Industrial Power

Industrial & Healthcare Business Unit

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AVNET
Reach Further™

Smarter and Smaller Systems Have a Profound Impact on Power System Architecture

- Higher Efficiency - Low Thermal Dissipation
- Small Size – High Integration
- Ease of Use and Faster Time-To-Market
- Robust and Reliable

Maxim Enables Industry Transformation

Power Dissipation, Size, Cost, Ease of Use

System Protection

- Integrated FETs
- 50% smaller solution size
- More robust

HV Bucks Sync Rectification

- 50% cooler
- 50% less space
- 75% less BOM count
- Internal FETs & compensation

No Opto Isolated Power

- Eliminate optocouplers
- Flyback & Iso Buck
- High efficiency active clamp

Industrial PMICs

- Multi-rail Solutions – reduce solution size
- Reduce Solution Size
- Reduce Total Cost of Ownership
- High Efficiency Synchronous Solutions

MOSFET Drivers

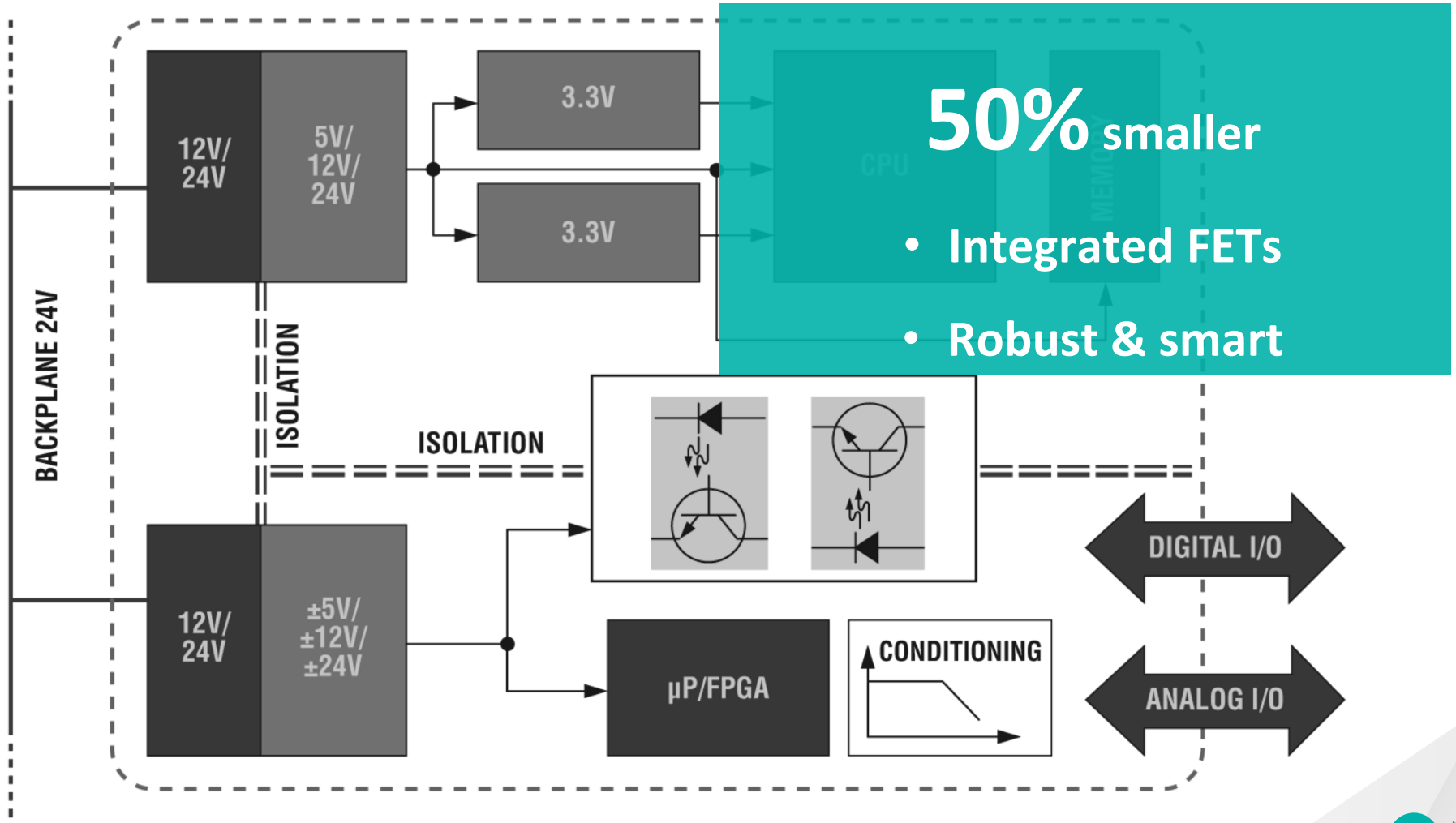
- Single and dual configurations
- Fast propagation delays
- Smallest packages & P2P options

Power Modules

- Ease of use
- QFN-like pinout
- P2P in same size
- Shielded inductor

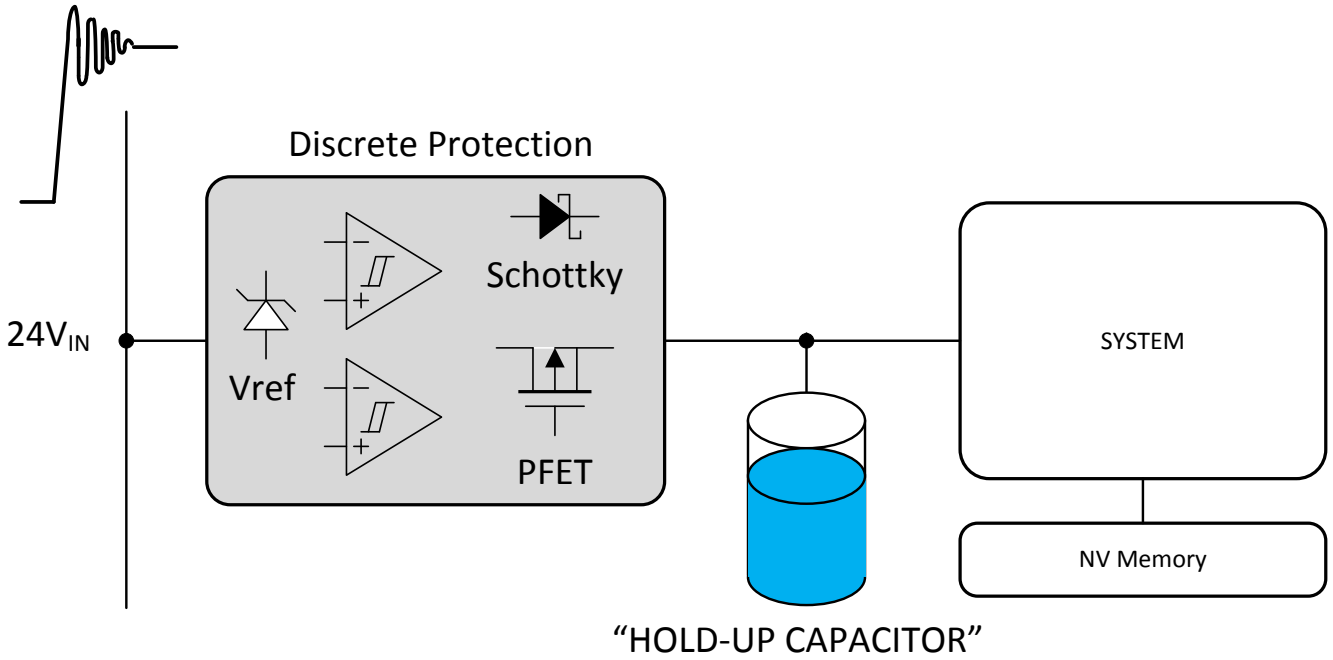
Protect Against Voltage and Current Faults

- **Protection**
- Isolated
- FET Drivers
- DC-DC
- PMICs
- Power Modules



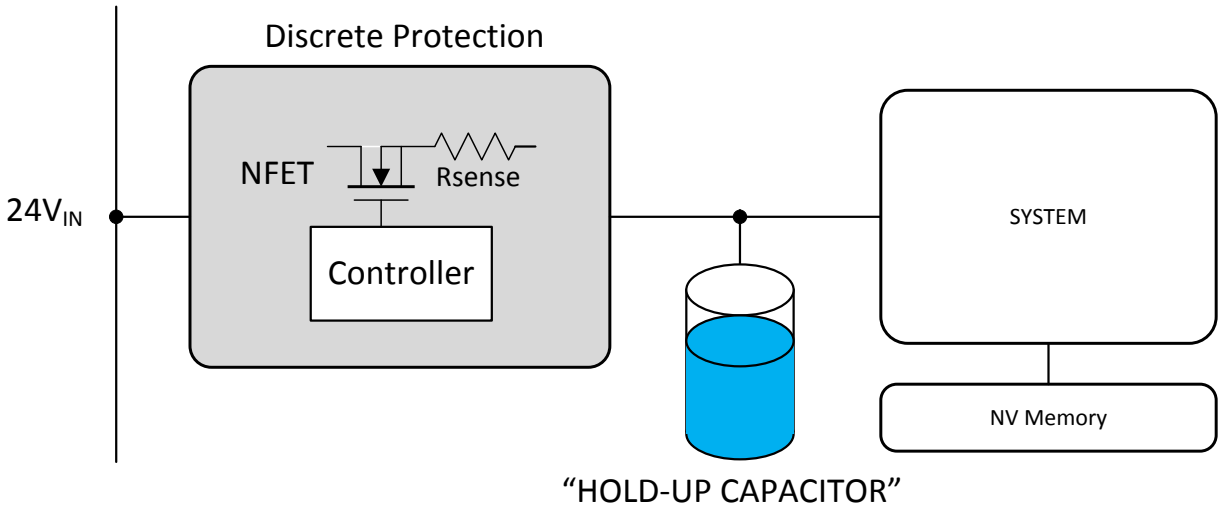
Voltage Protection

- Hot plugging causes supply bounce
- Surges and transients cause overvoltage events
- Supply reversal can occur during improper cabling

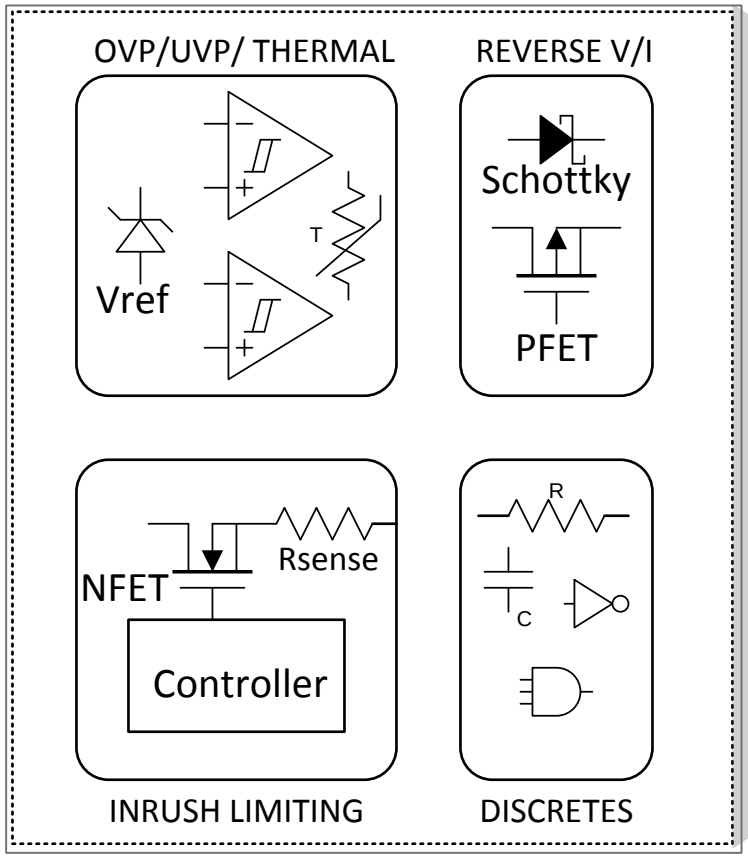


Current Protection

- Limit inrush current that bulk “hold-up” capacitors draw
- Isolate short-circuits on the system side from the supply side
- Short-circuits can also occur on the supply side and cause large reverse currents that must not discharge the capacitors



