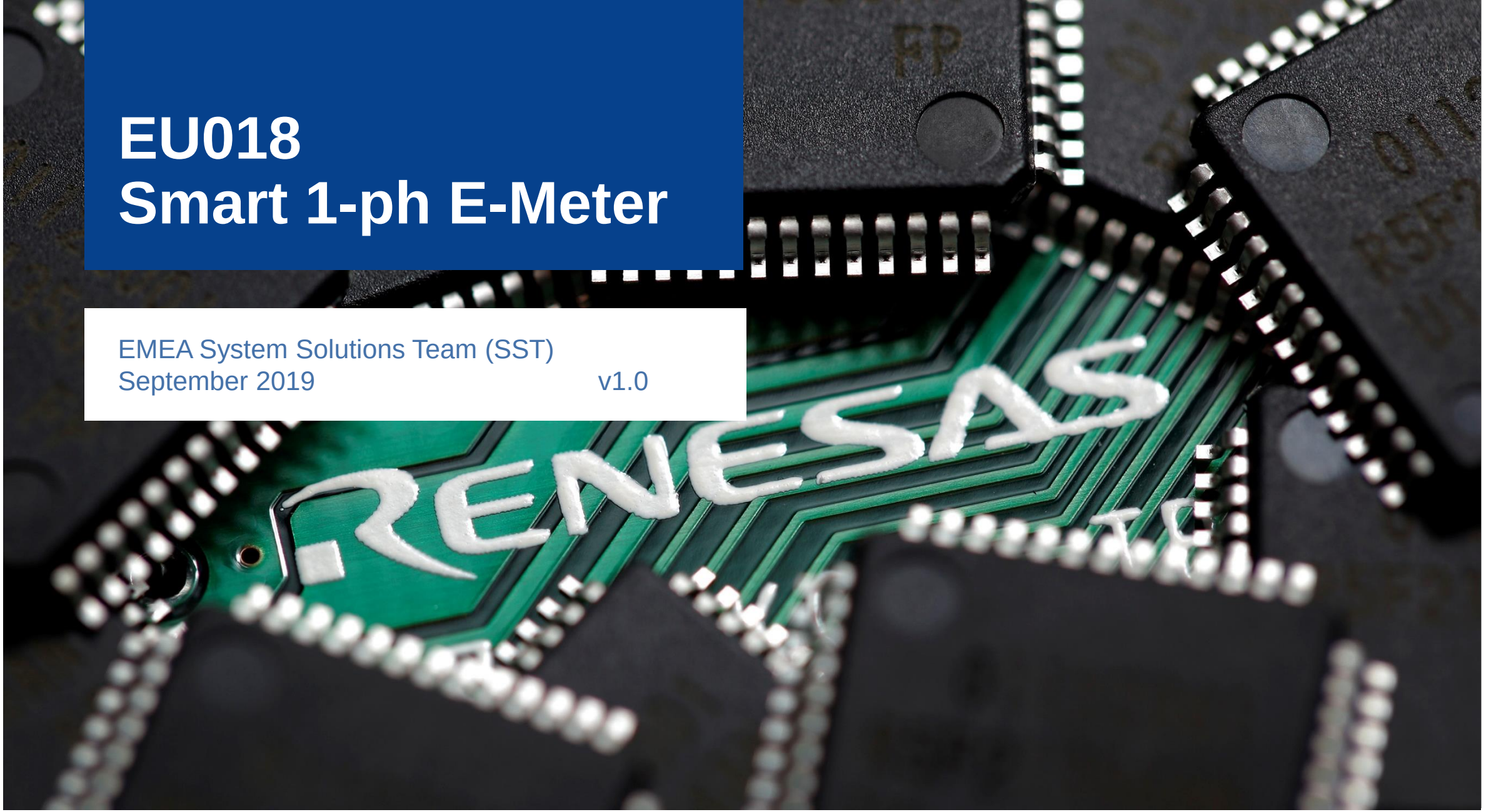
EU018
Smart 1-ph E-Meter



EMEA System Solutions Team (SST)
September 2019 v1.0

Smart 1-ph E-Meter

- **Overview 1/2**
  - As a result of increasing law regulation, energy subscribers will be provided more degree of freedom to **flexibly choose between tariffs and utilities**, optimizing this way their energy costs.
  - On the other hand, with an increase of renewable energy generation, local utilities require a more efficient way to **monitor the energy consumed on subscriber level**, in order to quicker adjust the conventional electrical energy generation.
  - Despite the above, the utility's business model chosen – **pre-paid vs. after-paid** – will mainly be driven by local consumption and payment habits.
  - Consequently, future electricity meters will require **reliable bi-directional communication paths** to address above needs; the solutions to be chosen will be depending upon local circumstances and will be either **wired or wireless**.
  - Although the solution presented addresses a **1-ph shunt E-Meter**, the same principles of operation are applicable to CT and Rogowski-coil based sensing approaches with the intrinsic isolation provided by the inductive.

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Smart 1-ph E-Meter

- **Overview 2/2 – System Requirements**
  - Physical separation of metrology and application (WELMEC)
  - Galvanic isolation between metrology and application
  - Tamper detection
  - Application: ARM Cortex Core
  - Wired connectivity:
    - PLC (G3-PLC, PRIME),
    - RS485
    - IrDA
    - MODBUS (optional)
  - Wireless connectivity:
    - GPRS (2G)
    - LTE-M (5G)
    - Sub-1-GHz

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Smart 1-ph E-Meter

- **System benefits 1/3**
  - Alternatively to the suggested intelligent AFE (**RL78 / I1C**) the final solution may use the cost effective RL78 / I1B, a design variant of the I1C without hardware encryption; both devices integrate a 24 Bit ΣΔ ADC.
  - The calculated energy parameters will be digitized and transferred via UART to the applications controller, through an optical isolator (**PS9821**). Depending upon the number of lines the serial interface is based on, “n” number of isolators may be finally needed.
  - The selected applications controller (**RA6M1***) is a Cortex M4 device with 512 kB flash and 256 kB RAM.
  - The suggested LED/IrDA and RS485 interfaces (**ISL3179E**) address the capability of bi-direction serial connectivity in production and/or out in the field.
  - For remote rural deployments with poor grid quality, 2G or 5G wireless connectivity is a must, addressed by **Quectel’s BG95** module.
  - The suggested mech. switch is a common approach to detect tamper approaches, triggering a register flag upon case opening.

