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4/3/2/1-Phase PWM Controller for High-Density Power Supply

General Description

The RT8841 is a 4/3/2/1-phase synchronous buck controller with 2 integrated MOSFET drivers for VR11 CPU power application. RT8841 uses differential inductor DCR current sense to achieve phase current balance and active voltage positioning. Other features include adjustable operating frequency, adjustable soft start, power good indication, external error-amp compensation, over voltage protection, over current protection and enable/shutdown for various applications. RT8841 comes to a small footprint with WQFN-40L 6x6 package.

Applications

- Desktop CPU Core Power
- Low Voltage, High Current DC/ DC Converter

Ordering Information

RT8841□ □

- Package Type
  QW : WQFN-40L 6X6 (W-Type)
  (Exposed Pad-Option 1)
- Lead Plating System
  P : Pb Free
  G : Green (Halogen Free and Pb Free)

Note :

Richtek products are :

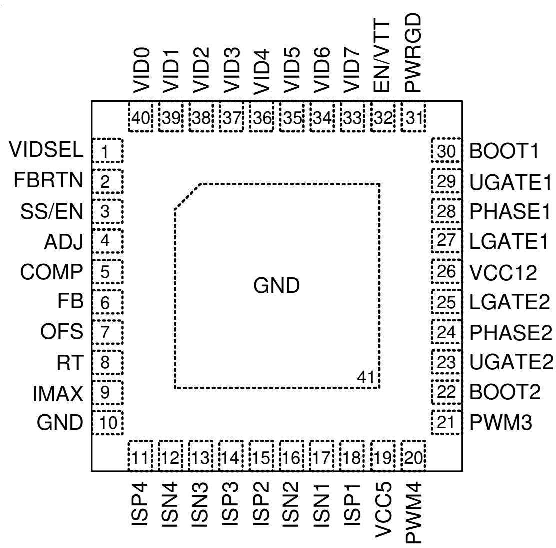
- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes.

Features

- **12V Power Supply Voltage**
- **4/3/2/1-Phase Power Conversion**
- **2 Embedded MOSFET Drivers**
- **Internal Regulated 5V Output**
- **VID Tables for Intel VRD11/VRD10.x and AMD K8, K8_M2 CPUs**
- **Continuous Differential Inductor DCR Current Sense**
- **Adjustable Soft Start**
- **Adjustable Frequency**
- **Power Good Indication**
- **Adjustable Over Current Protection**
- **Over Voltage Protection**
- **Small 40-Lead WQFN Package**
- **RoHS Compliant and 100% Lead(Pb)-Free**

Pin Configurations

(TOP VIEW)



WQFN-40L 6x6

Typical Application Circuit

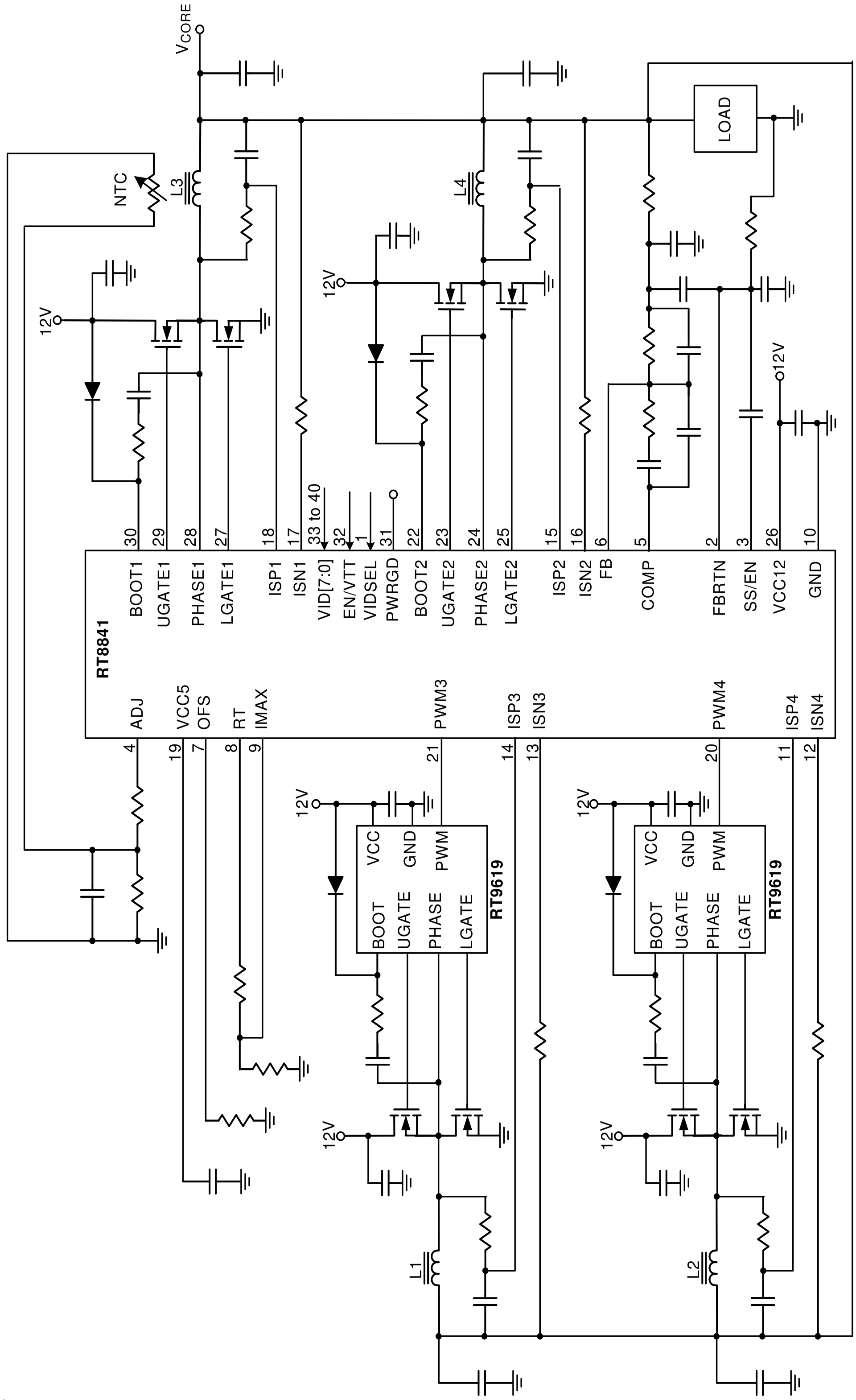


Table 1. Output Voltage Program (VRD10.x + VID6)

Pin Name							Nominal Output Voltage DACOUT
VID4	VID3	VID2	VID1	VID0	VID5	VID6	
0	1	0	1	0	1	1	1.60000V
0	1	0	1	0	1	0	1.59375V
0	1	0	1	1	0	1	1.58750V
0	1	0	1	1	0	0	1.58125V
0	1	0	1	1	1	1	1.57500V
0	1	0	1	1	1	0	1.56875V
0	1	1	0	0	0	1	1.56250V
0	1	1	0	0	0	0	1.55625V
0	1	1	0	0	1	1	1.55000V
0	1	1	0	0	1	0	1.54375V
0	1	1	0	1	0	1	1.53750V
0	1	1	0	1	0	0	1.53125V
0	1	1	0	1	1	1	1.52500V
0	1	1	0	1	1	0	1.51875V
0	1	1	1	0	0	1	1.51250V
0	1	1	1	0	0	0	1.50625V
0	1	1	1	0	1	1	1.50000V
0	1	1	1	0	1	0	1.49375V
0	1	1	1	1	0	1	1.48750V
0	1	1	1	1	0	0	1.48125V
0	1	1	1	1	1	1	1.47500V
0	1	1	1	1	1	0	1.46875V
1	0	0	0	0	0	1	1.46250V
1	0	0	0	0	0	0	1.45625V
1	0	0	0	0	1	1	1.45000V
1	0	0	0	0	1	0	1.44375V
1	0	0	0	1	0	1	1.43750V
1	0	0	0	1	0	0	1.43125V
1	0	0	0	1	1	1	1.42500V
1	0	0	0	1	1	0	1.41875V
1	0	0	1	0	0	1	1.41250V
1	0	0	1	0	0	0	1.40625V
1	0	0	1	0	1	1	1.40000V
1	0	0	1	0	1	0	1.39375V
1	0	0	1	1	0	1	1.38750V
1	0	0	1	1	0	0	1.38125V
1	0	0	1	1	1	1	1.37500V
1	0	0	1	1	1	0	1.36875V
1	0	1	0	0	0	1	1.36250V

