ISL85415EVAL1Z

Wide VIN 500mA Synchronous Buck Regulator

AN1859
Rev 4.00
May 16, 2014

Description

The ISL85415EVAL1Z kit is intended for use for point-of-load applications sourcing from 3V to 36V. The kit is used to demonstrate the performance of the ISL85415 Wide V_{IN} Low Quiescent Current High Efficiency Sync Buck Regulator with 500mA output current.

The ISL85415 is offered in a 4mmx3mm 12 Ld DFN package with 1mm maximum height. The converter occupies 1.516 cm^2 area.

Key Features

- Wide input voltage range 3V to 36V
- Synchronous operation for high efficiency
- No compensation required
- Integrated high-side and low-side NMOS devices
- Selectable PFM or forced PWM mode at light loads
- Internal fixed (500kHz) or adjustable switching frequency 300kHz to 2MHz
- Continuous output current up to 500mA
- Internal or external soft-start
- Minimal external components required
- Power-good and enable functions available

Recommended Equipment

The following materials are recommended to perform testing:

- 0V to 50V Power Supply with at least 2A source current capability
- Electronic loads capable of sinking current up to 1.5A
- Digital multimeters (DMMs)
- 100MHz quad-trace oscilloscope
- Signal generator

Quick Setup Guide

1. Ensure that the circuit is correctly connected to the supply and loads prior to applying any power.
2. Connect the bias supply to VIN, the plus terminal to VIN (P4) and the negative return to GND (P5).
3. Verify that the position is ON for S1.
4. Turn on the power supply.
5. Verify the output voltage is 3.3V for V_{OUT}.

Evaluating the Other Output Voltage

The ISL85415VAL1Z kit output is preset to 3.3V; however, output voltages can be adjusted from 0.6V to 15V. The output voltage programming resistor, R_2, will depend on the desired output voltage of the regulator and the value of the feedback resistor R_1, as shown in Equation 1.

$$R_2 = R_1\left(\frac{0.6}{V_{OUT} - 0.6}\right) \quad \text{(EQ. 1)}$$

If the output voltage desired is 0.6V, then R_1 is shorted. Please note that if V_{OUT} is less than 1.8V, the switching frequency and compensation must be changed for 300kHz operation due to minimum on-time limitation. Please refer to datasheet ISL85415 for further information.

Table 1 on page 2 shows the component selection that should be used for the respective V_{OUTs}.

FIGURE 1. FRONT OF EVALUATION BOARD ISL85415EVAL1Z

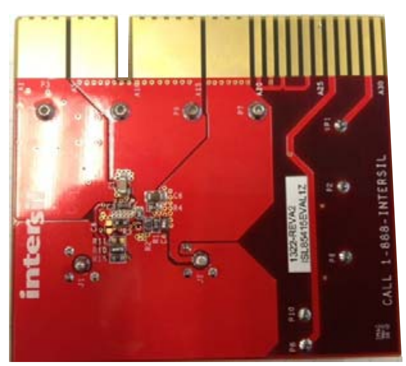


FIGURE 2. BACK OF EVALUATION BOARD ISL85415EVAL1Z

TABLE 1. EXTERNAL COMPONENT SELECTION

V_{OUT} (V)	L_1 (µH)	C_{OUT} (µF)	R_1 (kΩ)	R_2 (kΩ)	C_{FB} (pF)	R_{FS} (kΩ)	R_{COMP} (kΩ)	C_{COMP} (pF)
12	45	10	90.9	4.75	22	115	100	470
5	22	2x22	90.9	12.4	100	120	100	470
3.3	22	2x22	90.9	20	100	120	100	470
2.5	22	2x22	90.9	28.7	100	120	100	470
1.8	22	22	100	50	22	120	50	470

Frequency Control

The ISL85415 has a FS pin that controls the frequency of operation. Programmable frequency allows for optimization between efficiency and external component size. It also allows low frequency operation for low V_{OUTs} when minimum on time would limit the operation otherwise. Default switching frequency is 500kHz when FS is tied to V_{CC} (R_{10} = 0). By removing R_{10} the switching frequency could be changed from 300kHz (R_{12} = 340k) to 2MHz (R_{12} = 32.4k). Please refer to datasheet ISL85415 for calculating the value of R_{10}. Do not leave this pin floating.

Disabling/Enabling Function

The ISL85415 evaluation board contains S1 switch that enables or disables the part, thus allowing low quiescent current state. Table 2 details this function.

