ISL8117A-LDEMO2Z

Demonstration Board

UG102
Rev.0.00
January 30, 2017

Description

The ISL8117A-LDEMO2Z (shown in Figure 4 on page 4) features the ISL8117A. The ISL8117A is a 60V high-voltage, synchronous buck controller that offers external soft-start, independent enable functions, and integrates UV/OV/OC/OT protection. Its current mode control architecture and internal compensation network keep peripheral component count minimal. Programmable switching frequency ranging from 100kHz to 2MHz helps to optimize inductor size, while the strong gate driver delivers up to 30A for the buck output.

Specifications

The board is designed for wide-input voltage applications. The current rating of the ISL8117A-LDEMO2Z buck-boost board is limited by the FETs and inductor selected. The electrical ratings of the Board are shown in Table 1.

TABLE 1. ELECTRICAL RATINGS

PARAMETER	RATING
Input Voltage	6.5V to 42V
Switching Frequency	200kHz
Output Voltage	12V
Output Current	3A
Output Voltage Ripple	$100mV_{P-P}$

Key Features

- Small, compact design
- Wide input range: 6.5V to 42V
- Programmable soft-start
- Supports prebias output with SR soft-start
- External frequency sync
- PGOOD indicator
- OCP, OVP, OTP, UVP protection

Related Literature

- For a full list of related documents, visit our website
  - ISL8117A product page

Ordering Information

PART NUMBER	DESCRIPTION
ISL8117A-LDEMO2Z Buck-Boost Board	High voltage PWM step-down synchronous buck converter

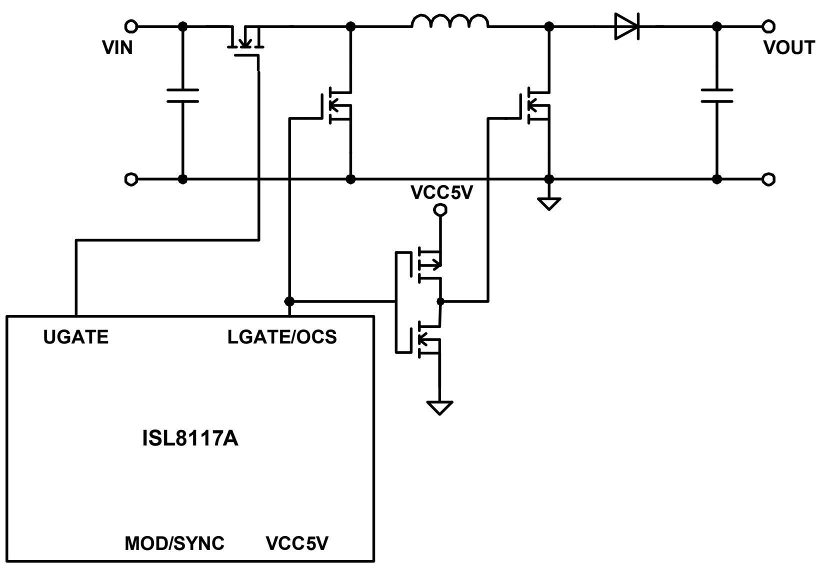

FIGURE 1. BLOCK DIAGRAM

Recommended Testing Equipment

The following materials are recommended to perform testing:

- 0V to 42V power supply with at least 10A source current capability
- Electronic loads capable of sinking current up to 10A
- Digital Multimeters (DMMs)
- 100MHz quad-trace oscilloscope

Quick Test Guide

1. Ensure that the circuit is correctly connected to the supply and electronic loads prior to applying any power. Refer to Figure 3 on page 3 for proper setup.
2. Turn on the power supply.
3. Adjust input voltage V_{IN} within the specified range and observe output voltage. The output voltage variation should be within 5%.
4. Adjust load current within the specified range and observe output voltage. The output voltage variation should be within 5%.
5. Use an oscilloscope to observe output voltage ripple and phase node ringing. For accurate measurement, refer to Figure 2 for proper test setup.

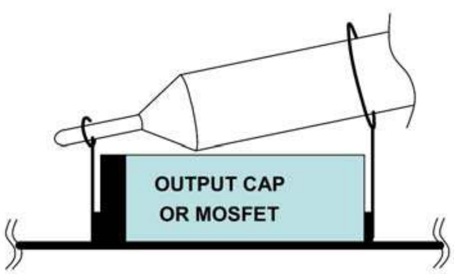

FIGURE 2. PROPER PROBE SETUP TO MEASURE OUTPUT RIPPLE AND PHASE NODE RINGING

Functional Description

The ISL8117A-LDEMO2Z buck-boost board is a compact design with high efficiency and high-power density.

As shown in Figure 3, 6.5V to 42V V_{IN} is supplied to J1 (+) and J2 (-). The regulated 12V output on J3 (+) and J4 (-) can supply up to 3A to the load.

Operating Range

The input voltage range is from 6.5V to 42V for an output voltage of 12V. The rated load current is 3A with the OCP point set at minimum 5A at room temperature ambient conditions.

The temperature operating range of ISL8117A is -40°C to +125°C. Note that airflow is needed for higher temperature ambient conditions.

Evaluating the Other Output Voltages

The ISL8117A-LDEMO2Z buck-boost board output is preset to 12V, however, the output can be adjusted. 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.

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

PCB Layout Guidelines

Careful attention to layout requirements is necessary for successful implementation of an ISL8117A-LDEMO2Z based DC/DC converter. The ISL8117A switches at a high frequency and therefore, the switching times are very short. At these switching frequencies, even the shortest trace has significant impedance.

Also, the peak gate drive current rises significantly in an extremely short time. Transition speed of the current from one device to another causes voltage spikes across the interconnecting impedances and parasitic circuit elements. These voltage spikes can degrade efficiency, generate EMI, and increase device overvoltage stress and ringing. Careful component selection and proper PC board layout minimizes the magnitude of these voltage spikes.