Table 1. Output Voltage Program (VRD10.x + VID6)

Pin Name							Nominal Output Voltage DACOUT
VID4	VID3	VID2	VID1	VID0	VID5	VID6	
1	0	1	0	0	0	0	1.35625V
1	0	1	0	0	1	1	1.35000V
1	0	1	0	0	1	0	1.34375V
1	0	1	0	1	0	1	1.33750V
1	0	1	0	1	0	0	1.33125V
1	0	1	0	1	1	1	1.32500V
1	0	1	0	1	1	0	1.31875V
1	0	1	1	0	0	1	1.31250V
1	0	1	1	0	0	0	1.30625V
1	0	1	1	0	1	1	1.30000V
1	0	1	1	0	1	0	1.29375V
1	0	1	1	1	0	1	1.28750V
1	0	1	1	1	0	0	1.28125V
1	0	1	1	1	1	1	1.27500V
1	0	1	1	1	1	0	1.26875V
1	1	0	0	0	0	1	1.26250V
1	1	0	0	0	0	0	1.25625V
1	1	0	0	0	1	1	1.25000V
1	1	0	0	0	1	0	1.24375V
1	1	0	0	1	0	1	1.23750V
1	1	0	0	1	0	0	1.23125V
1	1	0	0	1	1	1	1.22500V
1	1	0	0	1	1	0	1.21875V
1	1	0	1	0	0	1	1.21250V
1	1	0	1	0	0	0	1.20625V
1	1	0	1	0	1	1	1.20000V
1	1	0	1	0	1	0	1.19375V
1	1	0	1	1	0	1	1.18750V
1	1	0	1	1	0	0	1.18125V
1	1	0	1	1	1	1	1.17500V
1	1	0	1	1	1	0	1.16875V
1	1	1	0	0	0	1	1.16250V
1	1	1	0	0	0	0	1,15625V
1	1	1	0	0	1	1	1.15000V
1	1	1	0	0	1	0	1.14375V
1	1	1	0	1	0	1	1.13750V
1	1	1	0	1	0	0	1.13125V
1	1	1	0	1	1	1	1.12500V
1	1	1	0	1	1	0	1.11875V

Table 1. Output Voltage Program (VRD10.x + VID6)

Pin Name							Nominal Output Voltage DACOUT
VID4	VID3	VID2	VID1	VID0	VID5	VID6	
1	1	1	1	0	0	1	1.11250V
1	1	1	1	0	0	0	1.10625V
1	1	1	1	0	1	1	1.10000V
1	1	1	1	0	1	0	1.09375V
1	1	1	1	1	0	1	OFF
1	1	1	1	1	0	0	OFF
1	1	1	1	1	1	1	OFF
1	1	1	1	1	1	0	OFF
0	0	0	0	0	0	1	1.08750V
0	0	0	0	0	0	0	1.08125V
0	0	0	0	0	1	1	1.07500V
0	0	0	0	0	1	0	1.06875V
0	0	0	0	1	0	1	1.06250V
0	0	0	0	1	0	0	1.05625V
0	0	0	0	1	1	1	1.05000V
0	0	0	0	1	1	0	1.04375V
0	0	0	1	0	0	1	1.03750V
0	0	0	1	0	0	0	1.03125V
0	0	0	1	0	1	1	1.02500V
0	0	0	1	0	1	0	1.01875V
0	0	0	1	1	0	1	1.01250V
0	0	0	1	1	0	0	1.00625V
0	0	0	1	1	1	1	1.00000V
0	0	0	1	1	1	0	0.99375V
0	0	1	0	0	0	1	0.98750V
0	0	1	0	0	0	0	0.98125V
0	0	1	0	0	1	1	0.97500V
0	0	1	0	0	1	0	0.96875V
0	0	1	0	1	0	1	0.96250V
0	0	1	0	1	0	0	0.95625V
0	0	1	0	1	1	1	0.95000V
0	0	1	0	1	1	0	0.94375V
0	0	1	1	0	0	1	0.93750V
0	0	1	1	0	0	0	0.93125V
0	0	1	1	0	1	1	0.92500V
0	0	1	1	0	1	0	0.91875V
0	0	1	1	1	0	1	0.91250V
0	0	1	1	1	0	0	0.90625V
0	0	1	1	1	1	1	0.90000V

Table 1. Output Voltage Program (VRD10.x + VID6)

Pin Name							Nominal Output Voltage DACOUT
VID4	VID3	VID2	VID1	VID0	VID5	VID6	
0	0	1	1	1	1	0	0.89375V
0	1	0	0	0	0	1	0.88750V
0	1	0	0	0	0	0	0.88125V
0	1	0	0	0	1	1	0.87500V
0	1	0	0	0	1	0	0.86875V
0	1	0	0	1	0	1	0.86250V
0	1	0	0	1	0	0	0.85625V
0	1	0	0	1	1	1	0.85000V
0	1	0	0	1	1	0	0.84375V
0	1	0	1	0	0	1	0.83750V
0	1	0	1	0	0	0	0.83125V

Note: (1) 0 : Connected to GND
(2) 1 : Open

Table 2. Output Voltage Program (VRD11)

Pin Name								Nominal Output Voltage
VID7	VID6	VID5	VID4	VID3	VID2	VID1	VID0	DACOUT
0	0	0	0	0	0	0	0	OFF
0	0	0	0	0	0	0	1	OFF
0	0	0	0	0	0	1	0	1.60000V
0	0	0	0	0	0	1	1	1.59375V
0	0	0	0	0	1	0	0	1.58750V
0	0	0	0	0	1	0	1	1.58125V
0	0	0	0	0	1	1	0	1.57500V
0	0	0	0	0	1	1	1	1.56875V
0	0	0	0	1	0	0	0	1.56250V
0	0	0	0	1	0	0	1	1.55625V
0	0	0	0	1	0	1	0	1.55000V
0	0	0	0	1	0	1	1	1.54375V
0	0	0	0	1	1	0	0	1.53750V
0	0	0	0	1	1	0	1	1.53125V
0	0	0	0	1	1	1	0	1.52500V
0	0	0	0	1	1	1	1	1.51875V
0	0	0	1	0	0	0	0	1.51250V
0	0	0	1	0	0	0	1	1.50625V
0	0	0	1	0	0	1	0	1.50000V
0	0	0	1	0	0	1	1	1.49375V
0	0	0	1	0	1	0	0	1.48750V
0	0	0	1	0	1	0	1	1.48125V
0	0	0	1	0	1	1	0	1.47500V
0	0	0	1	0	1	1	1	1.46875V
0	0	0	1	1	0	0	0	1.46250V
0	0	0	1	1	0	0	1	1.45625V
0	0	0	1	1	0	1	0	1.45000V
0	0	0	1	1	0	1	1	1.44375V
0	0	0	1	1	1	0	0	1.43750V
0	0	0	1	1	1	0	1	1.43125V
0	0	0	1	1	1	1	0	1.42500V
0	0	0	1	1	1	1	1	1.41875V
0	0	1	0	0	0	0	0	1.41250V
0	0	1	0	0	0	0	1	1.40625V
0	0	1	0	0	0	1	0	1.40000V
0	0	1	0	0	0	1	1	1.39375V
0	0	1	0	0	1	0	0	1.38750V
0	0	1	0	0	1	0	1	1.38125V
0	0	1	0	0	1	1	0	1.37500V
0	0	1	0	0	1	1	1	1.36875V

Table 2. Output Voltage Program (VRD11)