TABLE 2. SWITCH SETTINGS

S1	ON/OFF CONTROL
ON	Enable V_{OUT}
OFF	Disable V_{OUT}

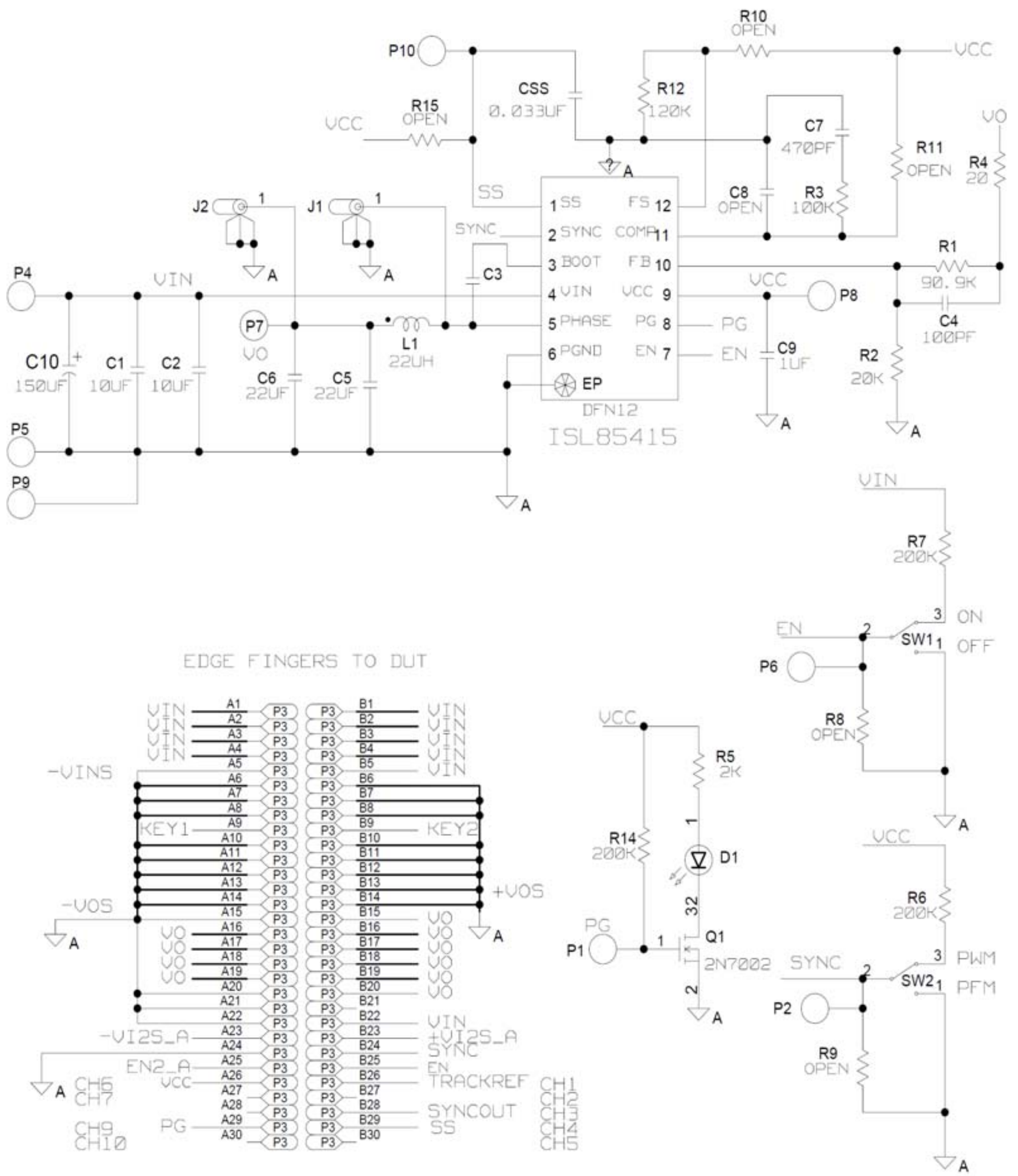
SYNC Control

The ISL85415 evaluation board has a SYNC pin that allows external synchronization frequency to be applied. Default board configuration has R_6 = 200k to V_{CC}, which defaults to PWM operation mode and also to the pre-selected switching frequency set by R_{12} (see ISL85415 datasheet and previous section "Frequency Control" for details). If this pin is tied to GND the IC will operate in PFM mode. S2 switch allows to force the PFM or PWM modes.

Soft-Start /COMP Control

R_{15} selects between internal (R_{15} = 0) and external soft-start. R_{11} selects between internal (R_{11} = 0) and external compensation. Please refer to Pin Description Table of the ISL85415 datasheet.

ISL85415EVAL1Z Schematic



NOTE: The input electrolytic capacitor C10 is optional and it is used to prevent transient voltages when the input test leads have large parasitic inductance. It can be removed if the IC is used in a system application.

ISL85415 Bill of Materials

PART NUMBER	QTY	UNITS	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART
ISL85400EVAL1ZREVAPCB	1	ea	SEE LABEL-RENAME BOARD	PWB-PCB, ISL85400EVAL1Z REVA, ROHS	INTERSIL	ISL85400EVAL1ZREVAPCB
EEE-FK1H151P-T	1	ea	C10	CAP, SMD, 10.3mm, 150µF, 50V, 20%, ROHS, ALUM. ELEC.	PANASONIC	EEE-FK1H151P
H1045-00101-50V5-T	1	ea	C4	CAP, SMD, 0603, 100pF, 50V, 5%, C0G, ROHS	PANASONIC	ECJ-1VC1H101J
H1045-00104-50V10-T	1	ea	C3	CAP, SMD, 0603, 0.1µF, 50V, 10%, X7R, ROHS	AVX	06035C104KAT2A
H1045-00105-16V10-T	1	ea	C9	CAP, SMD, 0603, 1µF, 16V, 10%, X5R, ROHS	MURATA	GRM188R61C105KA12D
H1045-00333-16V10-T	1	ea	CSS	CAP, SMD, 0603, 33000pF, 16V, 10%, X7R, ROHS	VENKEL	C0603X7R160-333KNE
H1045-00471-50V5-T	1	ea	C7	CAP, SMD, 0603, 470pF, 50V, 5%, NP0, ROHS	PANASONIC	ECJ-1VC1H471J
H1045-DNP	0	ea	C8	CAP, SMD, 0603, DNP-PLACE HOLDER, ROHS		
H1065-00106-50V10-T	2	ea	C1, C2	CAP, SMD, 1206, 10µF, 50V, 10%, X5R, ROHS	TDK	C3216X5R1H106K
H1065-00226-6R3V20-T	2	ea	C5, C6	CAP, SMD, 1206, 22µF, 6.3V, 20%, X5R, ROHS	PANASONIC	ECJ-DV50J226M
DR73-220-R	1	ea	L1	COIL-PWR INDUCTOR, SMD, 7.6mm, 22µH, 20%, 1.62A, ROHS	COOPER/ COILTRONICS	DR73-220-R
131-4353-00	2	ea	J1, J2	CONN-SCOPE PROBE TEST PT, COMPACT, PCB MNT, ROHS	TEKTRONIX	131-4353-00
1514-2	4	ea	P4, P5, P7, P9	CONN-TURRET, TERMINAL POST, TH, ROHS	KEYSTONE	1514-2
5002	5	ea	P1, P2, P6, P8, P10	CONN-MINI TEST POINT, VERTICAL, WHITE, ROHS	KEYSTONE	5002
LTST-C190KGKT-T	1	ea	D1	LED, SMD, 0603, GREEN CLEAR, 2V, 20mA, 571nm, 35mcd, ROHS	LITEON/VISHAY	LTST-C190KGKT
ISL85415FRZ for ISL85415EVAL1Z	1	ea	U1	IC-500mA BUCK REGULATOR, 12P, DFN, 3X4, ROHS	INTERSIL	ISL85415FRZ
2N7002LT1G-T	1	ea	Q1	TRANSISTOR-MOS, N-CHANNEL, SMD, SOT23, 60V, 115mA, ROHS	ON SEMICONDUCTOR	2N7002LT1G
H2511-00200-1/10W1-T	1	ea	R4	RES, SMD, 0603, 20Ω, 1/10W, 1%, TF, ROHS	PANASONIC	ERJ-3EKF20R0V

