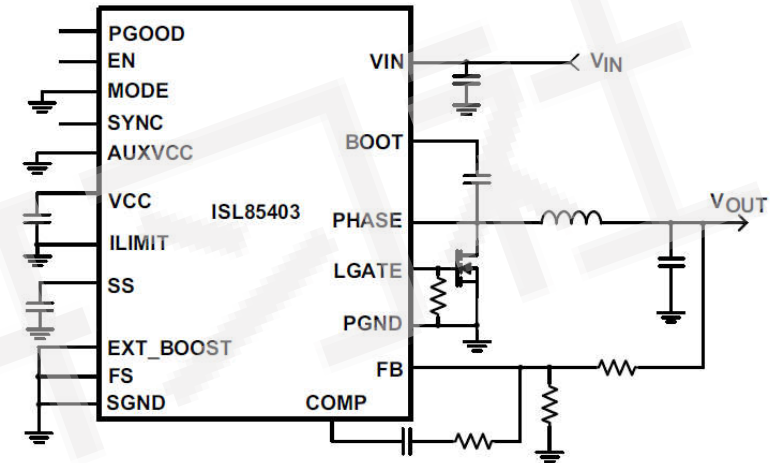
High Efficiency

- Optional external low side FET for higher efficiency
- Selectable PWM / PFM modes
- 300uA input quiescent PFM mode current
- Less than 5uA shutdown current

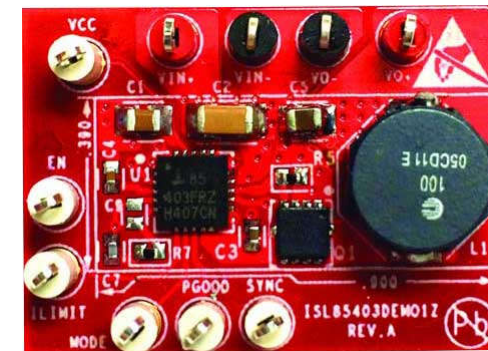
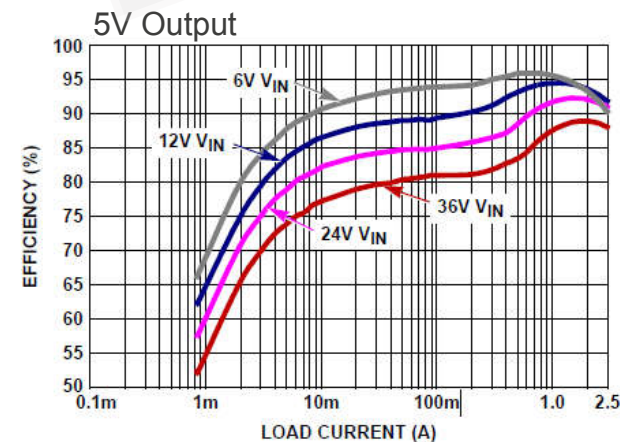
High Performance

- 200KHz to 2.2MHz frequency range
- +/- 1% voltage regulation accuracy

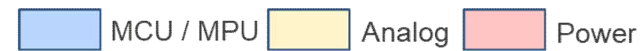
Part #	V _{IN} Range(V)	Temp.(°C)	Package
ISL85403FRZ-T	3 to 40	-40 to 125	20 Ld 4x4 QFN



Typical Application Circuit



ISL85403EVAL1Z Evaluation Board

[illegible]



ISL81401 – BI-DIRECTIONAL CC/CV BUCK-BOOST CONTROLLER

SUPPORT 4.5V-40V INPUT VOLTAGE RANGE FOR BUCK, BOOST, BUCK-BOOST OUTPUT

Wide Working Range

- Power input voltage range from 4.5V to 40V
- Support buck, boost buck-boost outputs
- Bi-directional with CC/CV mode

High Performance

- 100KHz to 600KHz frequency range
- +/- 1% voltage regulation accuracy
- Single inductor 4 switch topology
- Support pre-bias start
- Shut down current 2.7uA

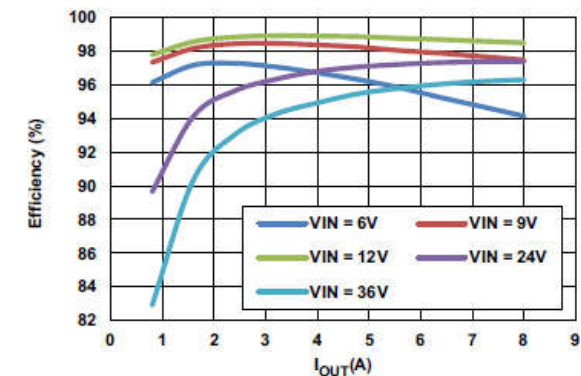
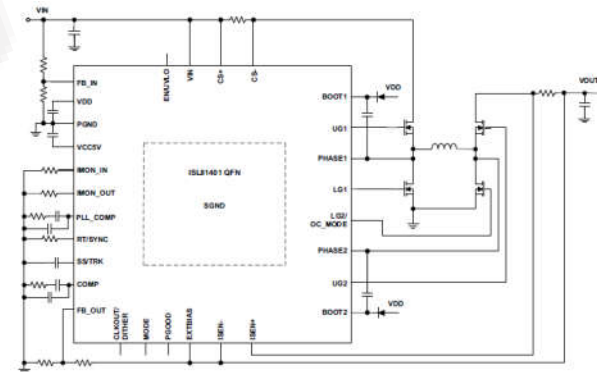
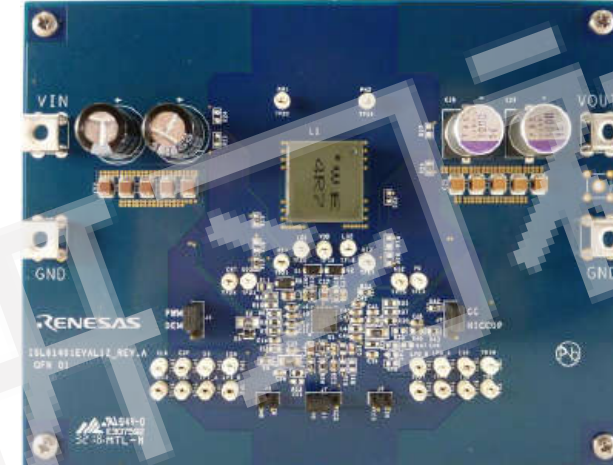


Figure 3. Efficiency (V_{OUT} = 12V, CCM)

ISL81401EVAL1Z Evaluation Board

Part #	V _{IN} Range(V)	Temp.(°C)	Package
ISL81401FRZ-T	4.5 to 40	-40 to 125	32 Ld 5x5 QFN
ISL81601FRZ-T	4.5 to 60	-40 to 125	32 Ld 5x5 QFN
ISL81801FRZ-T	4.5 to 80	-40 to 125	32 Ld 5x5 QFN

Renesas super capacitor power solution – Comparison

	Competitors	Renesas Solutions	
		ISL85403	ISL81401
Topology	2 ICs Buck + Boost	1 IC buck-boost	1 IC buck-boost
Input voltage	4.5 ~18 V	3 ~ 40 V	4.5 ~40 V
Loading	2 ~ 3 A	2.5 A	20+ A
Cost	High	Low	Mid
Bi-directional with CC/CV charging	-	-	Yes
Efficiency	<30%@0.1A, <20%@1A	82%@0.1A, 50%+@1A+	82%@0.1A, 50%+@1A+

Renesas super capacitor power solution –Selection guide

	Loading		Bi-directional		BOM cost	
	< 2.5A	>2.5A	CC/CV	CV	Low	Mid
ISL85403	Y			Y	Y	
ISL81401	Y	Y	Y			Y

BIG IDEAS FOR EVERY SPACE

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RAA214020

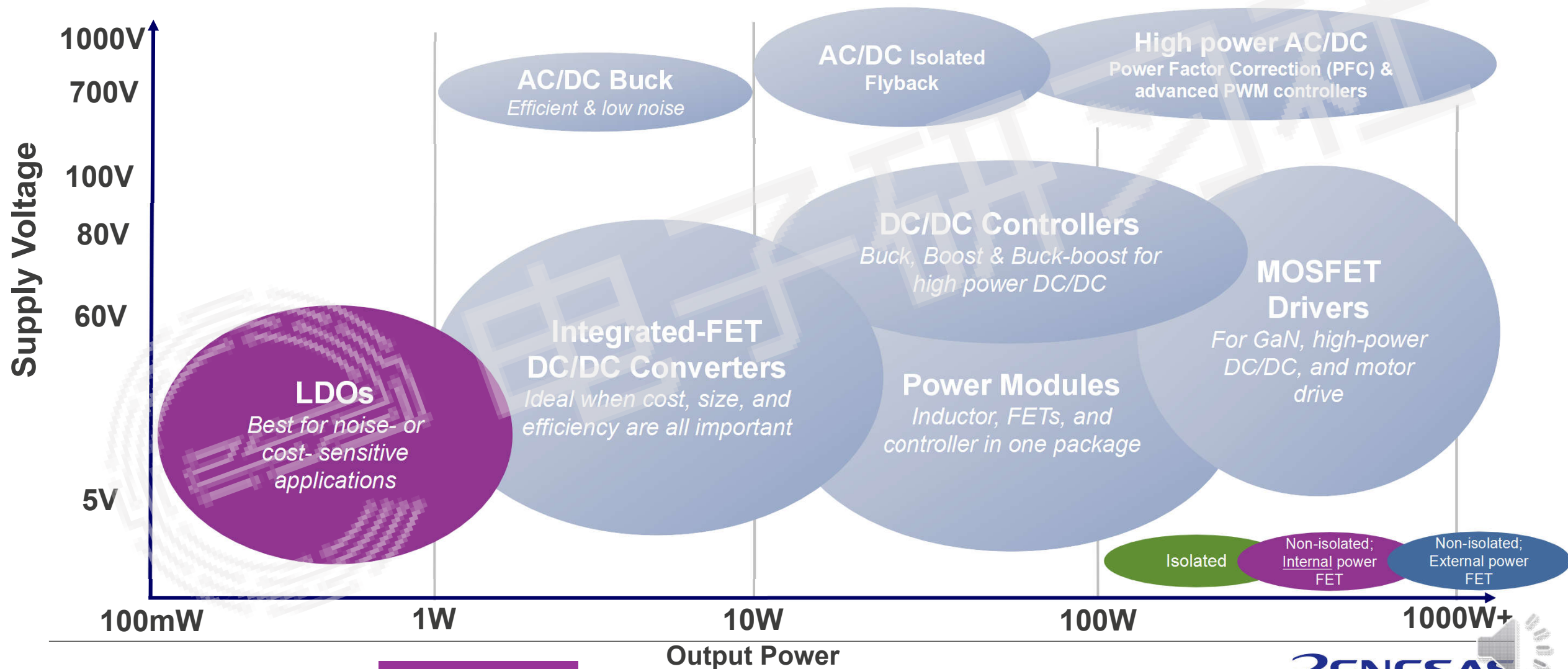
RENESAS HIGH PSRR LOW NOISE LDO

Industrial Power and Analog Product Line
Renesas Electronics Corporation

BIG IDEAS
FOR EVERY SPACE

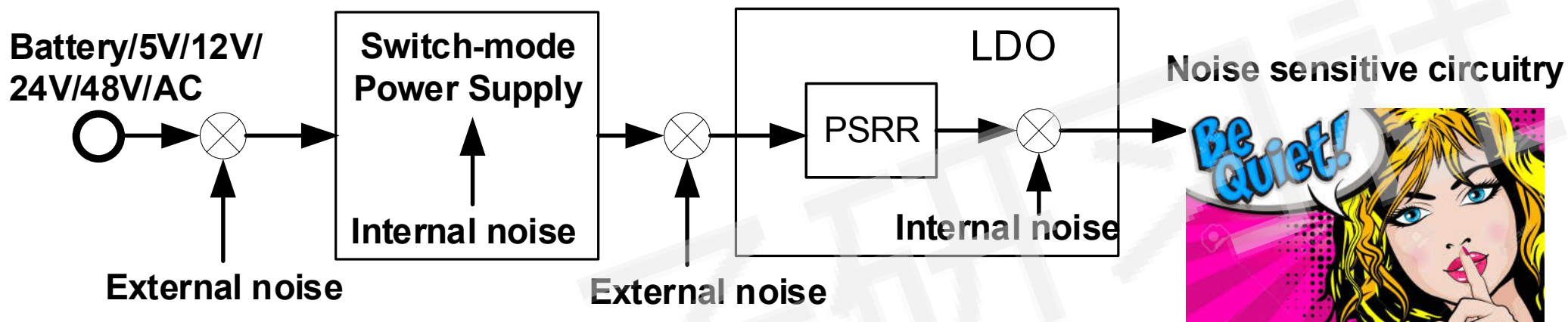
IPA'S FULL MENU OF POWER SOLUTIONS

FROM MILLIWATTS TO KILOWATTS, WE CAN SUPPORT YOUR APPLICATION



RENESAS CONFIDENTIAL

POWER SUPPLY NOISE DEMYSTIFIED



- Noise sensitive circuitry may be powered from various voltage sources in various applications
- When converting the source voltage to the appropriate level, usually a switch-mode power supply is required
- The power supply generates its own noise during switching, also collects external noises at input and output, its output voltage may carry wide frequency spectrum, and often may interfere with the load
- For noise-sensitive load, a low noise LDO is preferred as the point-of-load supply
- The low noise LDO often has very high PSRR (Power Supply Rejection Ratio) to block the incoming noise, and has very low self-generated noise as well

APPLICATIONS WHERE A LOW NOISE SUPPLY IS DESIRED

- Clock and Timing IC in PCIe and networking
- RF & Wireless
- IoT and Smart Utilities
- 4G and 5G Telecom
- SerDes, FPGA, DSP and other digital loads
- High end Audio
- High speed Analog (VCO, ADC, DAC, LVD)
- Imaging CMOS sensor
- High Accuracy Test and Measurement
- Medical