Pin Name								Nominal Output Voltage
VID7	VID6	VID5	VID4	VID3	VID2	VID1	VID0	DACOUT
0	0	1	0	1	0	0	0	1.36250V
0	0	1	0	1	0	0	1	1.35625V
0	0	1	0	1	0	1	0	1.35000V
0	0	1	0	1	0	1	1	1.34375V
0	0	1	0	1	1	0	0	1.33750V
0	0	1	0	1	1	0	1	1.33125V
0	0	1	0	1	1	1	0	1.32500V
0	0	1	0	1	1	1	1	1.31875V
0	0	1	1	0	0	0	0	1.31250V
0	0	1	1	0	0	0	1	1.30625V
0	0	1	1	0	0	1	0	1.30000V
0	0	1	1	0	0	1	1	1.29375V
0	0	1	1	0	1	0	0	1.28750V
0	0	1	1	0	1	0	1	1.28125V
0	0	1	1	0	1	1	0	1.27500V
0	0	1	1	0	1	1	1	1.26875V
0	0	1	1	1	0	0	0	1.26250V
0	0	1	1	1	0	0	1	1.25625V
0	0	1	1	1	0	1	0	1.25000V
0	0	1	1	1	0	1	1	1.24375V
0	0	1	1	1	1	0	0	1.23750V
0	0	1	1	1	1	0	1	1.23125V
0	0	1	1	1	1	1	0	1.22500V
0	0	1	1	1	1	1	1	1.21875V
0	1	0	0	0	0	0	0	1.21250V
0	1	0	0	0	0	0	1	1.20625V
0	1	0	0	0	0	1	0	1.20000V
0	1	0	0	0	0	1	1	1.19375V
0	1	0	0	0	1	0	0	1.18750V
0	1	0	0	0	1	0	1	1.18125V
0	1	0	0	0	1	1	0	1.17500V
0	1	0	0	0	1	1	1	1.16875V
0	1	0	0	1	0	0	0	1.16250V
0	1	0	0	1	0	0	1	1.15625V
0	1	0	0	1	0	1	0	1.15000V
0	1	0	0	1	0	1	1	1.14375V
0	1	0	0	1	1	0	0	1.13750V
0	1	0	0	1	1	0	1	1.13125V
0	1	0	0	1	1	1	0	1.12500V
0	1	0	0	1	1	1	1	1.11875V

Table 2. Output Voltage Program (VRD11)

Pin Name								Nominal Output Voltage
VID7	VID6	VID5	VID4	VID3	VID2	VID1	VID0	DACOUT
0	1	0	1	0	0	0	0	1.11250V
0	1	0	1	0	0	0	1	1.10625V
0	1	0	1	0	0	1	0	1.10000V
0	1	0	1	0	0	1	1	1.09375V
0	1	0	1	0	1	0	0	1.08750V
0	1	0	1	0	1	0	1	1.08125V
0	1	0	1	0	1	1	0	1.07500V
0	1	0	1	0	1	1	1	1.06875V
0	1	0	1	1	0	0	0	1.06250V
0	1	0	1	1	0	0	1	1.05625V
0	1	0	1	1	0	1	0	1.05000V
0	1	0	1	1	0	1	1	1.04375V
0	1	0	1	1	1	0	0	1.03750V
0	1	0	1	1	1	0	1	1.03125V
0	1	0	1	1	1	1	0	1.02500V
0	1	0	1	1	1	1	1	1.01875V
0	1	1	0	0	0	0	0	1.01250V
0	1	1	0	0	0	0	1	1.00625V
0	1	1	0	0	0	1	0	1.00000V
0	1	1	0	0	0	1	1	0.99375V
0	1	1	0	0	1	0	0	0.98750V
0	1	1	0	0	1	0	1	0.98125V
0	1	1	0	0	1	1	0	0.97500V
0	1	1	0	0	1	1	1	0.96875V
0	1	1	0	1	0	0	0	0.96250V
0	1	1	0	1	0	0	1	0.95625V
0	1	1	0	1	0	1	0	0.95000V
0	1	1	0	1	0	1	1	0.94375V
0	1	1	0	1	1	0	0	0.93750V
0	1	1	0	1	1	0	1	0.93125V
0	1	1	0	1	1	1	0	0.92500V
0	1	1	0	1	1	1	1	0.91875V
0	1	1	1	0	0	0	0	0.91250V
0	1	1	1	0	0	0	1	0.90625V
0	1	1	1	0	0	1	0	0.90000V
0	1	1	1	0	0	1	1	0.89375V
0	1	1	1	0	1	0	0	0.88750V
0	1	1	1	0	1	0	1	0.88125V
0	1	1	1	0	1	1	0	0.87500V
0	1	1	1	0	1	1	1	0.86875V

Table 2. Output Voltage Program (VRD11)

Pin Name								Nominal Output Voltage
VID7	VID6	VID5	VID4	VID3	VID2	VID1	VID0	DACOUT
0	1	1	1	1	0	0	0	0.86250V
0	1	1	1	1	0	0	1	0.85625V
0	1	1	1	1	0	1	0	0.85000V
0	1	1	1	1	0	1	1	0.84375V
0	1	1	1	1	1	0	0	0.83750V
0	1	1	1	1	1	0	1	0.83125V
0	1	1	1	1	1	1	0	0.82500V
0	1	1	1	1	1	1	1	0.81875V
1	0	0	0	0	0	0	0	0.81250V
1	0	0	0	0	0	0	1	0.80625V
1	0	0	0	0	0	1	0	0.80000V
1	0	0	0	0	0	1	1	0.79375V
1	0	0	0	0	1	0	0	0.78750V
1	0	0	0	0	1	0	1	0.78125V
1	0	0	0	0	1	1	0	0.77500V
1	0	0	0	0	1	1	1	0.76875V
1	0	0	0	1	0	0	0	0.76250V
1	0	0	0	1	0	0	1	0.75625V
1	0	0	0	1	0	1	0	0.75000V
1	0	0	0	1	0	1	1	0.74375V
1	0	0	0	1	1	0	0	0.73750V
1	0	0	0	1	1	0	1	0.73125V
1	0	0	0	1	1	1	0	0.72500V
1	0	0	0	1	1	1	1	0.71875V
1	0	0	1	0	0	0	0	0.71250V
1	0	0	1	0	0	0	1	0.70625V
1	0	0	1	0	0	1	0	0.70000V
1	0	0	1	0	0	1	1	0.69375V
1	0	0	1	0	1	0	0	0.68750V
1	0	0	1	0	1	0	1	0.68125V
1	0	0	1	0	1	1	0	0.67500V
1	0	0	1	0	1	1	1	0.66875V
1	0	0	1	1	0	0	0	0.66250V
1	0	0	1	1	0	0	1	0.65625V
1	0	0	1	1	0	1	0	0.65000V
1	0	0	1	1	0	1	1	0.64375V
1	0	0	1	1	1	0	0	0.63750V
1	0	0	1	1	1	0	1	0.63125V
1	0	0	1	1	1	1	0	0.62500V
1	0	0	1	1	1	1	1	0.61875V

Table 2. Output Voltage Program (VRD11)

Pin Name								Nominal Output Voltage
VID7	VID6	VID5	VID4	VID3	VID2	VID1	VID0	DACOUT
1	0	1	0	0	0	0	0	0.61250V
1	0	1	0	0	0	0	1	0.60625V
1	0	1	0	0	0	1	0	0.60000V
1	0	1	0	0	0	1	1	0.59375V
1	0	1	0	0	1	0	0	0.58750V
1	0	1	0	0	1	0	1	0.58125V
1	0	1	0	0	1	1	0	0.57500V
1	0	1	0	0	1	1	1	0.56875V
1	0	1	0	1	0	0	0	0.56250V
1	0	1	0	1	0	0	1	0.55625V
1	0	1	0	1	0	1	0	0.55000V
1	0	1	0	1	0	1	1	0.54375V
1	0	1	0	1	1	0	0	0.53750V
1	0	1	0	1	1	0	1	0.53125V
1	0	1	0	1	1	1	0	0.52500V
1	0	1	0	1	1	1	1	0.51875V
1	0	1	1	0	0	0	0	0.51250V
1	0	1	1	0	0	0	1	0.50625V
1	0	1	1	0	0	1	0	0.50000V
1	0	1	1	0	0	1	1	X
1	0	1	1	0	1	0	0	X
1	0	1	1	0	1	0	1	X
1	0	1	1	0	1	1	0	X
1	0	1	1	0	1	1	1	X
1	0	1	1	1	0	0	0	X
1	0	1	1	1	0	0	1	X
1	0	1	1	1	0	1	0	X
1	0	1	1	1	0	1	1	X
1	0	1	1	1	1	0	0	X
1	0	1	1	1	1	0	1	X
1	0	1	1	1	1	1	0	X
1	0	1	1	1	1	1	1	X
1	1	0	0	0	0	0	0	X
1	1	0	0	0	0	0	1	X
1	1	0	0	0	0	1	0	X
1	1	0	0	0	0	1	1	X
1	1	0	0	0	1	0	0	X
1	1	0	0	0	1	0	1	X
1	1	0	0	0	1	1	0	X
1	1	0	0	0	1	1	1	X

