

Innovative 48V Direct Conversion

APEC 2016



Novel 48V Direct Conversion



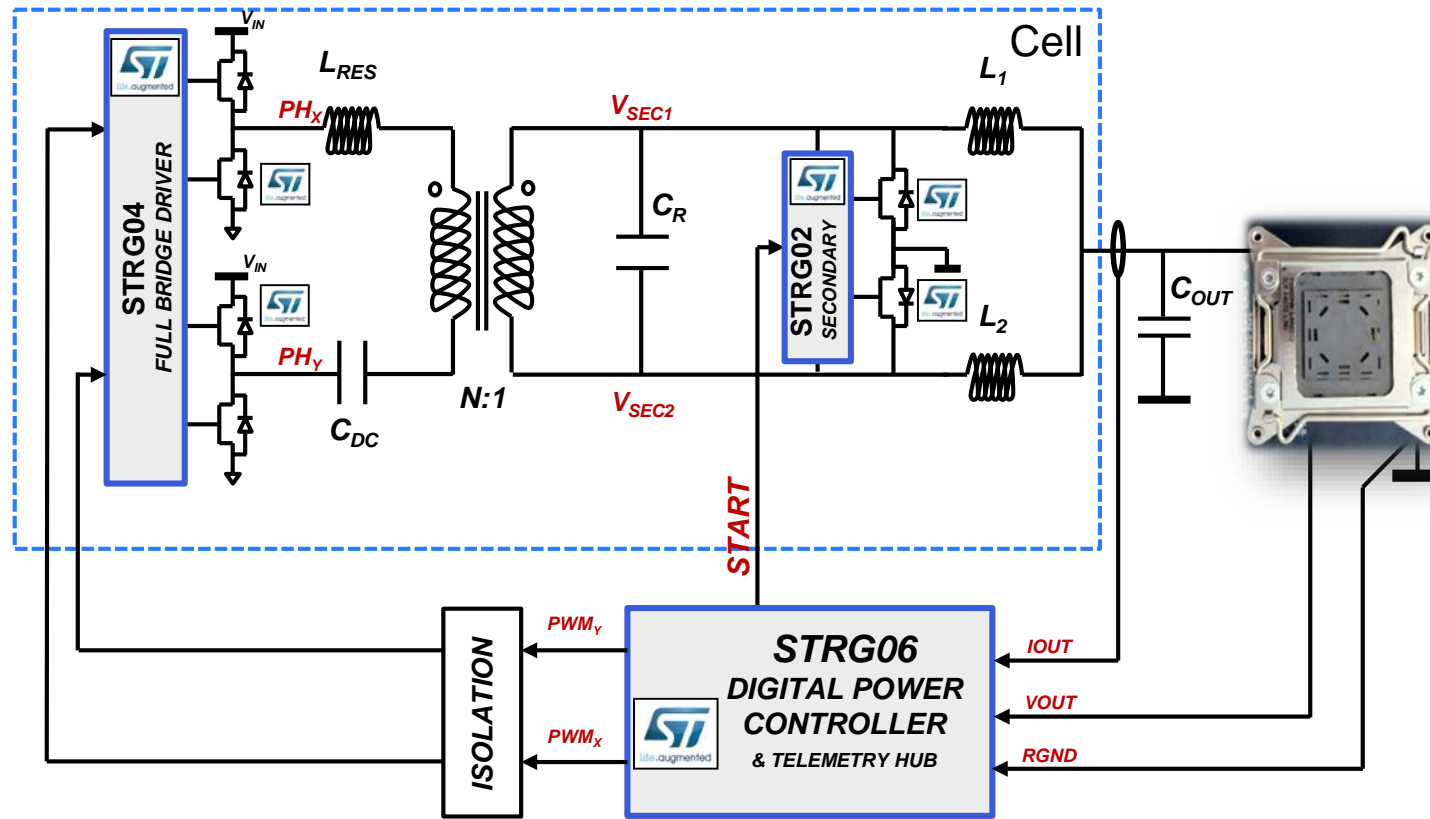
Innovative 48V Direct Conversion Architecture
Fully Compliant to Intel VR13 Requirements

Fully Isolated, Scalable, High Efficiency (ZVS,
ZCS), Energy Proportional Ideal for “Any POL”