There are three sets of critical components in a DC/DC converter using the ISL8117A:

1. The controller
2. The switching power components
3. The small signal components.

The switching power components are the most critical from a layout point of view because they switch a large amount of energy, which tends to generate a large amount of noise. The critical small signal components are those connected to sensitive nodes or those supplying critical bias currents. A multilayer printed circuit board is recommended.

Layout Considerations

1. The input capacitors, upper FET, lower FET, inductor, and output capacitor should be placed first. Isolate these power components on dedicated areas of the board with their ground terminals adjacent to one another. Place the input high-frequency, decoupling ceramic capacitors very close to the MOSFETs.
2. If signal components and the IC are placed in a separate area to the power train, it is recommended to use full ground planes in the internal layers with shared SGND and PGND to simplify the layout design. Otherwise, use separate ground planes for power ground and small signal ground. Connect the SGND and PGND together close to the IC. DO NOT connect them together anywhere else.
3. The loop formed by the input capacitors and the FET must be kept as small as possible.

4. Ensure the current paths from the input capacitor to the MOSFET, to the output inductor, and the output capacitor are as short as possible with maximum allowable trace widths.
5. Place the PWM controller IC close to the lower FET. The LGATE connection should be short and wide. The IC can be best placed over a quiet ground area. Avoid switching ground loop currents in this area.
6. Place VCC5V bypass capacitor very close to the VCC5V pin of the IC and connect its ground to the PGND plane.
7. Place the gate drive components (optional BOOT diode and BOOT capacitors) together near the controller IC.
8. The output capacitors should be placed as close to the load as possible. Use short, wide copper regions to connect output capacitors to load, to avoid inductance and resistances.
9. Use copper filled polygons or wide, but short trace to connect the junction of the FET and output inductor. Also keep the PHASE node connection to the IC short. DO NOT unnecessarily oversize the copper islands for the PHASE node. Since the phase nodes are subjected to very high dv/dt voltages, the stray capacitor formed between these islands and the surrounding circuitry will tend to couple switching noise.
10. Route all high-speed switching nodes away from the control circuitry.
11. Create a separate small analog ground plane near the IC. Connect the SGND pin to this plane. All small signal grounding paths including feedback resistors, current limit setting resistor, soft-starting capacitor, and EN pull-down resistor should be connected to this SGND plane.
12. Separate the current-sensing trace from the PHASE node connection.
13. Ensure the feedback connection to the output capacitor is short and direct.
14. Properly using via array and copper to improve the heat dissipating capacity of the PCB.