To be continued

Table 2. Output Voltage Program (VRD11)

Pin Name								Nominal Output Voltage
VID7	VID6	VID5	VID4	VID3	VID2	VID1	VID0	DACOUT
1	1	0	0	1	0	0	0	X
1	1	0	0	1	0	0	1	X
1	1	0	0	1	0	1	0	X
1	1	0	0	1	0	1	1	X
1	1	0	0	1	1	0	0	X
1	1	0	0	1	1	0	1	X
1	1	0	0	1	1	1	0	X
1	1	0	0	1	1	1	1	X
1	1	0	1	0	0	0	0	X
1	1	0	1	0	0	0	1	X
1	1	0	1	0	0	1	0	X
1	1	0	1	0	0	1	1	X
1	1	0	1	0	1	0	0	X
1	1	0	1	0	1	0	1	X
1	1	0	1	0	1	1	0	X
1	1	0	1	0	1	1	1	X
1	1	0	1	1	0	0	0	X
1	1	0	1	1	0	0	1	X
1	1	0	1	1	0	1	0	X
1	1	0	1	1	0	1	1	X
1	1	0	1	1	1	0	0	X
1	1	0	1	1	1	0	1	X
1	1	0	1	1	1	1	0	X
1	1	0	1	1	1	1	1	X
1	1	1	0	0	0	0	0	X
1	1	1	0	0	0	0	1	X
1	1	1	0	0	0	1	0	X
1	1	1	0	0	0	1	1	X
1	1	1	0	0	1	0	0	X
1	1	1	0	0	1	0	1	X
1	1	1	0	0	1	1	0	X
1	1	1	0	0	1	1	1	X
1	1	1	0	1	0	0	0	X
1	1	1	0	1	0	0	1	X
1	1	1	0	1	0	1	0	X
1	1	1	0	1	0	1	1	X
1	1	1	0	1	1	0	0	X
1	1	1	0	1	1	0	1	X
1	1	1	0	1	1	1	0	X
1	1	1	0	1	1	1	1	X

Table 2. Output Voltage Program (VRD11)

Pin Name								Nominal Output Voltage
VID7	VID6	VID5	VID4	VID3	VID2	VID1	VID0	DACOUT
1	1	1	1	0	0	0	0	X
1	1	1	1	0	0	0	1	X
1	1	1	1	0	0	1	0	X
1	1	1	1	0	0	1	1	X
1	1	1	1	0	1	0	0	X
1	1	1	1	0	1	0	1	X
1	1	1	1	0	1	1	0	X
1	1	1	1	0	1	1	1	X
1	1	1	1	1	0	0	0	X
1	1	1	1	1	0	0	1	X
1	1	1	1	1	0	1	0	X
1	1	1	1	1	0	1	1	X
1	1	1	1	1	1	0	0	X
1	1	1	1	1	1	0	1	X
1	1	1	1	1	1	1	0	OFF
1	1	1	1	1	1	1	1	OFF

Note: (1) 0 : Connected to GND
(2) 1 : Open
(3) X : Don't Care

Table 3. Output Voltage Program (K8)

VID4	VID3	VID2	VID1	VID0	Nominal Output Voltage DACOUT
0	0	0	0	0	1.550
0	0	0	0	1	1.525
0	0	0	1	0	1.500
0	0	0	1	1	1.475
0	0	1	0	0	1.450
0	0	1	0	1	1.425
0	0	1	1	0	1.400
0	0	1	1	1	1.375
0	1	0	0	0	1.350
0	1	0	0	1	1.325
0	1	0	1	0	1.200
0	1	0	1	1	1.275
0	1	1	0	0	1.250
0	1	1	0	1	1.225
0	1	1	1	0	1.200
0	1	1	1	1	1.175
1	0	0	0	0	1.150
1	0	0	0	1	1.125
1	0	0	1	0	1.100
1	0	0	1	1	1.075
1	0	1	0	0	1.050
1	0	1	0	1	1.025
1	0	1	1	0	1.000
1	0	1	1	1	0.975
1	1	0	0	0	0.950
1	1	0	0	1	0.925
1	1	0	1	0	0.900
1	1	0	1	1	0.875
1	1	1	0	0	0.850
1	1	1	0	1	0.825
1	1	1	1	0	0.800
1	1	1	1	1	Shutdown

Note: (1) 0 : Connected to GND
(2) 1 : Open

Table 4. Output Voltage Program (K8_M2)

Pin Name						Nominal Output Voltage DACOUT
VID5	VID4	VID3	VID2	VID1	VID0	
0	0	0	0	0	0	1.5500
0	0	0	0	0	1	1.5250
0	0	0	0	1	0	1.5000
0	0	0	0	1	1	1.4750
0	0	0	1	0	0	1.4500
0	0	0	1	0	1	1.4250
0	0	0	1	1	0	1.4000
0	0	0	1	1	1	1.3750
0	0	1	0	0	0	1.3500
0	0	1	0	0	1	1.3250
0	0	1	0	1	0	1.3000
0	0	1	0	1	1	1.2750
0	0	1	1	0	0	1.2500
0	0	1	1	0	1	1.2250
0	0	1	1	1	0	1.2000
0	0	1	1	1	1	1.1750
0	1	0	0	0	0	1.1500
0	1	0	0	0	1	1.1250
0	1	0	0	1	0	1.1000
0	1	0	0	1	1	1.0750
0	1	0	1	0	0	1.0500
0	1	0	1	0	1	1.0250
0	1	0	1	1	0	1.0000
0	1	0	1	1	1	0.9750
0	1	1	0	0	0	0.9500
0	1	1	0	0	1	0.9250
0	1	1	0	1	0	0.9000
0	1	1	0	1	1	0.8750
0	1	1	1	0	0	0.8500
0	1	1	1	0	1	0.8250
0	1	1	1	1	0	0.8000
0	1	1	1	1	1	0.7750
1	0	0	0	0	0	0.7625
1	0	0	0	0	1	0.7500

Table 4. Output Voltage Program (K8_M2)

Pin Name						Nominal Output Voltage DACOUT
VID5	VID4	VID3	VID2	VID1	VID0	
1	0	0	0	1	0	0.7375
1	0	0	0	1	1	0.7250
1	0	0	1	0	0	0.7125
1	0	0	1	0	1	0.7000
1	0	0	1	1	0	0.6875
1	0	0	1	1	1	0.6750
1	0	1	0	0	0	0.6625
1	0	1	0	0	1	0.6500
1	0	1	0	1	0	0.6375
1	0	1	0	1	1	0.6250
1	0	1	1	0	0	0.6125
1	0	1	1	0	1	0.6000
1	0	1	1	1	0	0.5875
1	0	1	1	1	1	0.5750
1	1	0	0	0	0	0.5625
1	1	0	0	0	1	0.5500
1	1	0	0	1	0	0.5375
1	1	0	0	1	1	0.5250
1	1	0	1	0	0	0.5125
1	1	0	1	0	1	0.5000
1	1	0	1	1	0	0.4875
1	1	0	1	1	1	0.4750
1	1	1	0	0	0	0.4625
1	1	1	0	0	1	0.4500
1	1	1	0	1	0	0.4375
1	1	1	0	1	1	0.4250
1	1	1	1	0	0	0.4125
1	1	1	1	0	1	0.4000
1	1	1	1	1	0	0.3875
1	1	1	1	1	1	0.3750

Note: (1) 0 : Connected to GND
(2) 1 : Open
(3) The voltage above are load independent for desktop and server platforms. For mobile platforms the voltage above correspond to zero load current.