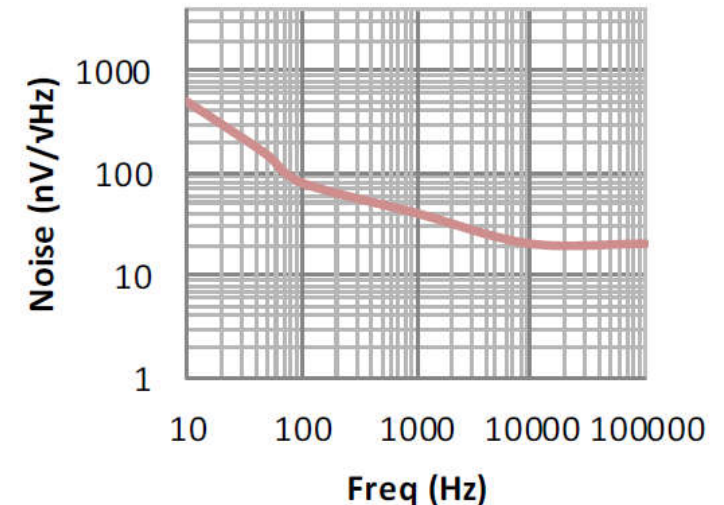
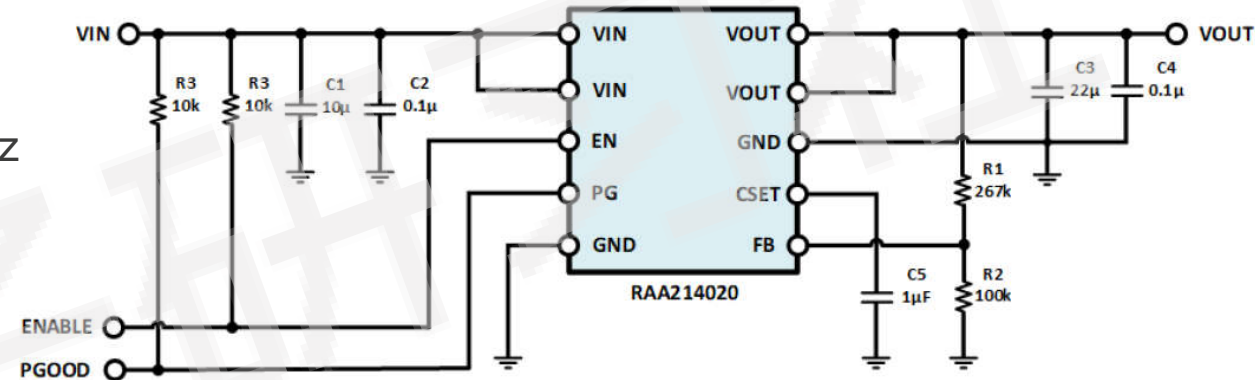
RAA214020: LOW NOISE LDO FOR SENSITIVE CIRCUITRY

- **Excellent noise Performance**

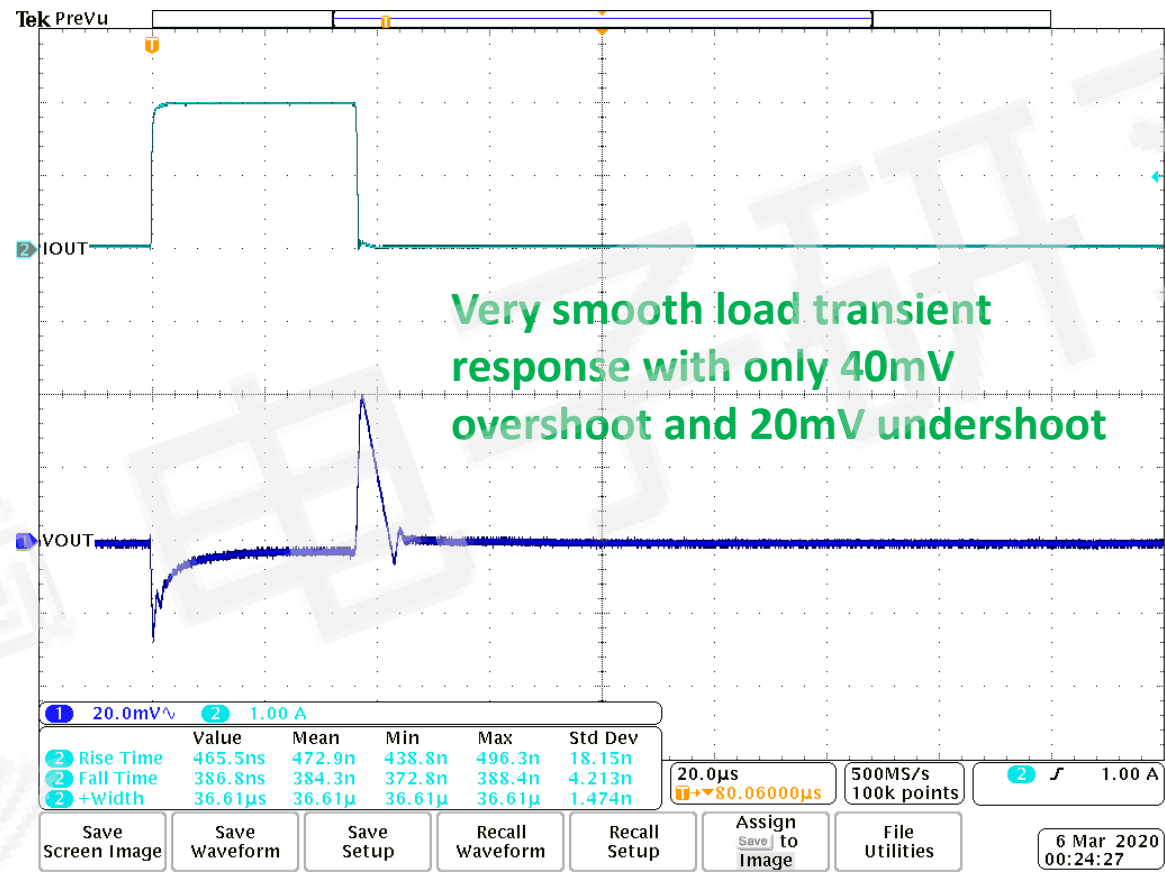
- Low Spot Noise Spectral Density: 85nV/Sqrt Hz @ 10Hz
- Low Integrated Noise: 4.54uV RMS from 10Hz-100kHz
- Very high PSRR @ 2A load current:
 - Freq=10kHz=80dB
 - Freq=100kHz=60dB
 - Freq=1MHz=40dB

- **Vin = 2.7V to 5.5V, Vout=0.9V to Vin-dropout**

- **Very low dropout of 500mV max @ 2A load current**

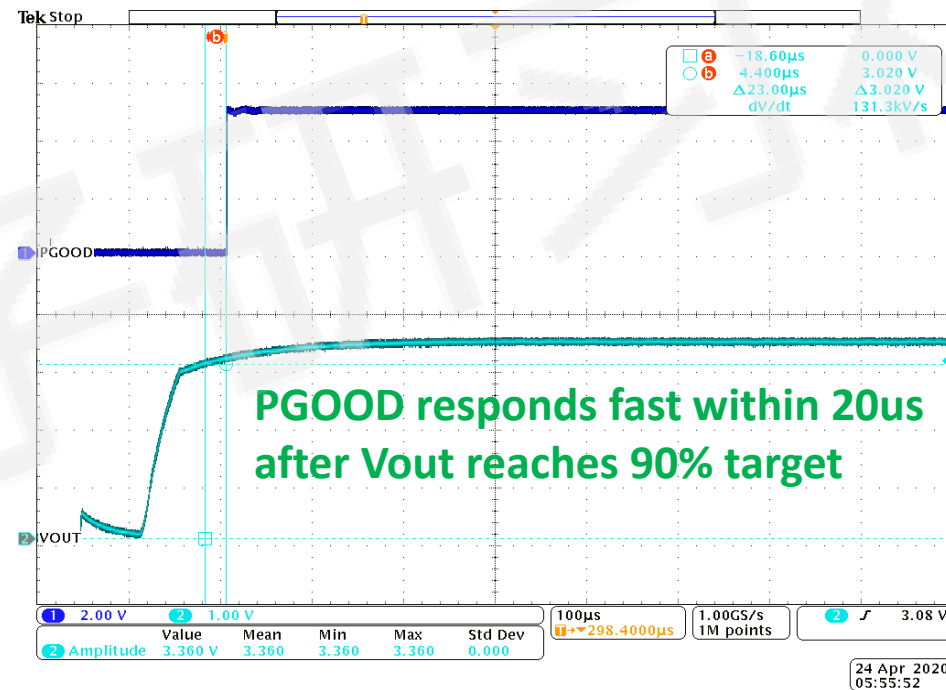
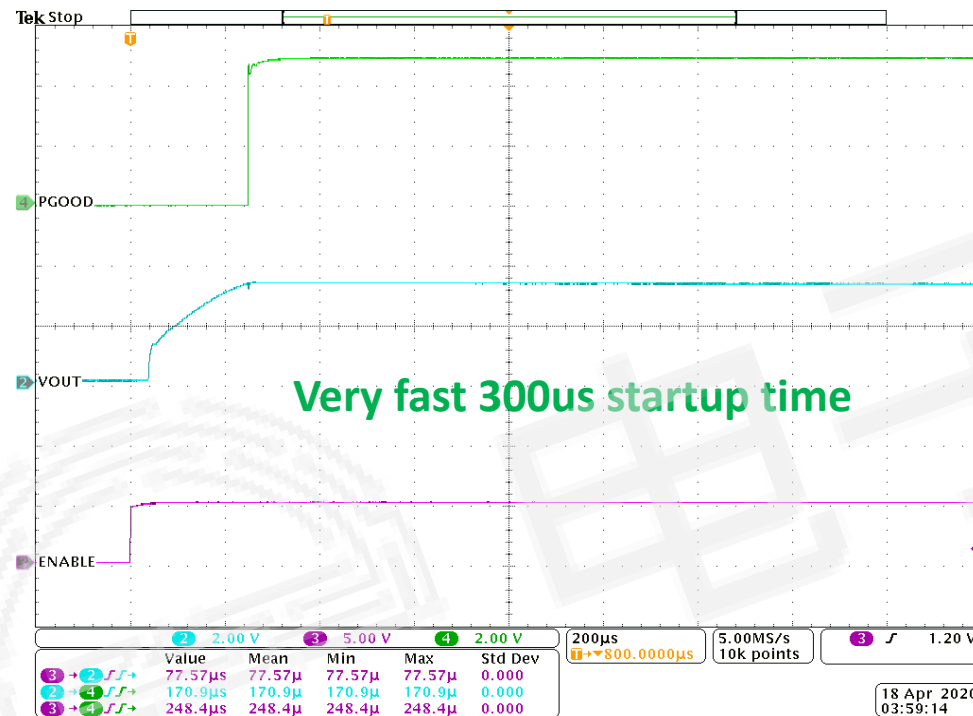


RAA214020 LOAD TRANSIENT RESPONSE



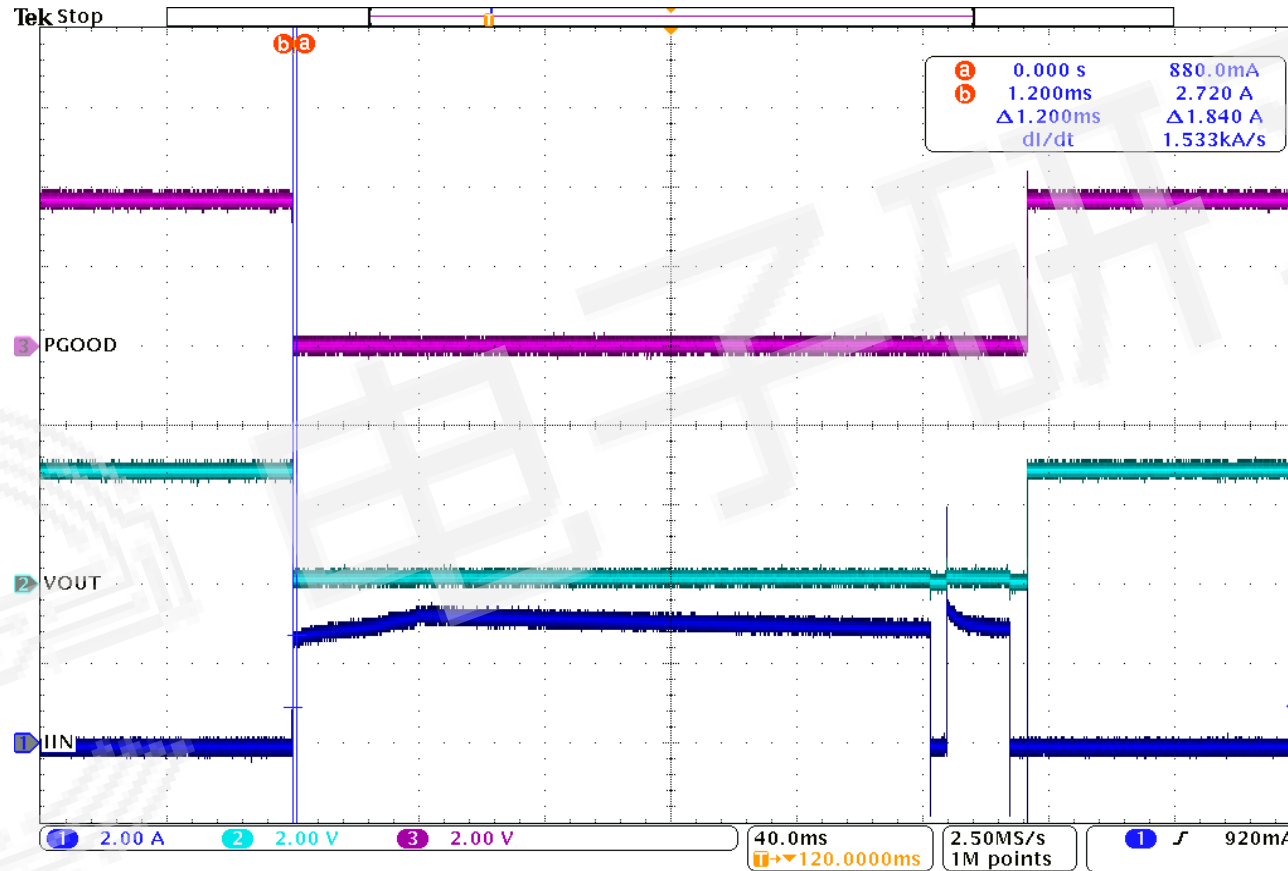
Test condition:
Vin = 5V
Vout = 3.3V
Iout = 100mA step to 2A
then to 100mA

RAA214020 STARTUP TIME



Test condition:
 $V_{in} = 5V$
 $V_{out} = 3.3V$
 $I_{out} = 2A$
 $C_{set} = 1\mu F$
 $C_{out} = 22\mu F$

SCP PROTECTION AND RECOVERY



Test condition:
 $V_{in} = 3.7V$
 $V_{out} = 3.3V$
 $I_{out} = 2A$
Internal Current Limit is
measured at 2.72Amps

24 Apr 2020
04:37:33



RAA210040

RENESAS POWER MODULE SOLUTION

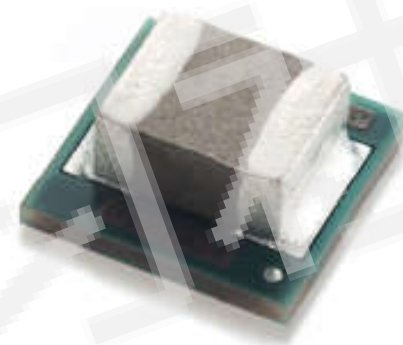
Industrial Power and Analog Product Line
Renesas Electronics Corporation

BIG IDEAS
FOR EVERY SPACE

OPPORTUNITY DRIVERS

Tiny module is a complete power solution that **integrates the power inductor** with IC-in-substrate assembly technology.