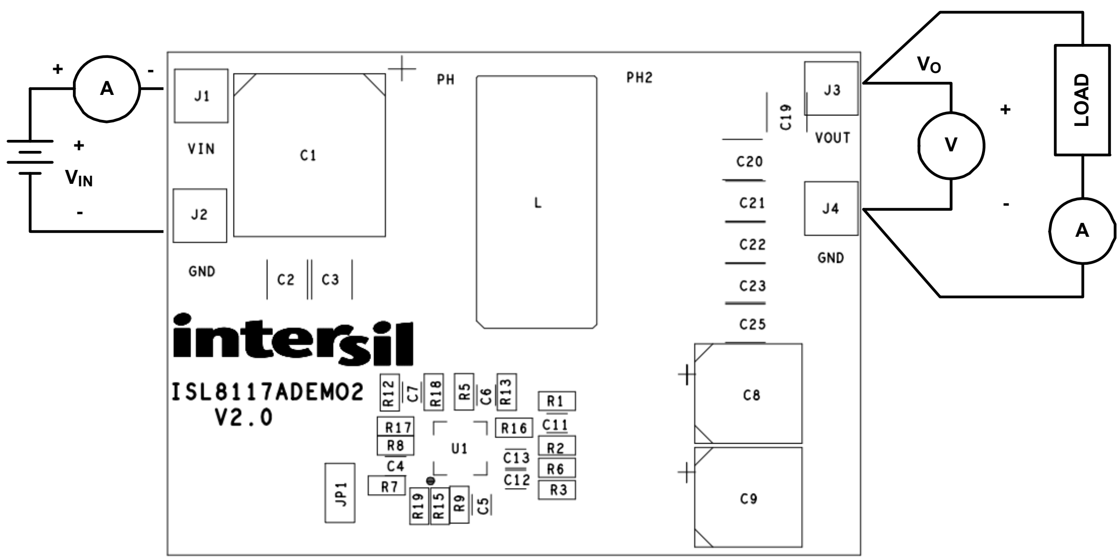

FIGURE 3. PROPER TEST SETUP

ISL8117A-LDEMO2Z Buck-Boost Board

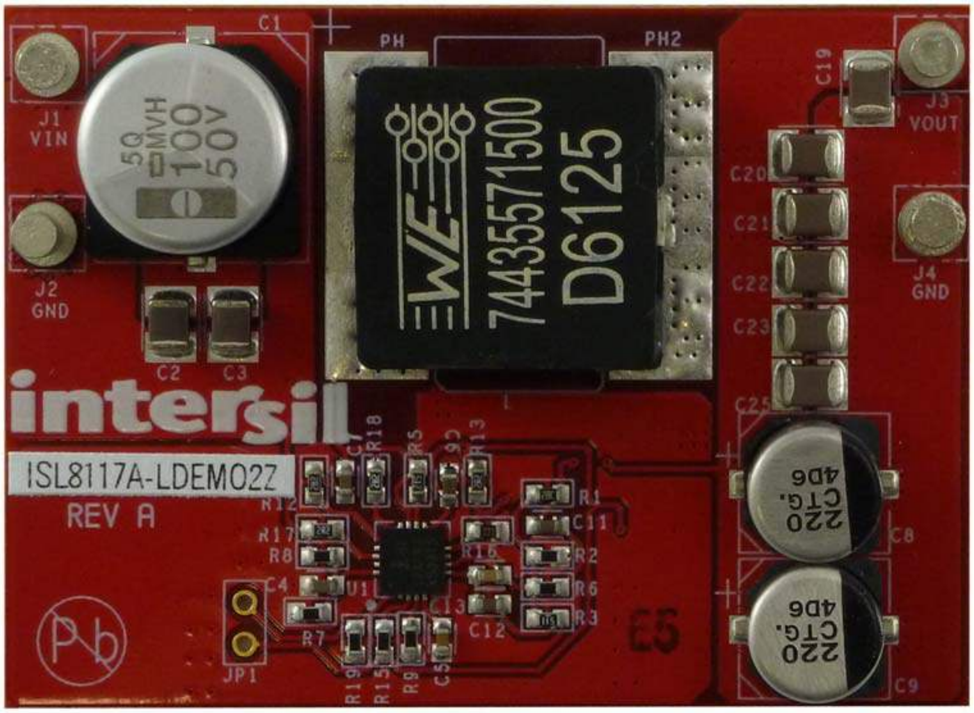

FIGURE 4. TOP VIEW

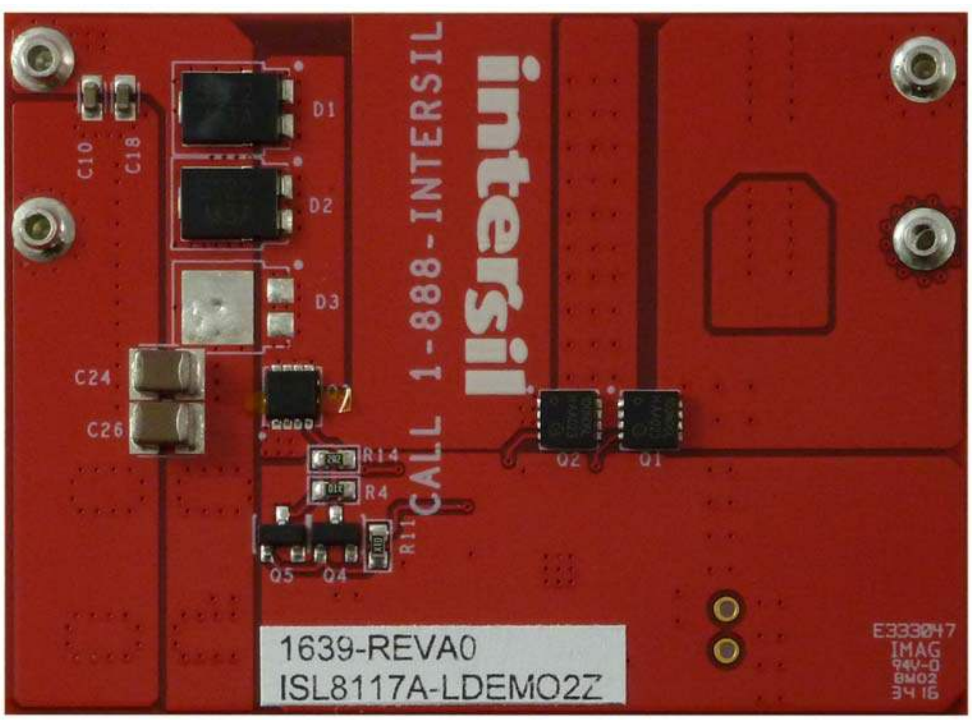

FIGURE 5. BOTTOM VIEW

ISL8117A-LDEMO2Z Schematic

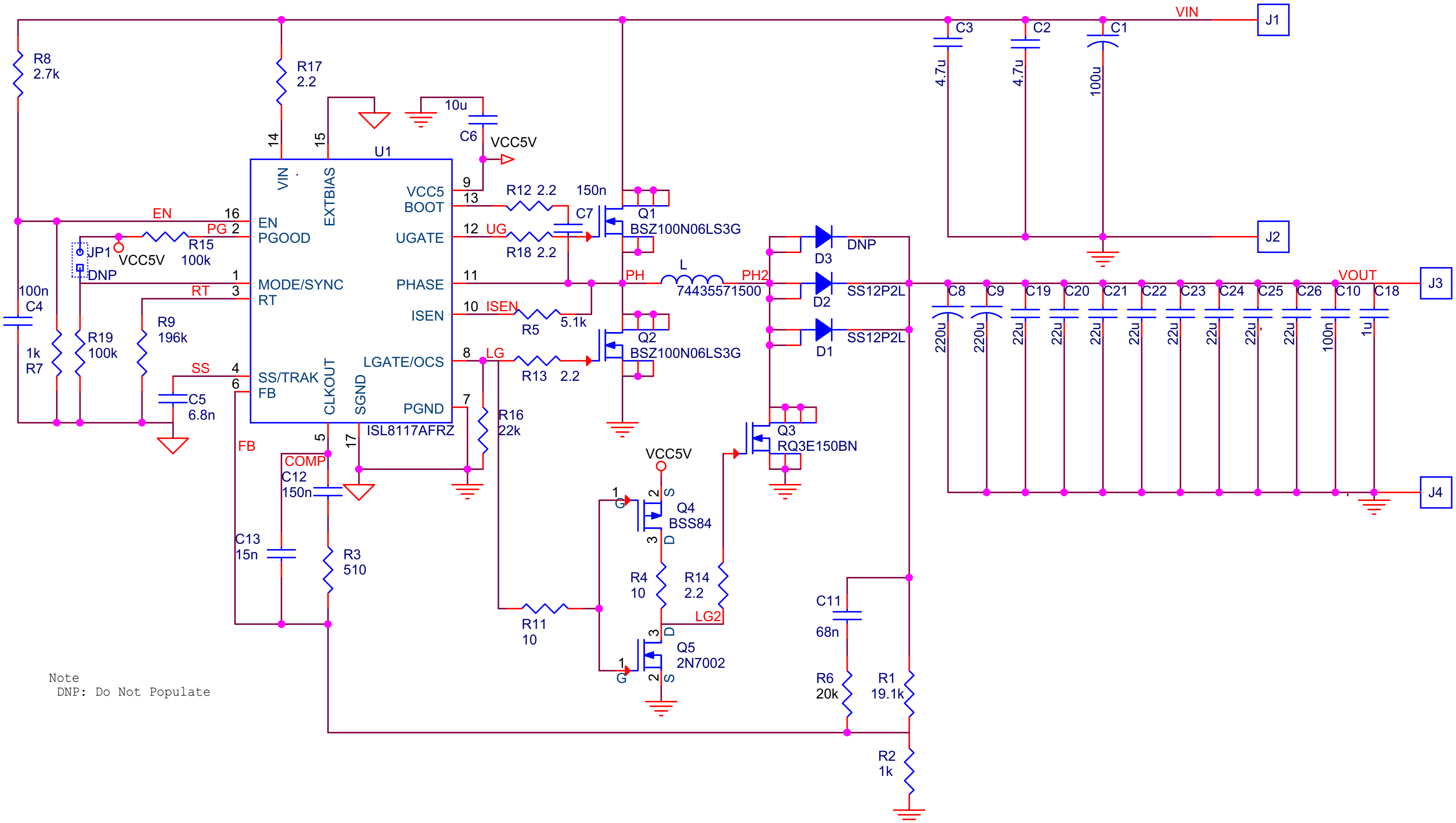

FIGURE 6. ISL8117A-LDEMO2Z SCHEMATIC

ISL8117A-LDEMO2Z Bill of Materials

PART NUMBER	QTY	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
CGA6N3X7S1H475K230AE-T	2	C2, C3	CAP-AEC-Q200, SMD, 1210, 4.7µF, 50V, 10%, X7S, ROHS	TDK
H1045-00104-25V10-T	2	C4, C10	CAP, SMD, 0603, 0.1µF, 25V, 10%, X7R, ROHS	MURATA
H1045-00105-25V10-T	1	C18	CAP, SMD, 0603, 1µF, 25V, 10%, X5R, ROHS	MURATA
H1045-00106-10V20-T	1	C6	CAP, SMD, 0603, 10µF, 10V, 20%, X5R, ROHS	MURATA
H1045-00153-50V10-T	1	C13	CAP, SMD, 0603, 0.015µF, 50V, 10%, X7R, ROHS	PANASONIC
H1045-00154-25V10-T	2	C7, C12	CAP, SMD, 0603, 0.15µF, 25V, 10%, X7R, ROHS	VENKEL
H1045-00682-50V10-T	1	C5	CAP, SMD, 0603, 6800pF, 50V, 10%, X7R, ROHS	AVX
H1045-00683-50V10-T	1	C11	CAP, SMD, 0603, 0.068µF, 50V, 10%, X7R, ROHS	MURATA
H1082-00226-16V10-T	8	C19-C26	CAP, SMD, 1210, 22µF, 16V, 10%, X7R, ROHS	MURATA
74435571500	1	L	COIL-PWR INDUCTOR, 15µH, 14A, 9mohm, SMD, 18.3, x9.1, WW, ROHS	WURTH ELEKTRONIK
EEE-TG1C221UP-T	2	C8, C9	CAP, SMD, 8X10.2, 220µF, 16V, 20%, ALUM.ELEC., ROHS	PANASONIC
EMVH500ARA101MKE0S-T	1	C1	CAP, SMD, 12.5X13.5, 100µF, 50V, 20%, ALUM.ELEC., ROHS	UNITED CHEMI-CON
1514-2	4	J1, J2, J3, J4	CONN-TURRET, TERMINAL POST, TH, ROHS	KEYSTONE