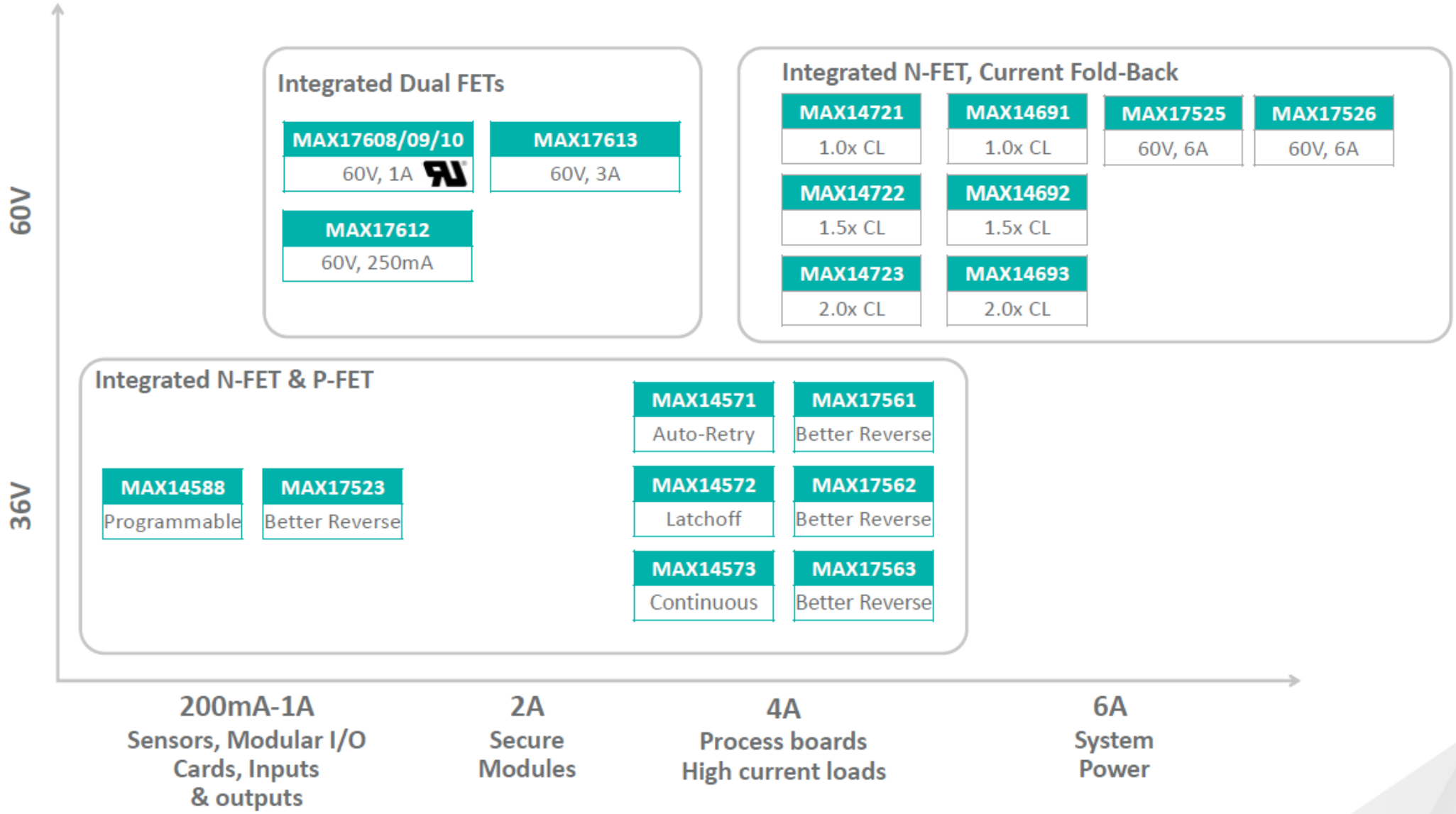
High Integration = Reliable Protection



Maxim Solution

- Smallest Solution Size
- Reduce qualification challenges
- Lower system costs

Part Selection Table



4.5V to 60V, 0.15A to 3A Adjustable Overvoltage and Overcurrent Protectors with Reverse Protection

NEW

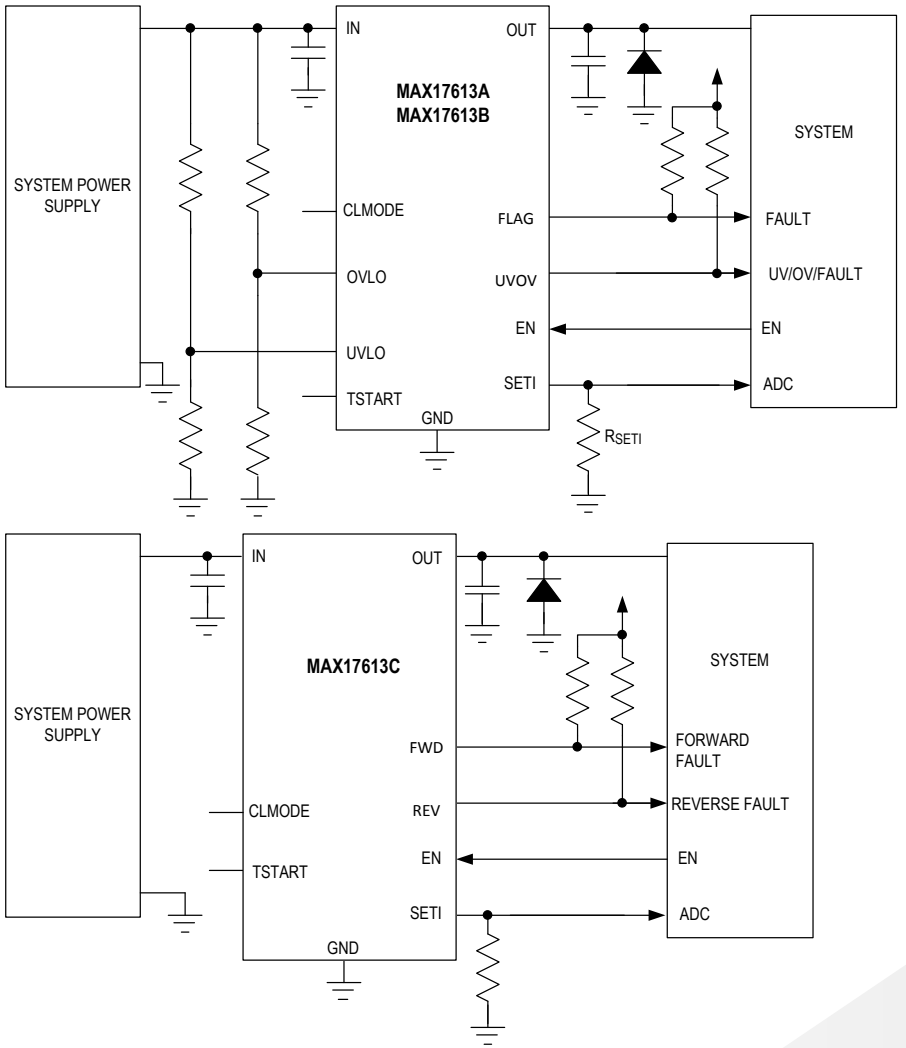
MAX17613 - Industry's most space-efficient and robust integrated protection IC

Benefits

- Wide V_{IN} increases system robustness
- Fast reverse-current protection response
- Extended operating temperature makes it suitable for a wider range of applications
- Integrated forward and reverse protection FETs reduce solution size
- Enhanced current-limit accuracy: 5%

Features

- 4.5V to 60V operating supply
- Negative polarity protection up to 60V
- Programmable forward iLIM: 0.3A to 3A
- Protection modes
  - > MAX17613A: OV, UV, forward + reverse iLIM
  - > MAX17613B: OV, UV, forward iLIM
  - > MAX17613C: forward + reverse iLIM

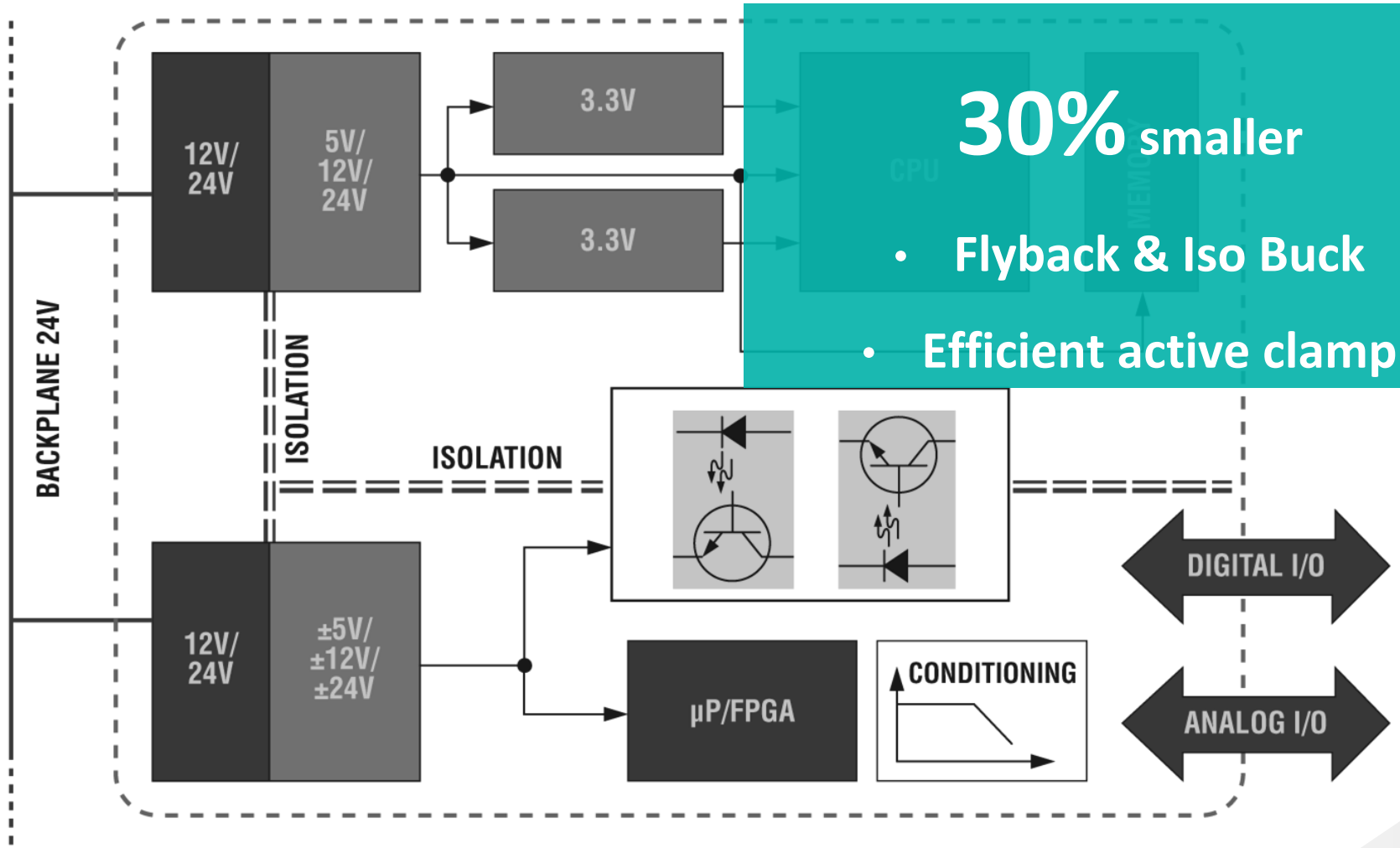


AVNET Reach Further™

maxim integrated™

Eliminate Optocouplers for Isolated DC-DC

- Protection
- **Isolated**
- FET Drivers
- DC-DC
- PMICs
- Power Modules



30% smaller

- Flyback & Iso Buck
- Efficient active clamp

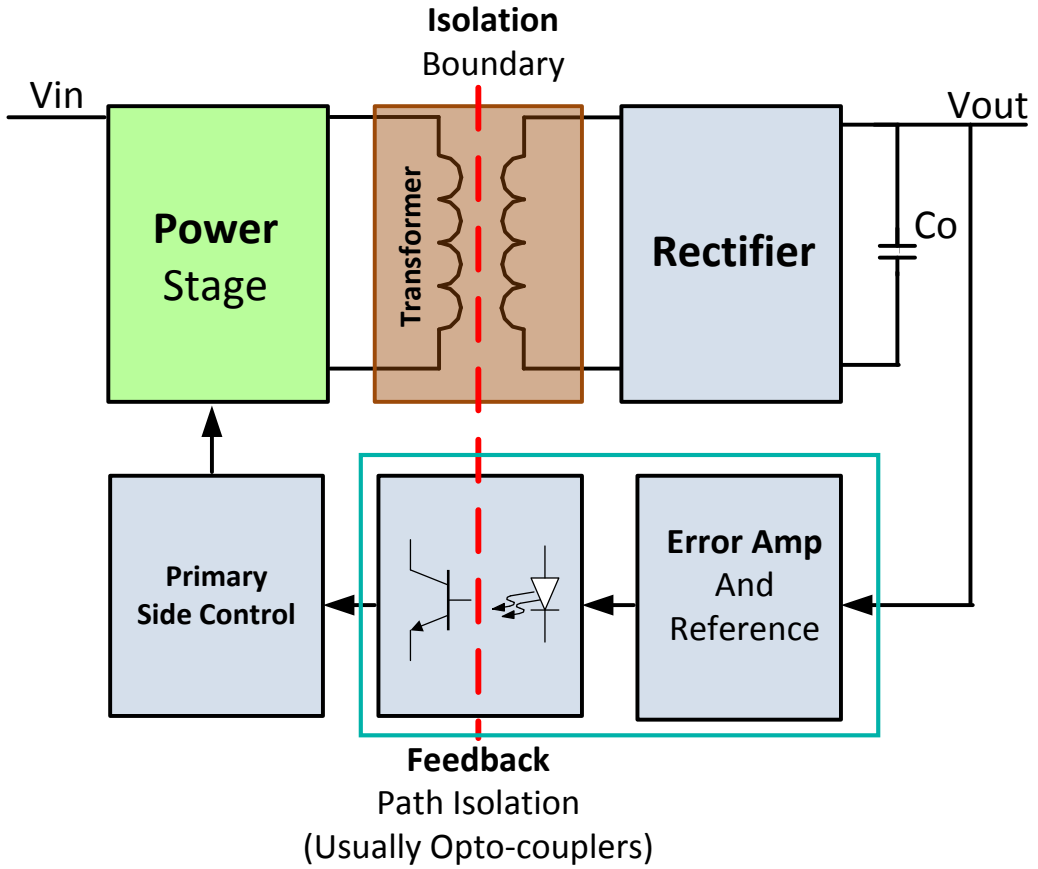
Rainier AC-DC and DC-DC Isolated Solutions

Choice of Traditional or No-Opto Solutions

- **Value**: High efficiency, smallest size, and lowest BOM
- **Why Maxim**: Eliminate unreliable Opto-couplers and related feedback components, Adjustable switching frequency for flyback/active clamp for better EMI and immunity against RF interference
- Applications
  - > Industrial and Building Automation DC-DC isolated controllers
  - > Boost for hold-up in industrial control
  - > White goods, smart meters, data concentrators, PLCs

Generic Isolated Power Supply

- Conventional Isolated DC-DC converters need:
  - > Opto-coupler
  - > Isolation transformer
  - > Secondary side Error Amp
  - > Discrete components to couple the feedback signal across the isolation boundary
- "No-Opto" technology eliminates Opto-coupler and discrete feedback