Flexible Architecture Extendable to 400V Direct
Conversion Bus



Innovative 48V Direct Conversion



System
Description

Main
Features

Experimental
Intel VR13
Results

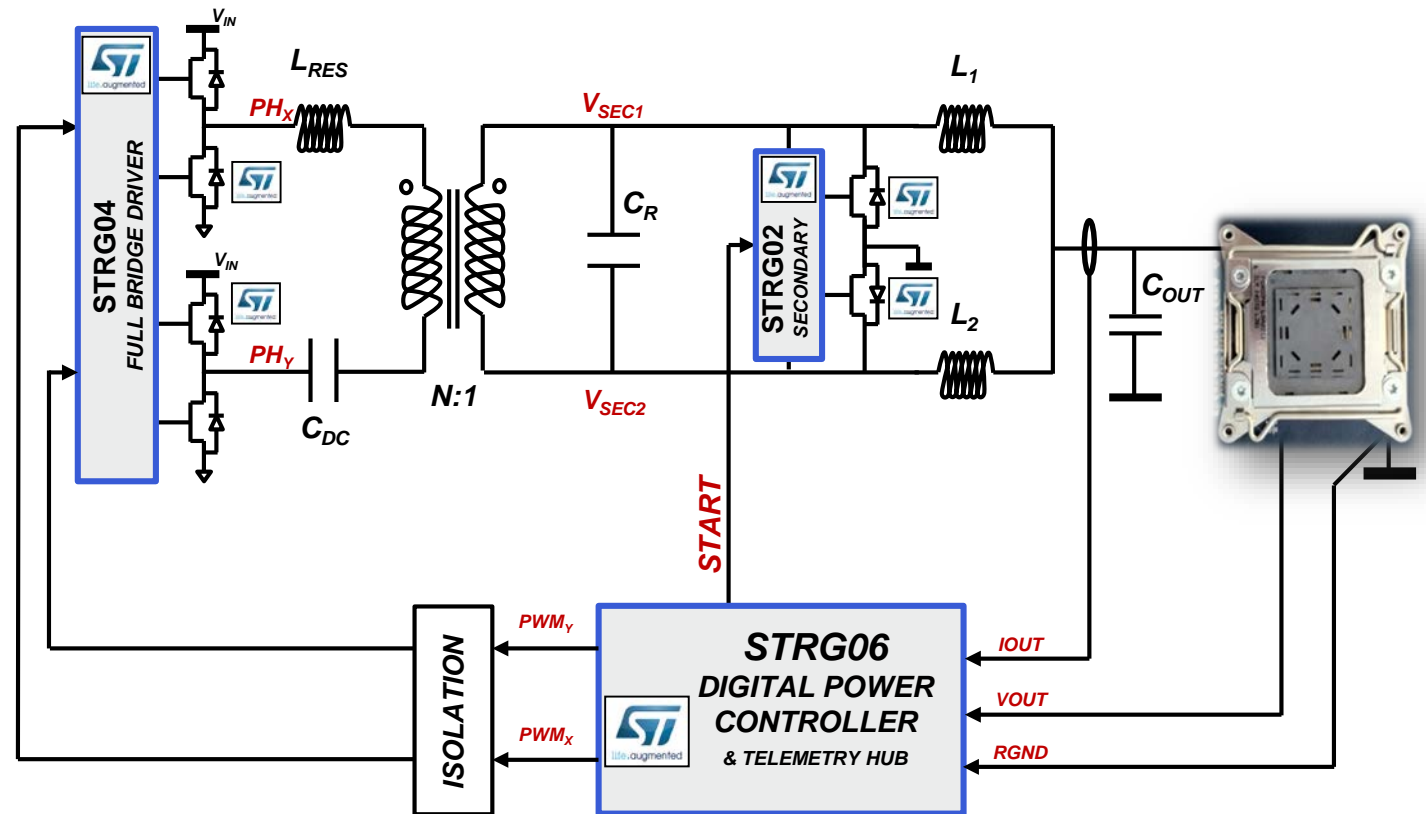
Available
Reference
Designs



System Description

Innovative, Isolated 48V to 0.5V-12V Architecture

- **STRG02** Single wire controlled Synchronous Rectifier able to zero voltage and zero current working
- **STRG04** 100V Full Bridge Driver with programmable predictive control for zero voltage operations in constant phase shift control
- **STRG06** Multiphase Resonant Constant On Time Digital Controller supporting up to 6 interleaved converters (automatically turned on/off by load request) with PMBUS and output voltage between 0.5V to 12V





Main Features

- Isolated Resonant Direct Conversion
 - from 48V to $V_{\text{CORE}}(1.xV) / V_{\text{DDR}}(1.2V) / V_{\text{SOC}}(1V) / V_{\text{IBC}}(12V, 5V, 3.3V)$
- Efficiency
 - ZVS and ZCS at any V_{in} [36V – 72V] and V_{out} [1.xV – 12V]
 - Energy Proportional Management → Pskip and Dynamic Cell Management
 - No Active Clamps needed
- Scalable and Flexible
 - Converters paralleled and interleaved
 - Scalability according to the power demand
 - Variable Frequency in CCM and DCM
 - Instantaneous turn-on of resonant converters when load increases
- Any Digital Load
 - High Bandwidth
 - Easy to compensate as a non isolated Buck converter
 - Up and down reference transitions → Sink mode required
- High Power Density, Telemetry, Auto-Tuning
 - >160W/inch²
 - Fully configurable and accessible through PMBus™
 - To minimize time and effort for compensation, optimizing application design time