SS12P2L-M3/86A-T	2	D1, D2	DIODE-SCHOTTKY RECTIFER, SMD, TO277A, 20V, 12A, ROHS	VISHAY
ISL8117AFRZ	1	U1	IC-55V SWITCHING CONTROLLER, 16P, QFN, ROHS	INTERSIL
2N7002-7-F-T	1	Q5	TRANSISTOR, N-CHANNEL, 3LD, SOT-23, 60V, 115mA, ROHS	DIODES, INC.
BSS84TA-T	1	Q4	TRANSISTOR, P-CHANNEL, 3LD, SOT-23, 50V, MOS	FAIRCHILD
BSZ100N06LS3G-T	2	Q1, Q2	TRANSIST-MOS, N-CHANNEL, 8P, PG-TSDSON-8, 60V, 20A, ROHS	INFINEON TECHNOLOGY
RQ3E150BNTB-T	1	Q3	TRANSISTOR-FET, N-CHANNEL, 30V, 15A, SMD, 8-PWRVDFN, ROHS	ROHM
H2511-00100-1/10W1-T	2	R4, R11	RES, SMD, 0603, 10Ω, 1/10W, 1%, TF, ROHS	KOA
H2511-002R2-1/10W1-T	5	R12, R13, R14, R17, R18	RES, SMD, 0603, 2.2Ω, 1/10W, 1%, TF, ROHS	PANASONIC
H2511-01001-1/10W1-T	2	R2, R7	RES, SMD, 0603, 1k, 1/10W, 1%, TF, ROHS	PANASONIC
H2511-01003-1/10W1-T	1	R15, R19	RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS	VENKEL
H2511-01912-1/10W1-T	1	R1	RES, SMD, 0603, 19.1k, 1/10W, 1%, TF, ROHS	PANASONIC
H2511-01963-1/10W1-T	1	R9	RES, SMD, 0603, 196k, 1/10W, 1%, TF, ROHS	PANASONIC
H2511-02002-1/10W1-T	1	R6	RES, SMD, 0603, 20k, 1/10W, 1%, TF, ROHS	VENKEL
H2511-02202-1/10W1-T	1	R16	RES, SMD, 0603, 22k, 1/10W, 1%, TF, ROHS	VENKEL
H2511-02701-1/10W1-T	1	R8	RES, SMD, 0603, 2.7k, 1/10W, 1%, TF, ROHS	VENKEL
H2511-05100-1/10W1-T	1	R3	RES, SMD, 0603, 510Ω, 1/10W, 1%, TF, ROHS	VENKEL
H2511-05101-1/10W1-T	1	R5	RES, SMD, 0603, 5.1k, 1/10W, 1%, TF, ROHS	VENKEL
DNP	0	D3	DO NOT POPULATE OR PURCHASE	
DNP	0	JP1	DO NOT POPULATE OR PURCHASE	