It's beneficial for space-sensitive applications such as sensors, IoT, networking, wearables.



Connectivity



Smart Energy



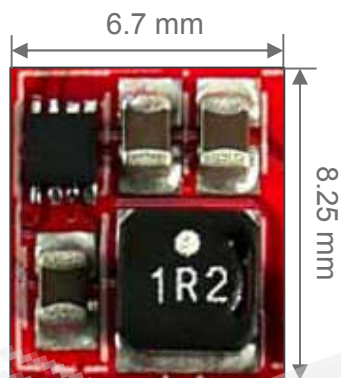
Home IoT



Industrial Automation

BENEFIT OVER DISCRETE SOLUTION

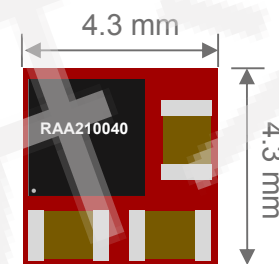
Discrete



- 55.3 mm²
- Higher loop noise
- More design and evaluation effort



Tiny Module

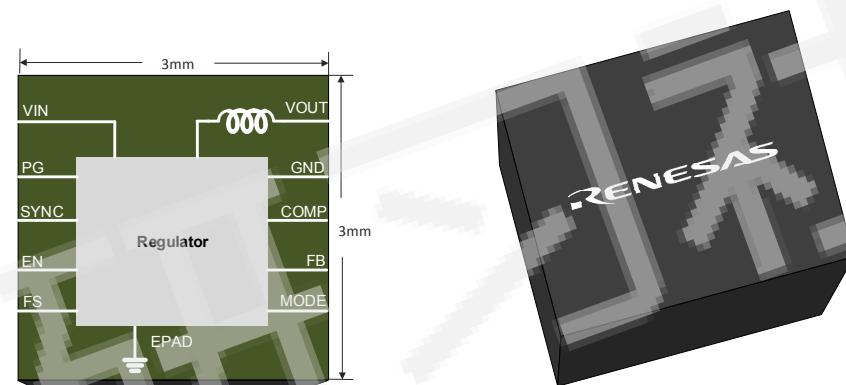


- 18.5 mm²
- Easier design and evaluation

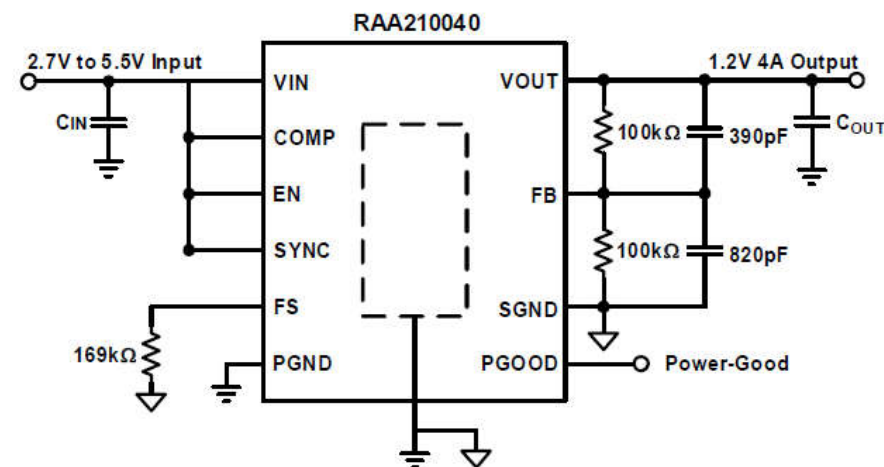
RAA210040 PRODUCT OVERVIEW

Features

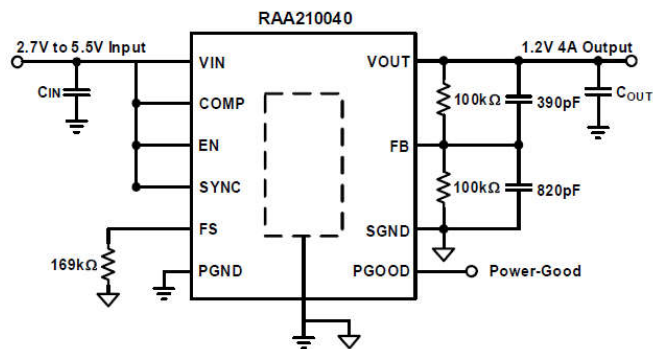
- 2.7V to 5.5V input, 0.6V to 5V output
- 4A continuous output current
- 92.3% efficiency at 5VIN and 3.3VOUT
- $\pm 1.5\%$ accuracy over line/load/temperature
- Dedicated enable pin and power-good flag
- Default 2MHz switching frequency with ext. sync up to 4MHz
- Selectable light-load PFM mode
- 10Ld, 3 mm \times 3 mm \times 1.7 mm



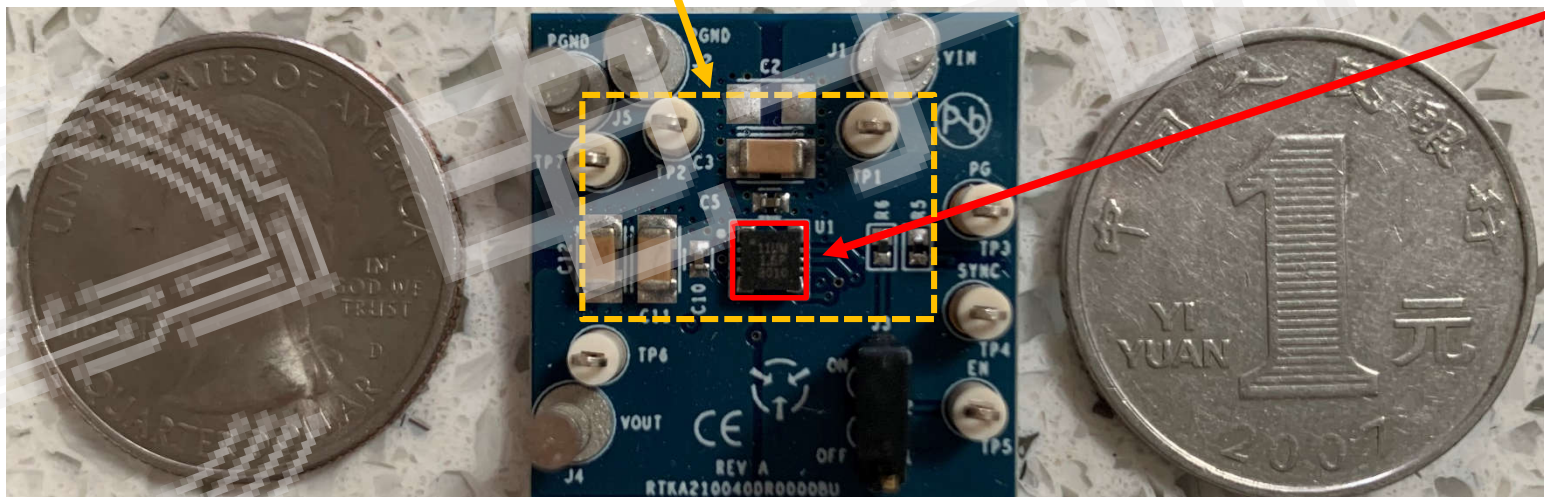
Typical Application Circuit



WORKING SOLUTION SIZE ON PCB



Total solution, including all passives, is smaller than a US quarter coin or \$1 Chinese Yuan. Capable of 4A output current

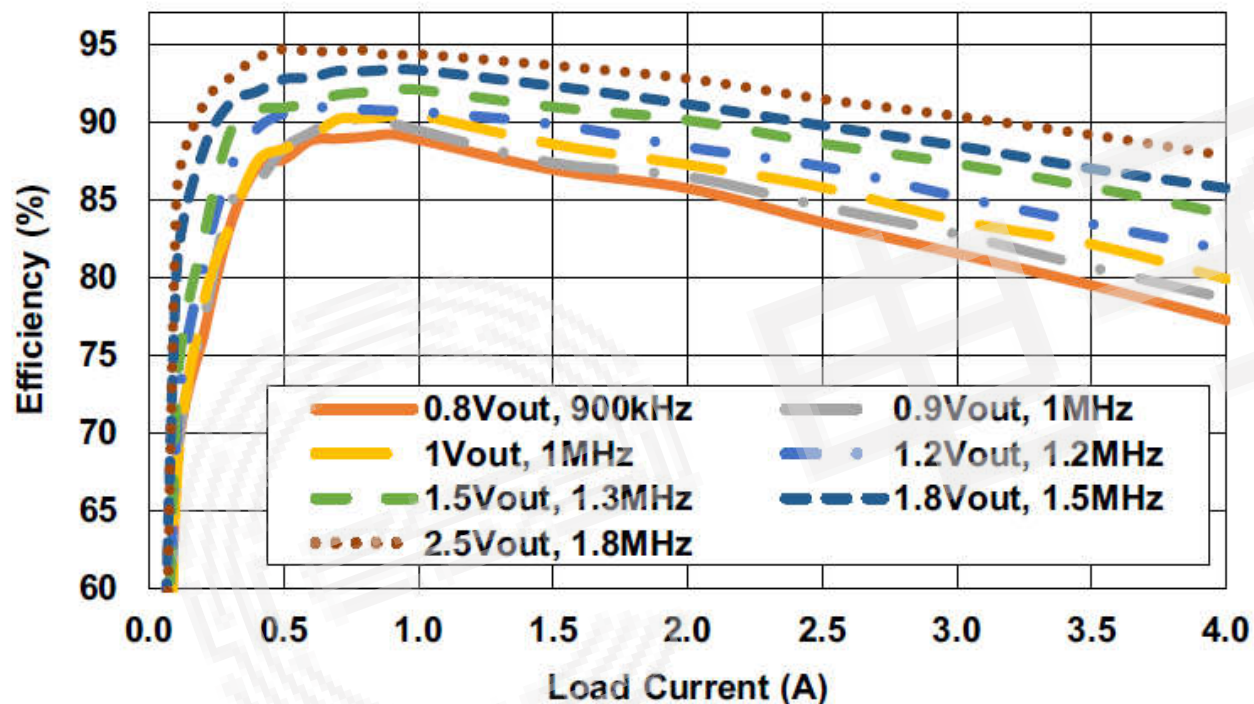


RAA210040

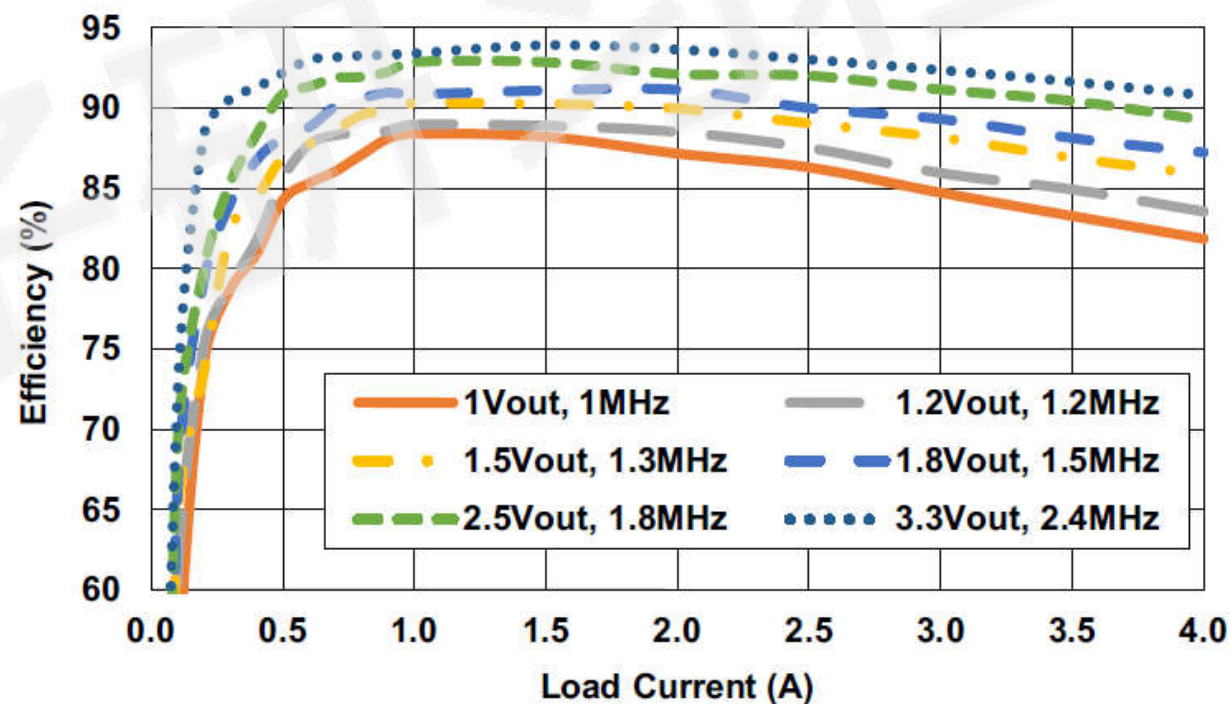
3x3 mm², integrated with controller, MOSFETs, and inductor