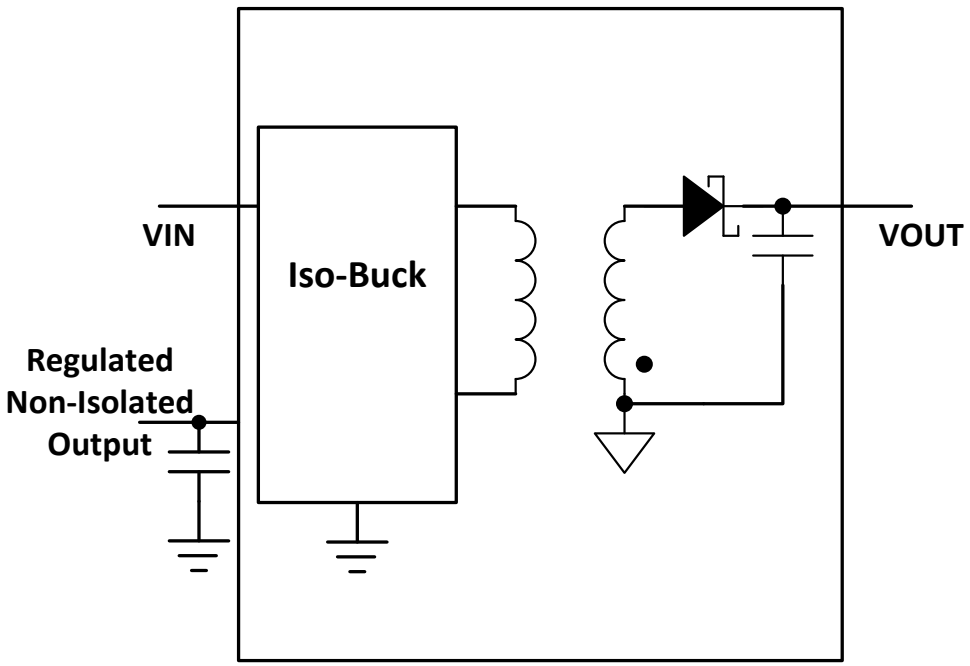
Portfolio Positioning

Specifications	MAX17596/97	MAX17599	MAX17681	MAX17686	MAX17682	MAX17687	MAX17690
Input voltage range	4V-36V	4V-36V	4.5V to 42V	4.5V to 60V	4.5V to 42V	4.5V to 60V	4.5V to 60V
Built-in FET	No	No	Yes	Yes	Yes	Yes	No
Switching frequency	100kHz to 1MHz	100kHz to 1MHz	200kHz	200kHz	100kHz to 500kHz	100kHz to 500kHz	50kHz to 250kHz
Topology	Flyback (w/Opto)	Active Clamp (w/Opto)	Iso-Buck (5W) (no Opto)	Iso-Buck (5W) (no Opto)	Iso-Buck (10W) (no Opto)	Iso-Buck (10W) (no Opto)	No-Opto Flyback
Vout accuracy	+/-3%	+/-3%	+/-8%	+/-8%	+/-8%	+/-8%	+/-5%
P_{GOOD}	No	No	Yes	Yes	Yes	Yes	No
Frequency dither	Yes	Yes	No	No	No	No	No
Sync	Yes	Yes	No	No	Yes	Yes	No
Current sense	External current sense resistor	External current sense resistor	Internal	Internal	Internal	Internal	External current sense resistor
Soft-start	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
Over current protection	Hiccup-mode	Hiccup-mode	Cycle-by-cycle/Hiccup	Cycle-by-cycle/Hiccup	Cycle-by-cycle/Hiccup	Cycle-by-cycle/Hiccup	Hiccup
Package	16 Ld. 3x3 TQFN	16 Ld. 3x3 TQFN	10 Ld. 2x3 TDFN	10 Ld. 2x3 TDFN	20 Ld. 4x4 TQFN	20 Ld. 4x4 TQFN	16 Ld. 3x3 TQFN

*Future

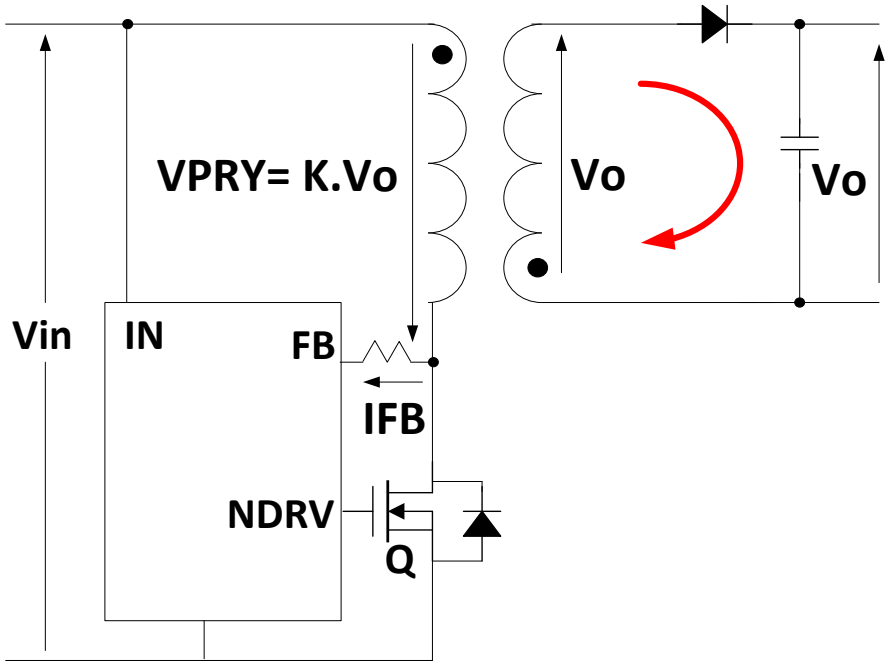
Eliminate Opto-Couplers for DC-DC Isolation

Iso-Buck



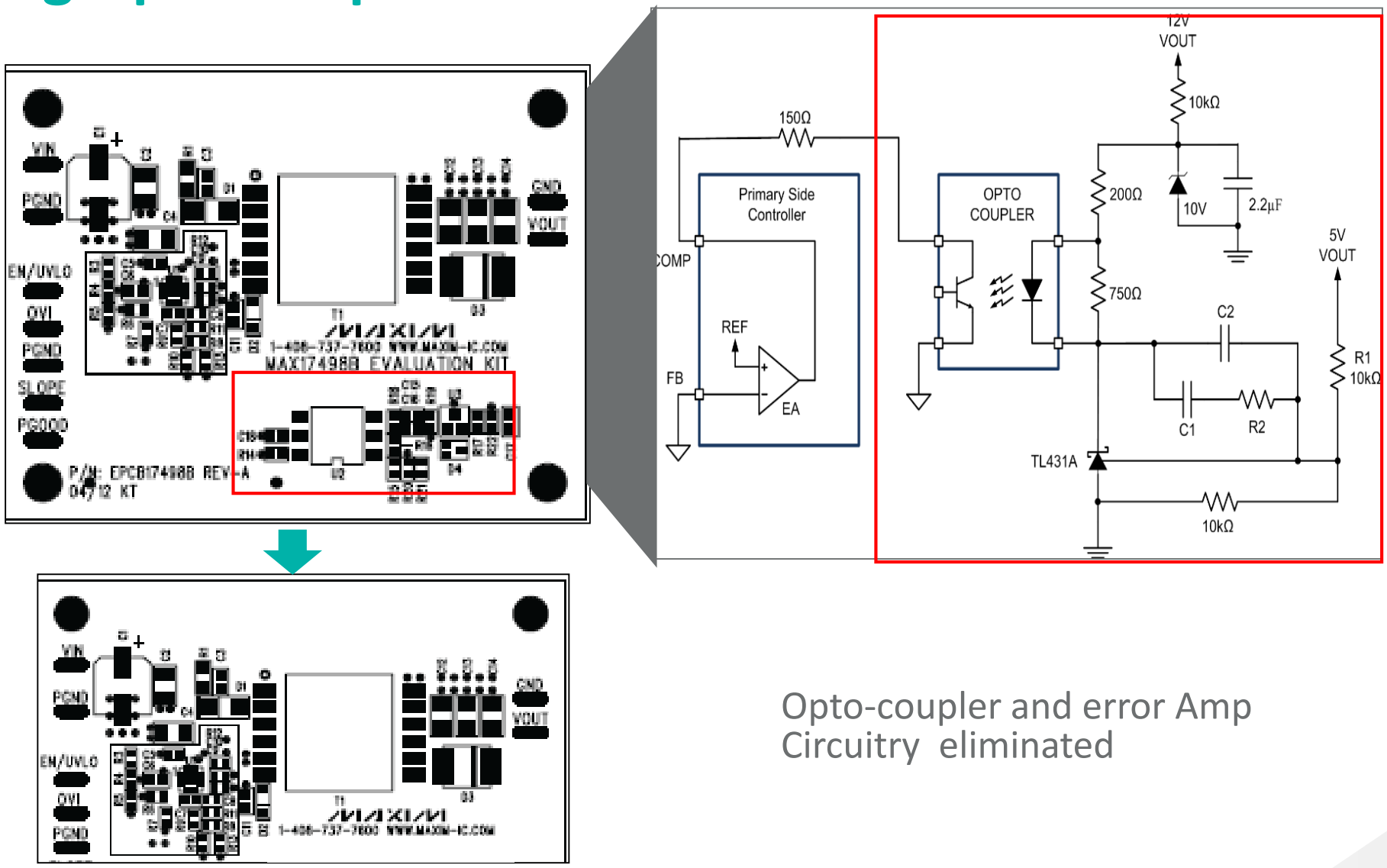
- Provides +/-10% isolated output voltage regulation
- Enables Multiple Outputs with and without Isolation
- Simple controls and only one magnetic element

No-Opto Flyback



- Provides accurate +/-5% isolated output voltage regulation
- Enables only Isolated output configurations
- Simple controls and only one magnetic element

Eliminating Opto-Coupler Saves 30% Area

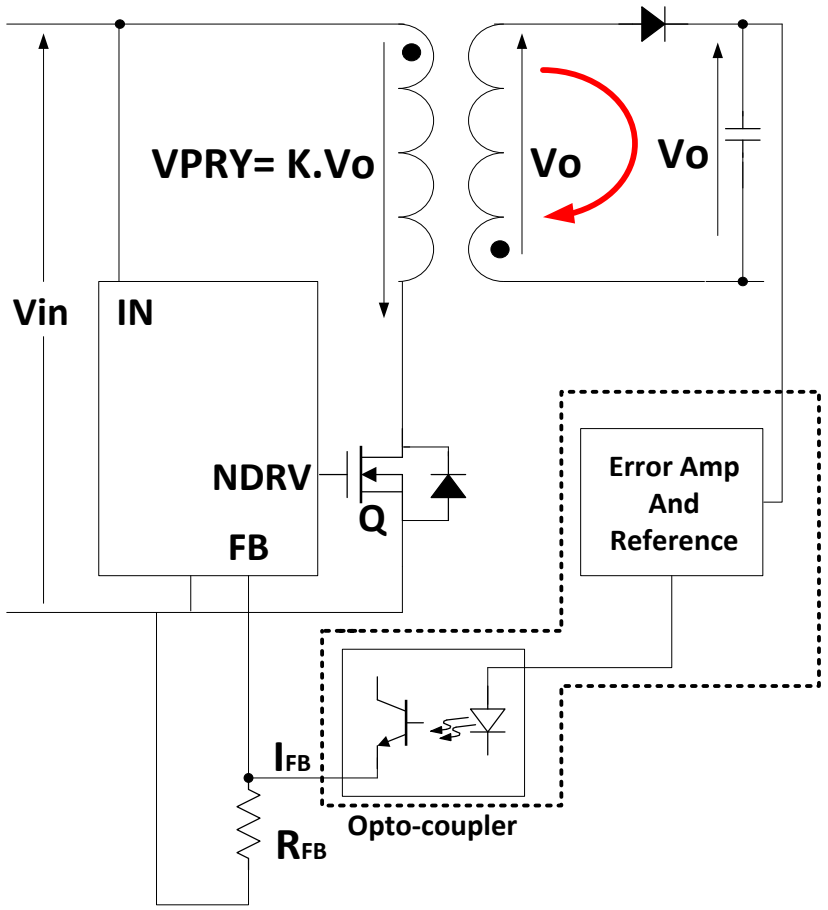


Opto-coupler and error Amp Circuitry eliminated

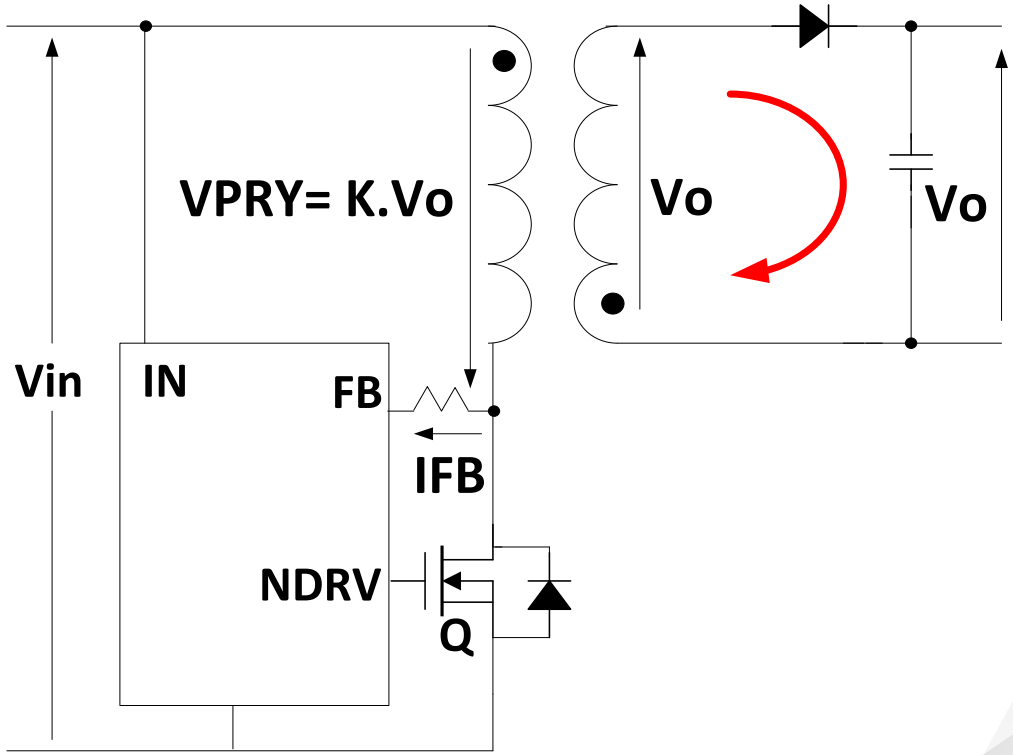
What is a No-Opto Flyback?