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September 2019

Smart 1-ph E-Meter

- **System benefits 2/3**
  - For urban deployments, either Sub-1-GHz communication via a data logger or wired connectivity via PLC is a must; while the **RAA604S00** supports a proprietary FSK or the Wi-SUN protocol, the **R9A06G037** as well as the following line driver (**ISL15102**) support both, the 3G-PLC as well as PRIME specification.
  - A good fitting choice to comply with the G3 requirement of 0-crossing detection, would be the suggested optical isolator (**PS2561FL**), required for both, non-isolated and isolated coupling designs.

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Smart 1-ph E-Meter

- **System benefits 3/3**
  - The required galvanic isolation is achieved using a switched-mode isolated power supply (**Flyback**) with multiple DC outputs; the recommended flyback-controller (**RAA223011***) covers voltage peaks up to V ≤ 420V.
  - As the BG95‘s nominal voltage is specified @ 3.8V (min 3.3 V), it’s supply will have to be separately supplied through an own DC-DC Buck (**ISL85412**); yet, whether this system will have to be galvanically isolated from the rest of the system is a matter of discussion and cost.
  - The rest of the system (except metrology) can be supplied through a similar, separate DC-DC Buck (**ISL85412**) as the other component’s nominal supply voltages are typically @ 3.3V
  - In order to guarantee galvanic isolation through the complete signal path, the metrology’s power will have to be supplied through a separate LDO (**ISL80410**); alternatively, an additional LDO (same part number => **ISL80410**) could be used to separately power the RS485 modem.

**official product launch October 2019*

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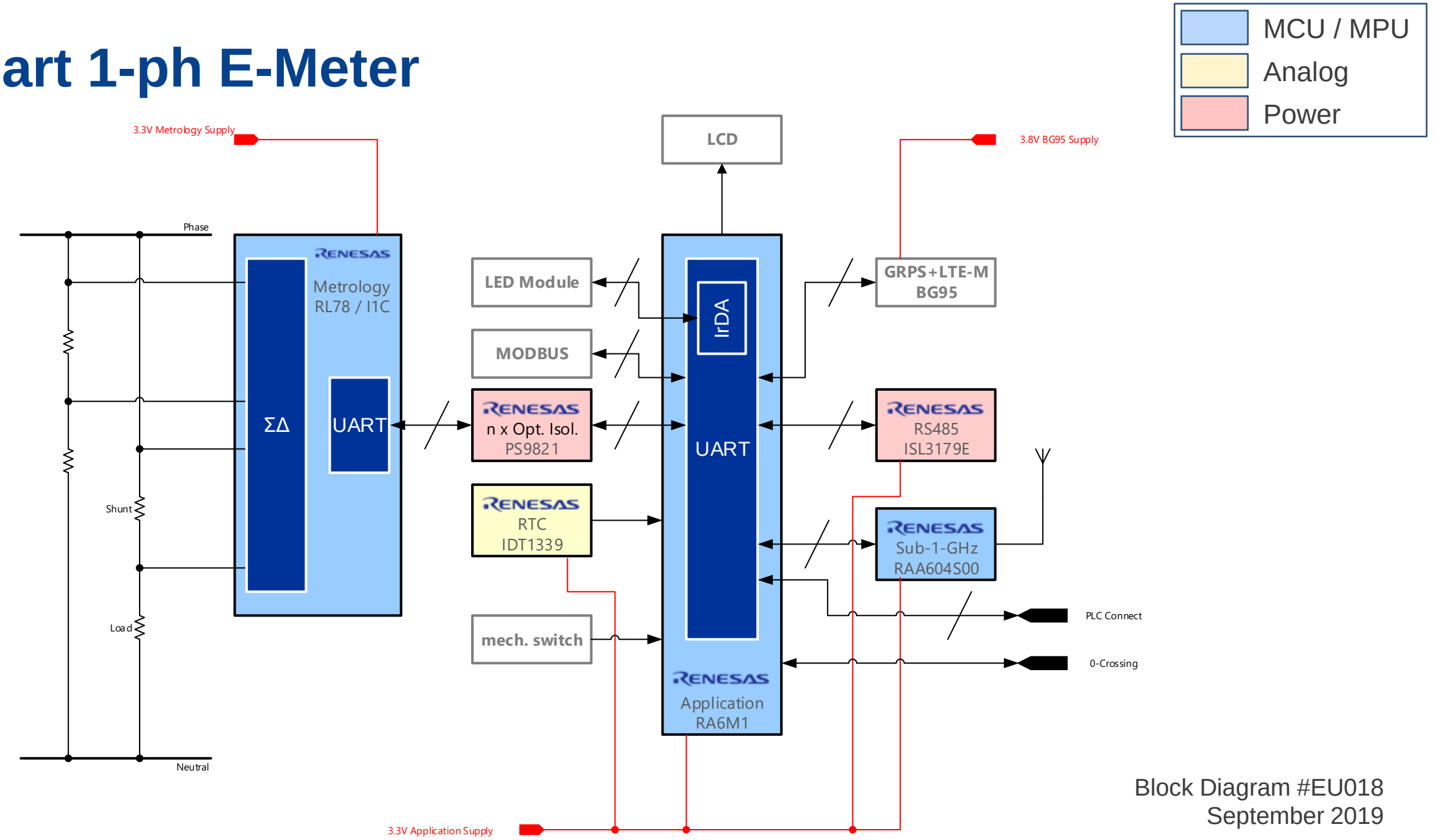
Smart 1-ph E-Meter