RAA210040 PERFORMANCE – EFFICIENCY

$V_{IN} = 5V$

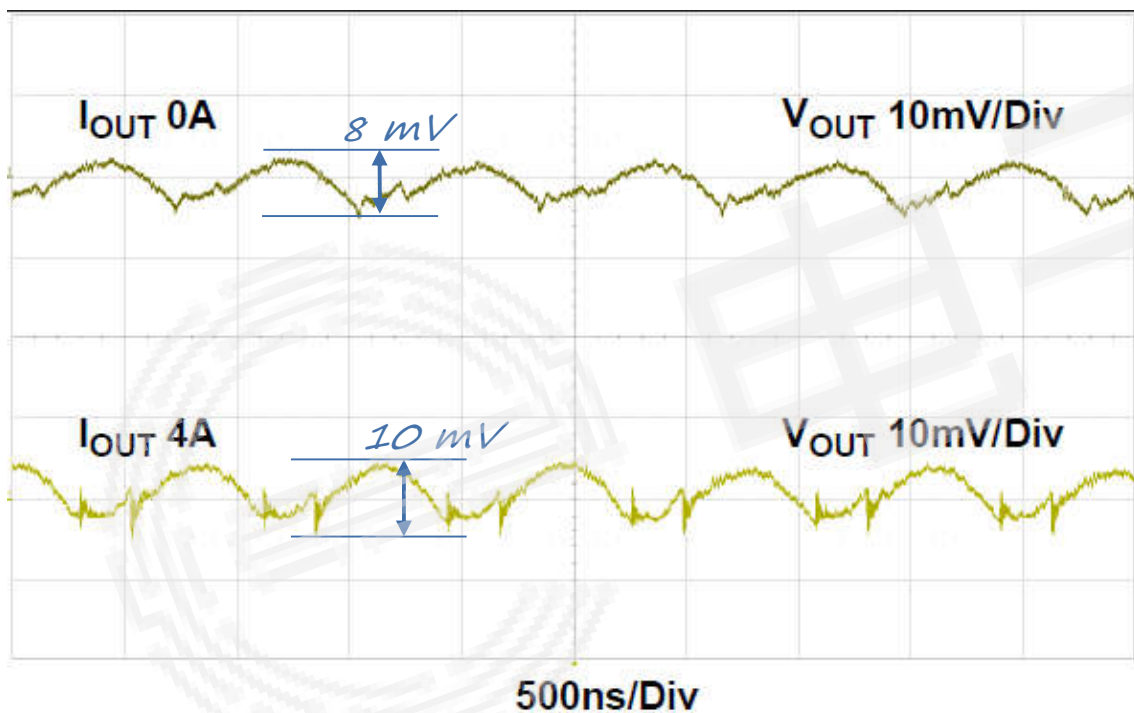


$V_{IN} = 3.3V$

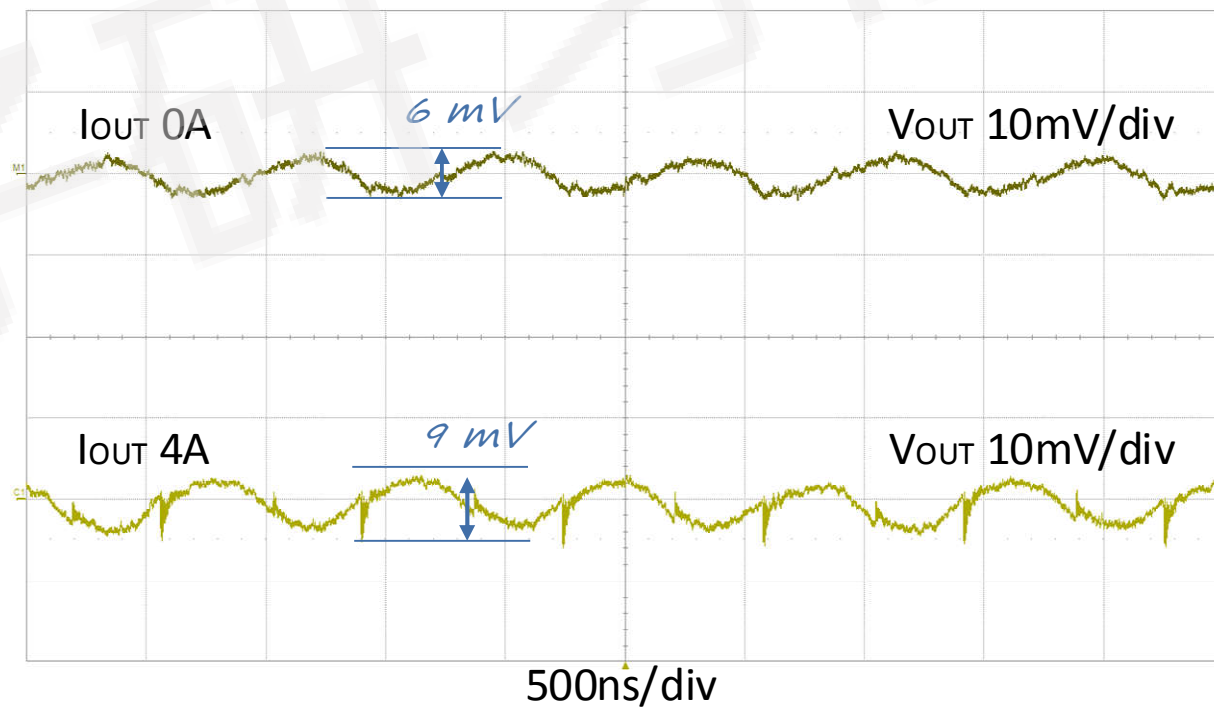


RAA210040 PERFORMANCE – OUTPUT RIPPLE

$V_{IN} = 5V$, $V_{OUT} = 1.2V$, $f_{SW} = 1.2MHz$,
 $C_{OUT} = 2 \times 22\mu F$ Ceramic

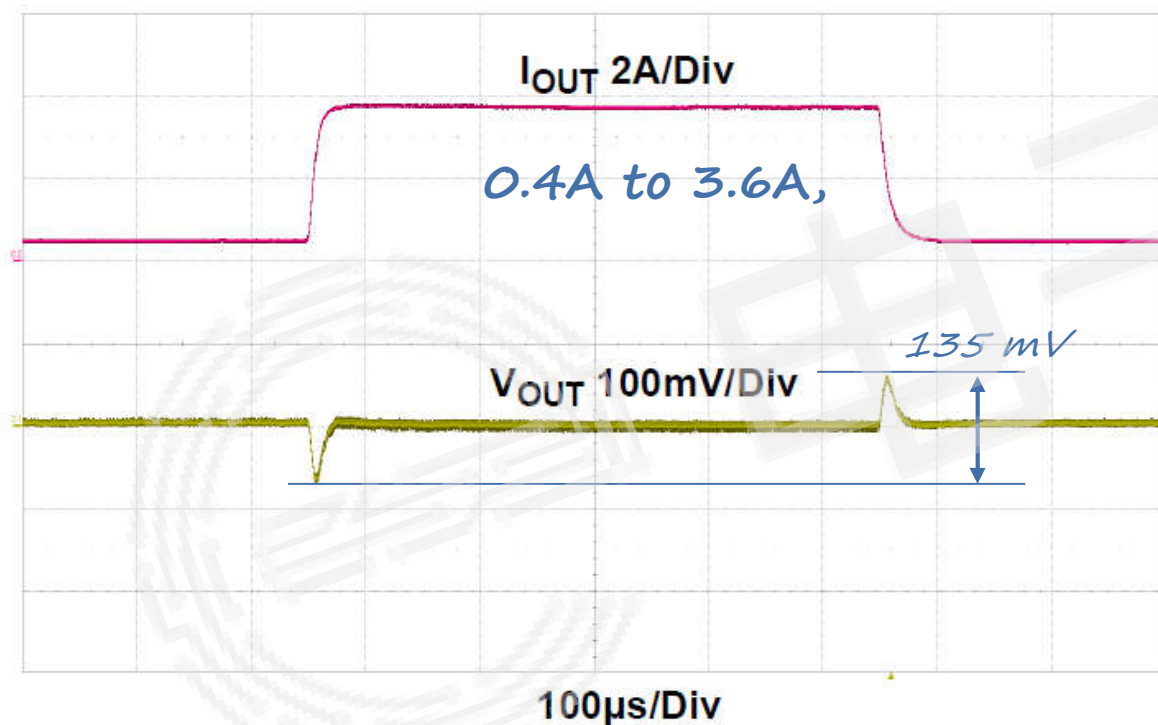


$V_{IN} = 3.3V$, $V_{OUT} = 1.2V$, $f_{SW} = 1.2MHz$,
 $C_{OUT} = 2 \times 22\mu F$ Ceramic

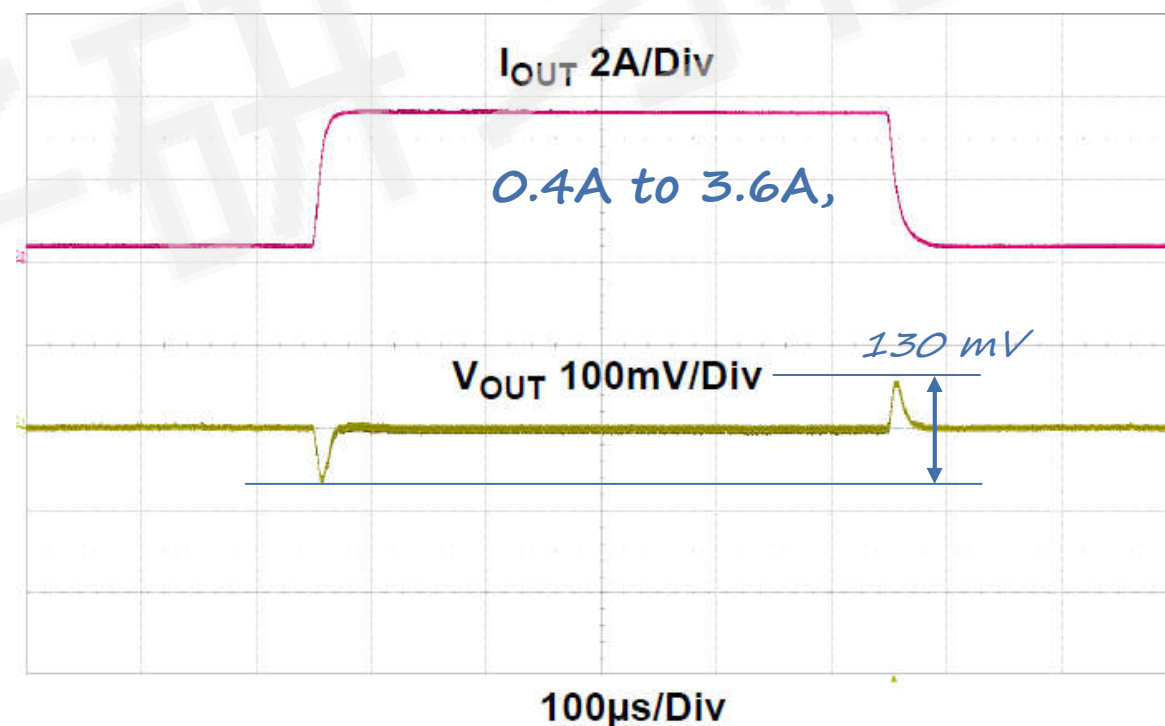


RAA210040 PERFORMANCE – LOAD TRANSIENT

$V_{IN} = 5V$, $V_{OUT} = 1.2V$, $f_{SW} = 1.2MHz$,
 $C_{OUT} = 2 \times 22\mu F$ Ceramic



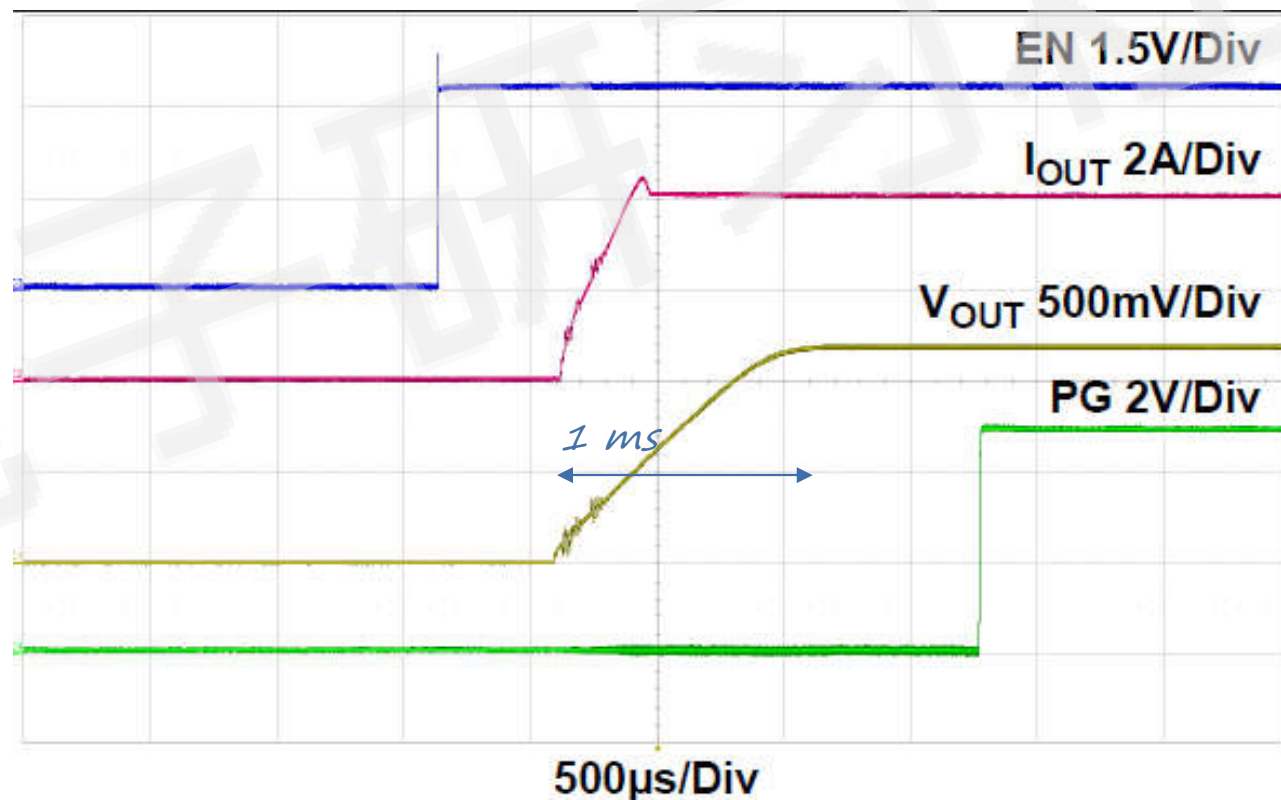
$V_{IN} = 3.3V$, $V_{OUT} = 1.2V$, $f_{SW} = 1.2MHz$,
 $C_{OUT} = 2 \times 22\mu F$ Ceramic