PCB Layout

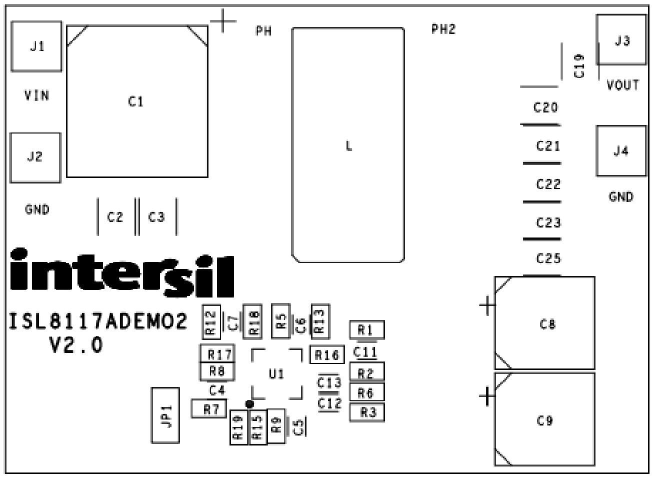

FIGURE 7. ASSEMBLY TOP

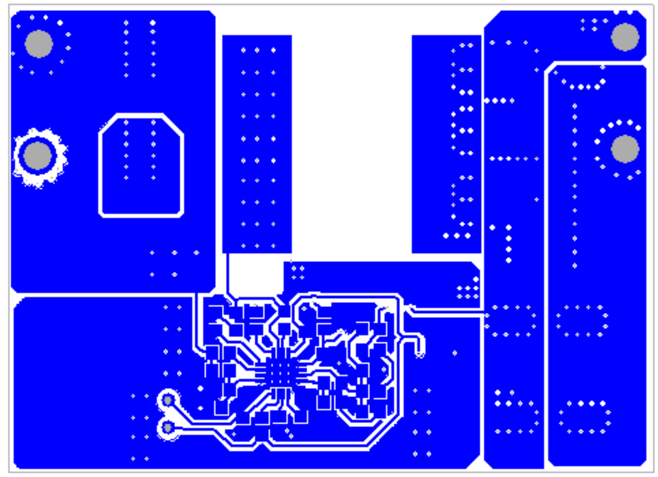

FIGURE 8. LAYER 1 - TOP

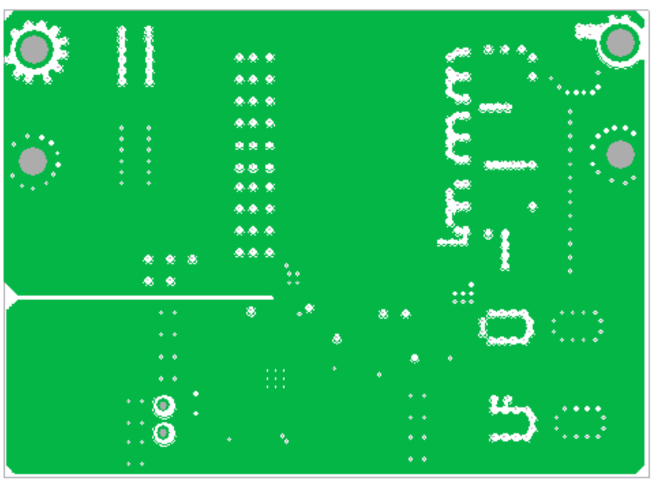

FIGURE 9. LAYER 2 (SOLID GROUND)