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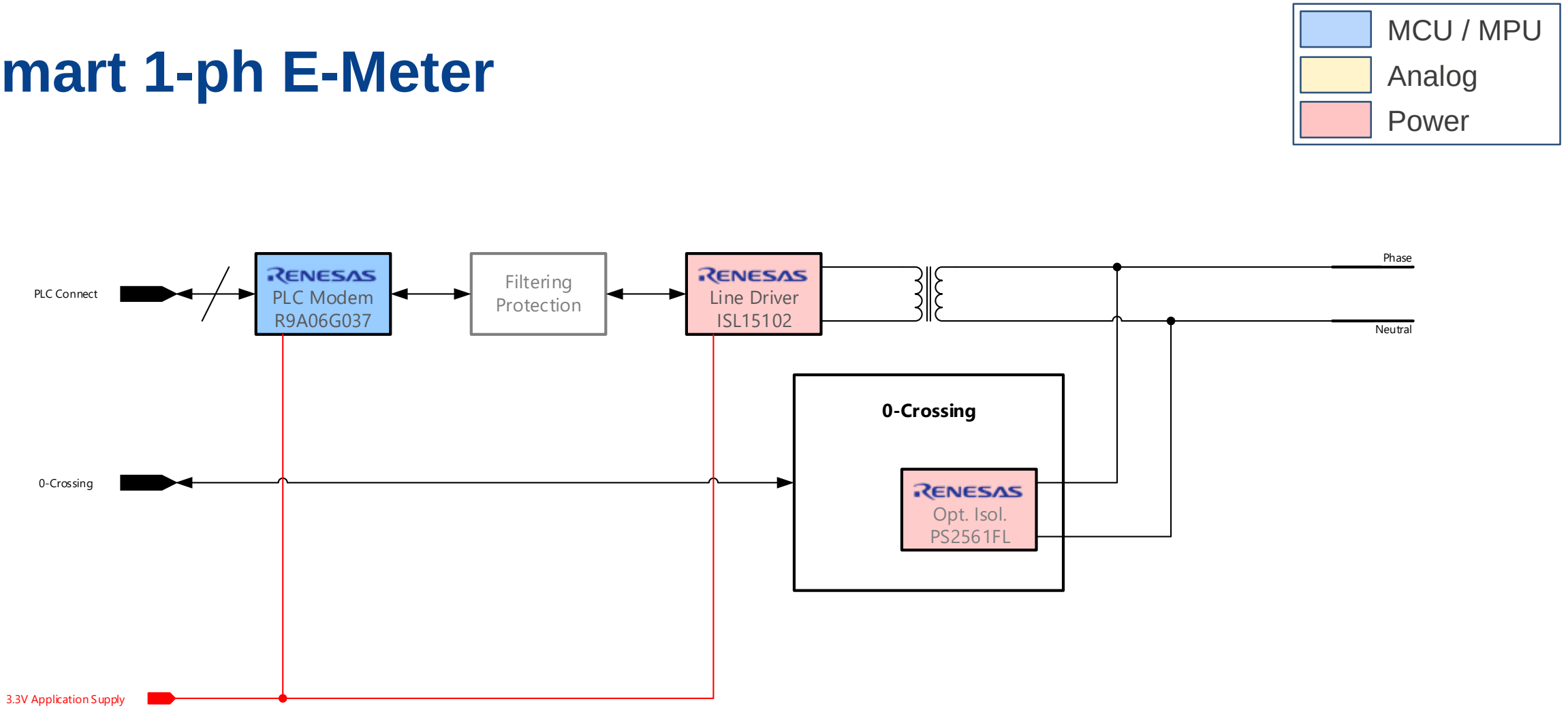
Smart 1-ph E-Meter



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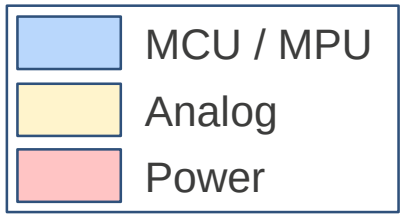
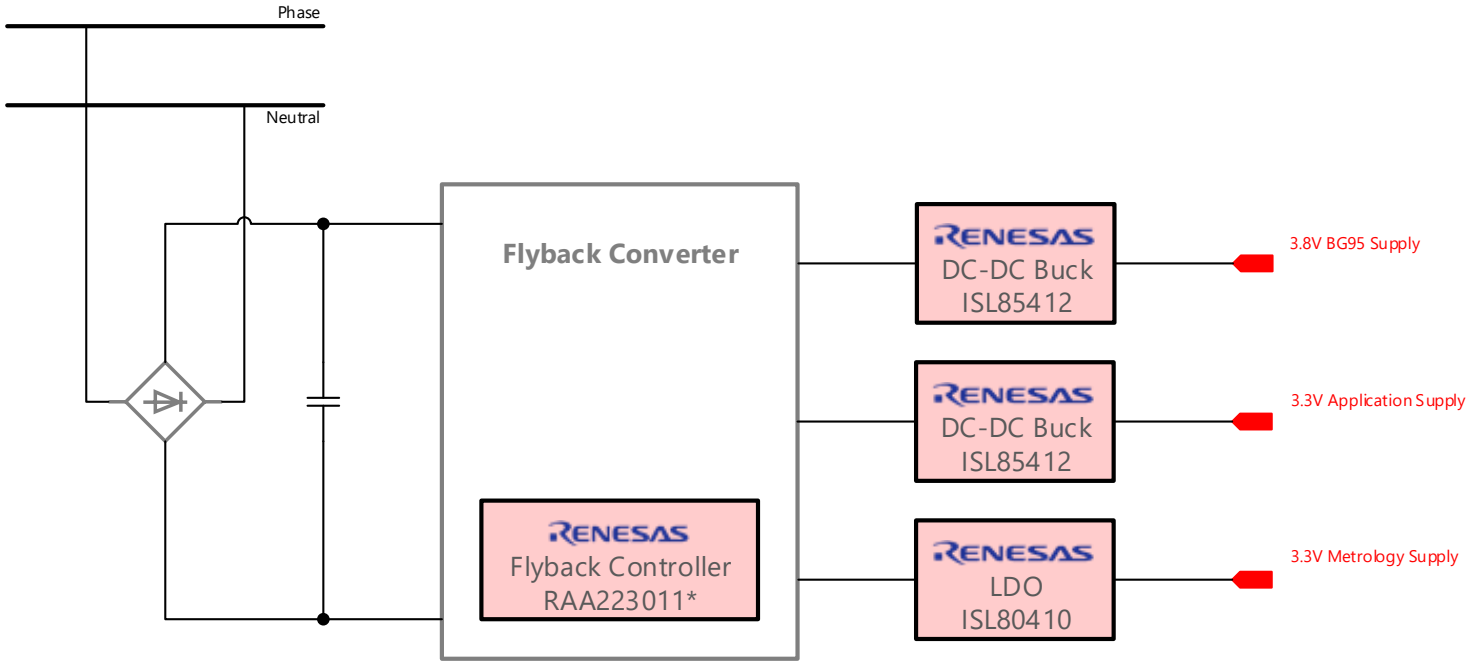
Smart 1-ph E-Meter