Primary side sensing eliminates opto-coupler and related feedback circuitry

Classic Flyback with Opto-Coupler Feedback

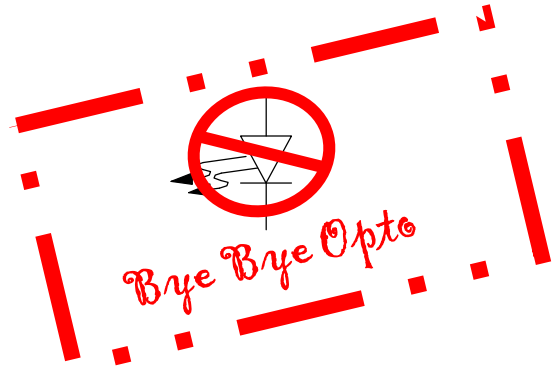


No-Opto Flyback



$$K = \frac{N_p}{N_s}$$

MAX17690- 4.5V to 60V, No-Opto Flyback



Patented Technology

USPTO # 9093910

Benefits

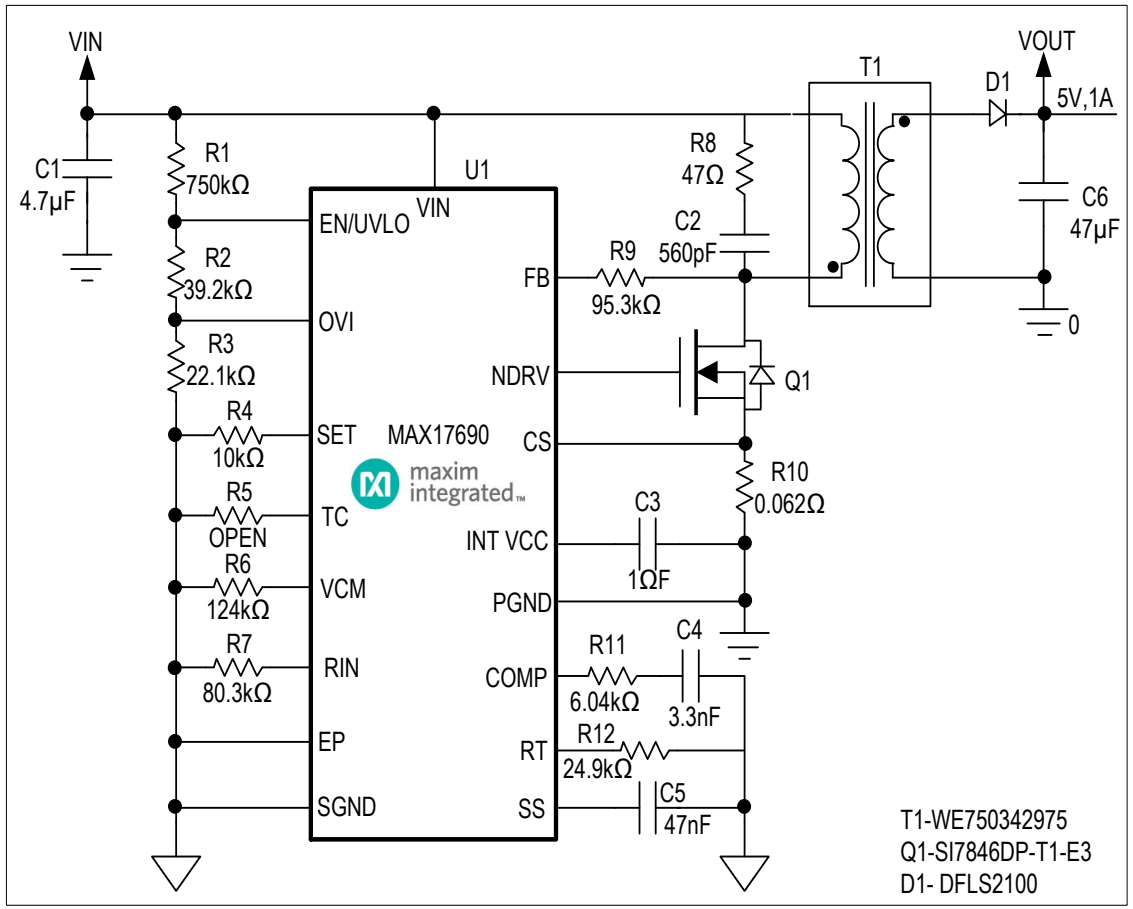
- No Opto-Coupler or Third Winding
- Low cost and less solution size
- 30% Smaller. 50% less BoM
- 5% Regulation Accuracy

Features

- Wide 4.5V-60V input
- 2A/4A Peak Source/Sink Current.
- Programmable Soft-start
- 50kHz to 250kHz fsw
- Hiccup Short-Circuit Protection

End Applications

- Industrial Power Systems
- Communications
- Medical



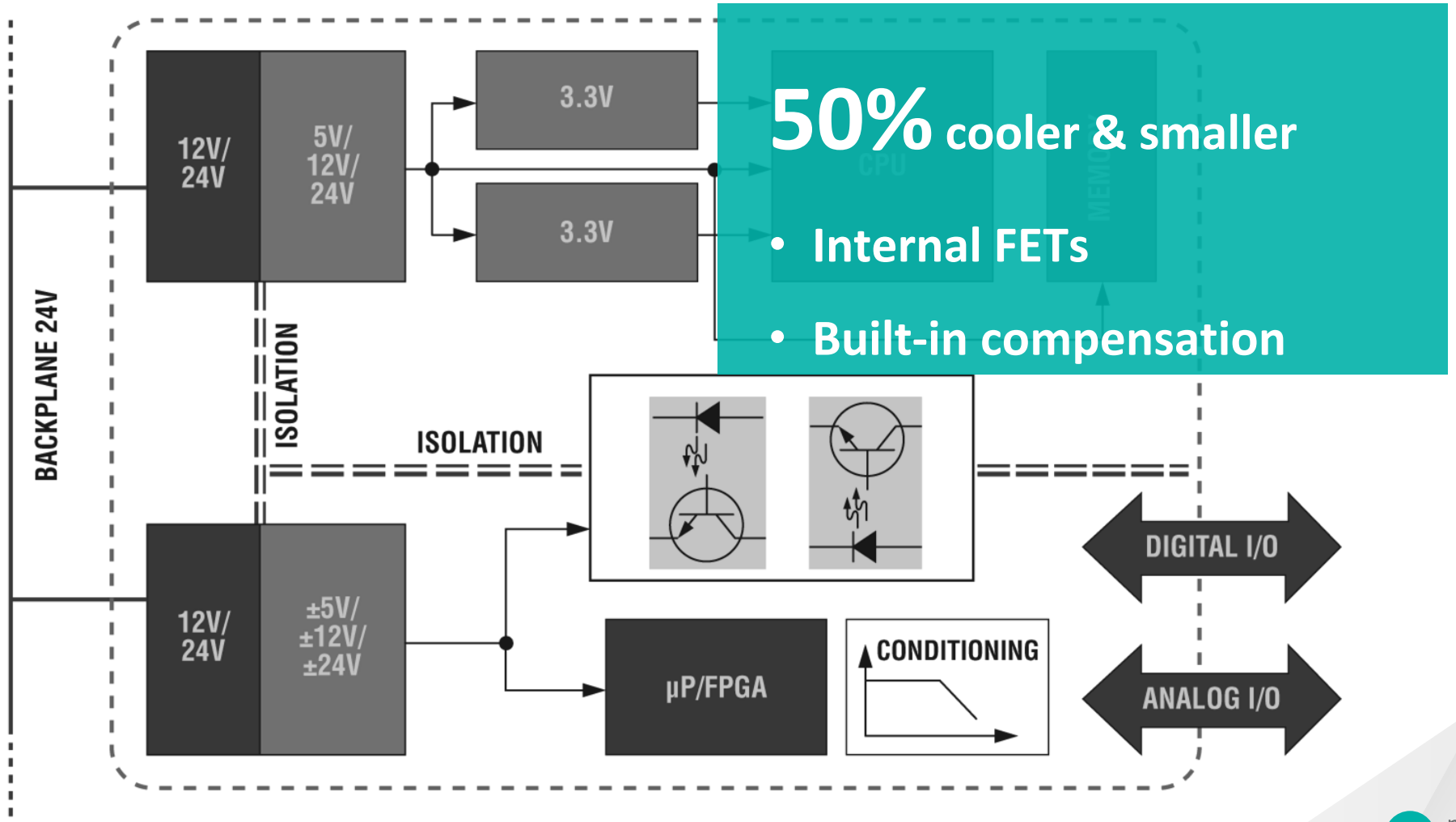
16 PIN 3x3 TQFN

AVNET Reach Further

maxim integrated

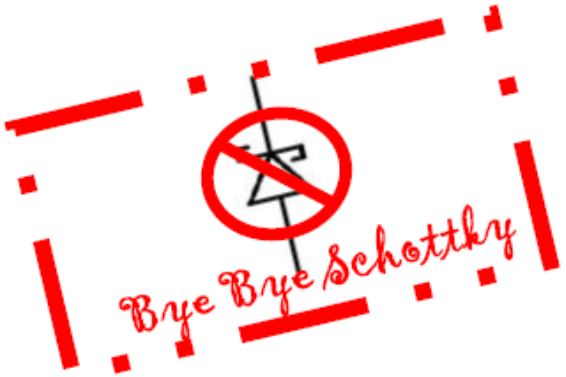
Reduce Heat Dissipation with Synchronous Himalaya DC-DC

- Protection
- Isolated
- FET Drivers
- **DC-DC**
- PMICs
- Power Modules



Himalaya 4.5-76V Synchronous Rectification High Voltage Buck Family, Boosts and LDOs

- Value
  - > Hi efficiency, low temperature, size, and solution cost
  - > Up to 50% cooler, 50% smaller solution and 75% reduction in BOM
- Why Maxim
  - > Unique process, IP, and design engineering
- Applications
  - > Industrial sensors, PLCs, I/O modules, DCS/SCADA Systems
  - > Energy storage systems
  - > Motor control and drives
- Roadmap
  - > 4.5-80V synchronous bucks
  - > Low Iq options for sensors/4-20mA loop powered applications



Optimized for Industrial Market

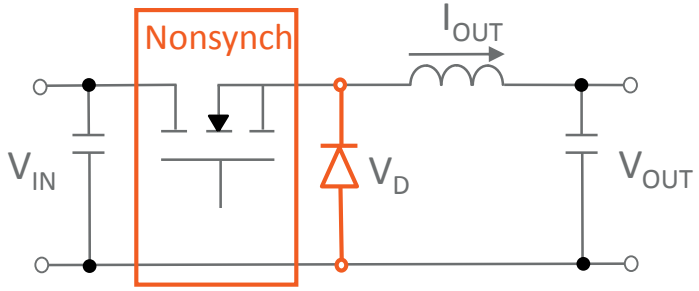
Maxim Delivers

- Optimized for 24V nominal Industrial Input
- Up to 76V operating input – protects against heavy transients
- Guaranteed over -40C to +125C temperature range
- Optimal Packaging for Industrial – Min. 0.5mm pin-pitch
- Extensive Protection schemes for robust operation
- Ease-of-Design – Minimal external components

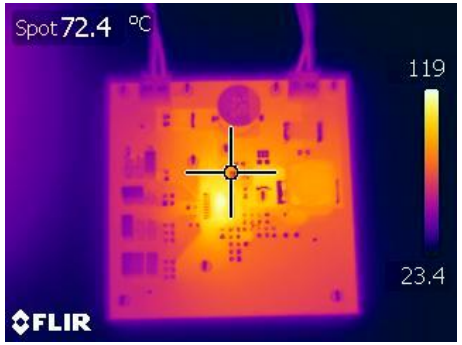
Maxim First to Bring Synchronous Switching to 60V

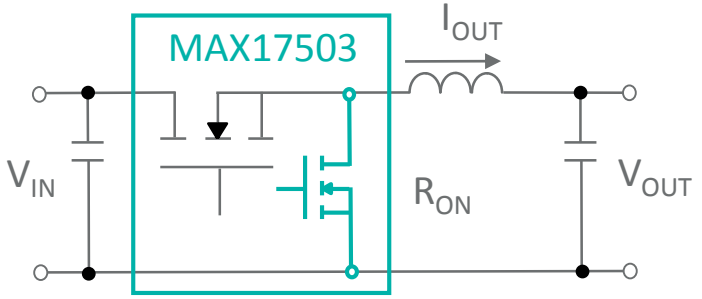
Buck Regulators Enable Cooler System Operation

EXAMPLE USED: V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 2.5A @ 500KHz