New Resonant Topology

Energy Proportional

Scalable

Digital Load and IBC

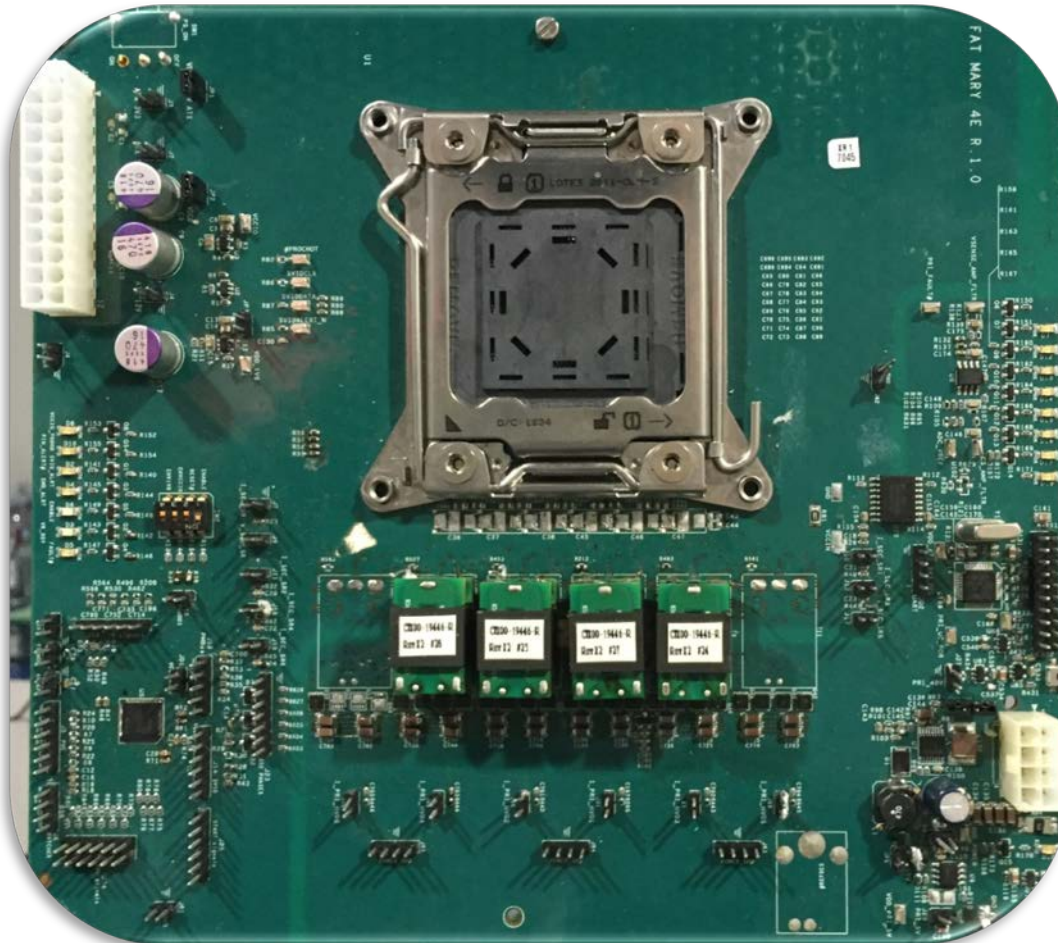
Power Density

Telemetry, Auto-Tuning



Intel VR13 Reference Design

Intel VR13 165W CPU Power Delivery



Features:

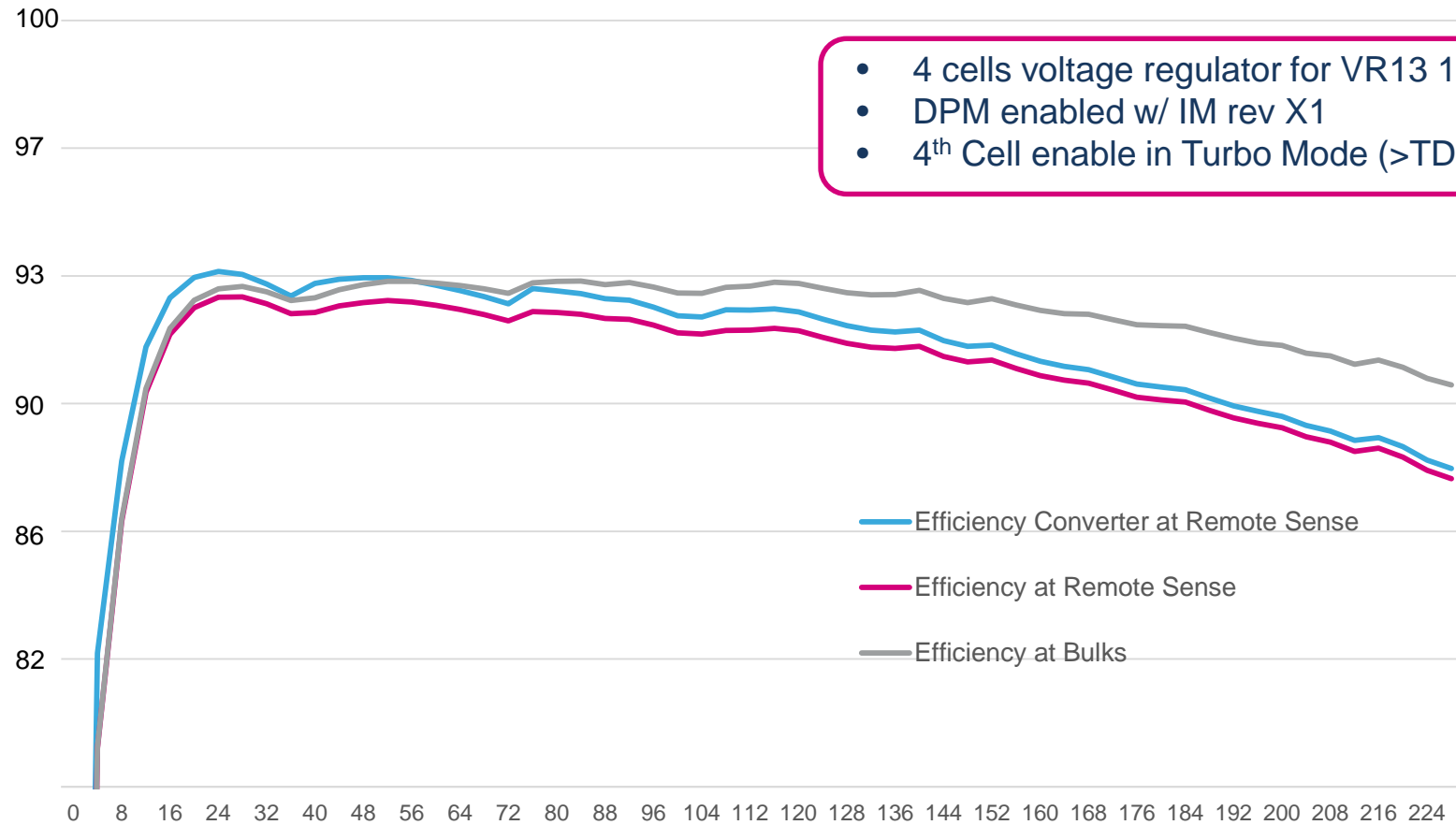
- Compliancy to VR13 165W CPU
- Minimal PCB area with 4 cells
- Efficiency peak 91%, flat until TDC (88A)
- Integrated magnetics
- MLCC output filter

Bill of materials:

- Magnetic electrical data:
 - Transformer turn ratio=5
 - $L_{res}=1.9\mu H$
 - $L_{out}=120nH$
- C_{res} : 2 x 100nF between phases, 33nF from each phase to GND
- C_{out} : 120 x MLCC 47uF 4V 0805



Intel VR13 Efficiency Performances





54V → 12V, 500W

Prototype spec:	
V_{in}	40V to 72V
$V_{in\ nom}$	54V
$V_{out\ nom}$	12V +/-1%
P_o	500W
Output current	42A
Frequency of operation	200-250KHz
Power density	160W/inch ²
Actual Peak Efficiency	97%
Load regulation	<0.1%
Line regulation	<0.1%
Board size	1.8 x 1.8 inch ²



54V \rightarrow 3.3V, 150W (Prototype)



Prototype spec:	
V_{in}	40V to 72V
$V_{in\ nom}$	54V
$V_{out\ nom}$	3.3V +/-1%
P_o	150W
Output current	44A
Frequency of operation	250KHz
Power density	160W/inch ²
Actual Peak Efficiency	95%
Load regulation	<0.1%
Line regulation	<0.1%
Board size	3.3 x 0.9 inch ²



54V → 1.21V, 50W (Prototype)

- Dual Cell Design: 54V to 1.2V
- 50A TDC at 1.21V
- 93.8% Peak Efficiency