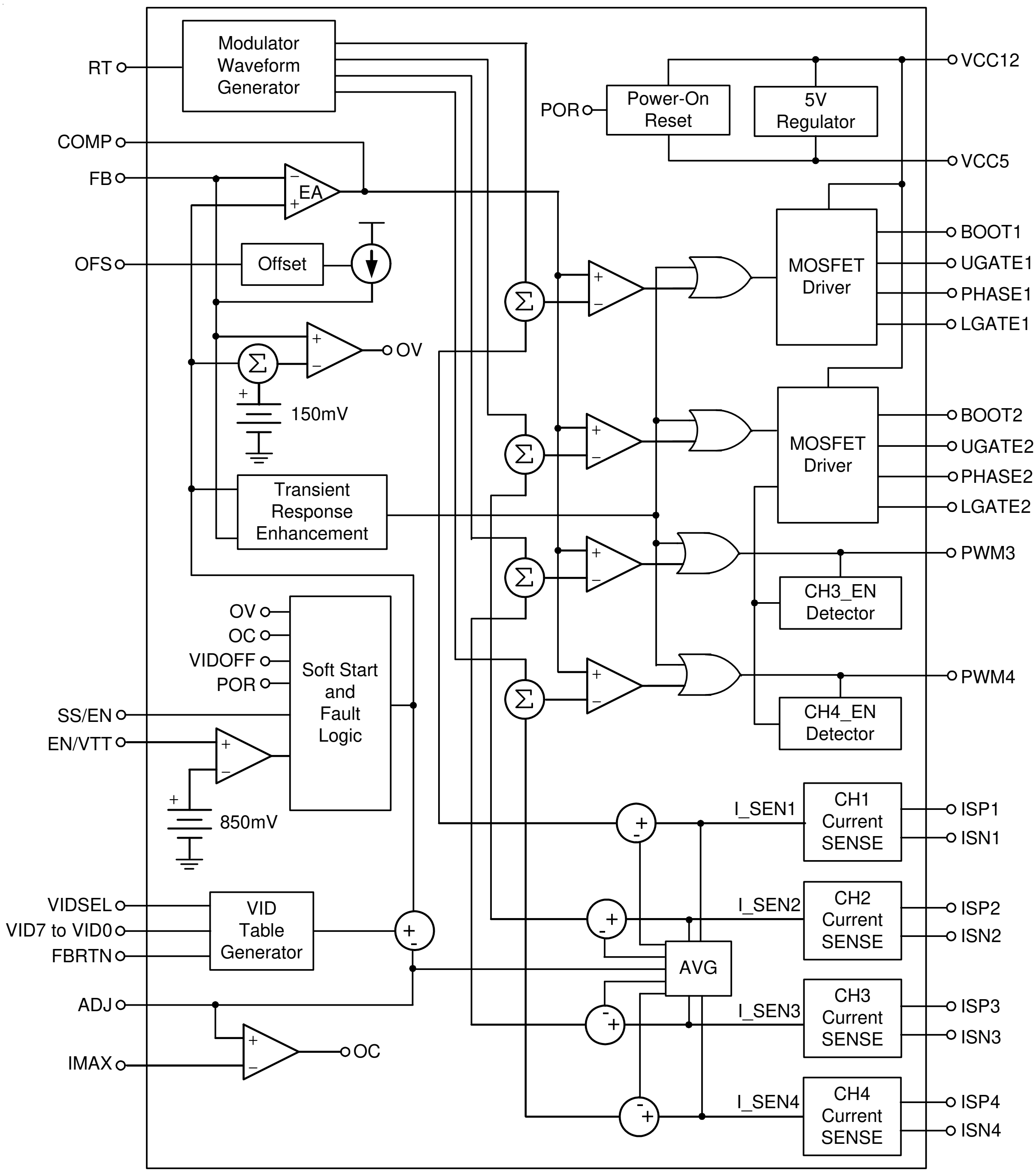
Functional Pin Description

Pin No.	Pin Name	Pin Function
1	VIDSEL	VID DAC Selection Pin.
2	FBRTN	Negative remote sense pin of output voltage.
3	SS/EN	Connect this pin to GND by a capacitor to adjust soft start time. Pull this pin to GND to disable controller.
4	ADJ	Connect this pin to GND by a resistor to set loadline.
5	COMP	Output of error-amp and input of PWM comparator.
6	FB	Inverting input of error-amp.
7	OFS	Connect this pin to GND by a resistor to set no-load offset voltage.
8	RT	Connect this pin to GND by a resistor to adjust frequency.
9	IMAX	Negative input of OCP comparator. (Positive input of OCP comparator is ADJ).
10	GND	Ground Pin.
11,14,15,18	ISP4, ISP3, ISP2, ISP1	Positive current sense pin of channel 1, 2, 3 and 4.
12,13,16,17	ISN4, ISN3, ISN2, ISN1	Negative current sense pin of channel 1, 2, 3 and 4.
19	VCC5	5V LDO output for system power supply pin.
20,21	PWM4, PWM3	PWM output for channel 4 and channel 3.
22,30	BOOT2, BOOT1	Bootstrap supply for channel 2 and channel 1.
23,29	UGATE2, UGATE1	Upper gate driver for channel 2 and channel 1.
24,28	PHASE2, PHASE1	Switching node of channel 2 and channel 1.
25,27	LGATE2, LGATE1	Lower gate driver for channel 2 and channel 1.
26	VCC12	IC power supply. Connect to 12V.
31	PWRGD	Power good indicator.
32	EN/VTT	VTT voltage detector input.
33 to 40	VID7 to VID0	Voltage identification input for DAC.
41 (Exposed pad)	GND	Exposed pad should be soldered to PCB board and connected to GND.

VID Table Selection

VIDSEL	VID [7]	Table
VTT	X	VR11
GND	X	VR10.x
VCC5	VTT	K8
VCC5	GND	K8_M2

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage ---------- –0.3V to 15V
- BOOTx to PHASEx ---------- –0.3V to 15V
- BOOTx to GND
  DC ---------- –0.3V to 30V
  <200ns ---------- –0.3V to 42V
- PHASEx to GND
  DC ---------- –2V to 15V
  <200ns ---------- –5V to 30V
- Input/Output Voltage ---------- –0.3V to 7V
- Power Dissipation, P_D @ T_A = 25°C
  WQFN–40L 6x6 ---------- 2.778W
- Package Thermal Resistance (Note 2)
  WQFN-40L 6x6, θ_{JA} ---------- 36°C/W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- ESD Susceptibility (Note 3)
  HBM (Human Body Mode) ---------- 2kV
  MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note 4)

- Supply Voltage, VCC12 ---------- 12V ± 10%
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- 0°C to 70°C

Electrical Characteristics

(VCC12 = 12V, V_{GND} = 0V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
VCC12 Supply Input						
VCC12 Supply Voltage	V_{VCC12}		10.8	12	13.2	V
VCC12 Supply Current	I_{CC}	No switching	--	6	--	mA
VCC5 power						
VCC5 Supply Voltage	V_{VCC5}	I_{LOAD} = 10mA	4.75	5.0	5.25	V
VCC5 Output Sourcing	I_{VCC5}		10	--	--	mA
Power-On Reset						
VCC12 Rising Threshold	$V_{VCC12TH}$	VCC12 Rising	9.2	9.6	10.0	V
VCC12 Hysteresis	$V_{VCC12HY}$	VCC12 Falling	--	0.9	--	V
EN/VTT						
EN/VTT Rising Threshold	V_{ENVTT}	EN/VTT Rising	0.80	0.85	0.90	V
Enable Hysteresis	$V_{ENVTTHY}$	EN/VTT Falling	--	100	--	mV
Reference Voltage accuracy						
DAC Accuracy		0.8V to 1.6V	–5	--	+5	mV
		0.5V to 0.8V	–8	--	+8	mV