ISL85415 Bill of Materials (Continued)

PART NUMBER	QTY	UNITS	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART
H2511-00R00-1/10W-T	1	ea	R15	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	VENKEL	CR0603-10W-000T
H2511-01003-1/10W1-T	1	ea	R3	RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS	VENKEL	CR0603-10W-1003FT
H2511-01203-1/10W1-T	1	ea	R12	RES, SMD, 0603, 120k, 1/10W, 1%, TF, ROHS	VISHAY/DALE	CRCW0603120KFKEA
H2511-02001-1/10W1-T	1	ea	R5	RES, SMD, 0603, 2k, 1/10W, 1%, TF, ROHS	KOA	RK73H1JTTD2001F
H2511-02002-1/10W1-T	1	ea	R2	RES, SMD, 0603, 20k, 1/10W, 1%, TF, ROHS	VENKEL	CR0603-10W-2002FT
H2511-02003-1/10W1-T	2	ea	R6, R7	RES, SMD, 0603, 200k, 1/10W, 1%, TF, ROHS	VENKEL	CR0603-10W-2003FT
H2511-09092-1/10W1-T	1	ea	R1	RES, SMD, 0603, 90.9k, 1/10W, 1%, TF, ROHS	PANASONIC	ERJ-3EKF9092V
H2511-DNP	0	ea	R8-R11, R14	RES, SMD, 0603, DNP-PLACE HOLDER, ROHS		
GT11MSCBE-T	2	ea	SW1, SW2	SWITCH-TOGGLE, SMD, 6PIN, SPDT, 2POS, ON-ON, ROHS	ITT INDUSTRIES/C&K DIVISION	GT11MSCBE
5X8-STATIC-BAG	1	ea	PLACE ASSY IN BAG	BAG, STATIC, 5X8, ZIPLOC, ROHS	INTERSIL	212403-013
DNP	0	ea	P3 (3VH30/1JN5)	DO NOT POPULATE OR PURCHASE		
LABEL-DATE CODE	1	ea		LABEL-DATE CODE_BOM REV#_SERIAL# LABEL ON ZIL & QUEL	INTERSIL	LABEL-DATE CODE
LABEL-RENAME BOARD	1	ea	RENAME PCB TO: ISL85415EVAL1Z	LABEL, TO RENAME BOARD	INTERSIL	LABEL-RENAME BOARD

ISL85415EVAL1Z Board Layout

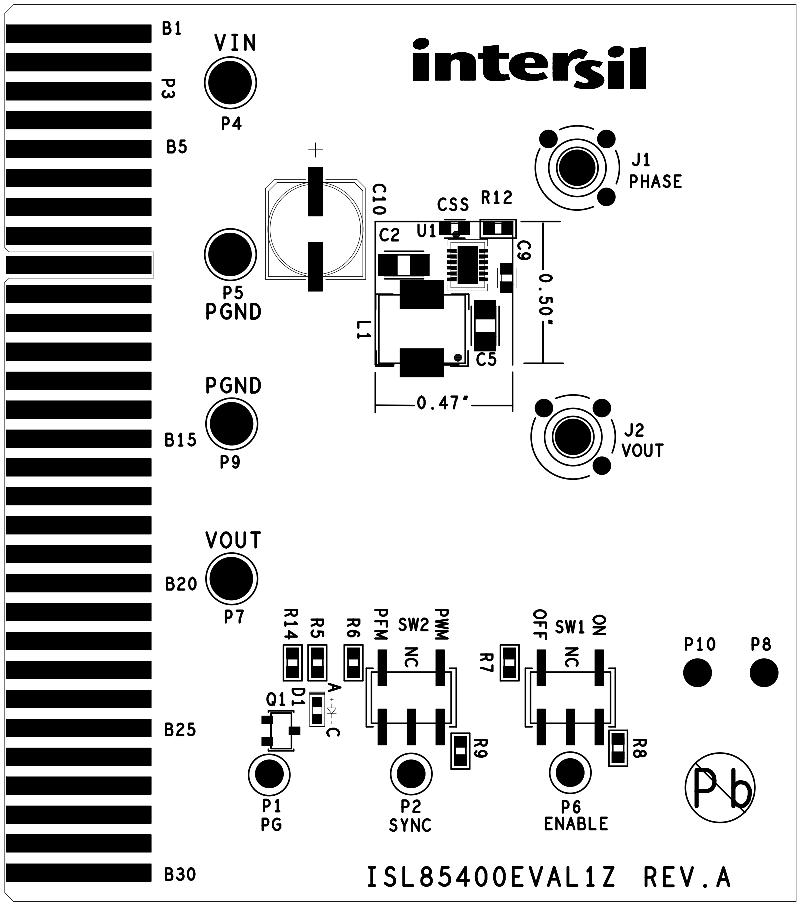


FIGURE 3. SILK SCREEN TOP

ISL85415EVAL1Z Board Layout (Continued)

