**Features**
- Programmable digital control loop
- Scalable for 4-, 3-, and 2-phase operation
- All phases actively current balanced
- Tracking pin for complex power sequencing
- \( V_{IN} \) Feed-forward
- Individual TMON input for each phase
- Enabling real-time system health monitoring
- Meets all high-performance FPGA requirements
  - Digital loop for excellent transient response
  - 0.5% set-point over line, load, temperature
  - Differential remote sensing
  - Monotonic startup into pre-bias output
  - Optimized FPGA configs stored in non-volatile memory (NVM)
- Programmable through PMBus*
  - \( V_{IN} \) margining, startup and shutdown delays
  - Programmable warnings, faults, and response
- Operational without PMBus
  - RVSET resistor for setting \( V_{OUT} \)
  - RTUNE resistor for single resistor-based compensation
- Programmable Overcurrent Response
  - Latch off (default)
  - Hiccup
- Protection features
  - Over-current protection
  - Over voltage protection \( V_{IN} > V_{OUT} \)
  - Under voltage protection \( V_{IN} < V_{OUT} \)
  - Over temperature
- Fuse-based NVM for improved reliability
- RoHS compliant (Exception-Free), MSL level 3, 260°C reflow
- Small 5 mm x 5 mm x 0.9 mm quad-flat no leads (QFN) package

**Applications**
- High-performance FPGA core supply
- ASIC, ASSP, and processor supply rails

**Multi-Phase, Single Output, Fully Digital Step-Down Controller with PMBus v1.3 Compliant Interface**

The ED8401 device is a digital multi-phase step-down controller for non-isolated, high-current DC/DC applications. A PMBus version 1.3 compliant interface provides setup, control, and telemetry for intelligent power management and system health monitoring.

The device’s DC and AC accuracy meet the most stringent tolerance requirements for FPGAs, ASICs, processors, and DDR memory devices. Differential remote sensing and ±0.5% set-point accuracy provide precise regulation over line, load, and temperature variation. The two-state digital control loop provides outstanding load transient response and very low ripple.

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*PMBus* refers to a protocol used for managing power delivery in systems with multiple power domains. It allows for efficient communication and control of power supplies across the system. The ED8401 device’s compatibility with PMBus v1.3 ensures seamless integration with systems that support this interface, providing enhanced control and monitoring capabilities.

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**Figure 1: Application Diagram for 4-Phase Configuration**

This diagram illustrates how the ED8401 controller can be configured for a 4-phase application. The controller manages multiple power stages, each with its own control inputs and outputs, allowing for precise voltage regulation and efficient power delivery across the system. The diagram also includes key components such as input, output, and control signals, providing a visual representation of the controller’s operation in a typical application scenario.
The ED8401 device can be configured and controlled in any application by two methods, either in pin-strap mode using onboard resistors, or using the PMBus interface. You can also configure the device during engineering evaluation using the PMBus interface, which offers a high degree of flexibility and programmability, and then use the pin-strap mode when devices are deployed in production. The Intel® Enpirion® Digital Power Configurator provides an easy-to-use graphical user interface for communicating with and configuring the device.

The ED8401 device offers a scalable solution by operating in 4-, 3-, or 2-phase mode. Combined with the Intel Enpirion ET6160LI 60 A power stage enables an optimized load current range from 40 A to greater than 200 A while offering high efficiency across the load range. The ET6160LI device supports short burst peak current >90 A per phase to meet dynamic reconfiguration transients.

### Output Voltage Ripple, No Load

![Output Voltage Ripple, No Load](image)

\[
V_{\text{IN}} = 12 \text{ V}, \quad V_{\text{OUT}} = 0.8 \text{ V} \\
2 \mu\text{s/div}, \quad V_{\text{OUT}}: 10 \text{ mV/div}, \quad 20 \text{ MHz bandwidth}
\]

### Output Voltage Ripple, 160 A Load

![Output Voltage Ripple, 160 A Load](image)

\[
V_{\text{IN}} = 12 \text{ V}, \quad V_{\text{OUT}} = 0.8 \text{ V} \\
2 \mu\text{s/div}, \quad V_{\text{OUT}}: 10 \text{ mV/div}, \quad 20 \text{ MHz bandwidth}
\]

### Output Voltage Transient Response, Load Step from 0 A to 80 A

![Output Voltage Transient Response, Load Step from 0 A to 80 A](image)

\[
V_{\text{IN}} = 12 \text{ V}, \quad V_{\text{OUT}} = 0.8 \text{ V} \\
V_{\text{OUT}}: 10 \text{ mV/div}, \quad I_{\text{OUT}}: 33\text{A/div}, \quad 10\text{A/μs}
\]

### Output Voltage Transient Response, Load Step from 80 A to 160 A

![Output Voltage Transient Response, Load Step from 80 A to 160 A](image)

\[
V_{\text{IN}} = 12 \text{ V}, \quad V_{\text{OUT}} = 0.8 \text{ V} \\
V_{\text{OUT}}: 10 \text{ mV/div}, \quad I_{\text{OUT}}: 33\text{A/div}, \quad 10\text{A/μs}
\]

For more information about Intel and Intel Enpirion PowerSoCs, visit [www.intel.com/enpirion](http://www.intel.com/enpirion)