RAA210040 PERFORMANCE – STARTUP

$V_{IN} = 5V$, $V_{OUT} = 1.2V$, $f_{SW} = 1.2MHz$, $I_{OUT} = 4A$

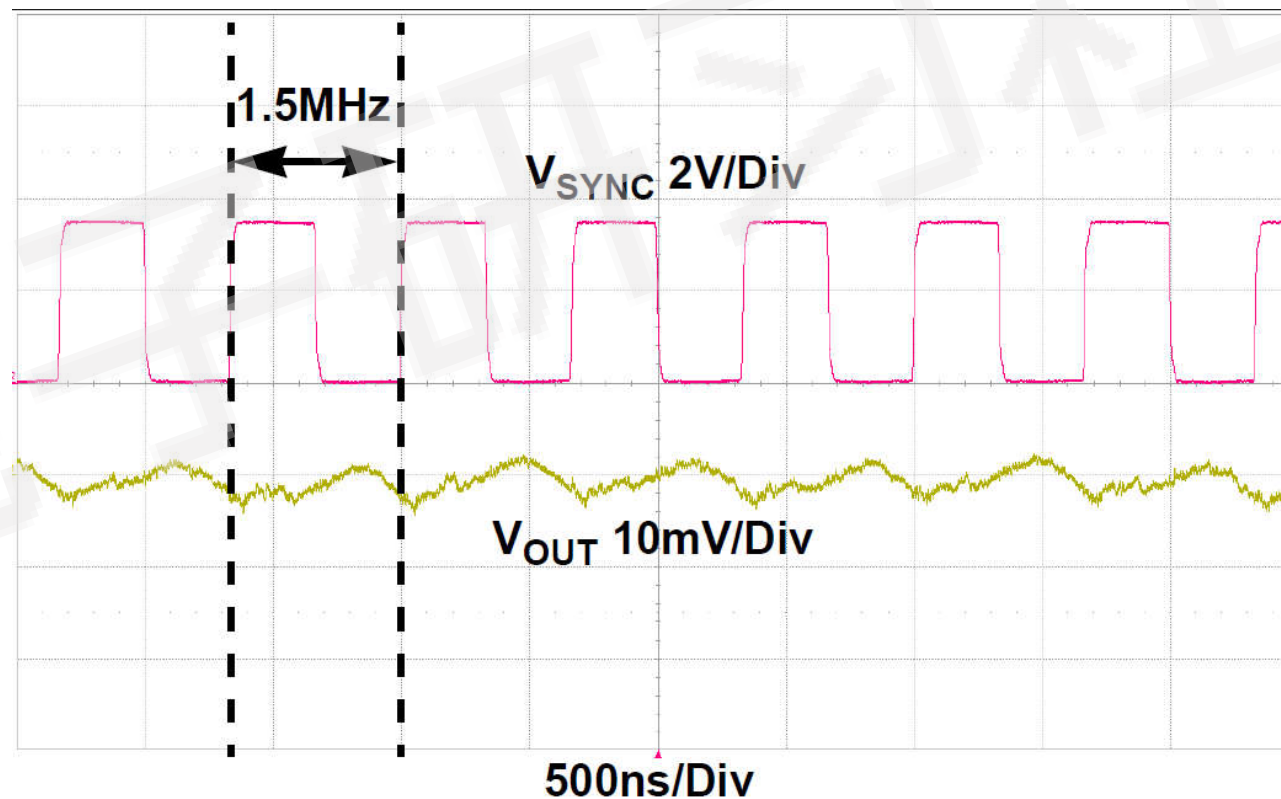
- Output voltage rises in a controlled fashion following voltage ramp in the soft-start block, which limits the inductor current as well
- The default soft start-up period is approximately 1ms.



RAA210040 PERFORMANCE – EXT. SYNC

- Synchronizing to an external clock through the SYNC pin
- Ranges from 500kHz to 4MHz

$V_{IN} = 3.3V$, $V_{OUT} = 1.2V$, $f_{SYNC} = 1.5MHz$, $I_{OUT} = 0A$



POWER MODULE FOR 5V BUS

<5 VIN BUS

NVM Memory

33A **ZL9024M**
 $2.75V_{IN} - 4V_{IN}$

5 VIN BUS

6A **ISL8203M**
 $2.85V_{IN} - 6V_{IN}$

5A **ISL8205M**
 $2.6V_{IN} - 5.5V_{IN}$

3A **ISL8202M**
 $2.6V_{IN} - 5.5V_{IN}$

4A **RAA210040**
 $2.7V_{IN} - 5.5V_{IN}$

5 VIN BUS DUAL OUTPUT

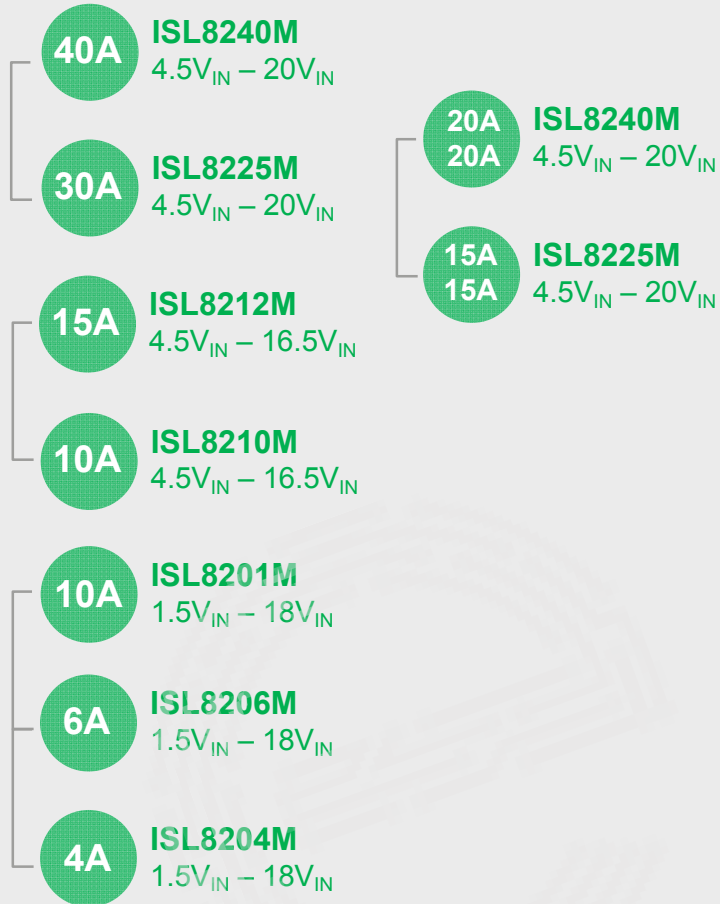
3A **ISL8203M**
 $2.85V_{IN} - 6V_{IN}$

2A **RAA21002X**
 $2.85V_{IN} - 6V_{IN}$

[Pin Compatible]

POWER MODULE FOR 12V+ BUS

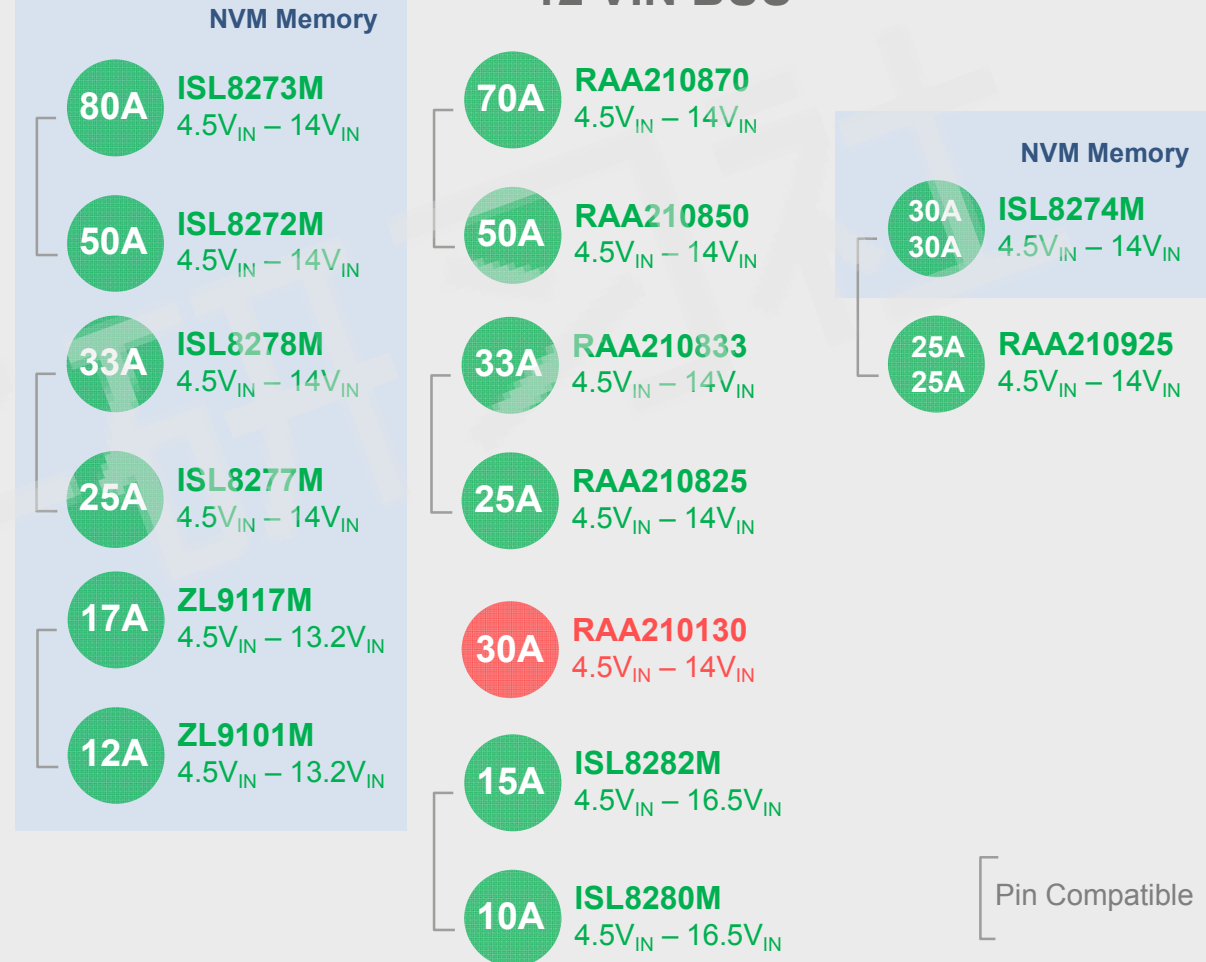
12 VIN BUS



24+ VIN BUS



12 VIN BUS



Analog

Digital – PMBUS

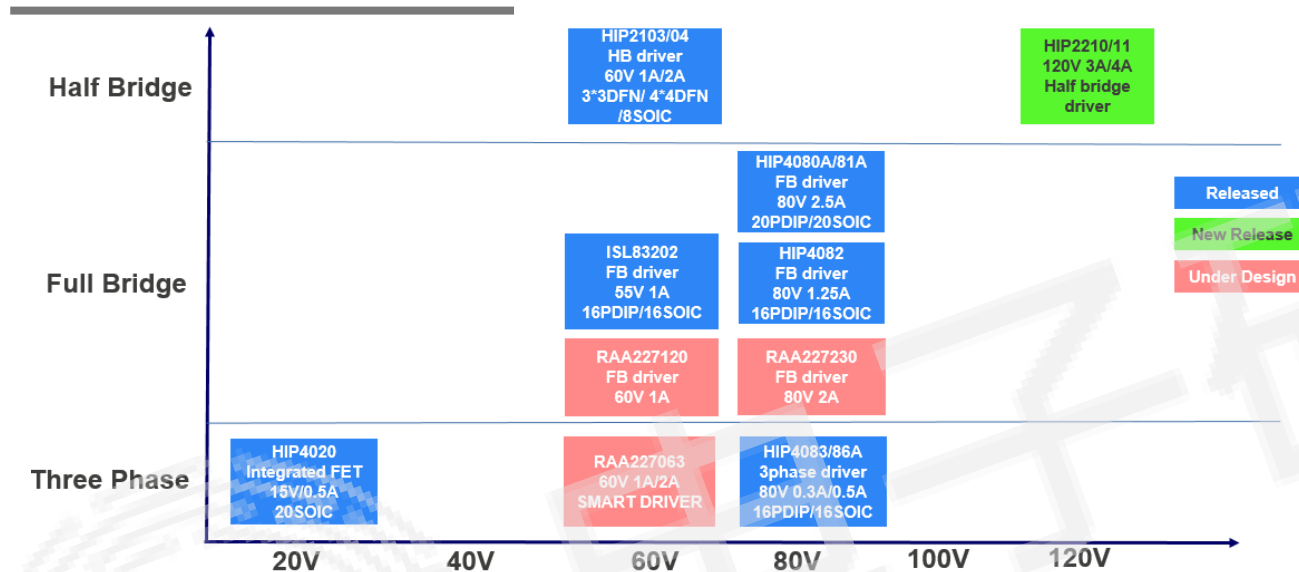


HIP221x:120V Half Bridge Driver for Industrial Applications

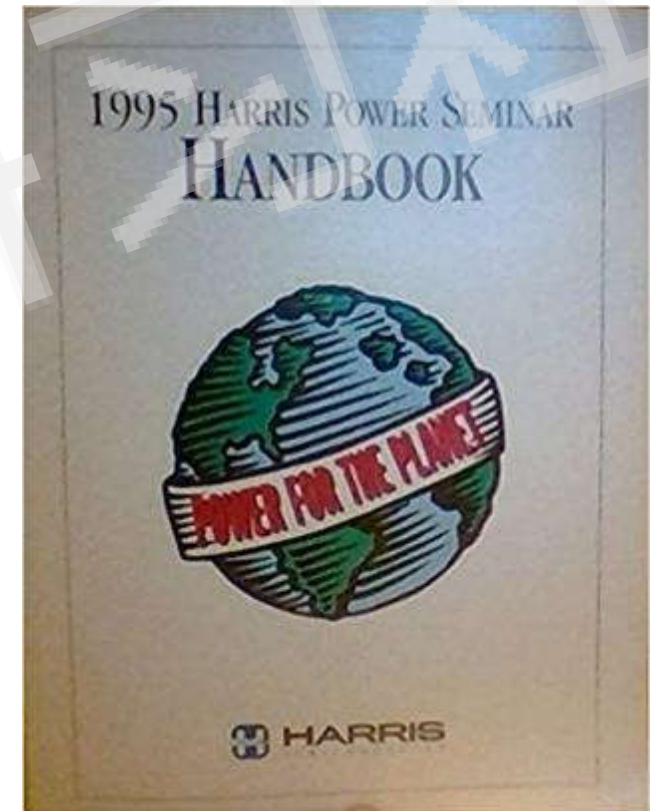
Industrial Power and Analog Product Line
Renesas Electronics Corporation