** official part release October 2019*

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September 2019

Smart 1-ph E-Meter

Device Category	P/N	Key Features
MCU	RA6M1 *official product launch October 2019*	120 MHz, Arm Cortex® –M4F, 512kB Flash, 256kB RAM, 64-100 Pin, Security, IrDA
	RL78/I1C	16Bit Core, 2kB Flash, 6-16kB RAM, 64-100 Pin, 24Bit ΣΔ, AES HW
Power	RAA223011 *official product launch October 2019*	700V, 4 W buck regulator (flyback)
	ISL85412	Synchronous Buck Regulator, 3.5V ≤ VIN ≤ 40V, integrated High + Low-Side NMOS-FETs
	ISL80410	40V, Low Quiescent Current, 150mA Linear Regulator
Analog	PS9821	High-speed digital output photocoupler
	IDT1339	Real-Time Clock With Serial I2C Interface
	ISL3179E	High ESD Protected, +125°C, 40Mbps, 3.3V, Full Fail-Safe, RS-485/RS-422 Transceivers
	RAA604S00	915-MHz-Band +30dBm RF Transceiver
	R9A06G037	high performance NB-PLC (Narrow Band Power Line Communication) modem IC
	ISL15102	Single Port, PLC Differential Line Driver
	PS2561FL	DC input/single transistor output photocoupler

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Pls replace with new Chinese format

Renesas RA6M1 Group Snapshot

120MHz ARM Cortex M4 Optimized entry point to RA6 Series

Features

- 120MHz Arm® Cortex®-M4F
- 512kB Flash Memory and 256kB SRAM
- 8kB DataFlash to store data as in EEPROM
- Scalable from 64pin to 100pin packages
- Capacitive Touch Sensing Unit
- USB2.0 Full Speed
- CAN 2.0B
- SCI (UART, Simple SPI, Simple I2C)
- SPI/ I2C Multimaster interface
- SDHI
- SSI/Serial Sound Interface

Benefits

- Integrated Crypto Module with several cryptography accelerators and Key management support
- Highly power efficient with 100uA/MHz in Active Mode, 1.3uA in Software Standby Mode and 900nA in VBAT Mode with RTC running.
- Large 256kB embedded SRAM suitable for handling communication stacks.

Applications

- Security (Fire Detection, Burglar Detection, Panel control)
- Metering (Electricity, Automated Meter Reading)
- Industry (Robotics, Door Openers, Sewing Machines, Vending machines, UPS)
- HVAC (Heating, Air Conditioning, Boiler Control)
- General purpose

Product Details

Leading performance 120-MHz Arm® Cortex®-M4 core, 512-KB code flash memory, 256-KB SRAM, Capacitive Touch Sensing Unit, USB 2.0 Full-Speed, SDHI, Quad SPI, security and safety features, and advanced analog.

The RA6M1 is built on a highly efficient 40nm process and is supported by an open and flexible ecosystem concept, called Flexible Software Package (FSP), using FreeRTOS as base, but can be replaced and expanded by any other RTOS or middleware user's need. RA6M1 is suitable for IoT application requiring Security, large embedded RAM and low power consumption

FLASH / RAM	512kB / 256kB	RA6M1	RA6M1	RA6M1	RA6M1
Pin Count Package Size Pitch		64pin LQFP 12x12 0.5mm	64pin QFN 8x8 0.4mm	100pin LQFP 14x14 0.5mm	100pin LGA 7x7 0.65mm

RL78/I1C – Low Power Smart AFE

High Precision 24 Bit ΣΔ ADC and AES HW

Small package

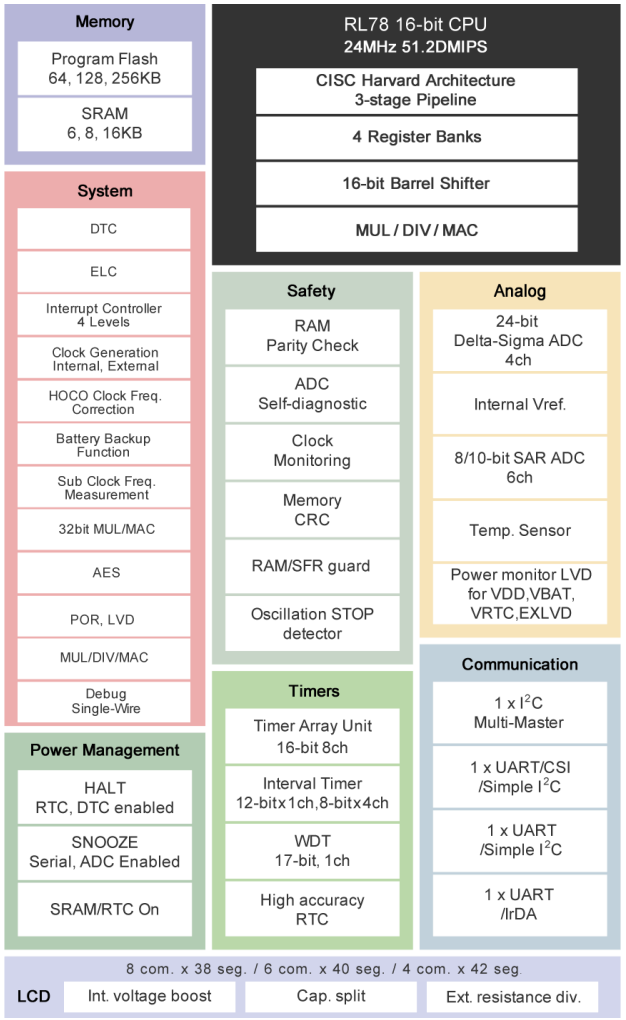
- RL78 CPU core
- DTC – Data Transfer Controller
- LCD Driver
- 4 ch. 24 Bit ΣΔ ADC
- AES HW

BOM cost reduction

- High integration of peripherals
- Reduce external parts
- Decreased complexity thank to high integration