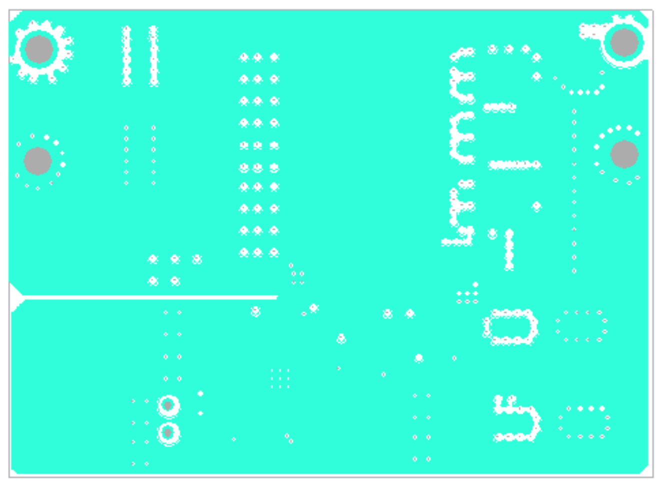

FIGURE 10. LAYER 3

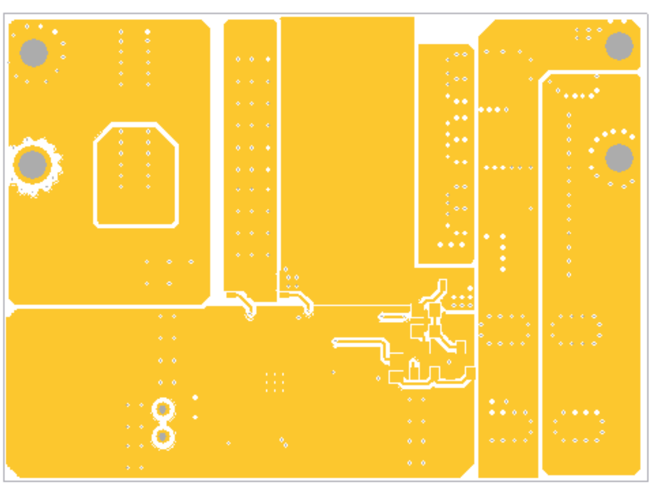

FIGURE 11. LAYER 4 -BOTTOM

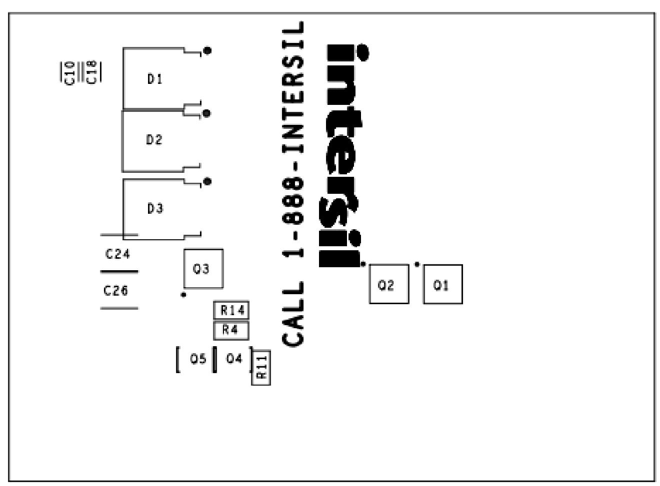

FIGURE 12. ASSEMBLY BOTTOM

Typical Evaluation Board Performance Curves

V_{IN} = 24V, V_{OUT} = 12V, unless otherwise noted.