BIG IDEAS
FOR EVERY SPACE

25 YEARS HISTORY OF BRIDGE DRIVERS WITH A WAVE OF NEW DESIGNS



- Intersil was founded in 1967, acquired by Harris Corporation in 1988
- “HIPXXXX” → “Harris Intelligent Power”, first bridge driver IC released in 1995 Harris Power Handbook, with multi hundred M\$ sold since
- Intersil acquired by Renesas in 2017
- Multiple driver IC iterations throughout history, until a new wave of designs starts with RAA227063 and HIP221X in 2018, and RAA227120/230 in 2019



HIP221X: 120V 3A/4A BRIDGE MOSFET DRIVERS

■ High Robustness

- 100% production tested 115V bootstrap voltage
- 100% production tested negative 10V rating on HS pin

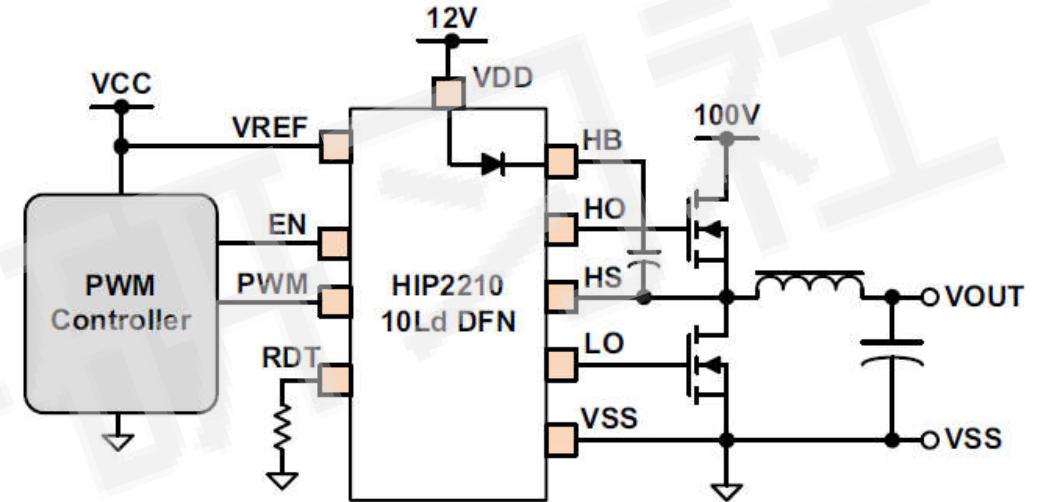
■ High Efficiency

- 3A source, 4A sink drive current

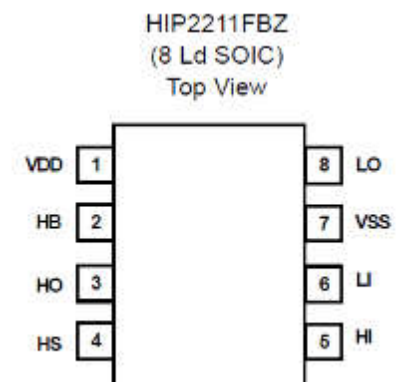
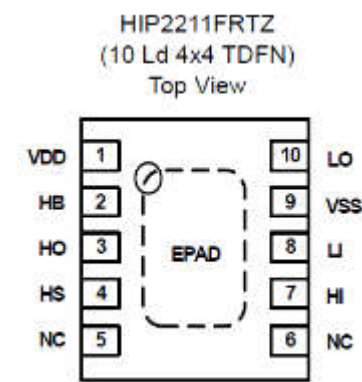
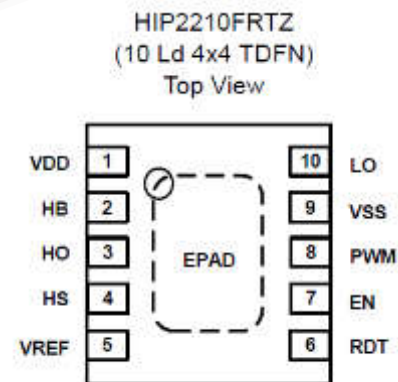
■ High Frequency

- 15ns fast propagation delay
- 2ns propagation delay matching

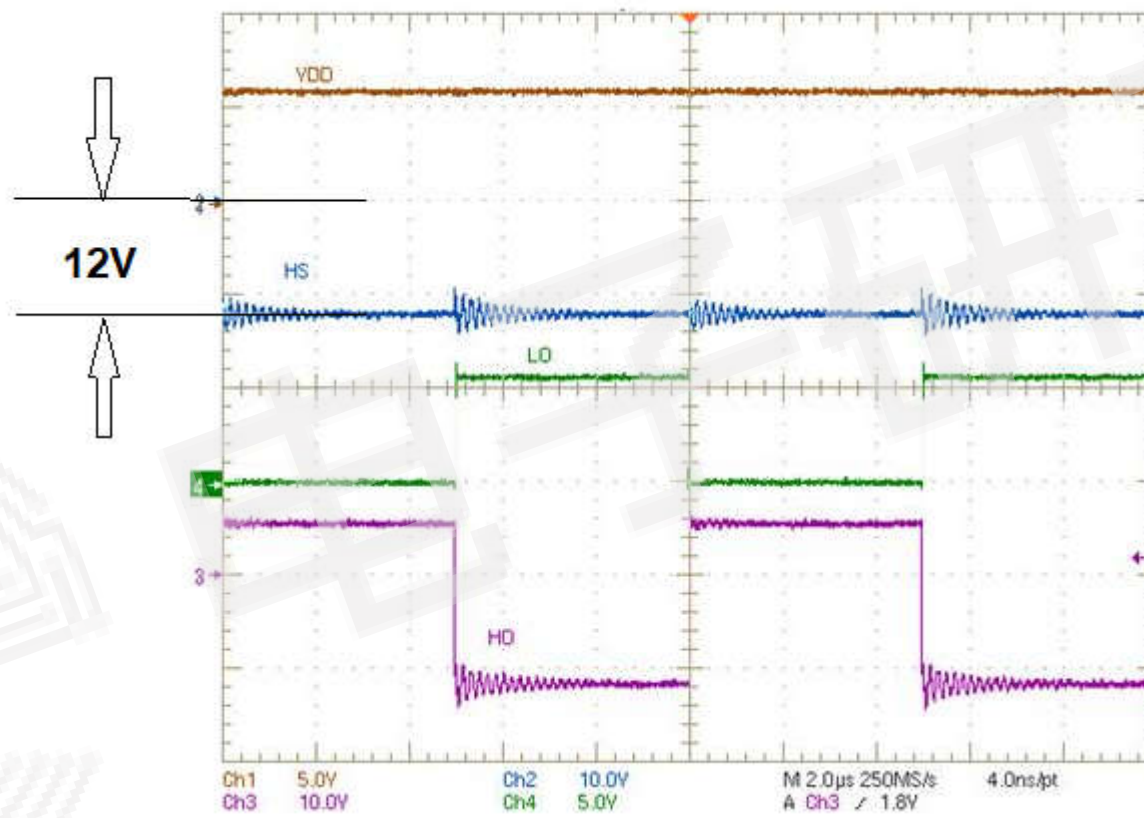
- HIP2210 with PWM input, EN and adjustable dead time
- HIP2211 with HI/LI 3.3V logic compatible
- Available in DFN4*4 and SOIC-8