Platform

- Pre-certified metrology SW
- Suitable for shunt, CT and Rogowski-coil meters



Part #	Program Flash	RAM	24bitΔΣADC	8/10bitSAR-ADC	Package
R5F10NLE/G	64KB - 128KB	6 – 8KB	4 ch	4 ch	64 – 100 LQFP
R5F10NME/G			3 ch		
R5F10NMJ	256KB	16KB			80 – 100 LQFP
R5F10NPJ/G	128KB - 256KB	8 – 16 KB	4 ch	6 ch	

Pls review with Hong

RAA223011 – Flyback Buck Regulator

700V, 4W, Quasi resonant SSR

High Performance

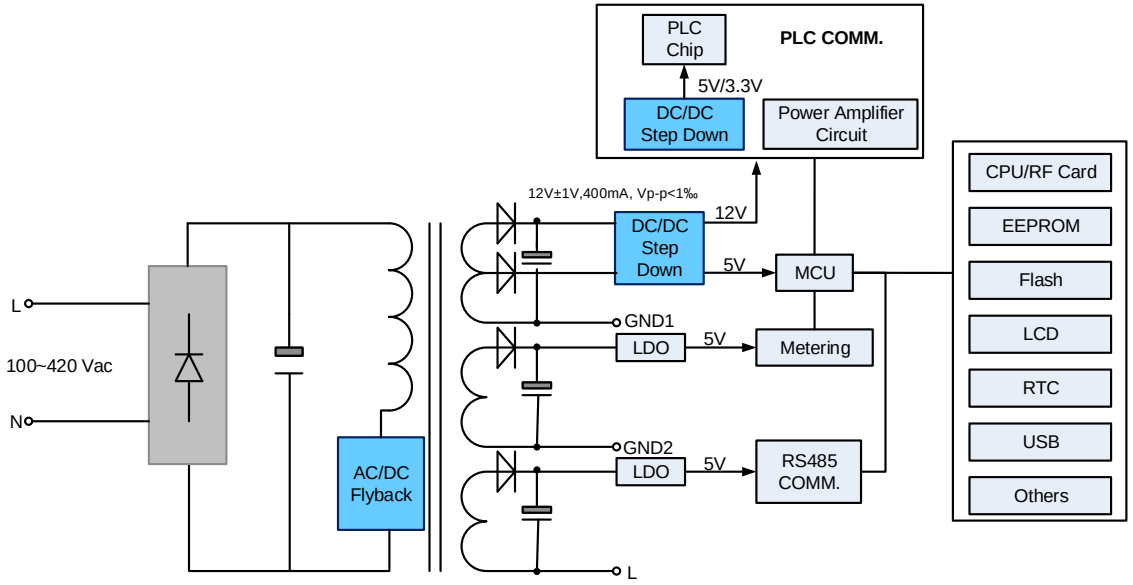
- no audible noise
- zero standby
- HV start @ 700V

High Efficiency

- Quasi resonant SSR

Excellent Safety

- Programmable Line OVP



Typical Application Circuit

Part #	Vin (V)	Pout [W]	Temp.(℃)	Package
RAA223011	700V	4W	-40 to +85	SOIC14-11
RAA223181	900V	5W	-40 to +85	
RAA223182	1000V	15W	-40 to +85	

ISL85412 – 40V Synchronous Buck Regulator

Wide V_{IN}, 150 mA Buck

Wide Working Rang

- Power input voltage range variable 3.5V to 40V
- Selectable PFM or forced PWM mode at light loads
- Continuous output current up to 150 mA

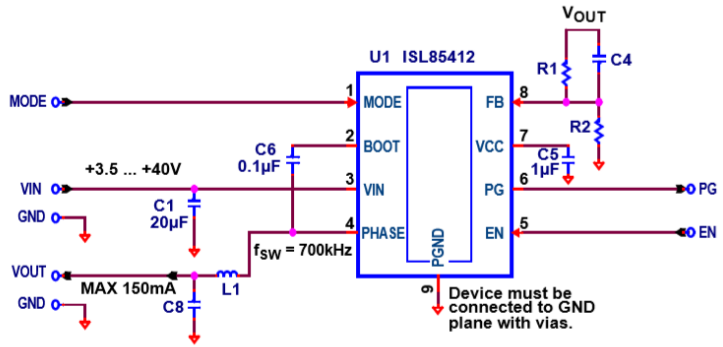
Easy to Use

- The minimum BOM due to minimal external components

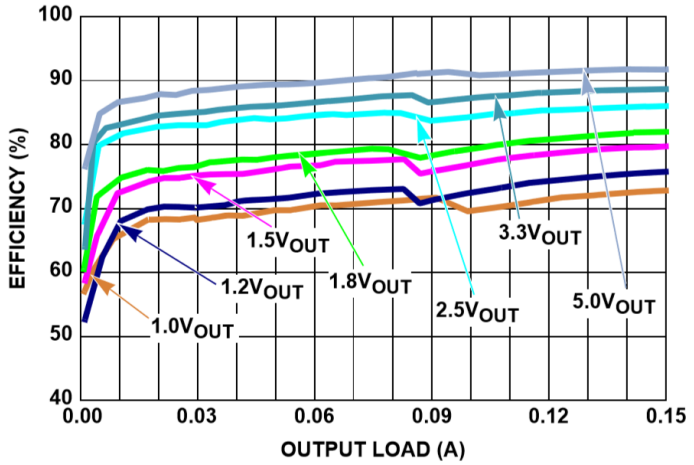
Excellent Safety

- No compensation required
- Internal soft start
- Power-good and enable functions selectable

Part #	Part Marking	Temp.(℃)	Package
ISL85412FRZ	5412	-40 to +125	8 ld TDFN
ISL85412EVAL1Z	Evaluation Board		
ISL85412DEMO1Z	Demonstration Board		



Typical Application Circuit



Efficiency vs. Load, PFM, V_{IN} = 12V

ISL80410 – High Voltage Adjustable V_{OUT} LDO

Low Quiescent Current and 40V/150mA Output

High Performance and Wide Input Range

- Wide V_{IN} range of 6V to 40V
- Adjustable output voltage from 2.5V to 12V
- Ensured 150mA output current
- ±1% accurate voltage reference (over temperature, load)