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Error Amplifier						
DC Gain	A_{DC}	No Load	--	80	--	dB
Gain-Bandwidth	GBW	C_{LOAD} = 10pF	--	10	--	MHz
Slew Rate	SR	C_{LOAD} = 10pF	10	--	--	V/us
Output voltage range	V_{COMP}		0.5		3.6	V
Max Current	I_{EA_SLEW}	Slew	300	--	--	uA
Power Sequence						
PWRGD Low Voltage	V_{PGOOD}	I_{PWRGD} = 4mA	--	--	0.4	V
Soft-Start Delay	T_{D1}		--	2	--	ms
V_{BOOT} Duration	T_{D3}		--	0.8	--	ms
PWRGD Delay	T_{D5}	Measured the time form V_{BOOT} change to PWRGD = 1	--	1.6	--	ms
Current Sense Amplifier						
Max Current	I_{GMMAX}	V_{CSP} = 1.3V Sink Current from CSN	100	--	--	uA
Input Offset Voltage	V_{OSCS}		−1.5	0	1.5	mV
Running Frequency	f_{OSC}	R_{RT} = 40kΩ	270	300	330	kHz
RT Pin Voltage	V_{RT}	R_{RT} = 40kΩ	1.52	1.60	1.68	V
Ramp Amplitude	V_{RAMP}	R_{RT} = 40kΩ	--	1.60	--	V
Soft Start						
Soft Start Current	I_{SS1}	Slew	13	16	19	uA
VID change Current	I_{SS2}	Slew	130	160	190	uA
Gate Driver						
UGATE Drive Source	$R_{UGATEsr}$	BOOT − PHASE = 8V 250mA Source Current	--	1	--	Ω
UGATE Drive Sink	$R_{UGATEsk}$	BOOT − PHASE = 8V 250mA Sink Current	--	1	--	Ω
LGATE Drive Source	$R_{LGATEsr}$	V_{LGATE} = 8V	--	1	--	Ω
LGATE Drive Sink	$R_{LGATEsk}$	250mA Sink Current	--	0.8	--	Ω
Protection						
Over-Voltage Threshold	V_{OVP}	Sweep FB Voltage, $V_{FB,EAP}$	125	150	175	mV
Over-Current Threshold	V_{OCP}	Sweep IMAX Voltage, $V_{IMAX,ADJ}$	−13	0	+13	mV
Dynamic Characteristic						
UGATE Rise Time	t_{rUGATE}	Ciss = 3000p	--	15	--	ns
UGATE Fall Time	t_{fUGATE}		--	10	--	ns
LGATE Rise Time	t_{rLGATE}		--	15	--	ns
LGATE Fall Time	t_{fLGATE}		--	10	--	ns
Input Threshold						
VID7 to VID0, VIDSEL Rising Threshold	$V_{ID7\ to\ 0}$, V_{IDSEL}	VID7 to VID0 Rising, VIDSEL Rising	--	1/2V_{TT} + 12.5mV	--	V
VID7 to VID0, VIDSEL Hysteresis	$V_{ID7\ to\ 0\_Hy}$, V_{IDSEL_Hy}	VID7 to VID0 Falling, VIDSEL Falling	--	25	--	mV

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

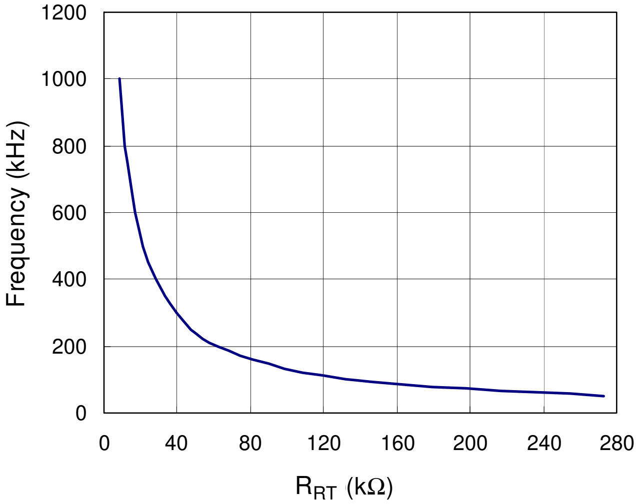
Note 2. θ_{JA} is measured in the natural convection at T_A = 25°C on a effective single layer thermal conductivity test board of JEDEC thermal measurement standard.

Note 3. Devices are ESD sensitive. Handling precaution is recommended.

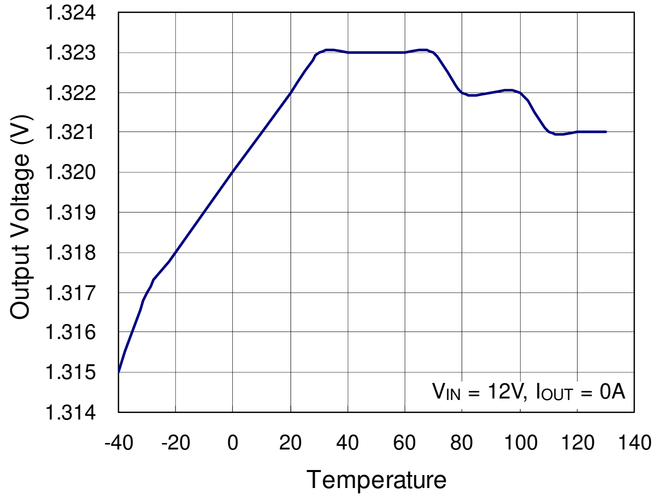
Note 4. The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