HIP2210 PWM Input with Programmable Dead Time

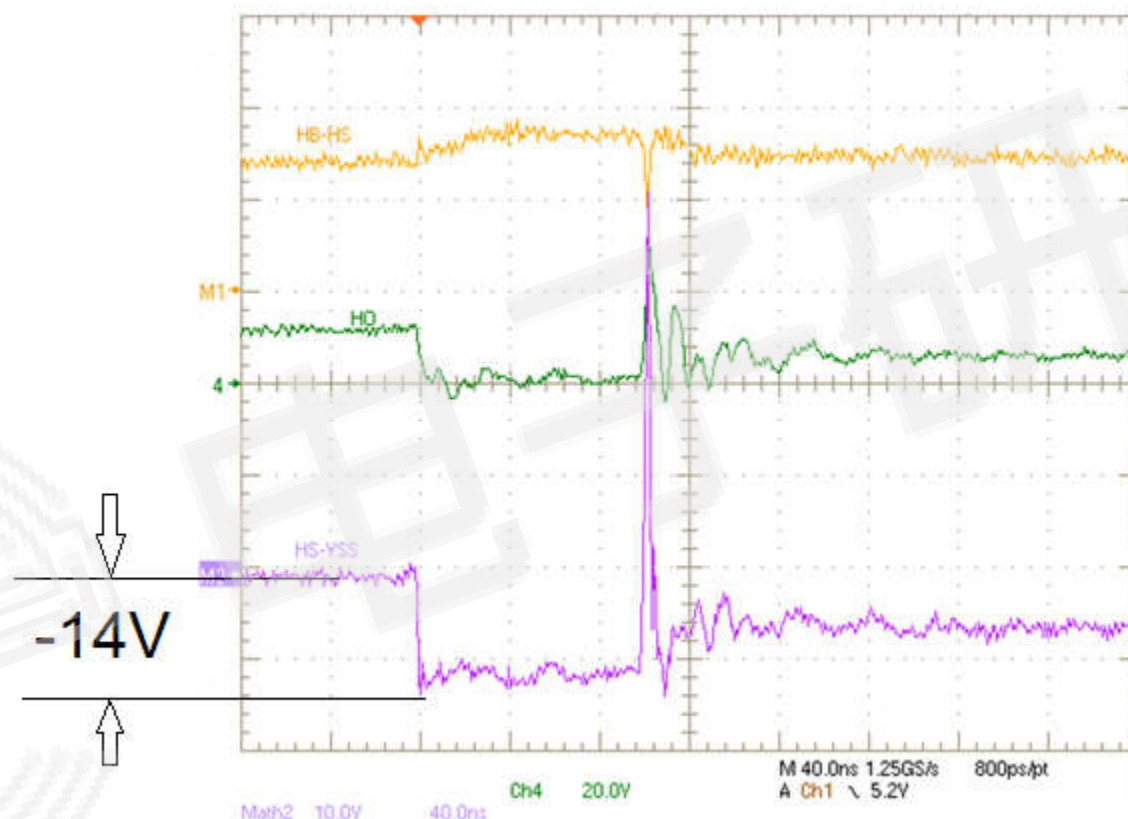


HIP221X STATIC NEGATIVE VOLTAGE RATING ON HS PIN



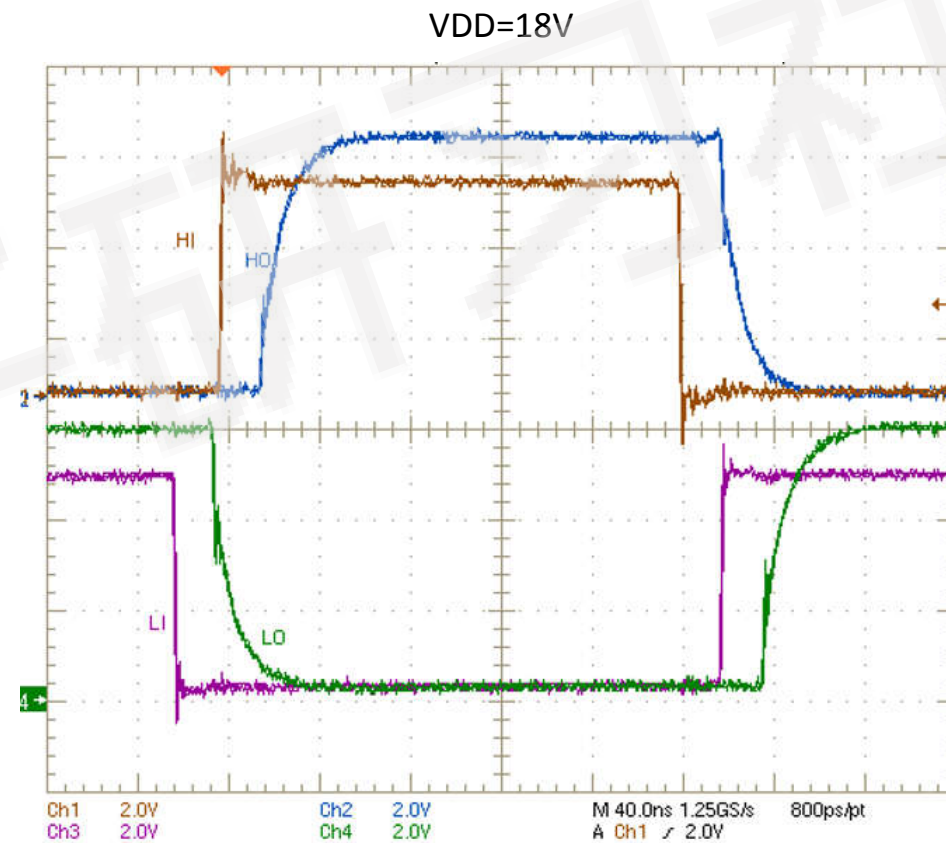
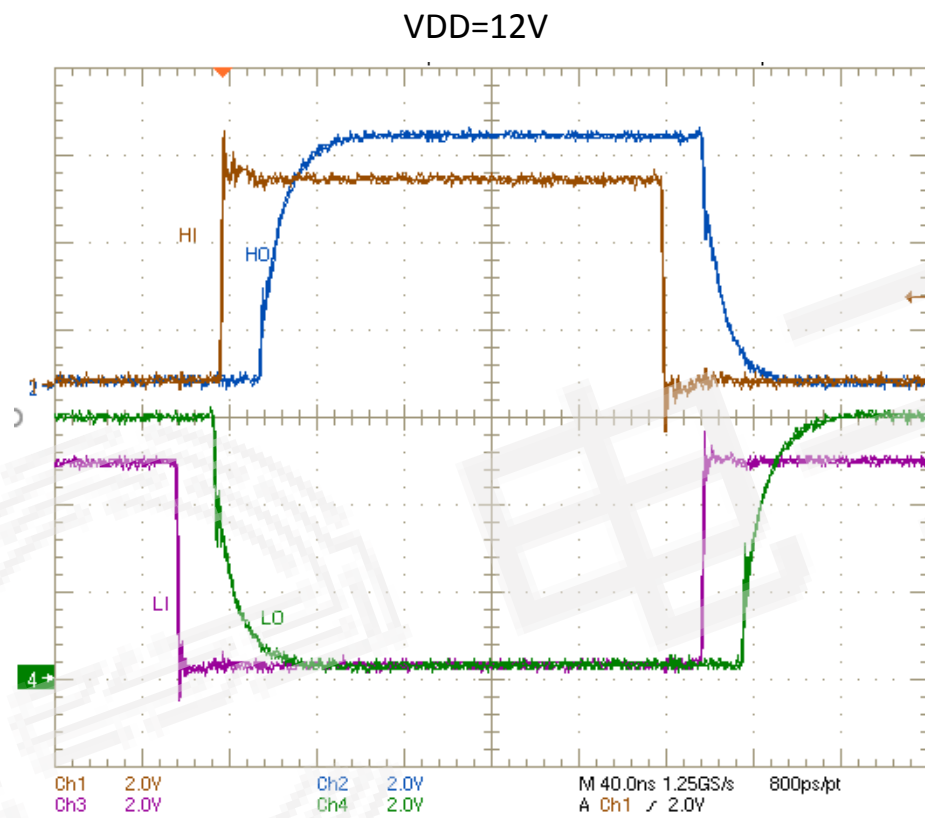
With static -12V on HS pin under 6V Vdd, the IC still operates fine

HIP221X DYNAMIC NEGATIVE VOLTAGE RATING ON HS PIN



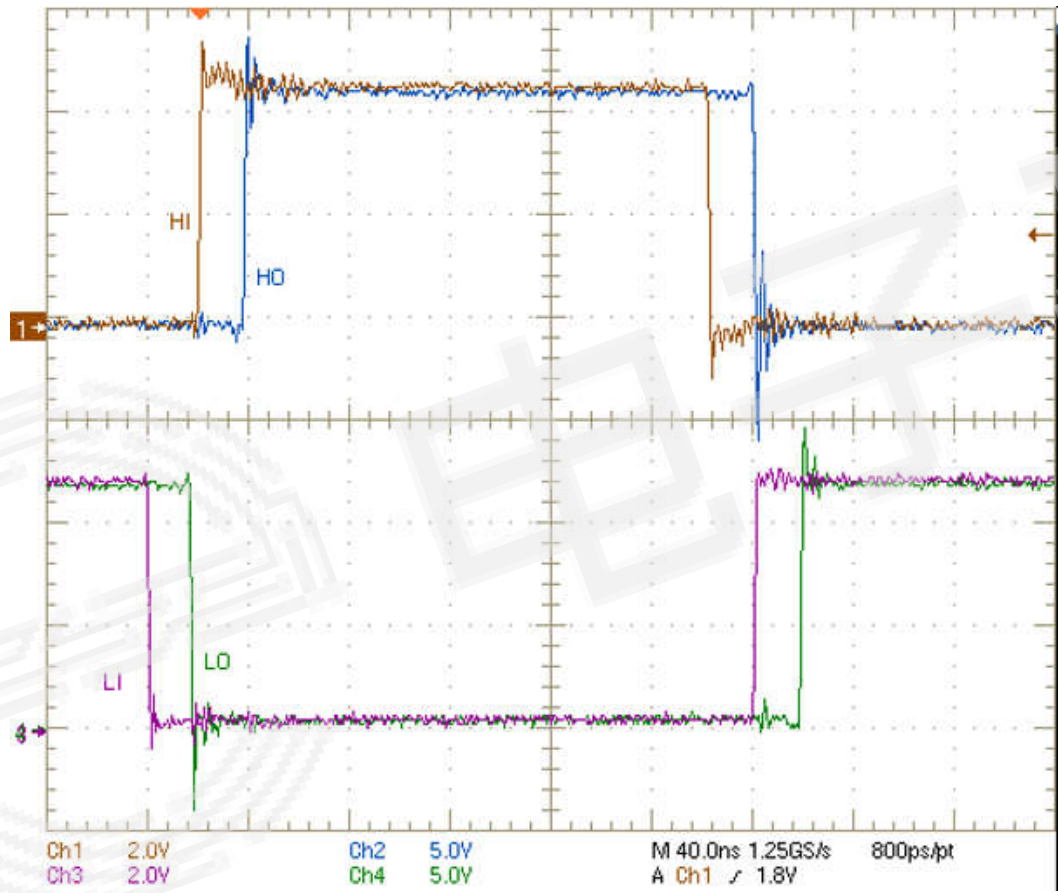
With dynamic -14V on HS pin for 100ns, the IC still operates fine

HIP221X ULTRA SMOOTH MOSFET SWITCHING



Driving Infineon IPD200N15N3 half-bridge (Fsw=1MHz, 20% duty)

HIP2211 EXTREME LOW PROPAGATION DELAY AND DELAY MATCHING TIME



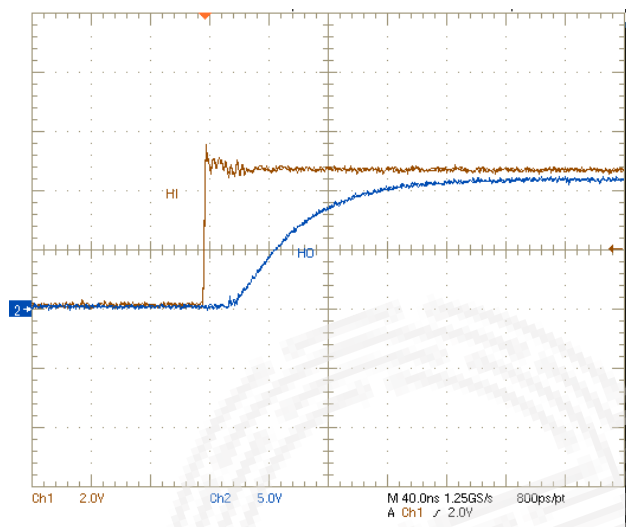
HI to HO turn on	HI to HO turn off	LI to LO turn on	LI to LO turn off
18ns	17.6ns	18.4ns	16.8ns