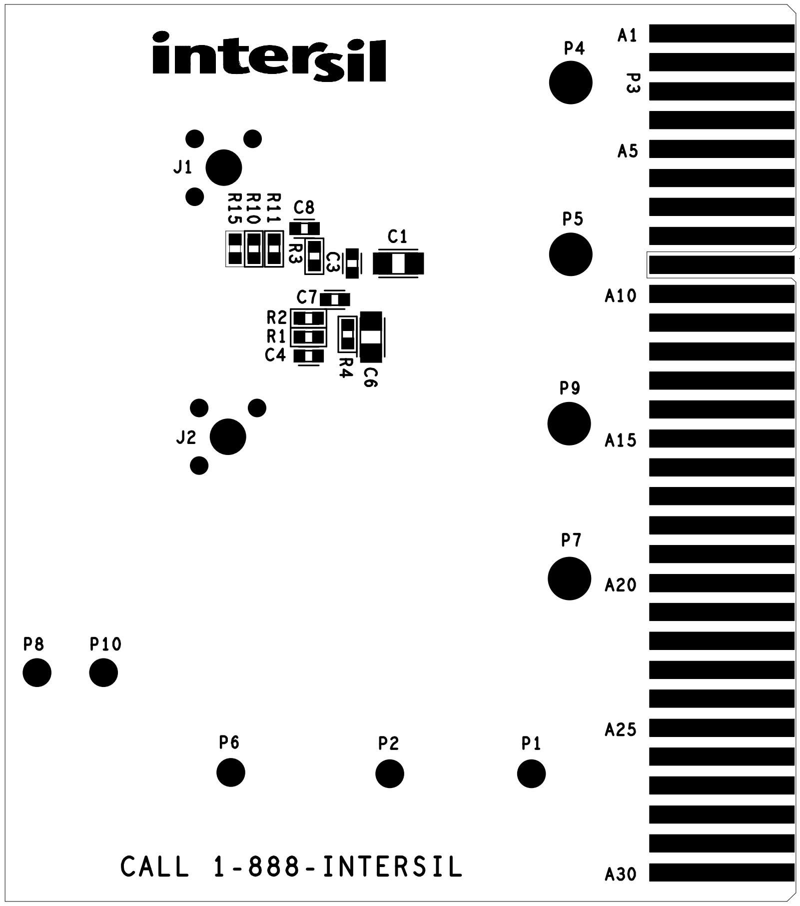


FIGURE 4. SILKSCREEN BOTTOM

Efficiency Curves F_{SW} = 800kHz, T_A = +25°C

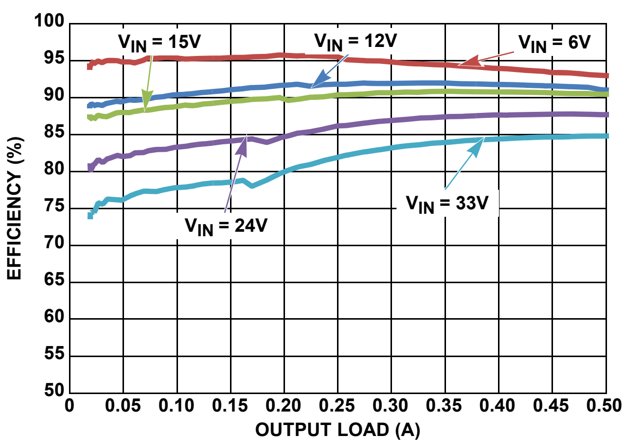


FIGURE 5. EFFICIENCY vs LOAD, PFM, V_{OUT} = 5V

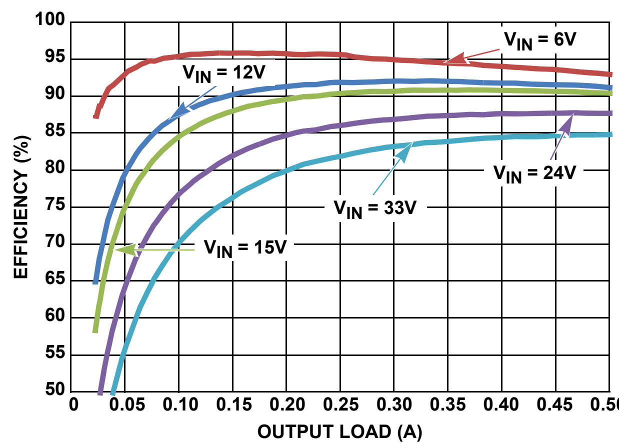


FIGURE 6. EFFICIENCY vs LOAD, PWM, V_{OUT} = 5V

Efficiency Curves F_{SW} = 800kHz, T_A = +25°C (Continued)