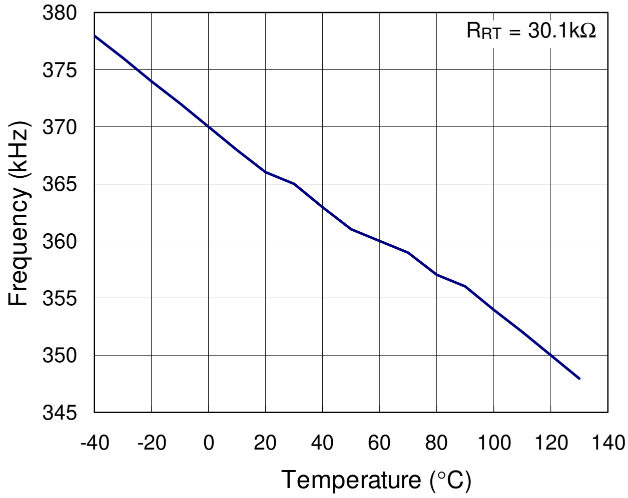
Frequency vs. R_{RT}



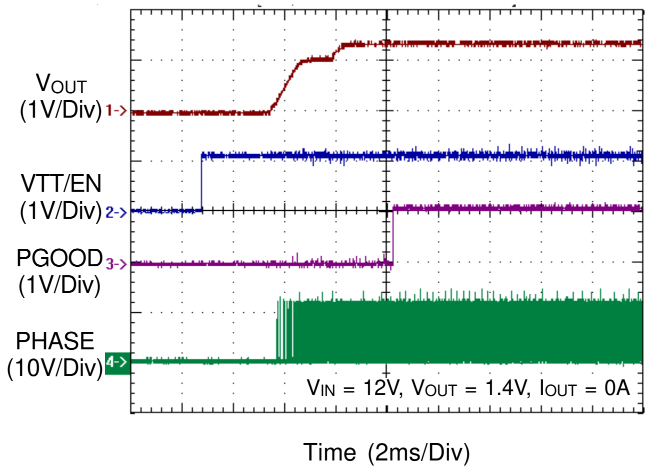
Output Voltage vs. Temperature



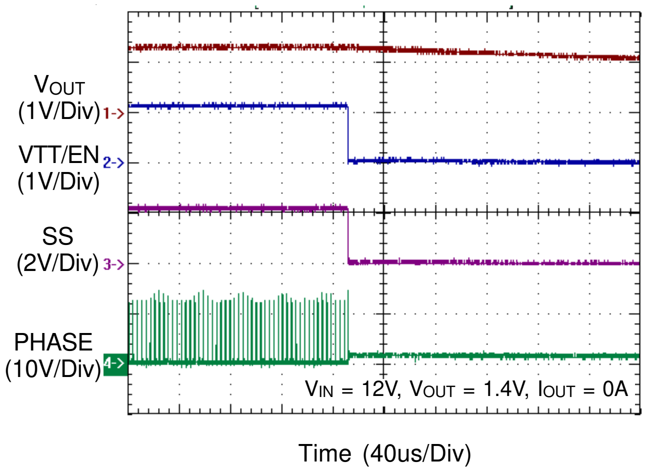
Frequency vs. Temperature



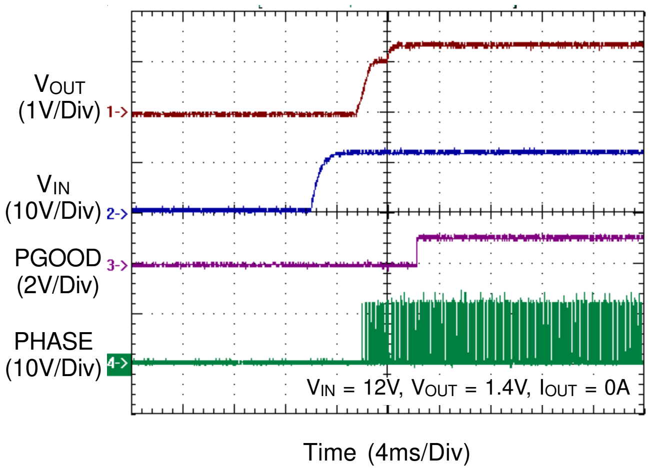
Power On from VTT/EN



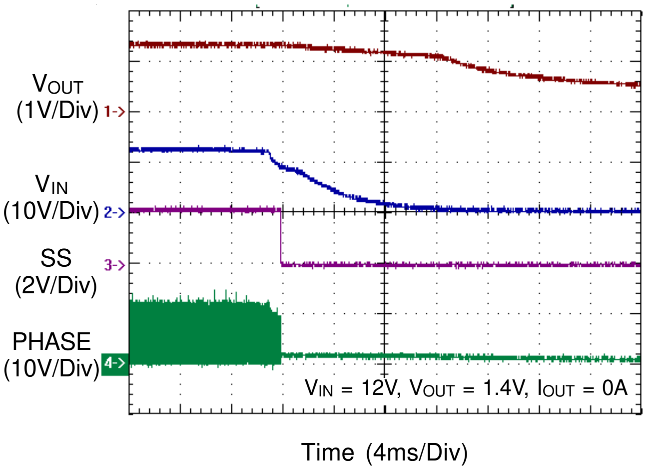
Power Off from VTT/EN



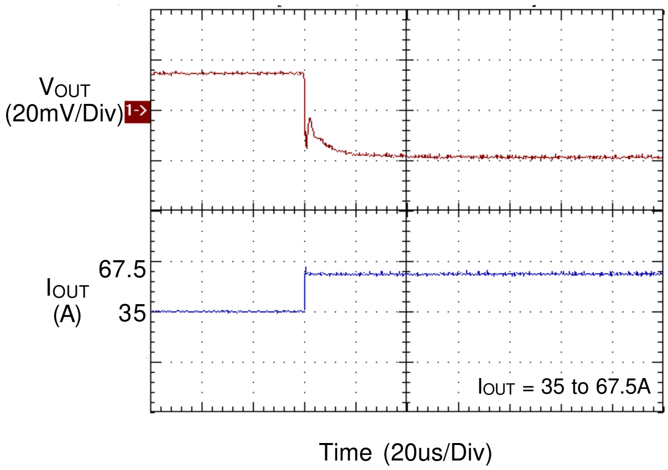
Power On from VIN



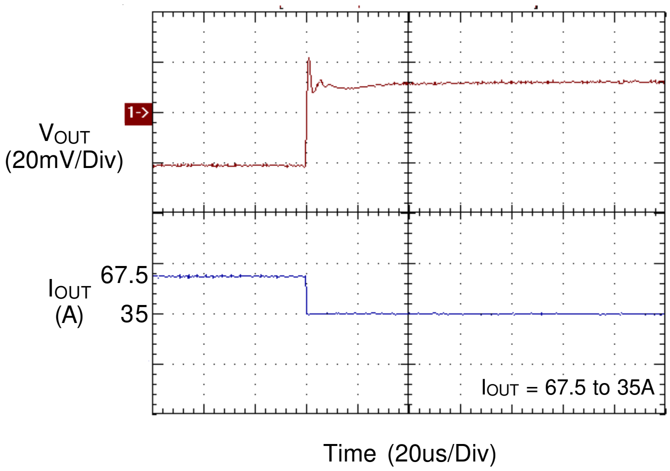
Power Off from VIN



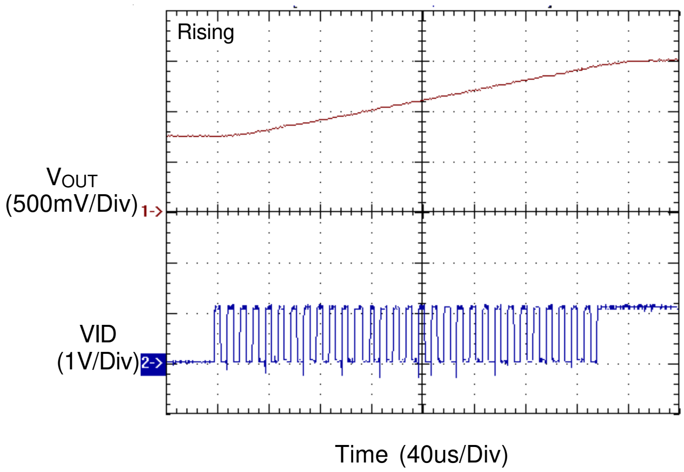
ACLL Drop



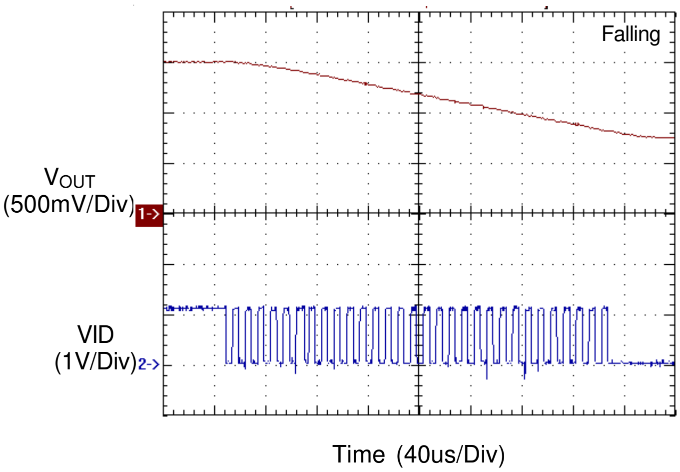
ACLL Overshoot



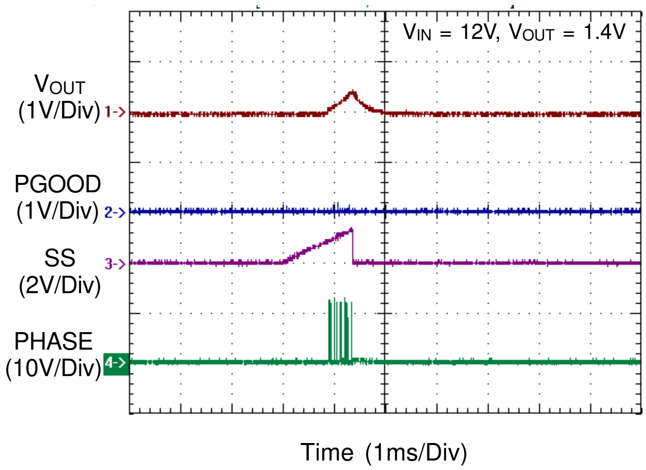
Dynamic VID

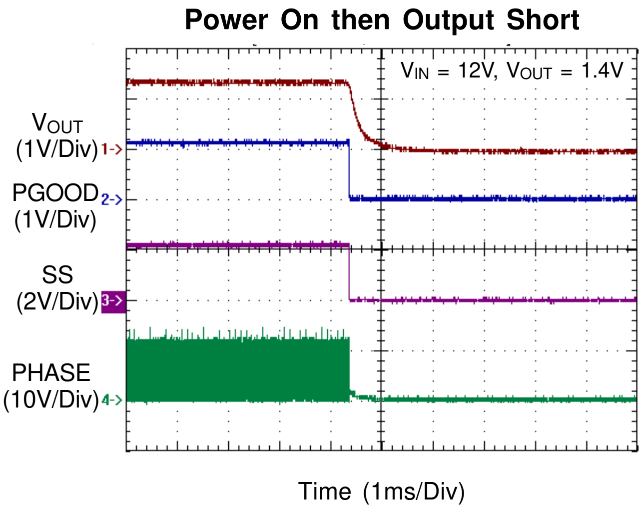


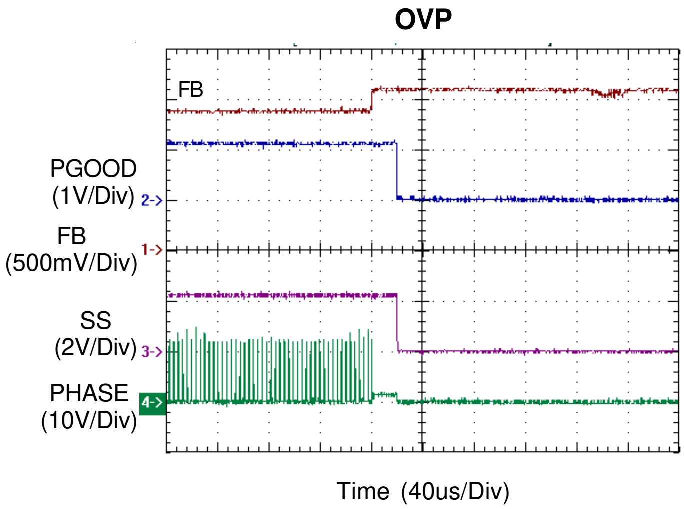
Dynamic VID



Output Short then Power On




Power On then Output Short
VIN = 12V, VOUT = 1.4V
VOUT
(1V/Div)
PGOOD
(1V/Div)
SS
(2V/Div)
PHASE
(10V/Div)
Time (1ms/Div)


OVP
FB
PGOOD
(1V/Div)
FB
(500mV/Div)
SS
(2V/Div)
PHASE
(10V/Div)
Time (40us/Div)

Application Information

RT8841 is a 4/3/2/1-phase synchronous buck DC/DC converter with 2 embedded MOSFET drivers. The internal VID DAC is designed to interface with the Intel 8-bit VR11 compatible CPUs.

Power Ready Detection

During start-up, RT8841 will detect $V_{CC}12$, $V_{CC}5$ and V_{TT}. When $V_{CC}12 > 9.6V$, $V_{CC}5 > 4.6V$ and $V_{TT} > 0.85V$ POR will go high. POR (Power On Reset) is the internal signal to indicate all voltage powers are ready to let RT8841 and the companioned MOSFET drivers to work properly. When POR = L, RT8841 will try to turn off both high side and low side MOSFETs.

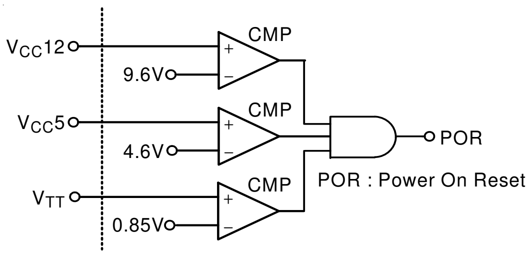


Figure 1. Circuit for Power Ready Detection

Phase Detection