LI to HI delay matching: 1.2ns

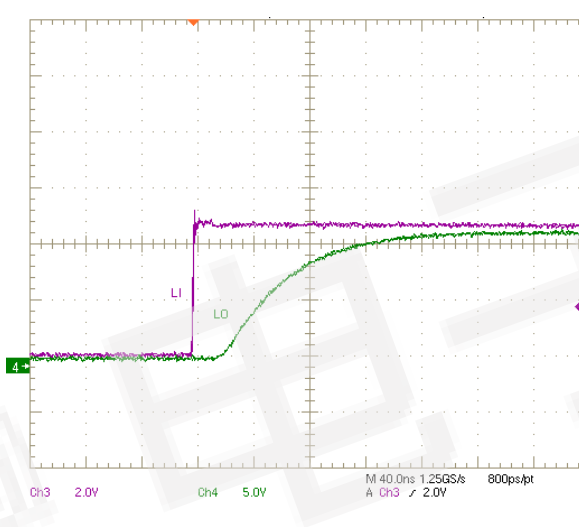
HI to LI delay matching: 0.8ns

HIP2211 FAST RISE / FALL TIME DRIVING CAPACITIVE LOAD WITH SMALL DELAYS

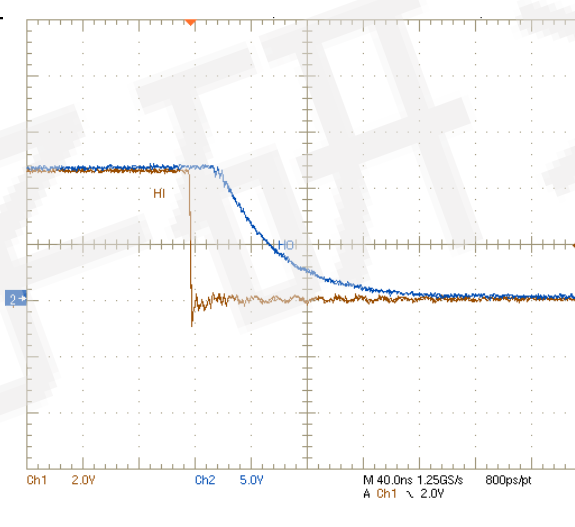
HI to HO rising edge



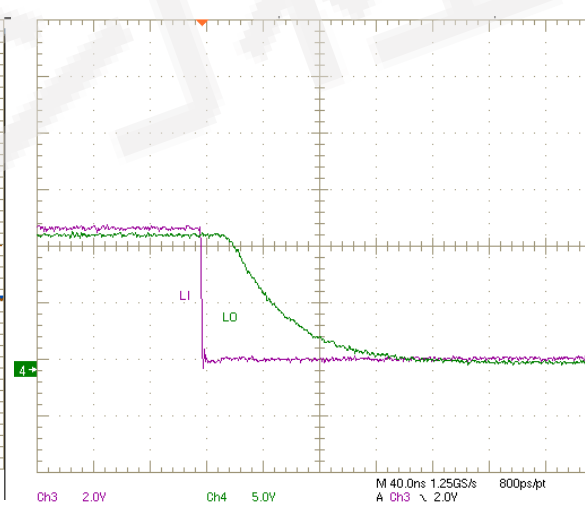
LI to LO rising edge



HI to HO falling edge



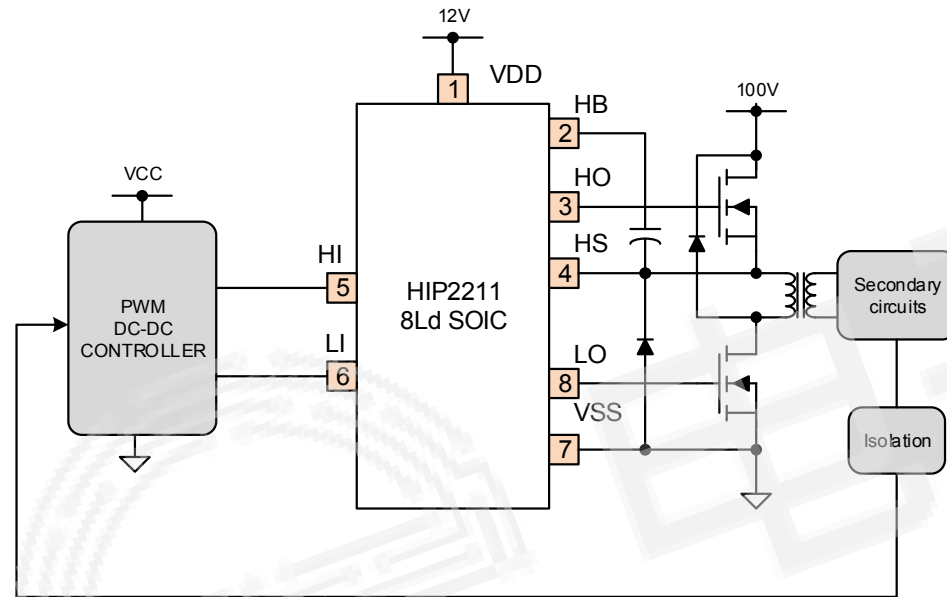
LI to LO falling edge



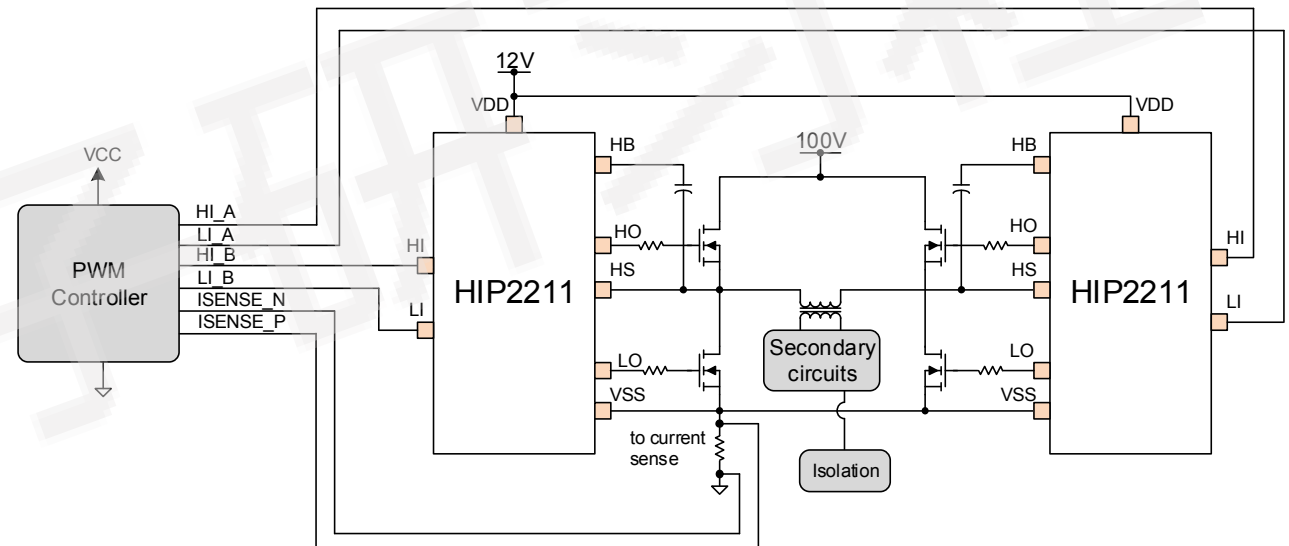
Driving 10nF capacitive load
VDD=HB=12V

RISE / FALL TIME ~100ns
Propagation delay ~ 10ns

APPLICATION BLOCK DIAGRAMS – POWER SUPPLIES

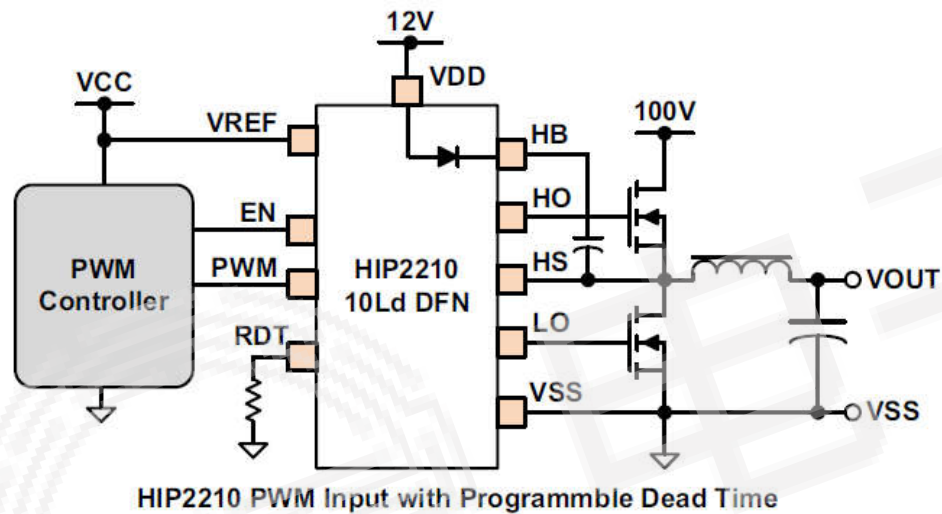


Up to 100V sync buck or
forward converters

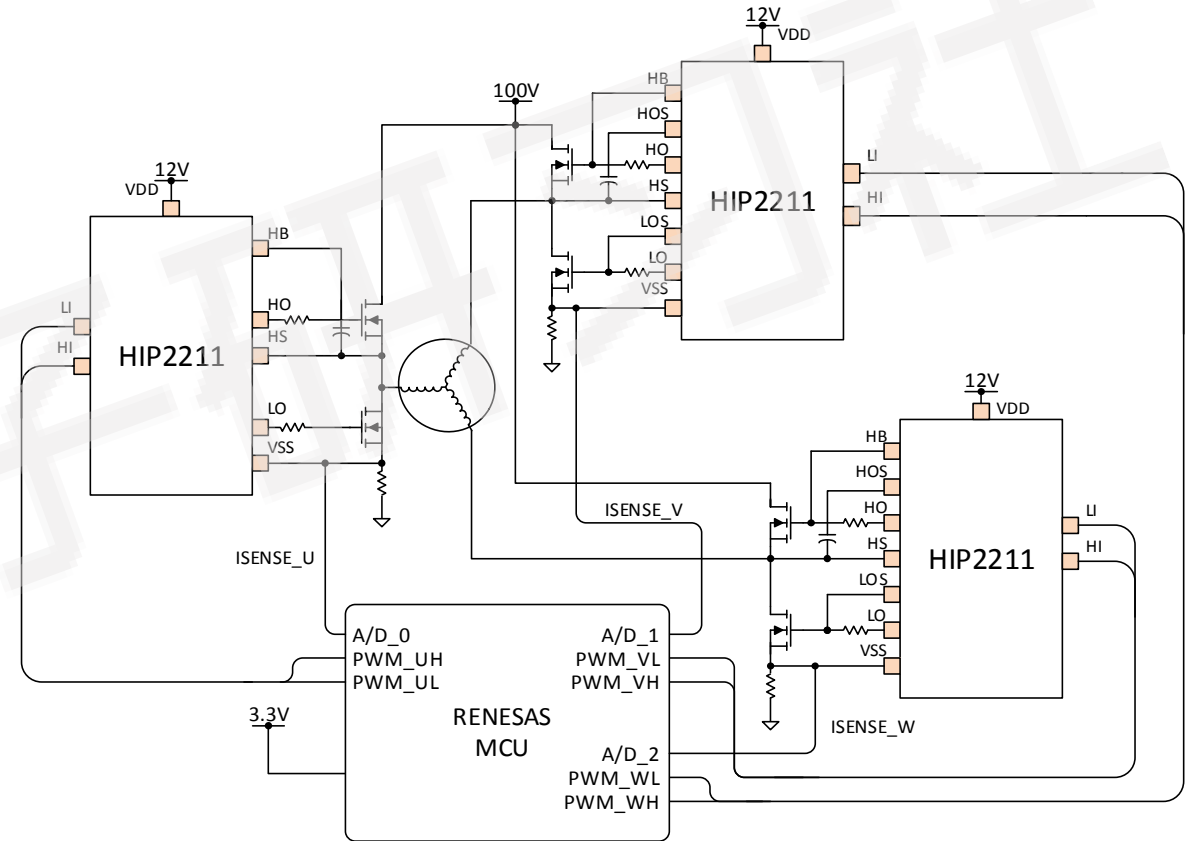


Up to 100V ZVS or LLC
Full bridge converters

APPLICATION BLOCK DIAGRAMS – MOTOR DRIVES



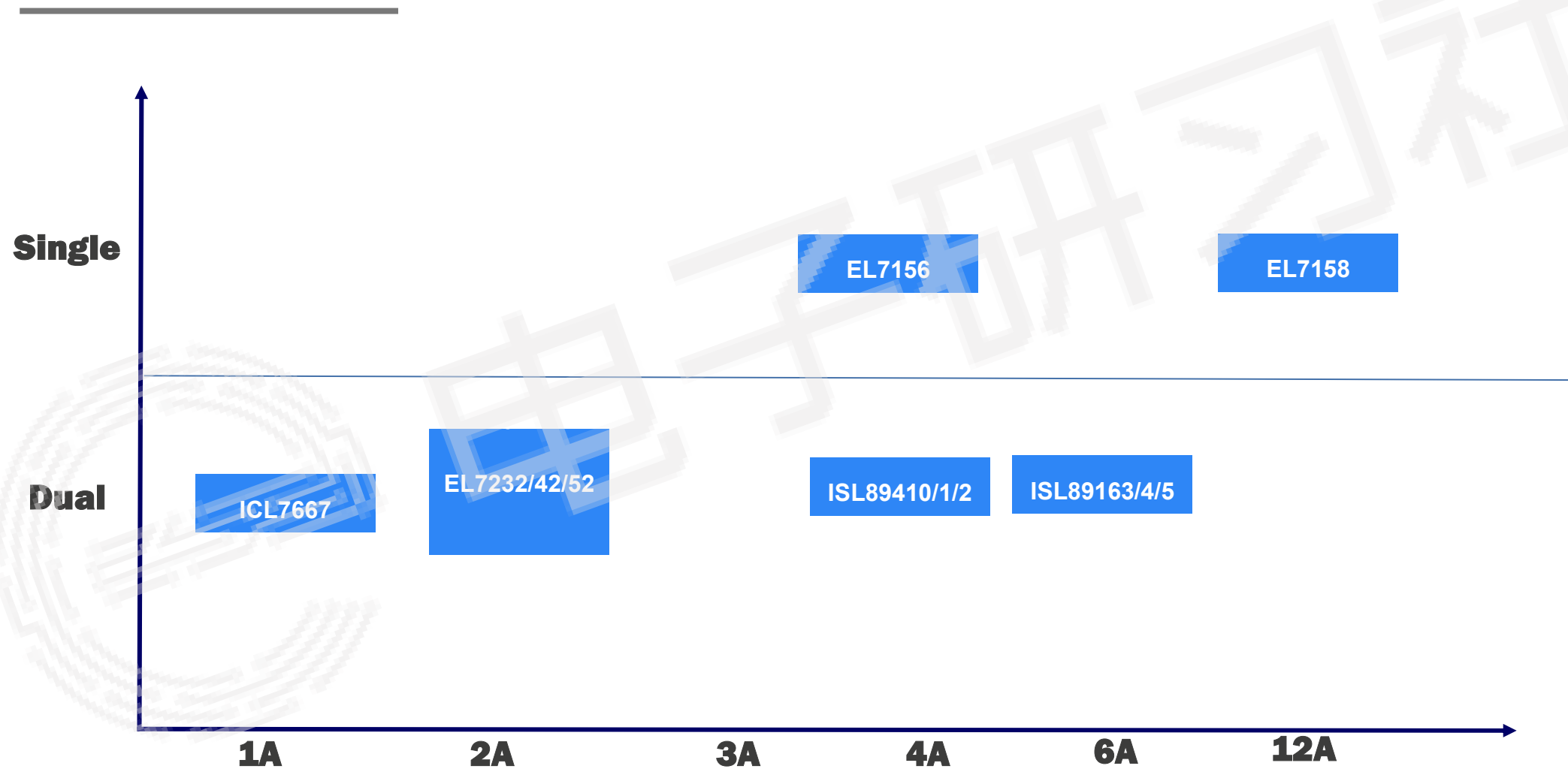
Up to 100V brushed
DC motor (use two)



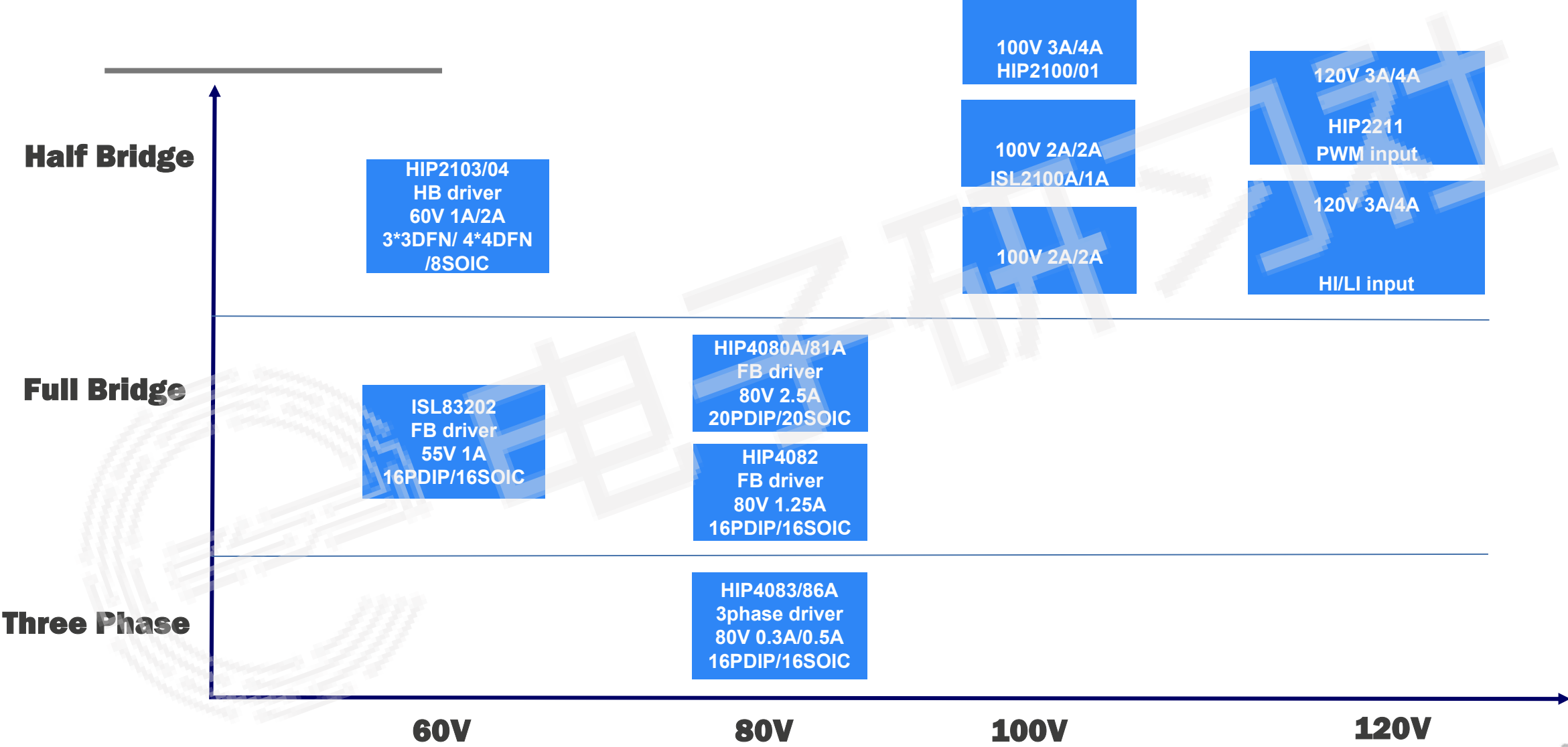
TARGET MARKETS

- **12V-48V motor drives / inverters**
 - Power tools
 - Water pumps
 - Cooling fans
 - Cleaning robots
- **48V Telecom power**
 - Active clamp Forward, Half bridge, full bridge >200W DC-DC conversion
- **Inverters**
 - Solar inverters
 - Aftermarket automotive inverters
- **UPS power**
- **High voltage high power sync buck controllers**
- **Class D audio**

LOW SIDE FET DRIVERS



BRIDGE FET DRIVERS LINEUP



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