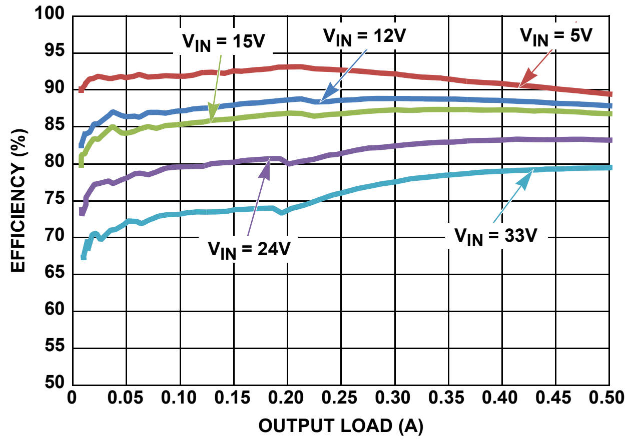


FIGURE 7. EFFICIENCY vs LOAD, PFM, V_{OUT} = 3.3V

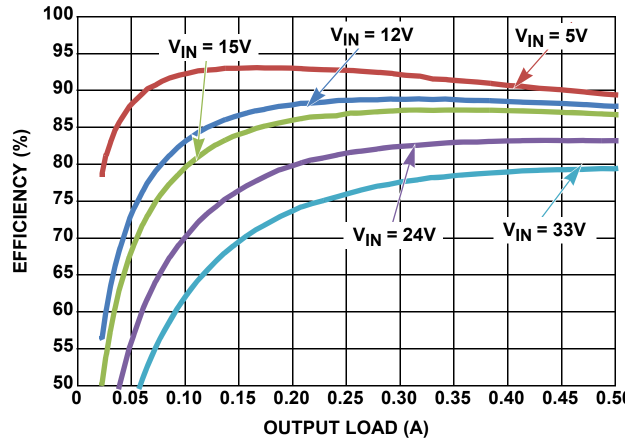


FIGURE 8. EFFICIENCY vs LOAD, PWM, V_{OUT} = 3.3V

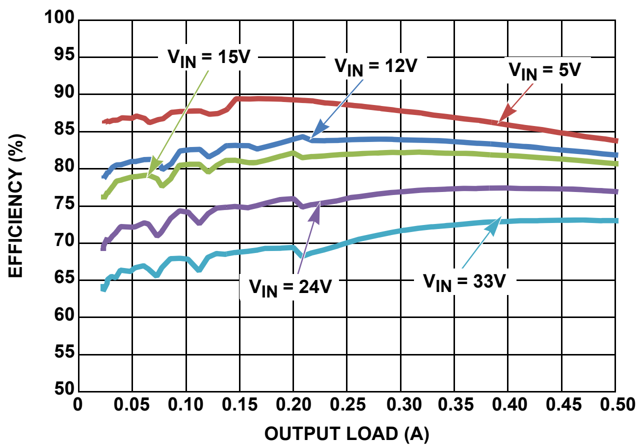


FIGURE 9. EFFICIENCY vs LOAD, PFM, V_{OUT} = 1.8V

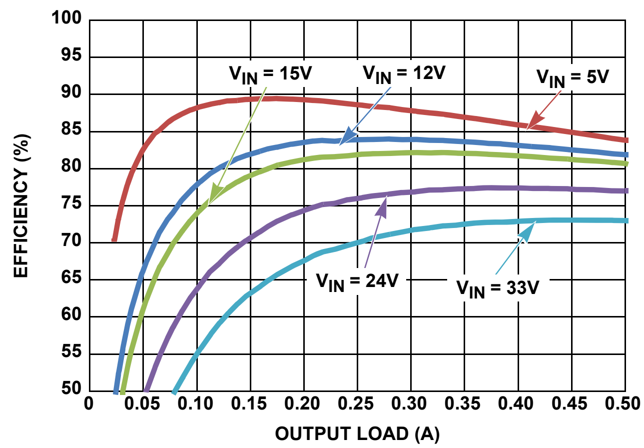


FIGURE 10. EFFICIENCY vs LOAD, PWM, V_{OUT} = 1.8V

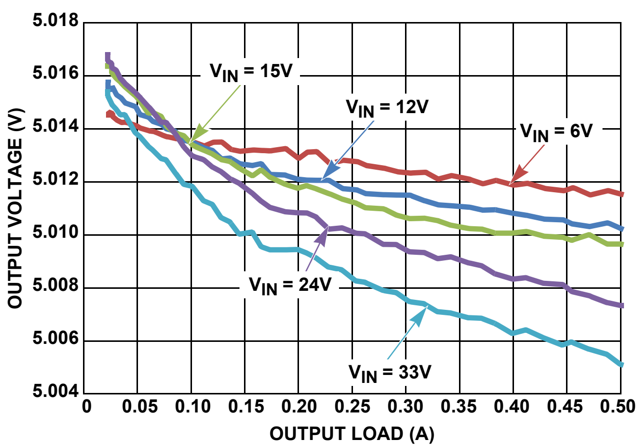


FIGURE 11. V_{OUT} REGULATION vs LOAD, PWM, V_{OUT} = 5V

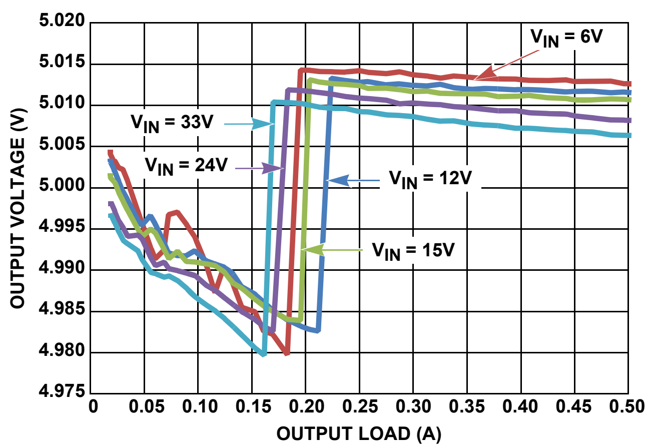


FIGURE 12. V_{OUT} REGULATION vs LOAD, PFM, V_{OUT} = 5V

Efficiency Curves F_{SW} = 800kHz, T_A = +25°C (Continued)