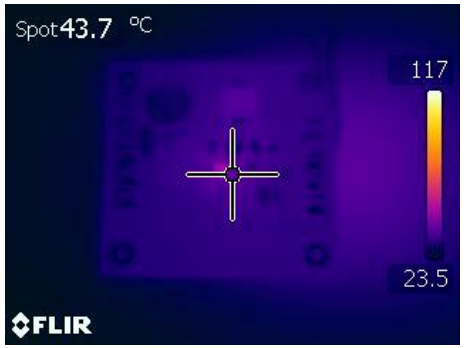


Total solution power loss = 2.3W





Total solution power loss = 1.1W

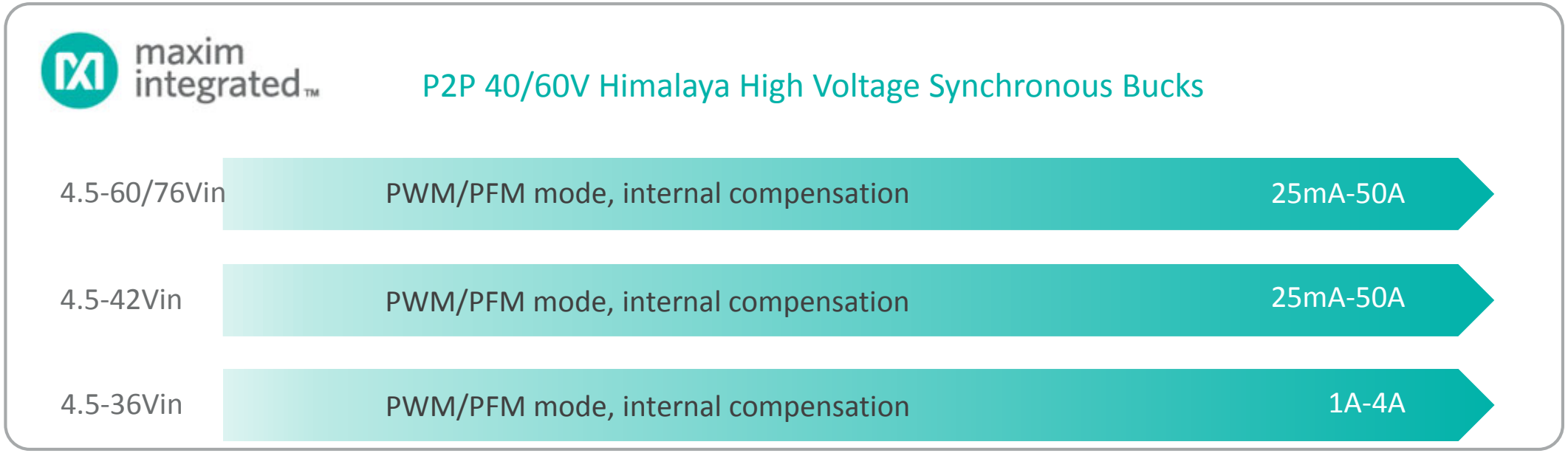


Advantage vs. Competition Asynchronous

Application: PLC I/O Module
Typical Configuration: 24Vin/5Vout, 2A, 500KHz HV Buck Regulator

Parameter	Competitor L	Competitor T	Maxim MAX17503	Advantage
Power Loss	1.8W	2.3W	1.1W	Up to 50% Cooler
Solution Size	195 sq.mm.	260 sq.mm.	137 sq.mm.	Up to 50% Smaller
BOM	14	17-21	8	Up to 75% Fewer Components

Himalaya High Voltage Buck Regulators



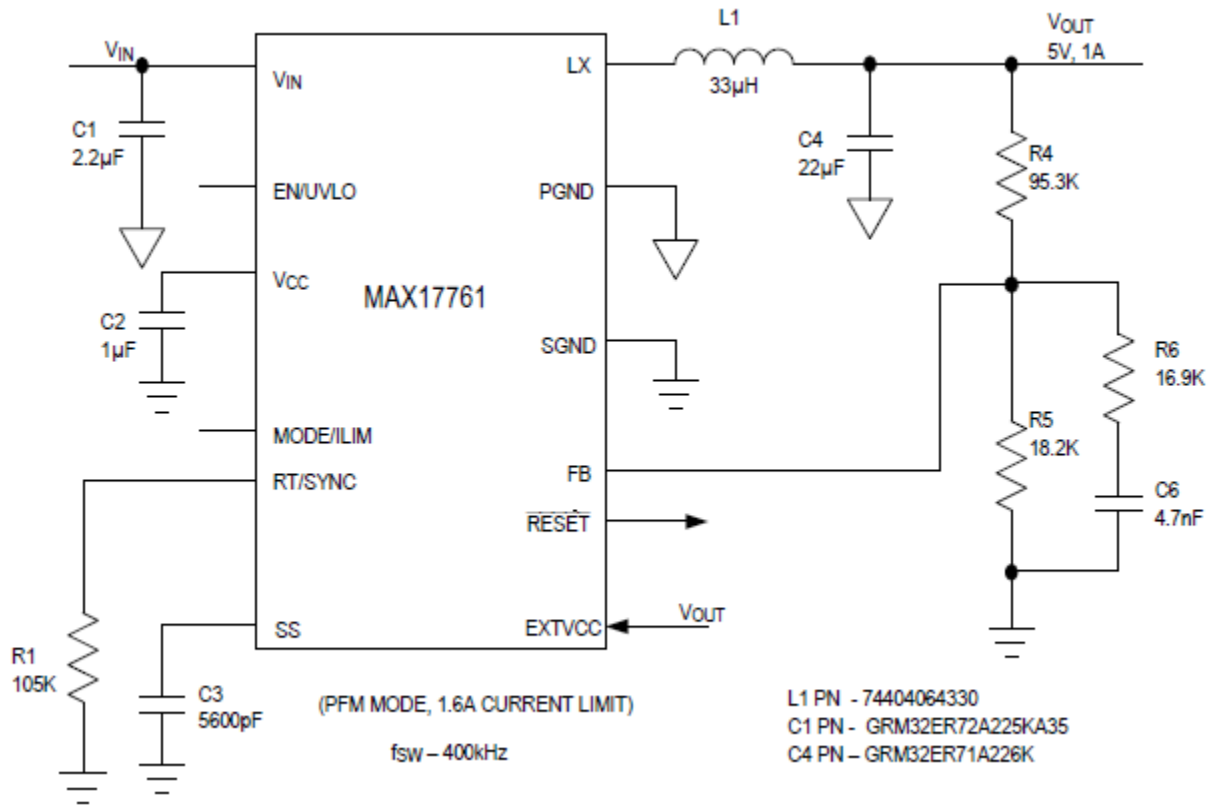
- 92% peak efficiency
- Integrated MOSFETs from 25mA to 5A; controllers up to 50A
- Wide -40°C to +125°C operating temperature range

Himalaya 4V–36/42V & 4–60V Synchronous Wide Input Bucks

Specifications	MAX17550/1/2 MAX17530/1/2	MAX15062 MAX15462	MAX17501/2 MAX17541/2 MAX17630	MAX17572/5 MAX17631	MAX17505/3 MAX17545/3 MAX17632	MAX17574	MAX17504 MAX17544 MAX17633	MAX17536 MAX17576 MAX17634	MAX17506 MAX17546
Input voltage range	4-42/60V	4.5-42/60V	4.5V-42/60V	4.5V-42/60V	4.5V-36/42/60V	4.5V-42/60V	4.5V-36/42/60V	4.5V-42/60V	4.5V-42/60V
Maximum output current	25/50/100mA	300mA	500mA/1A	1.5A/1A	2A/1.7A/2.5A	3A	3.5A	4A/4.25A	5A
Built-in High/Low FETs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Programmable frequency	Adjustable 100KHz-2.2MHz	Fixed 500KHz	Fixed 300/600KHz	Adjustable 400KHz-2.2MHz	Adjustable 200KHz-2.2MHz	Adjustable 100KHz- 2.2MHz	Adjustable 100KHz- 2.2MHz	Adjustable 100KHz- 2.2MHz	Adjustable 100KHz- 2.2MHz
Ext. Sync	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Internal compensation	Yes	Yes	Yes fixed output (3.3V/5V)	Yes	Yes	Yes	Yes	Yes	Yes
Preset output	No	3.3V,5V, Adj.	3.3V and 5V	**No**	No	**No**	No	No	No
Adj. output	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PFM mode	Yes	Yes	Yes (MAX17501)	No	Yes	Yes	Yes	Yes	Yes
Peak Efficiency	>90%	>90%	>90%	>92%	>90%	>92%	>90%	>90%	>90%
Package	TDFN10 2mmx3mm uMAX10 3mmx3mm	TDFN8 2mm x 2mm	TDFN10 3mmx2mm TSSOP14 5mmx4.4mm	TDFN12 3mmx3mm	TQFN20 4mmx4mm	TDFN24 4mmx5mm	TQFN20 5mmx5mm	TQFN20 5mmx5mm	TQFN20 5mmx5mm

MAX17761 - 4.5V to 76V, 1A Synchronous Step Down converter

NEW



Features

- 4.5V to 76Vin,1A Continuous current
- PFM/PWM Operation
- 200kHz to 600kHz Adj. Fsw with SYNC
- -40 to 125 Deg C operation

Benefits

- All Ceramic design
- Eliminates External Schottky
- High Efficiency enables cooler system operation
- Low component count

Applications

- Industrial Control power supplies
- High Voltage single board systems
- Base Station Power supplies

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MAX17651 – 4V to 60V, 100mA Linear Regulator

Benefits

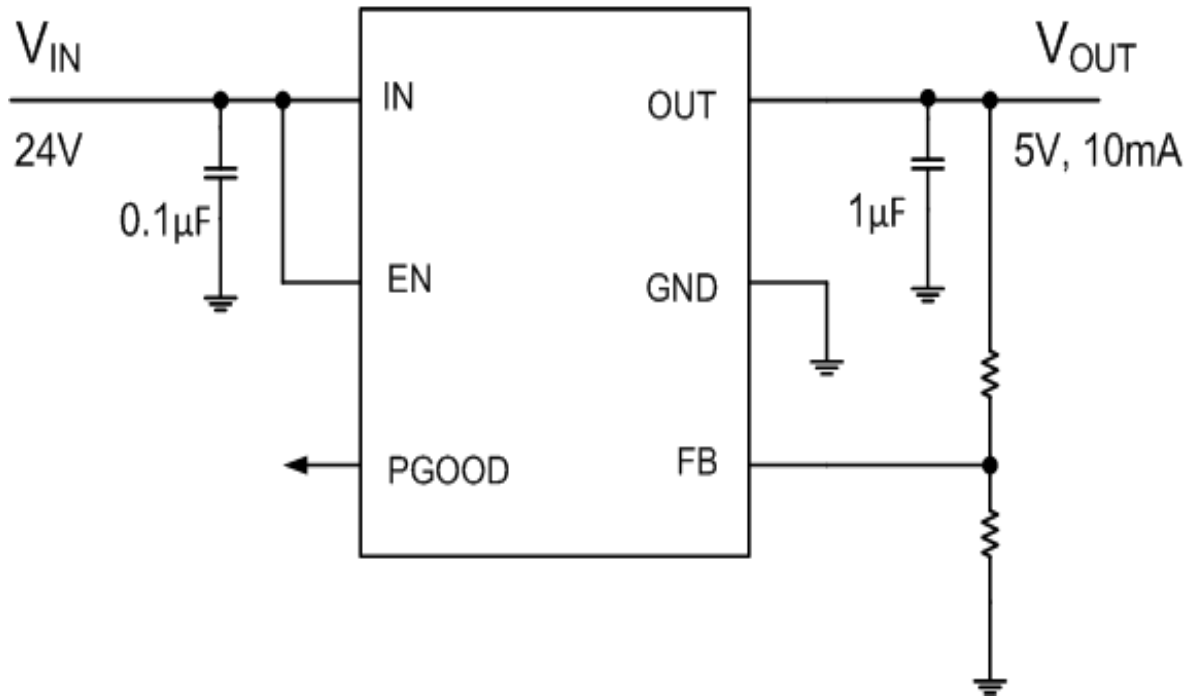
- Easy to Use with just 4 ext. components
- All Ceramic Capacitor design - compact layout
- -40C to 125C operating Junction temp
- Robust Protection Features

Features

- 4V to 60Vin, 0.6 to 59.5Vout, 100mA Iout
- 7µA No Load quiescent current
- 500mV dropout at 50mA
- Over-current protection, Thermal shutdown

Applications

- Low Current/Battery operated Industrial Power
- Utility meters
- Post Regulator for Switching Power Supplies
- Signal Chain Power for Process Control



Space Saving 6L TSOT

MAX15062

4.5V to 60V, 300mA Synchronous Buck Regulator

Benefits

- Widest input and output
- Smallest package & solution
- -40 to 125C
- As low as 4 *external components*
- Built-in monitoring, protection