The number of operational phases is determined by the internal circuitry that monitors the ISNx voltages during start up. Normally, the RT8841 operates as a 4-phase PWM controller. Pull ISN4 and ISP4 to $V_{CC}5$ programs 3-phase operation, pull ISN3 and ISP3 to $V_{CC}5$ programs 2-phase operation, and pull ISN2 and ISP2 to $V_{CC}5$ programs 1-phase operation. RT8841 detects the voltage of ISN4, ISN3 and ISN2 at POR rising edge. At the rising edge, RT8841 detects whether the voltage of ISN4, ISN3 and ISN2 are higher than "$V_{CC}5 - 1V$" respectively to decide how many phases should be active. Phase detection is only active during start up. When POR = H, the number of operational phases is determined and latched. The unused PWM pin can be connected to 5V, GND or left open.

Phase Switching Frequency

The phase switching frequency of the RT8841 is set by an external resistor connected from the RT pin to GND. The frequency follows the graph in Figure 2.

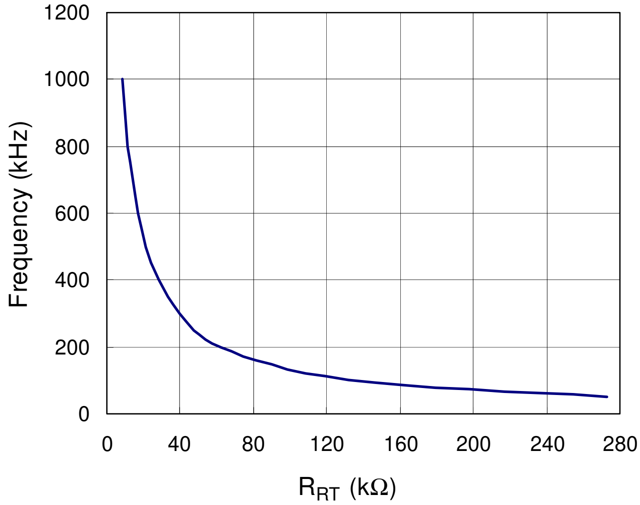


Figure 2. R_{RT} vs Phase Switching Frequency

Soft Start

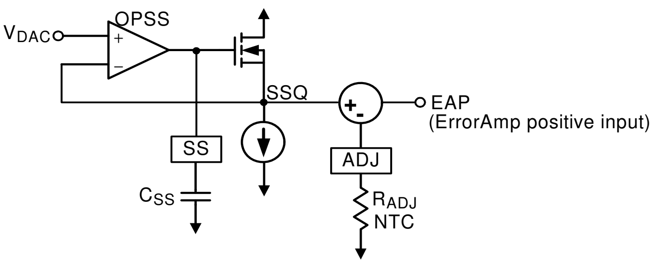


Figure 4. Circuit for Soft Start and Dynamic VID

The V_{OUT} start-up time is set by a capacitor from the SS pin to GND. In power_on_reset state (POR = L), the SS pin is held at GND. After power_on_reset stae (POR = H) and an extra delay 1600us, V_{SS} and V_{SSQ} begin to rise till $V_{SSQ} = V_{BOOT}$. When $V_{SSQ} = V_{BOOT}$, RT8841 stays in this state for 800us waiting for valid VID code sent by CPU. After receiving valid VID code, V_{OUT} continues ramping up or down to the voltage specified by VID code. Before PWRGD = H, output current of OPSS (I_{SS}) is limited to 8uA ($I_{SS}1$). When PWRGD = H, I_{SS} is limited to 80uA ($I_{SS}2$). The soft start waveform is shown in Figure 5.

V_{OUT} will trace V_{EAP} which is equal to "$V_{SSQ} - V_{ADJ}$". V_{ADJ} is a small voltage signal which is proportional to I_{OUT}. This voltage is used to generate loadline and will be described later. T1 is the delay time from power_on_reset state to the beginning of V_{OUT} rising.

$$T1 = 1600\mu s + 0.6V \times C_{SS}/I_{SS}1 \quad (1)$$

T2 is the soft start time from $V_{OUT} = 0$ to $V_{OUT} = V_{BOOT}$.