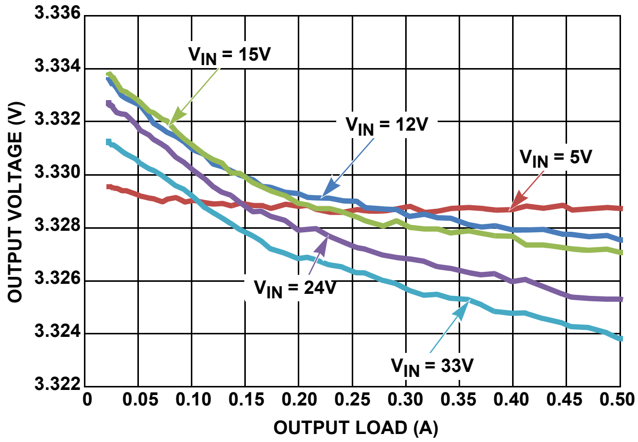


FIGURE 13. V_{OUT} REGULATION vs LOAD, PWM, V_{OUT} = 3.3V

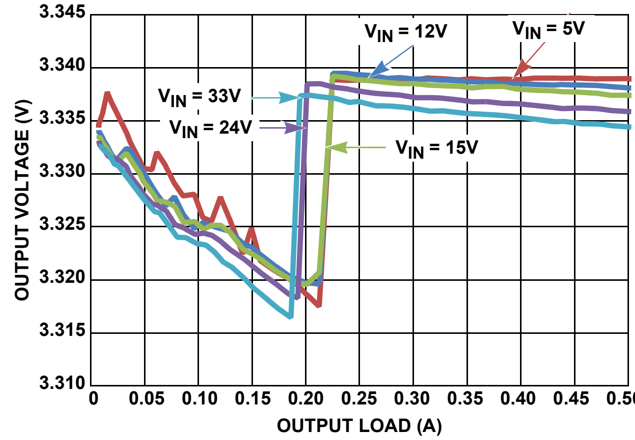


FIGURE 14. V_{OUT} REGULATION vs LOAD, PFM, V_{OUT} = 3.3V

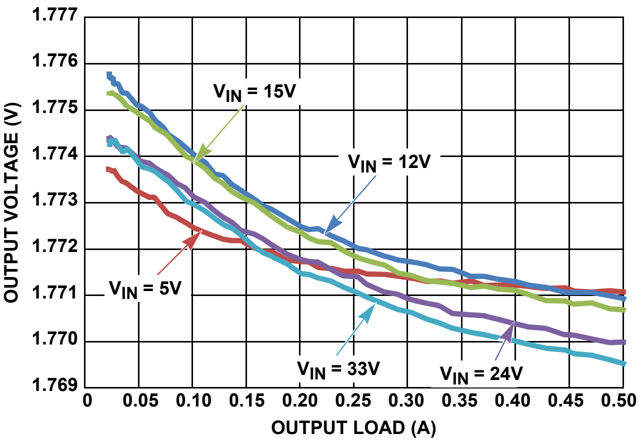


FIGURE 15. V_{OUT} REGULATION vs LOAD, PWM, V_{OUT} = 1.8V

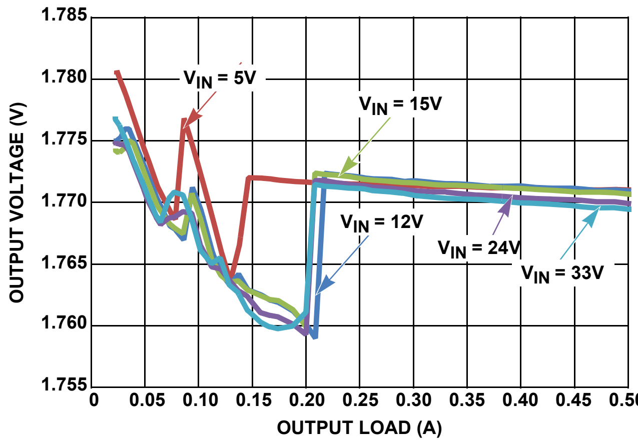


FIGURE 16. V_{OUT} REGULATION vs LOAD, PFM, V_{OUT} = 1.8V

Typical Performance Curves V_{IN} = 24V, V_{OUT} = 3.3V, F_{SW} = 800kHz, T_A = +25°C.

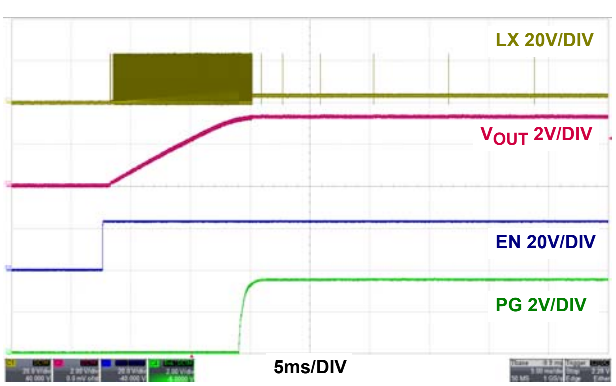


FIGURE 17. START-UP AT NO LOAD, PFM

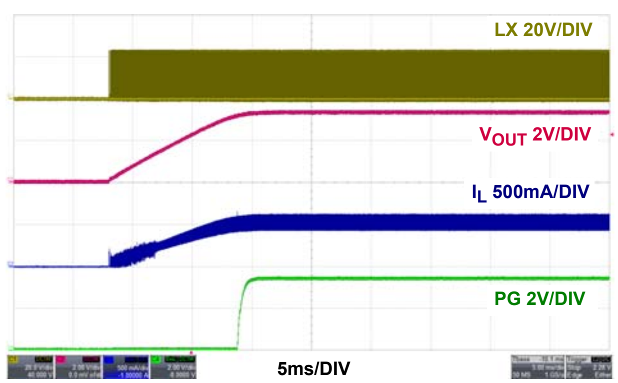


FIGURE 18. START-UP AT 500mA, PWM

Typical Performance Curves V_{IN} = 24V, V_{OUT} = 3.3V, F_{SW} = 800kHz, T_A = +25°C. (Continued)