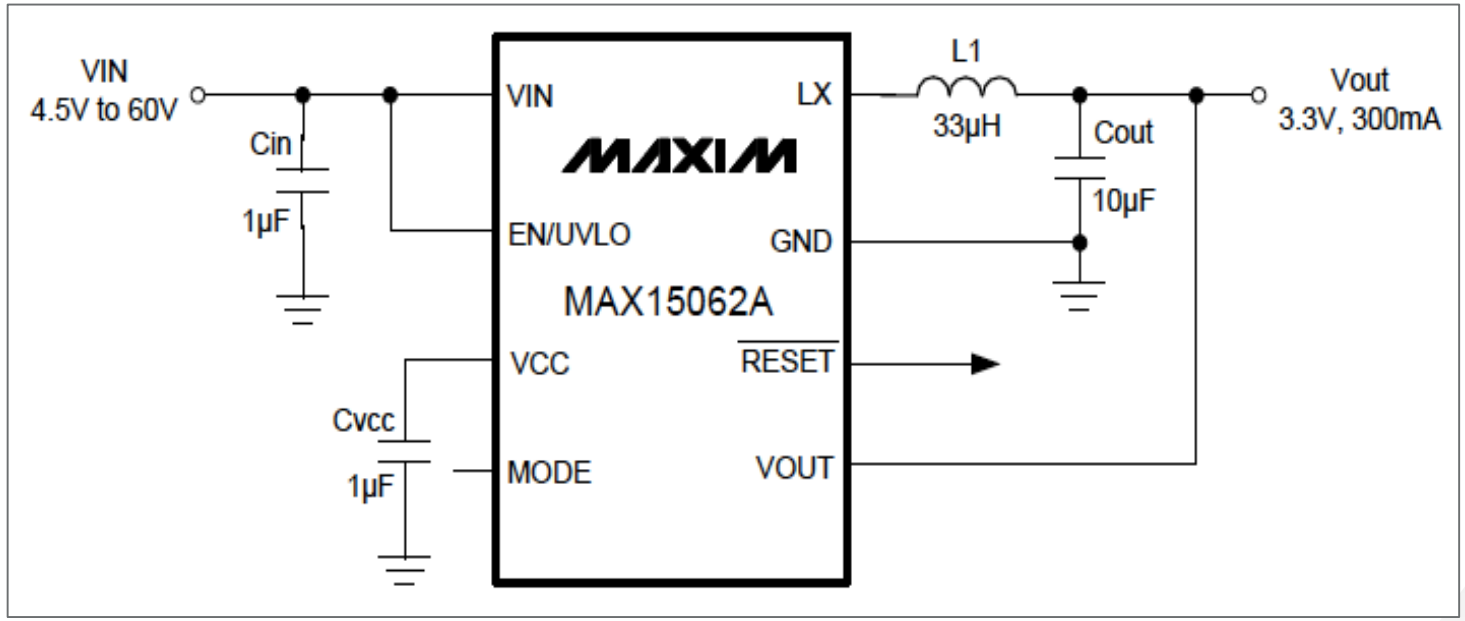
Features

- PFM/PWM – High Efficiency 500kHz Fsw
- 3.3V & 5V Fixed Vout; Adj Vout
- Internal compensation
- 92% Peak efficiency

Applications

- Factory /Bldg Automation
- Telecom
- General purpose

Typical operating circuit



2mm x 2mm TDFN8

3mm x 3mm uMAX10

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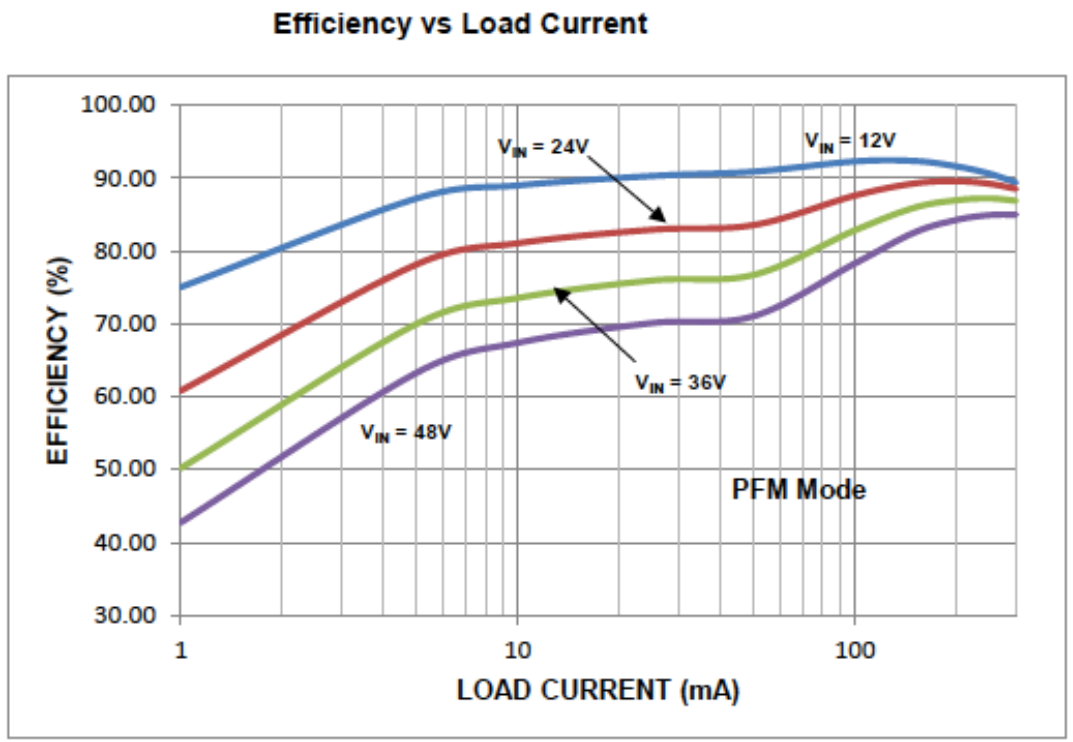
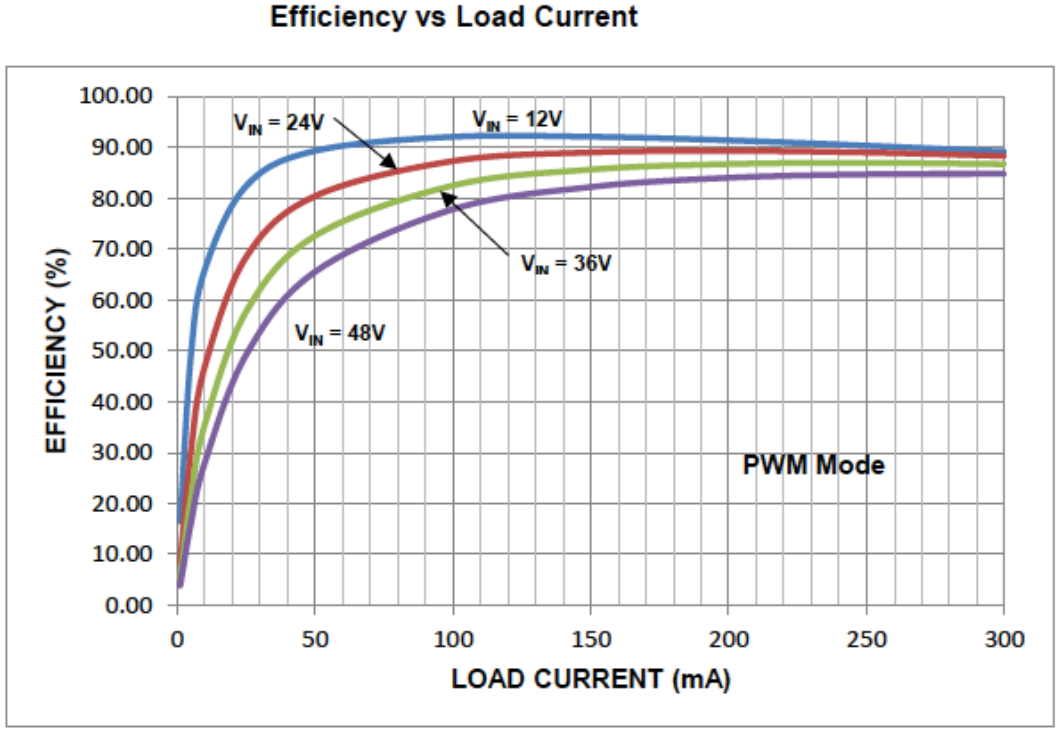
MAX15062 - 89% Efficiency at 24Vin/5Vout

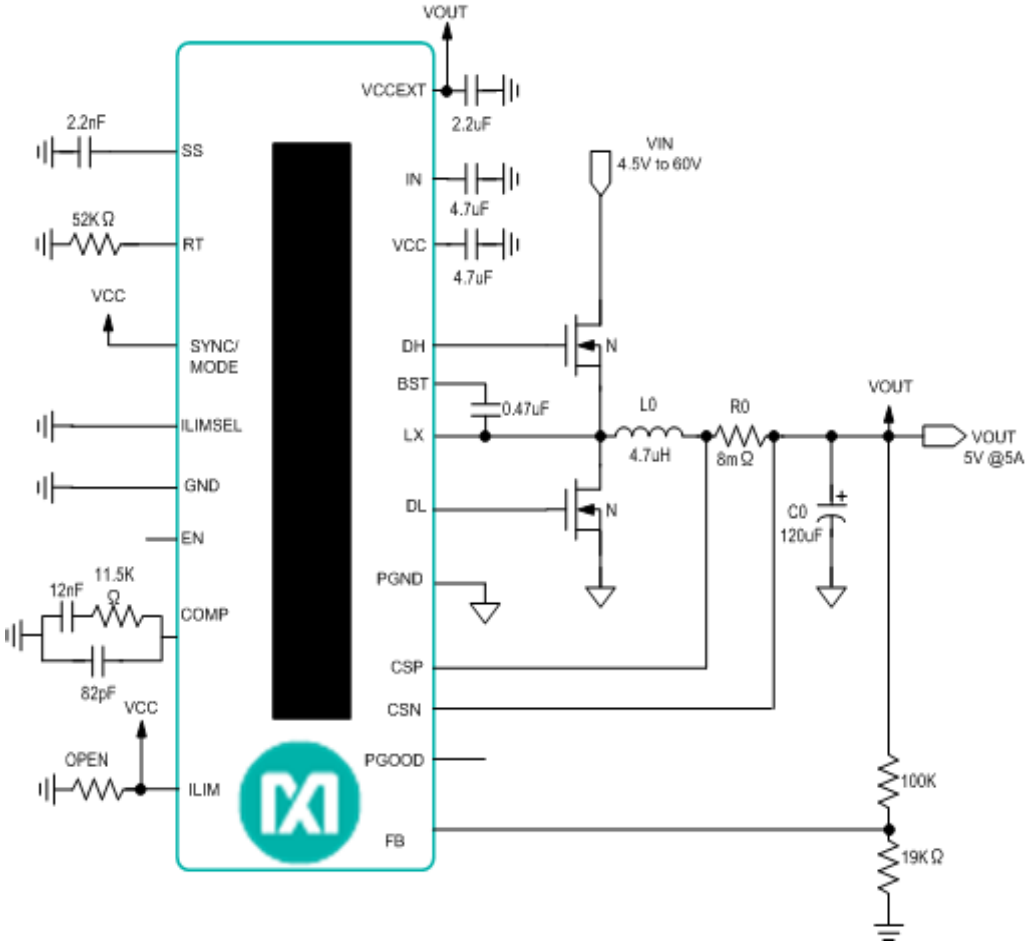


PFM



PWM

MAX17557 - 4.5V to 60V, External FET Step-Down DC-DC Controller



20 PIN 4x4 TQFN

Features

- 4.5V to 60V operating supply
- 100kHz to 1.1MHz Programmable Fsw
- Selectable DCM/PWM Operation
- SYNC to external clock
- Adj. Soft-Start and UVLO/EN threshold
- -40 to 125 Deg C operation

Benefits

- Wide Vin increases robustness
- High accuracy with Remote Sense
- Reduce temperature rise with Vout Boot-strap
- Built-in power monitoring with PGOOD and EN

Applications

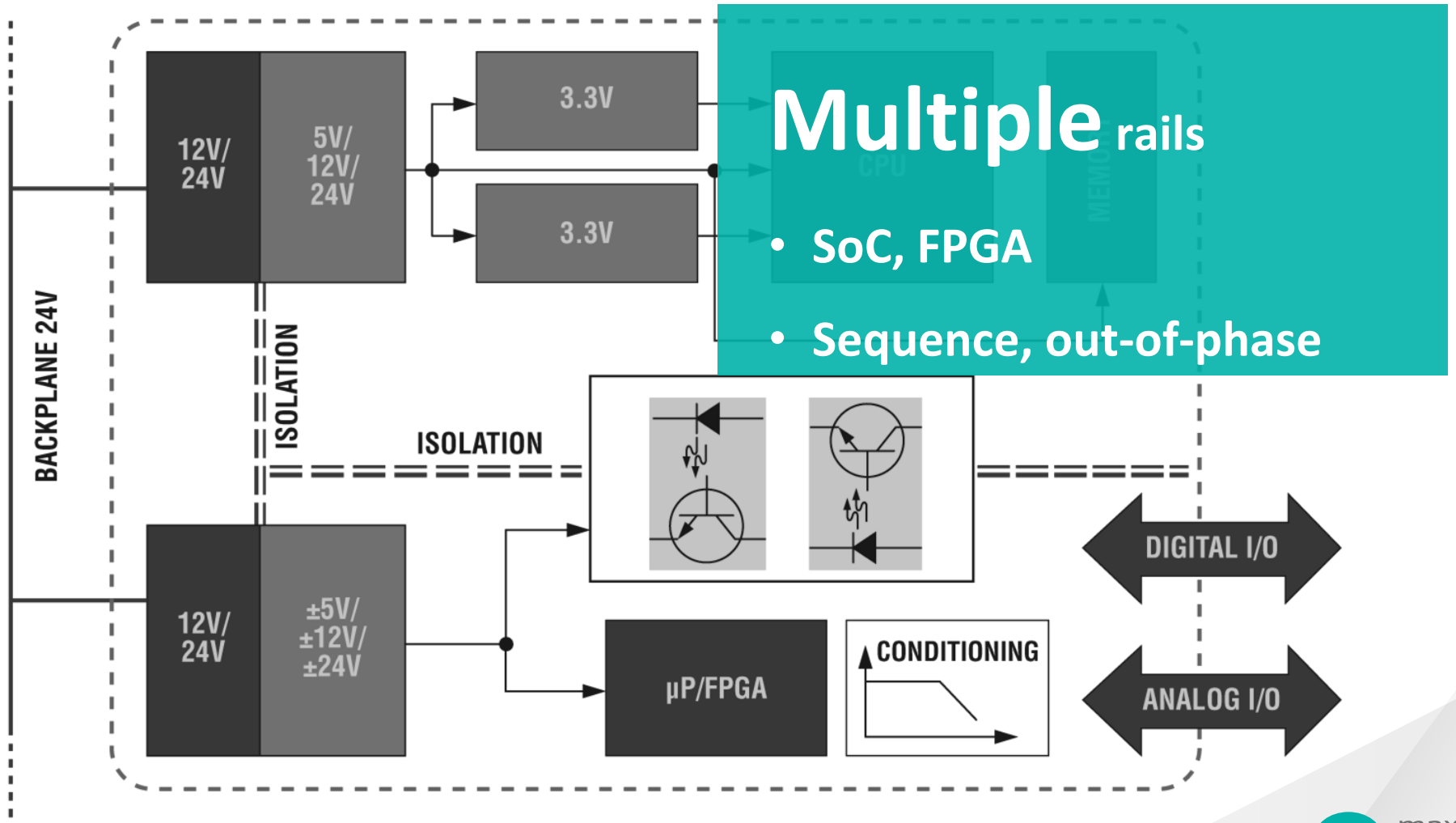
- High Voltage Telecom Power supply
- Industrial process control- PLCs
- Building Automation and HVAC
- General Purpose High Voltage Power supply