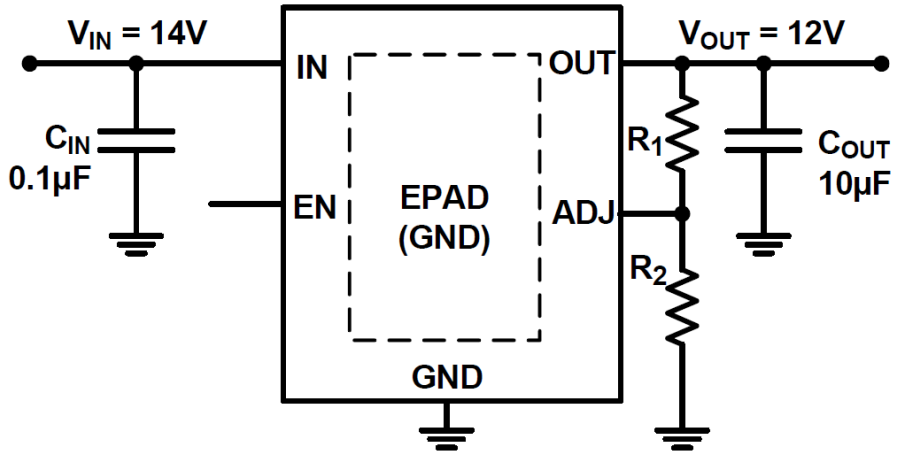
High Efficiency

- Ultra low 18µA typical quiescent current
- Low 2µA of typical shutdown current
- Low dropout voltage of 295mV at 150mA
- Low 26µVRMS noise

Excellent Safety

- 40V tolerant logic level (TTL/CMOS) enable input
- 5kV ESD HBM rated
- Thermal shutdown and current limit protection

Part #	Vin (V)	Vout (V)	Iout (mA)	Package
ISL80410IBEZ	6V to 40V	2.5V to 12V	ADJ	8 Ld EPSOIC
ISL80410IBEZ-T	6V to 40V	2.5V to 12V	ADJ	8 Ld EPSOIC
ISL80410IBEZ-T7A	6V to 40V	2.5V to 12V	ADJ	8 Ld EPSOIC



Typical Application Circuit

ISL80410EVAL1Z Evaluation Board

PS9821 – High CMR Photocoupler

15 Mbps, Open Collector Type

High Performance

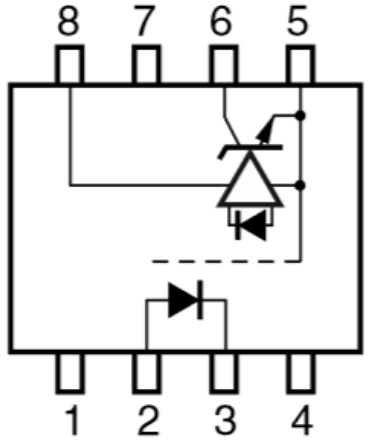
- Low power consumption (VCC = 3.3 V)
- Pulse width distortion ($|t_{PHL} - t_{PLH}|$ = 35 ns MAX.)
- High common mode transient immunity (CMH, CML = ±15 kV/ μs MIN.)
- High-speed (15 Mbps)
- High isolation voltage (BV = 2 500 Vr.m.s.)

Safety Standards

- UL approved: File No. E72422
- DIN EN60747-5-2 (VDE0884 Part2) approved No.40008347 (option)

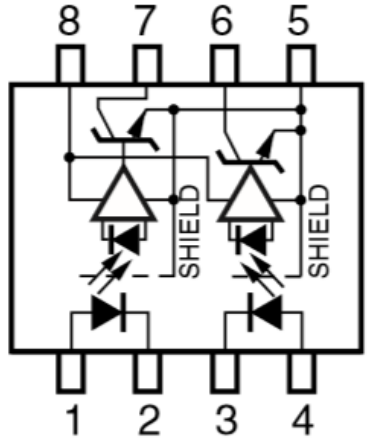
Part #	Number of channels	Safety Standard	Package
PS9821-1	1	UL, DIN, EN	8 Pin SSOP
PS9821-2	2		

PS9821-1



1. NC
2. Anode
3. Cathode
4. NC
5. GND
6. Vo
7. NC
8. Vcc

PS9821-2



1. Anode1
2. Cathode1
3. Cathode2
4. Anode2
5. GND
6. Vo2
7. Vo1
8. Vcc

PIN Connection

IDT1339 – RTC with Serial I²C Interface

15 Mbps, Open Collector Type

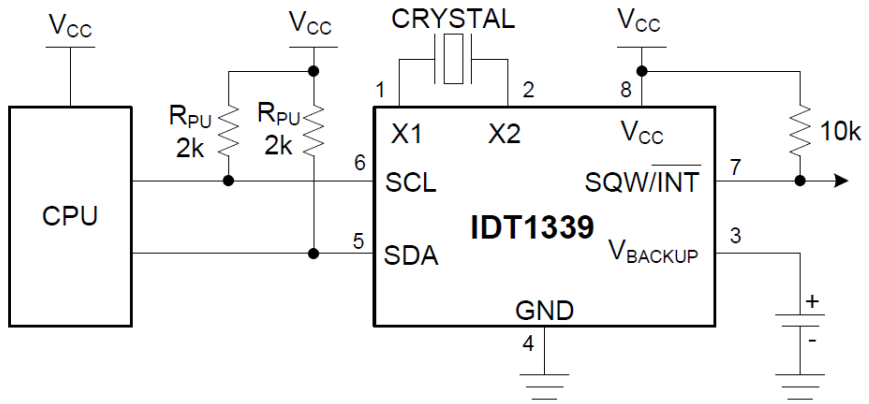
High Performance

- seconds, minutes, hours, day, date, month, and year with leap-year compensation, valid up to 2100
- Fast mode I2C Serial interface
- Two time-of-day alarms
- Two time-of-day alarms
- Automatic power-fail detect and switch circuitry
- Trickle-charge capability

Safety Standards

- UL approved

Part #	Package	Safety Standard	Temperature [°C]
IDT1339	8 Pin MSOP/SOIC	UL, DIN, EN	-40°C ≤ T ≤ +85°C
IDT1339C	16 Pin SOIC		