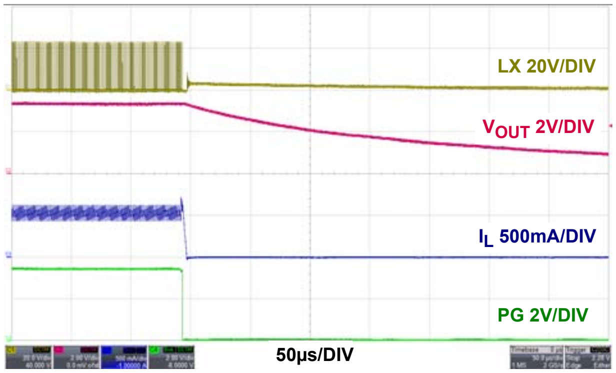


FIGURE 19. SHUTDOWN AT 500mA, PWM

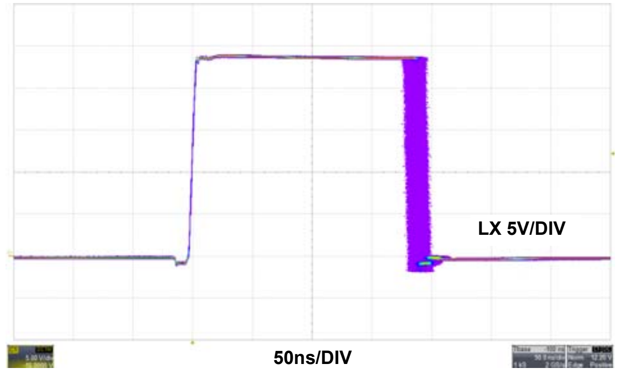


FIGURE 20. JITTER AT 500mA, PWM

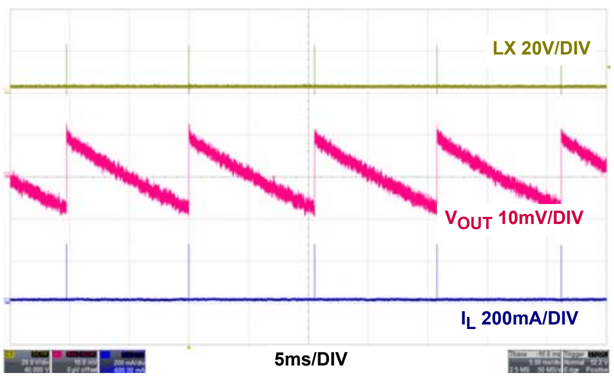


FIGURE 21. STEADY STATE AT NO LOAD, PFM

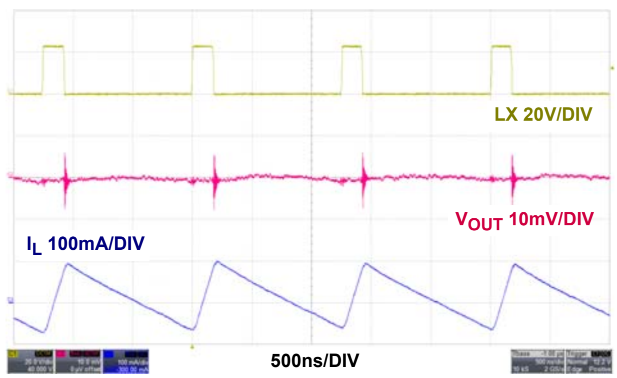


FIGURE 22. STEADY STATE AT NO LOAD, PWM

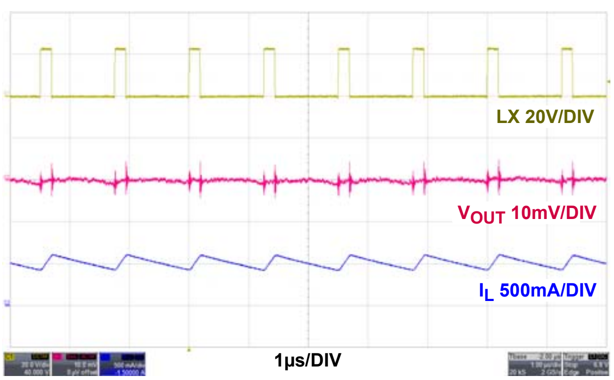


FIGURE 23. STEADY STATE AT 500mA LOAD, PWM

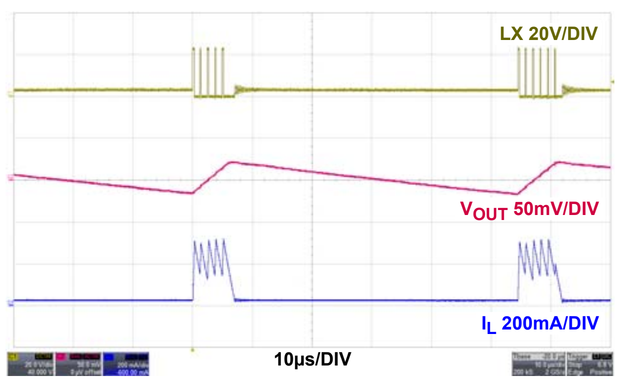


FIGURE 24. LIGHT LOAD OPERATION AT 20mA, PFM

Typical Performance Curves V_{IN} = 24V, V_{OUT} = 3.3V, F_{SW} = 800kHz, T_A = +25°C. (Continued)