AVNET Reach Further™

maxim integrated™

Integrate High Voltage and Low Voltage Rails in One PMIC

- Protection
- Isolated
- FET Drivers
- DC-DC
- **PMICs**
- Power Modules



Industrial PMICs

Wide Input, Multi-rail PMICs

- Value
  - > Highly Integrated Multi-rail solution
  - > Reduce Solution size and Total Cost-of-Onwership
  - > Hi efficiency, low temperature, size, and solution cost
- Why Maxim
  - > Unique process, IP, and design engineering
- Applications
  - > Industrial sensors, PLCs, I/O modules, DCS/SCADA Systems
  - > Energy storage systems
  - > Motor control and drives
- Roadmap
  - > Up to 60V synchronous solutions
  - > Internal and External FET options to support 500mA to 50A load

4.5V to 60V, Synchronous 1.5A High Voltage Buck Regulator with Integrated, 2.7V to 5.5V, Dual 1A Buck Regulators

MAX17673 - Space-efficient Industrial PMIC

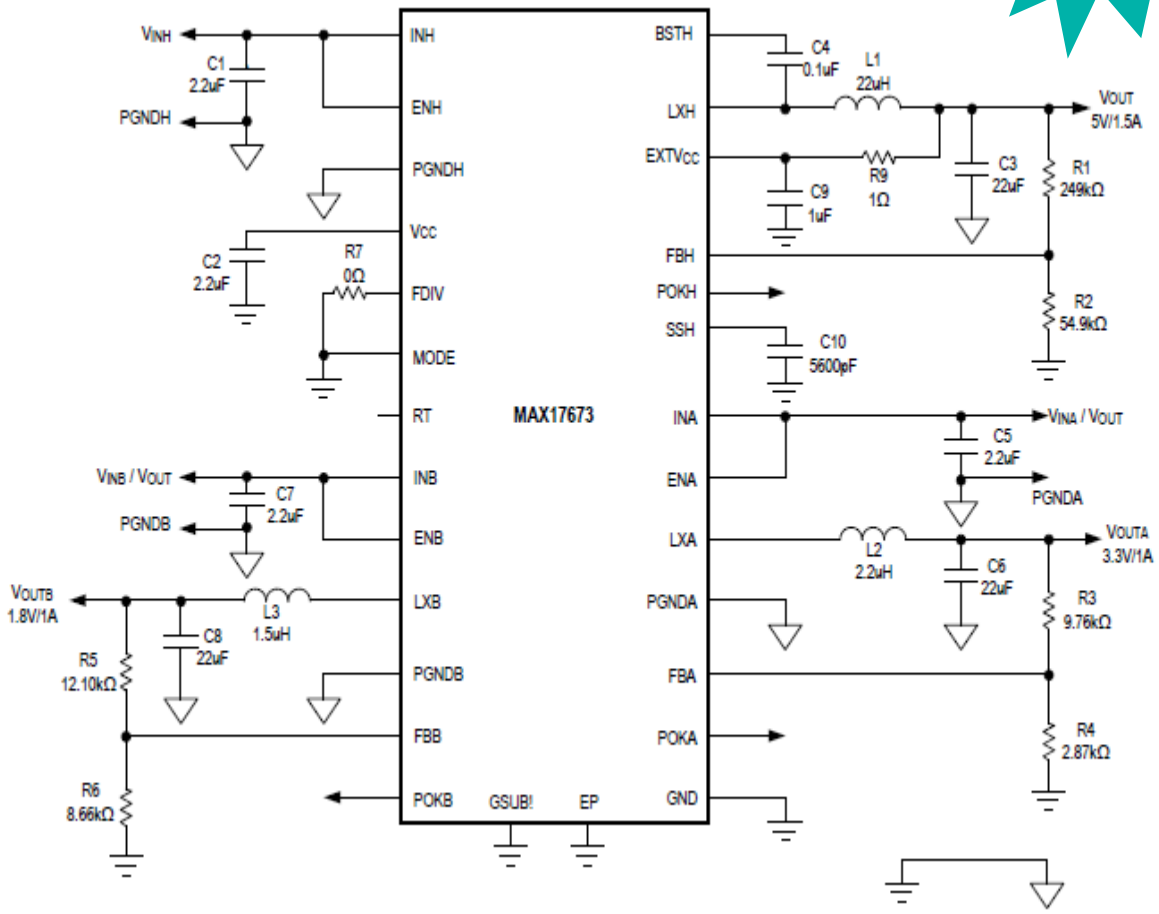
NEW

Benefits

- Wide V_{IN} increases system robustness
- All ceramic design
- Highly Integrated One-chip, multi-output PMIC reduces solution size
- High efficiency enables cooler system operation
- Low component count

Features

- High Voltage Buck Regulator: 4.5V to 60V, 1.5A
- Low Voltage Dual Buck: 2.7V to 5.5V, 1A:1A
- Independent EN (Enable) for HV and LV Bucks
- Independent POK (Power Good) for HV and LV
- Adjustable Switching Frequency:
  - HV: 250kHz to 800kHz
  - LV: 1MHz to 4MHz
- Selectable PFM/PWM Mode



Inverting Supplies Product Selector Guide

Inverting Regulators for Industrial Control

Part	Pkg	Configuration	Vin	Vout	Iout	Switching Freq	Internal FET?
ICL7661/2	8SO/DIP	Charge Pump	4.5-20V	-4.5 to -20V	600mA	500KHz	Yes
MAX17550/1/2	TDFN 2x3	DC-DC Buck	4.5-60V	-24 to -0.9V	25-100mA	100KHz – 2.2MHz	Yes
MAX15062	TDFN 2x2	DC-DC Buck	4.5-60V	-24V to -0.9V	300mA	500KHz	Yes
MAX17501/2	TDFN 2x3 TSSOP	DC-DC Buck	4.5-60V	-24 to -0.9V	0.5-1A	300KHz, 600KHz	Yes
MAX17503/5	TQFN 4x4	DC-DC Buck	4.5-60V	-24 to -0.9V	1.7-2.5A	200KHz-2.2MHz	Yes
MAX17504	TQFN 5x5	DC-DC Buck	4.5-60V	-24 to -0.9V	3.5A	200KHz-2.2MHz	Yes

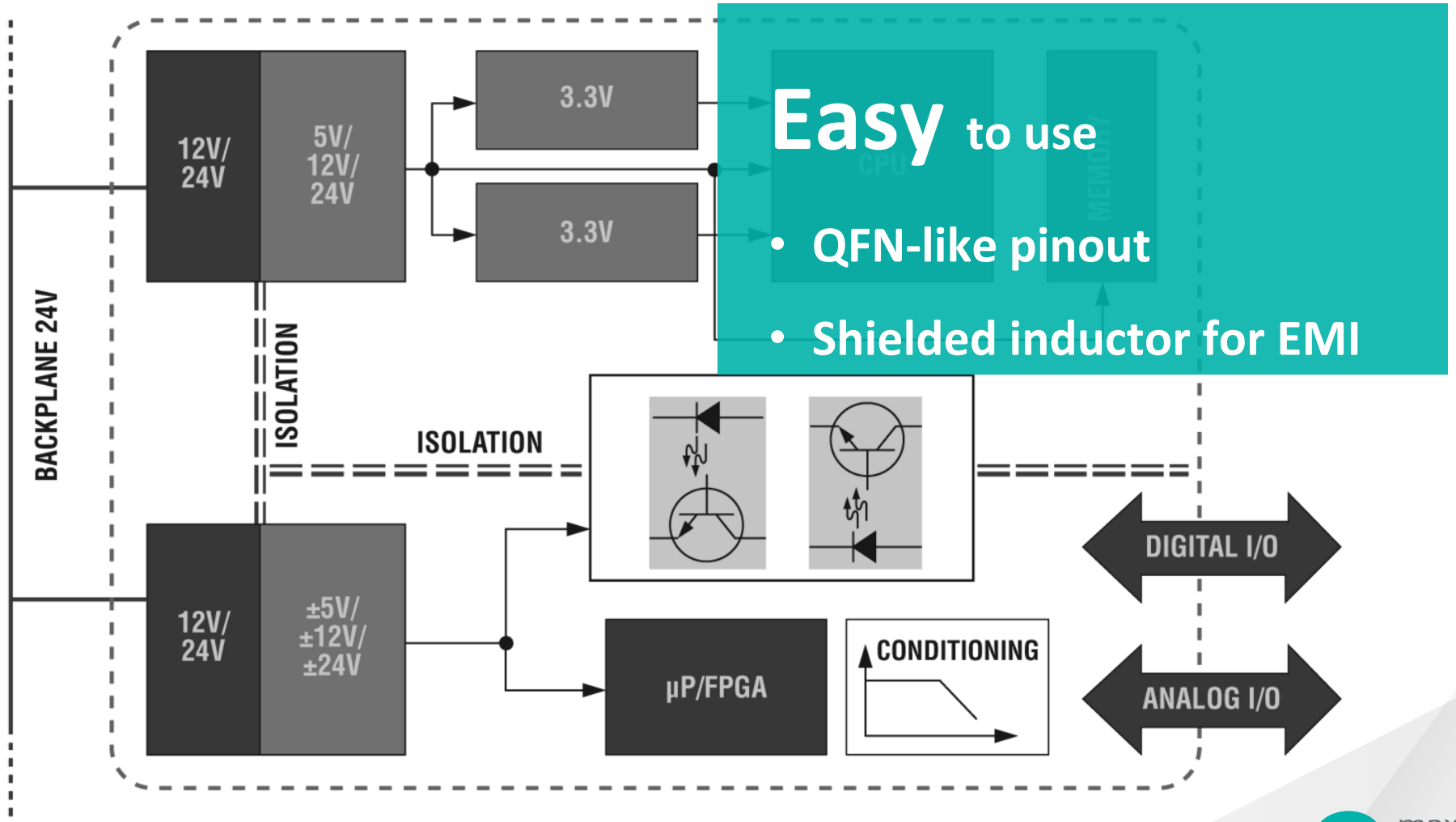
Boost Product Selector Guide

Boost Regulators for Industrial Control

Part	Pkg	Configuration	Vin	Vout	Iout	Switching Freq	Internal FET?
MAX17597	16TQFN	DC-DC Boost	4.5V–36V	Up to 250V	≥4A	100KHz-1MHz	No
MAX17498B	16TQFN	DC-DC Boost	4.5V-36V	1.25-60V	2A	500KHz	Yes 60V Boost
MAX17497B	16TQFN	DC-DC Boost + 3.3V Buck	4.5V-36V 7V-16V	1.25V-60V; 3.3V	1A; 0.6A	500KHz Boost 1MHz Buck	Yes 60V Boost Synch Buck

Reduce BoM and Complexity with Readymade Power Modules

- Protection
- Isolated
- FET Drivers
- DC-DC
- PMICs
- **Power Modules**



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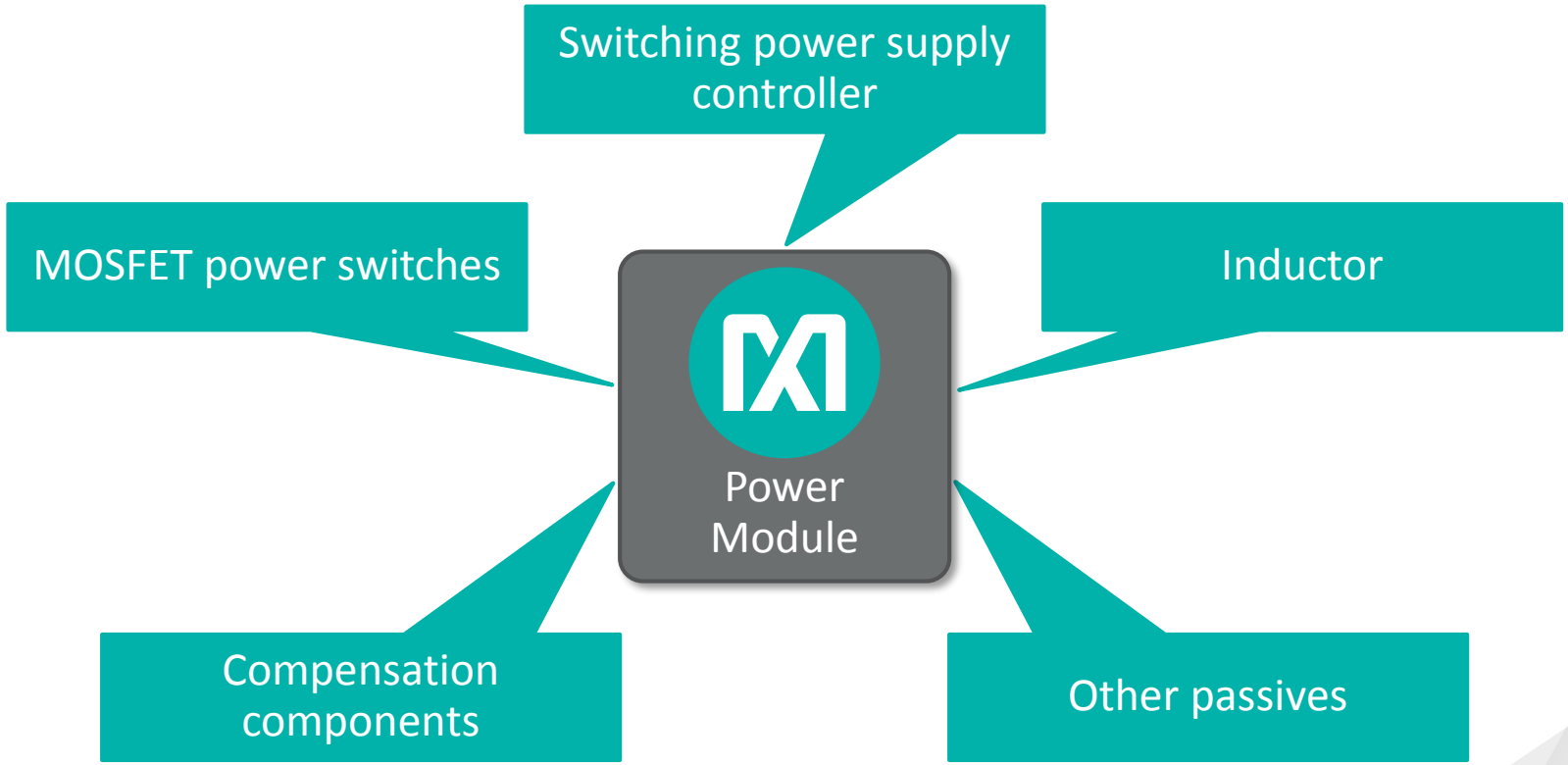
What is a Power Module?