Typical Operating Circuit

ISL3179E – 40 Mbps RS-485 Transceiver

High ESD Protected, 3.3V, Full Fail-Safe

High Speed:

- 40Mbps data rate

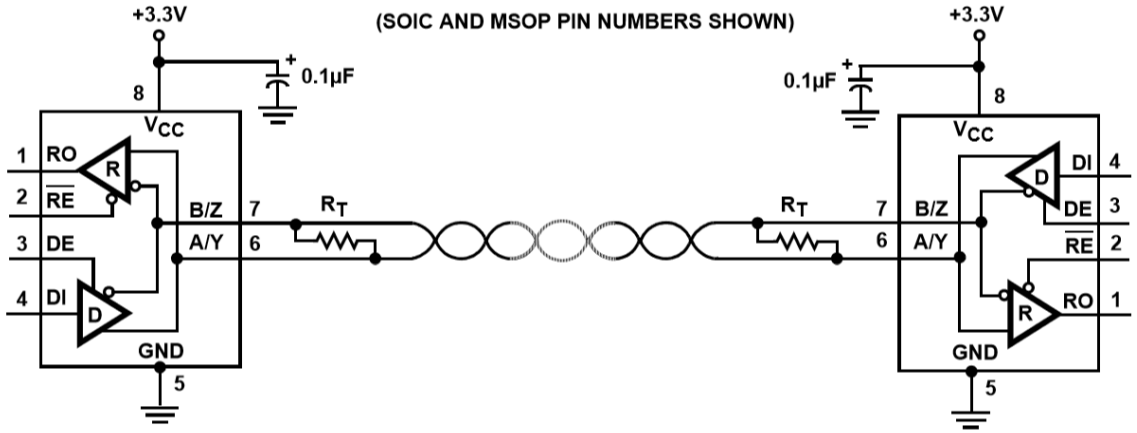
High Reliability

- Class 3 HBM on all pins > 9 kV
- 16.5kV ESD bus-pin protection

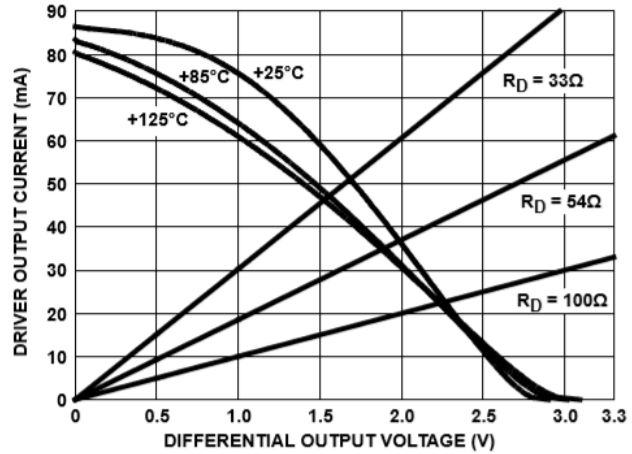
Good Connectivity

- Operates from a single +3.3V supply (10% tolerance)

Part #	HALF/FULL DUPLEX	Vcc [V]	VOD [V]	Data Rate [Mbps]
ISL3179E	Half	3.3	1.5	40
ISL3180E	Full	3.3	1.5	40
ISL3159E	Half	5	2.1	40
ISL3259E	Full	5	2.1	100



Typical Operating Circuits



Driver Output Current vs. Differential Output Voltage

RAA604S00 – Sub-1-GHz Transceiver

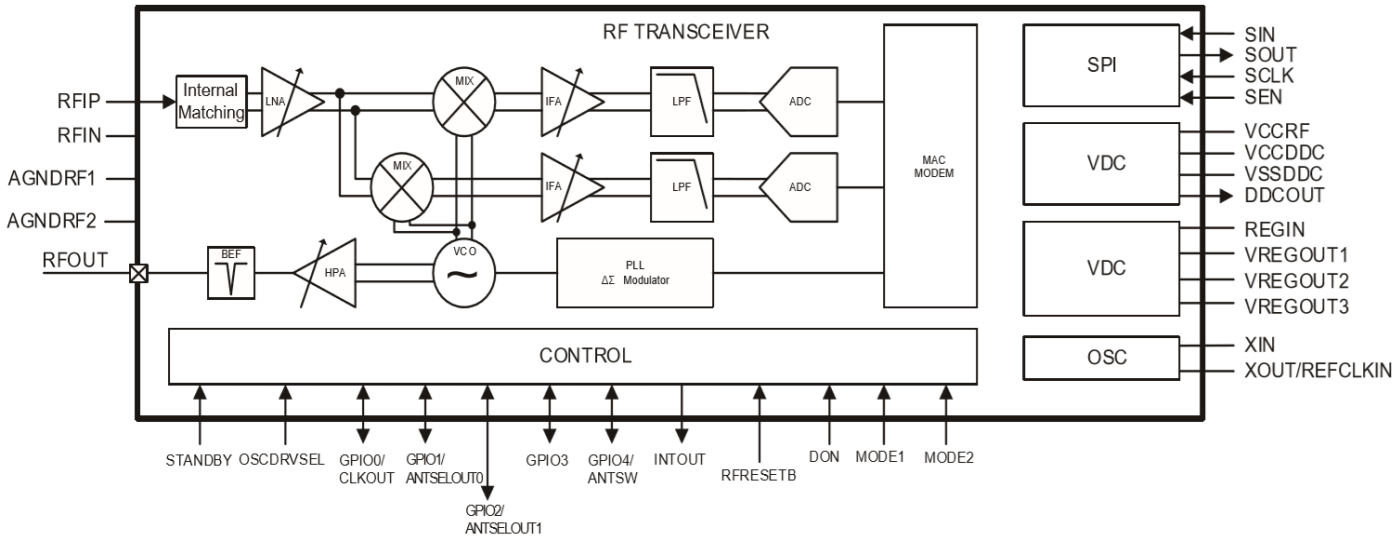
863 to 928 MHz, FSK Modulation

Specification:

- RF frequency range: 863 to 928 MHz
- Modulation method: 2FSK/GFSK, 4FSK/GFSK
- Data rate:
  - 2FSK/GFSK; 10 k to 300 kbps
  - 4FSK/GFSK; 200 k/400 kbps
- Forward Error Correction (FEC) function