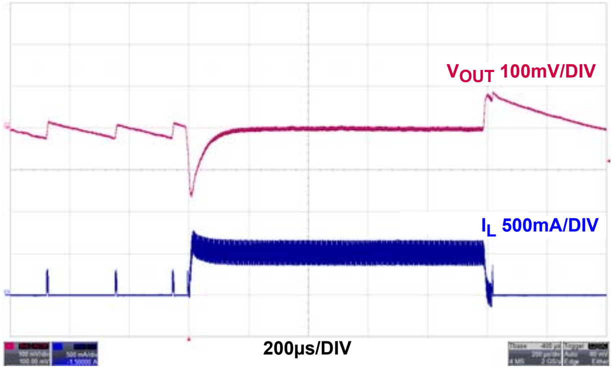


FIGURE 25. LOAD TRANSIENT, PFM

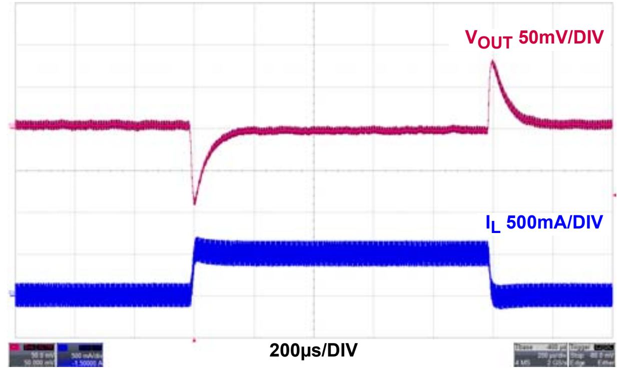


FIGURE 26. LOAD TRANSIENT, PWM

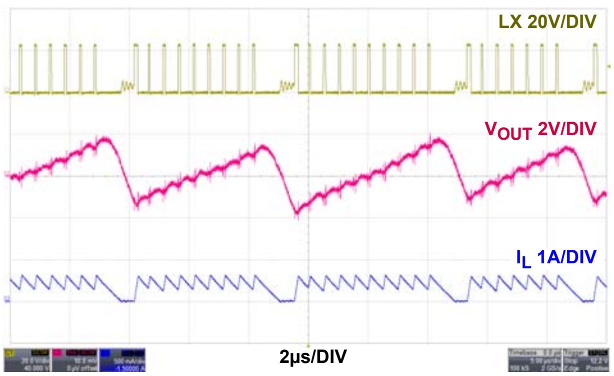


FIGURE 27. PFM TO PWM TRANSITION

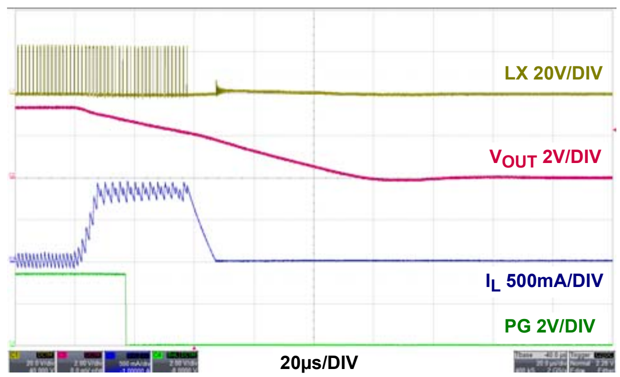


FIGURE 28. OVERCURRENT PROTECTION, PWM

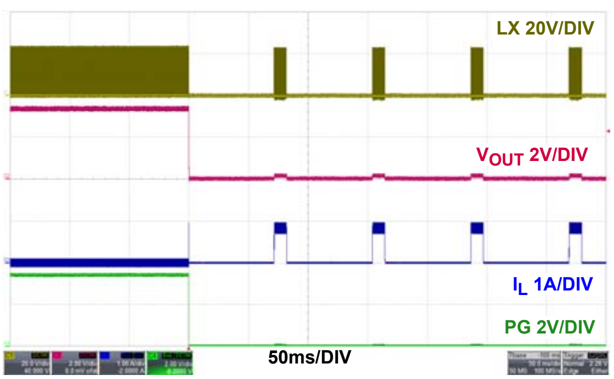


FIGURE 29. OVERCURRENT PROTECTION HICCUP, PWM

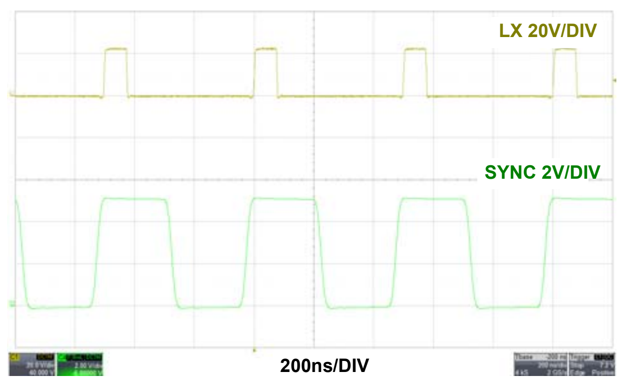


FIGURE 30. SYNC AT 500mA LOAD, PWM

Typical Performance Curves V_{IN} = 24V, V_{OUT} = 3.3V, F_{SW} = 800kHz, T_A = +25°C. (Continued)

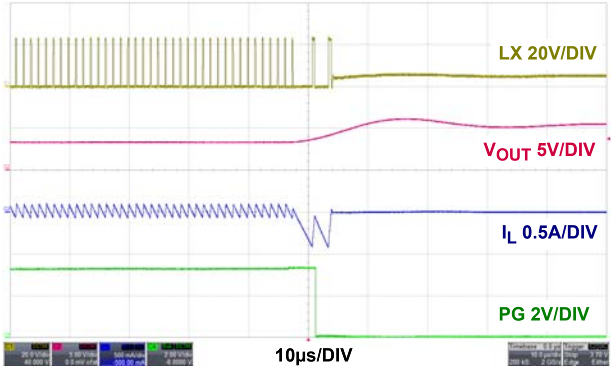


FIGURE 31. NEGATIVE CURRENT LIMIT, PWM

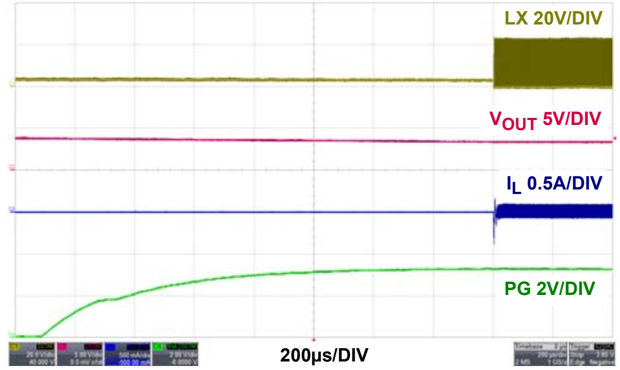


FIGURE 32. NEGATIVE CURRENT LIMIT RECOVERY, PWM

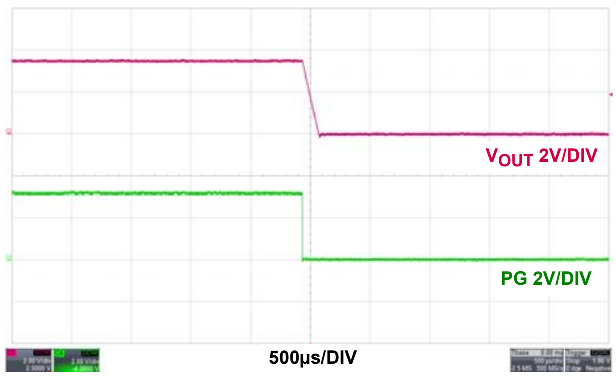


FIGURE 33. OVER-TEMPERATURE PROTECTION, PWM

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

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

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

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

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 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. 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 P. R. 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, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700, Fax: +91-80-67208777

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

Colophon 7.0