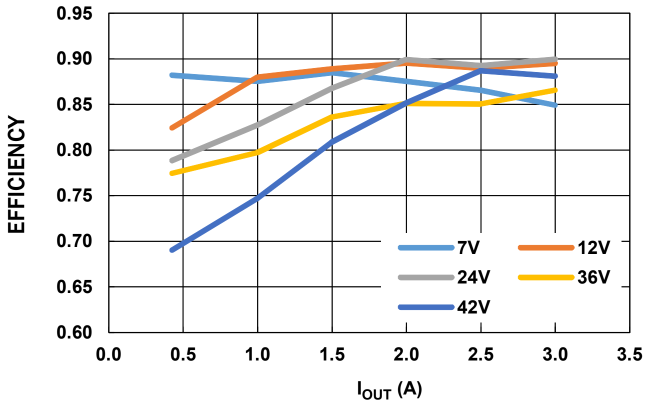

FIGURE 13. EFFICIENCY

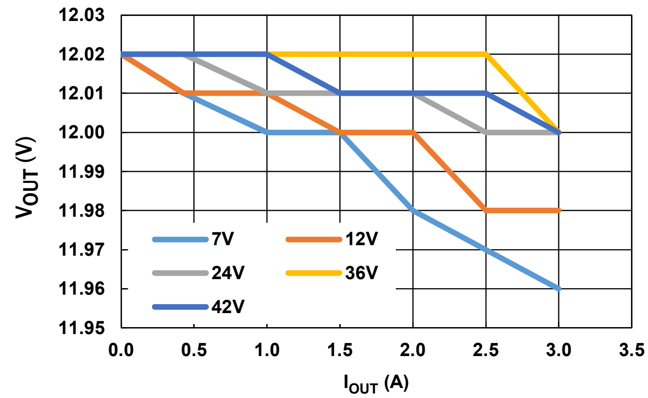

FIGURE 14. LOAD REGULATION

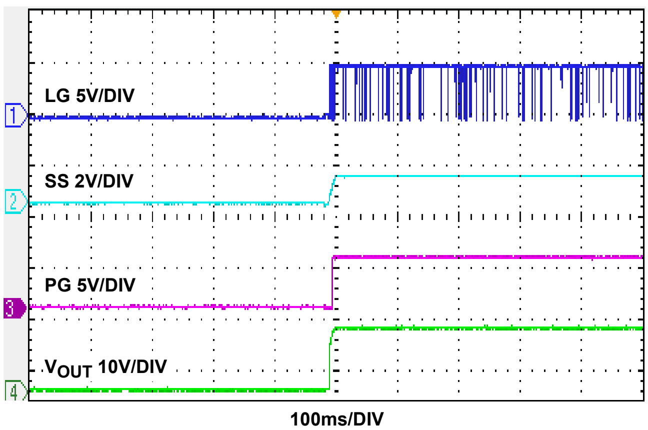

FIGURE 15. START-UP WAVEFORMS, I_O = 0A

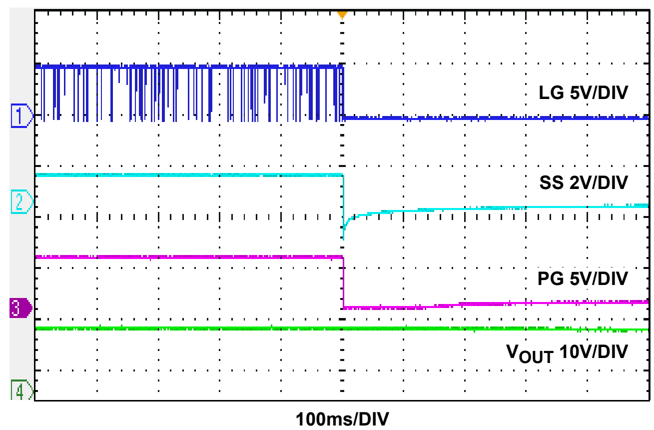

FIGURE 16. SHUT-DOWN WAVEFORMS, I_O = 0A

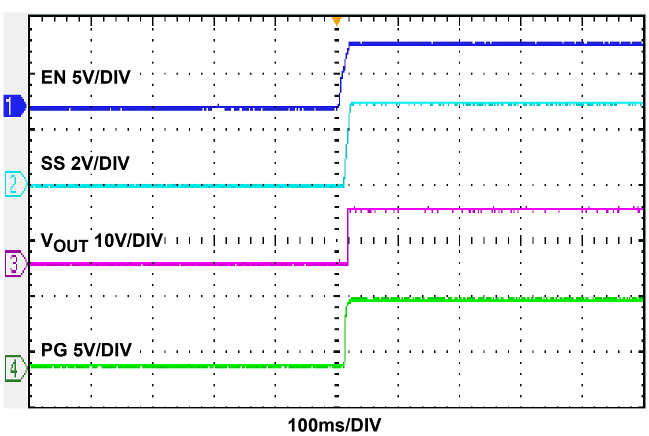

FIGURE 17. START-UP WAVEFORMS, I_O = 0A

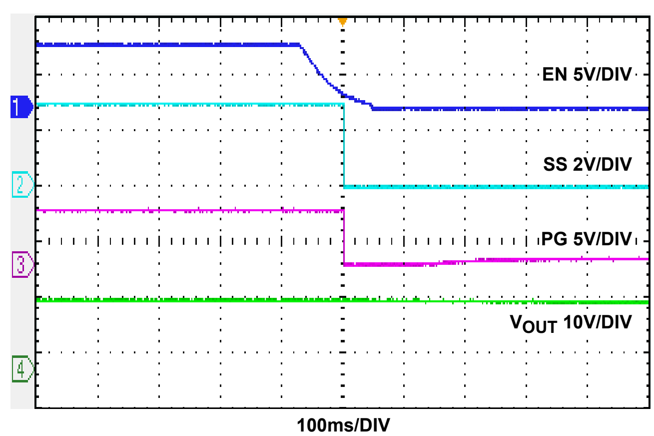

FIGURE 18. SHUT-DOWN WAVEFORMS, I_O = 0A

Typical Evaluation Board Performance Curves (Continued)

V_{IN} = 24V, V_{OUT} = 12V, unless otherwise noted.