Performance

- I_{RX} = 6.9 A @ 100kbps, 2GFSK, V_{IN} = 3.0V
- I_{TX} = 21 A @ 100kbps, 2GFSK, V_{IN} = 3.0V, P_{TX} = 10dbm



Blockdiagram

Part #	Packaging Specification	Fields of Application
RAA604S002GNP#AC0	Tray	Industrial
RAA604S002GNP#HC0	Embossed Tape	Industrial
RAA604S002GNP#AC1	Tray	Consumer
RAA604S002GNP#HC1	Embossed Tape	Cosnumer

R9A06G037 – Power Line Communication Modem

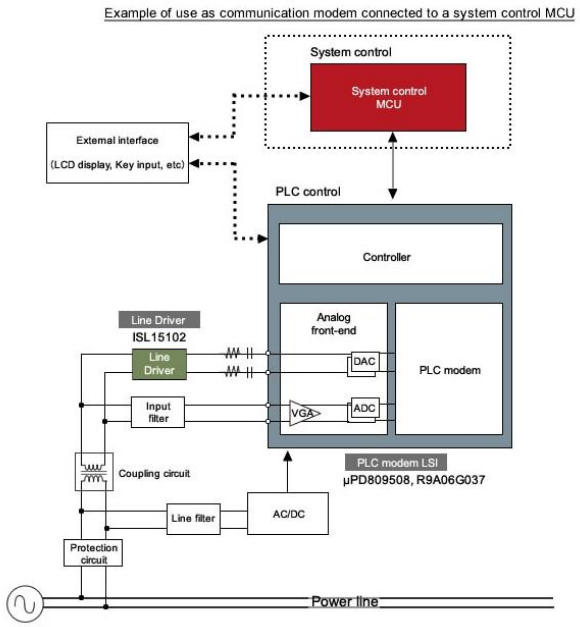
G3-PLC, PRIME

Specification:

- Narrow Band PLC
- high performance DSP core
- Arm® Cortex®-M3 MCU Core

Performance

- G3-PLC: CENELEC, ARIB and FCC
- PRIME
- Power Supply Voltage : 3.3V
- Operating Temperature : -40 to +85℃



System Block Diagram

Part #	Description
R9A06G037GNP#AA0	Device
RTK0EE0003D01002BJ	GCPX3 Evaluation Kit J70D1 (Global version) : High voltage version
RTK0EE0007D01001BJ	BCPX3 Evaluation Kit J80D1 (RX651) : Low voltage version * Voice correspondence
RTK0EE0007D02001BJ	BCPX3 Evaluation Kit J80D2 (RL78/G13) : Low voltage version

ISL15102 – Single Port, PLC Differential Line Driver

Heavy Line Load Driver

High Performance

- Single differential driver
- Internal VCM
- 90MHz signal bandwidth
- 900V/µs slew rate

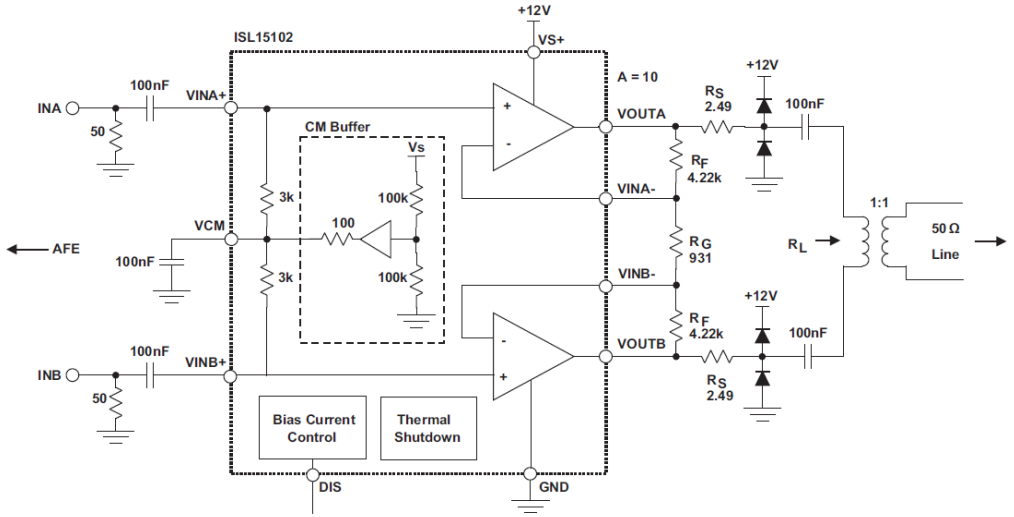
Broad Operating Range

- Single +8V to +28V supply, absolute maximum 30V
- Supports narrowband and broadband DMT PLC

Excellent Safety

- -86dB THD at 200kHz in to 50Ω line load
- -70dB THD at 3MHz in to 50Ω line load
- Thermal shutdown

Part #	Nominal ± V_S [V]	Bandwidth [MHZ]	Applications
ISL15100	±6, +12	180	Broadband PLC
ISL1571		250	
ISL15110		120	MIMO PLC



Typical Application Circuit

PS2561FL – Photocoupler

lead bending type (Gull-wing) for surface mount

High Performance

- Operating ambient temperature: 110°C
- High Isolation voltage (BV = 5 000 Vr.m.s.)
- High collector to emitter voltage (VCEO = 80 V)
- High current transfer ratio (CTR = 450% TYP.)
- High-speed switching (tr = 5 μ s TYP., tf = 7 μ s TYP.)

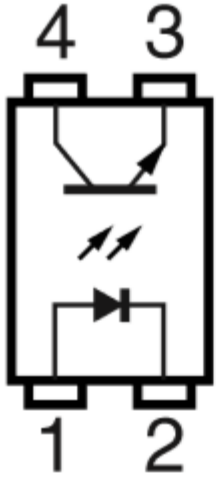
Safety Standards

- UL approved: No. E72422

Part #	Output Current(A)	Safety Standard	Package
PS2561F-1	1	UL approved: No. E72422	4-PIN DIP
PS2561FL-1			4-PIN Gull-wing

PIN CONNECTION

(Top View)



1. Anode
2. Cathode
3. Emitter
4. Collector

Renesas.com