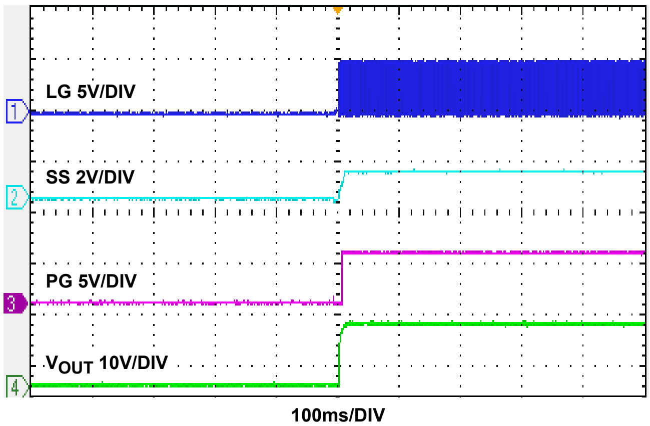

FIGURE 19. START-UP WAVEFORMS, I_O = 3A

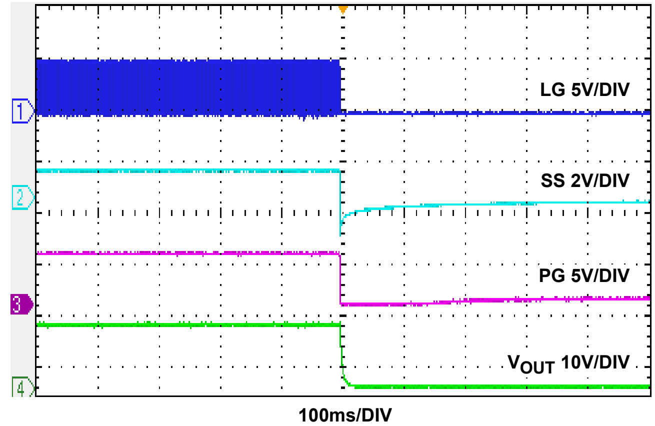

FIGURE 20. SHUT-DOWN WAVEFORMS, I_O = 3A

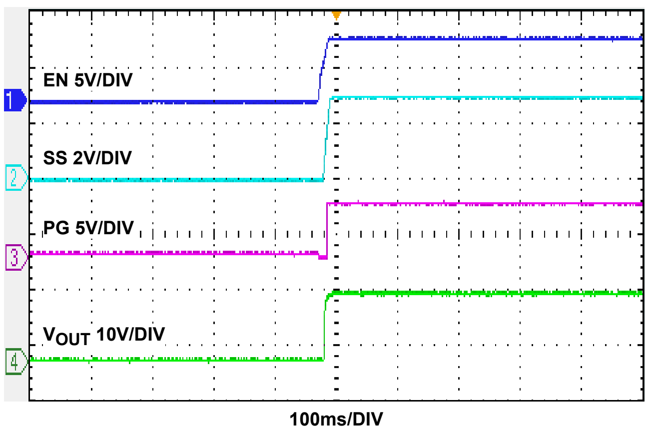

FIGURE 21. START-UP WAVEFORMS, I_O = 3A

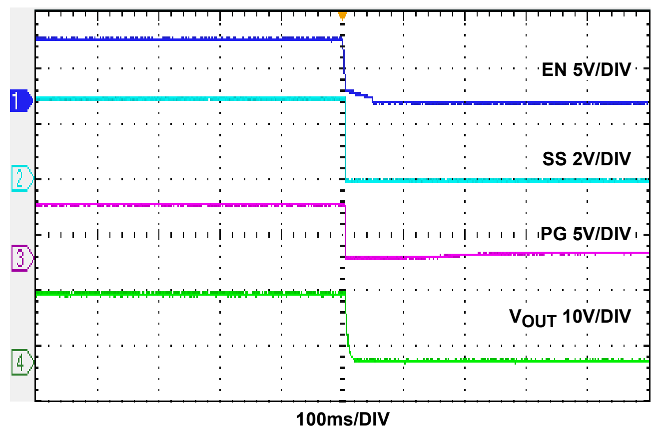

FIGURE 22. SHUT-DOWN WAVEFORMS, I_O = 3A

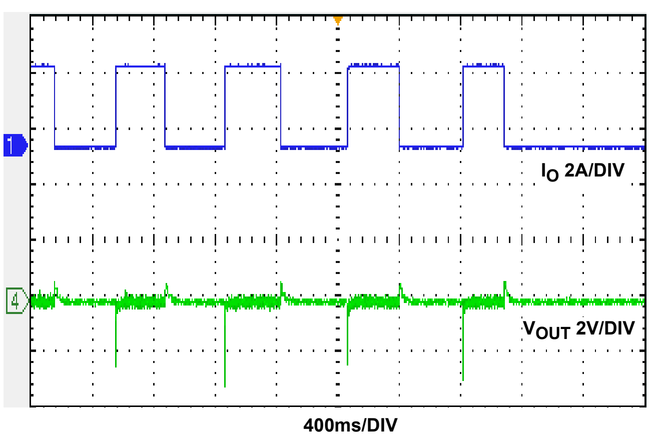

FIGURE 23. LOAD TRANSIENT, I_O = 0A TO 3A

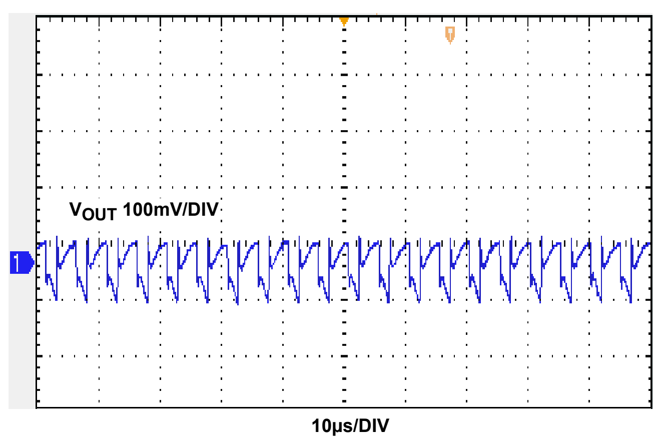

FIGURE 24. OUTPUT RIPPLE, I_O = 3A

Typical Evaluation Board Performance Curves (Continued)

V_{IN} = 24V, V_{OUT} = 12V, unless otherwise noted.

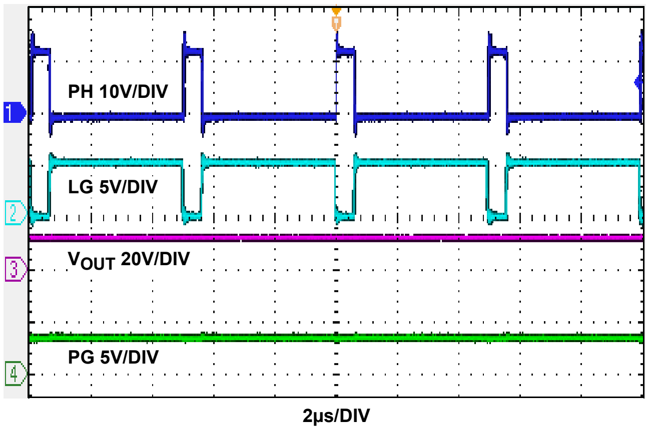

FIGURE 25. PHASE, LGATE, V_{OUT} AND PG WAVEFORMS; V_{IN} = 12V, I_O = 0A

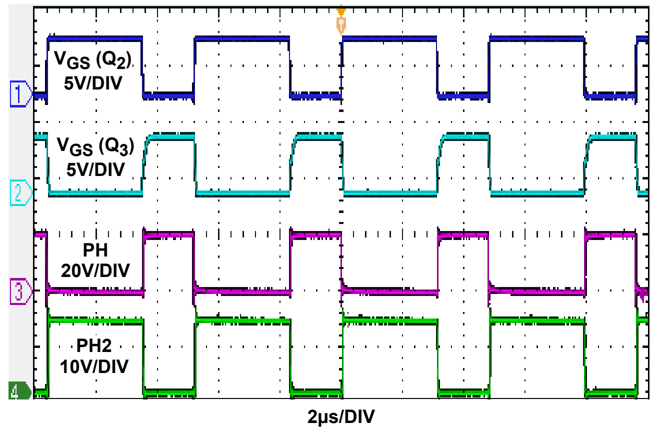

FIGURE 26. DRIVER SIGNAL OF Q_2, Q_3, PH AND PH2 WAVEFORMS; V_{IN} = 24V, I_O = 3A

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