A self-contained power solution which integrates several components

- Typically resulting in:
  - > Smaller solution size
  - > Higher power density
  - > Better reliability



Himalaya Power Modules

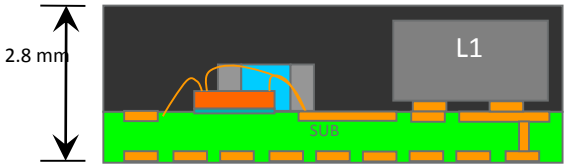
- Minimal external BOM components
- Himalaya technology delivers industry's highest efficiency
- Cost reduction path from module to IC for volume production
- EMI compliant portfolio

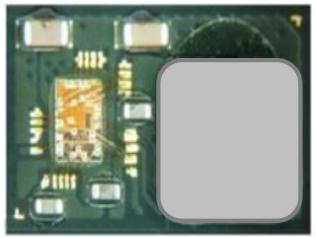
$76V_{IN}$	1A Product offering	1.0A
$60V_{IN}$	100mA to 3.5A Product offering	3.5A
$42V_{IN}$	100mA to 5A Product offering	5A
$36V_{IN}$	1A to 2A Product offering	2A
$24V_{IN}$	0.1A to 0.3A Product offering	0.3A
$5V_{IN}$	1A to 6A Product offering	6A

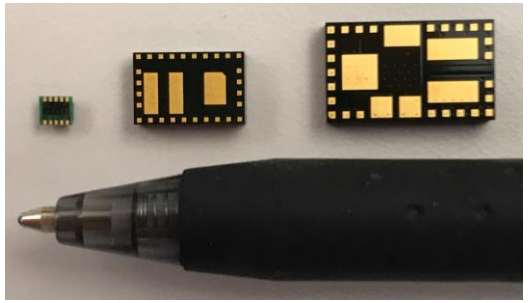
Himalaya Module Packaging

System-in-Package (SiP)

- Multiple layer substrate → **better routability**
- Wire bonding and SMT → **more integration**
- Overmolding → **rugged construction**
- Pins on periphery → **simple layout**

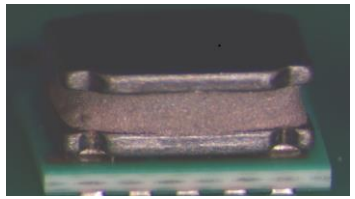


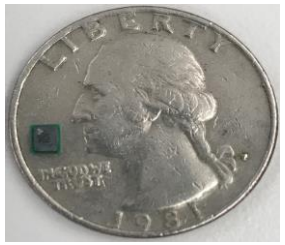




uSLIC™ package

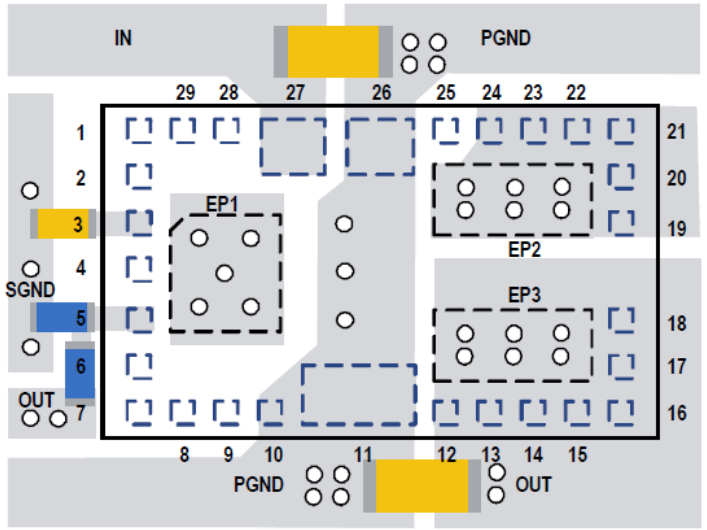
- Multiple layer substrate → **better routability**
- Inductor Stacking → **smaller footprint**
- Pick and Place → **manufacturability**
- Pins on periphery → **easier board layout**

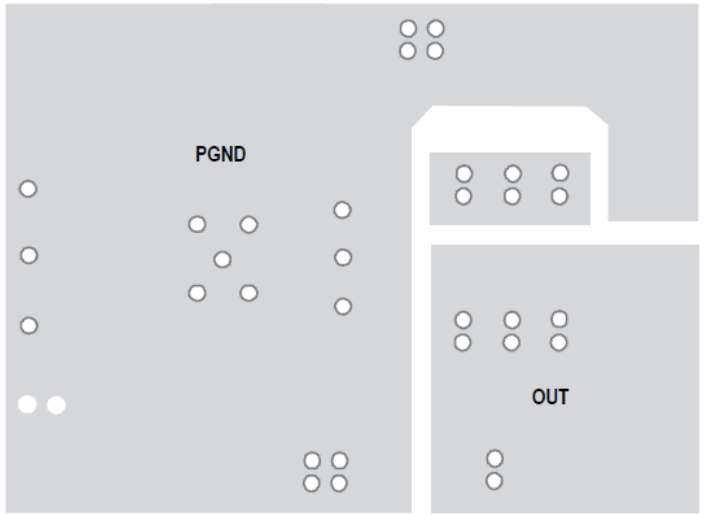




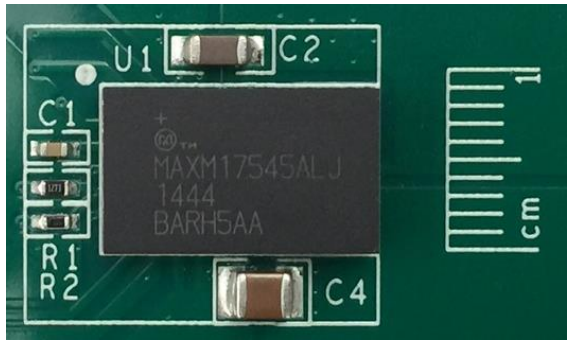
Himalaya Modules Provide True Ease-of-Use

Easy Layout





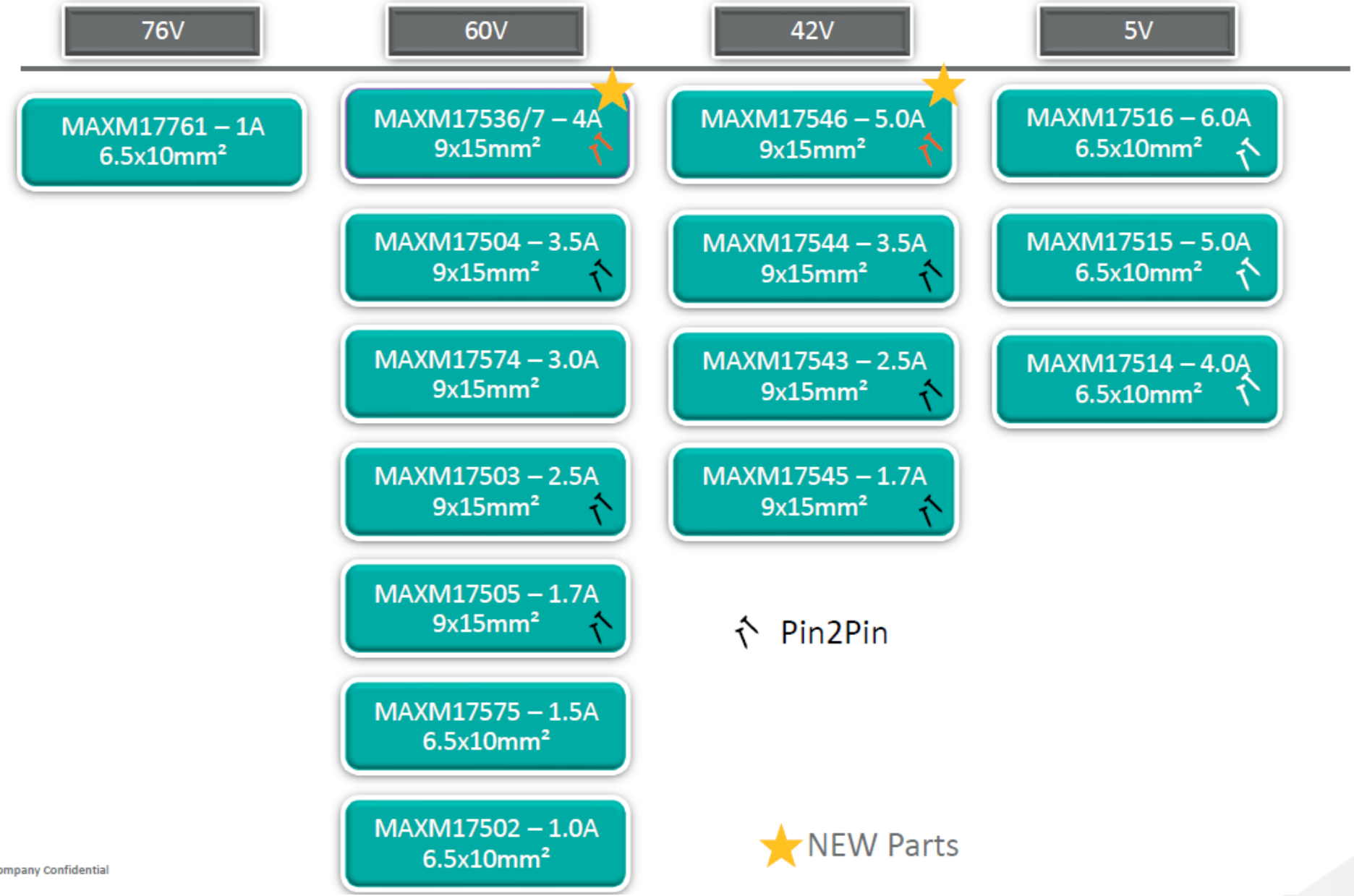
Minimal BOM



Smallest Solution

SIP Power Module Portfolio

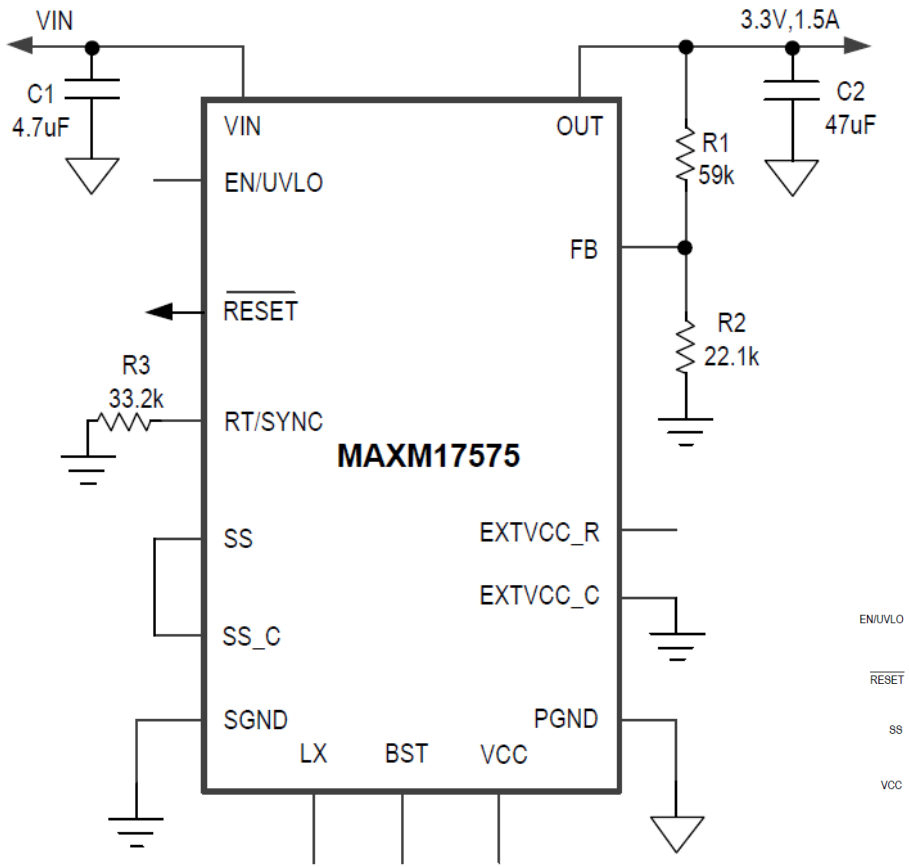
Production



MAXM17575

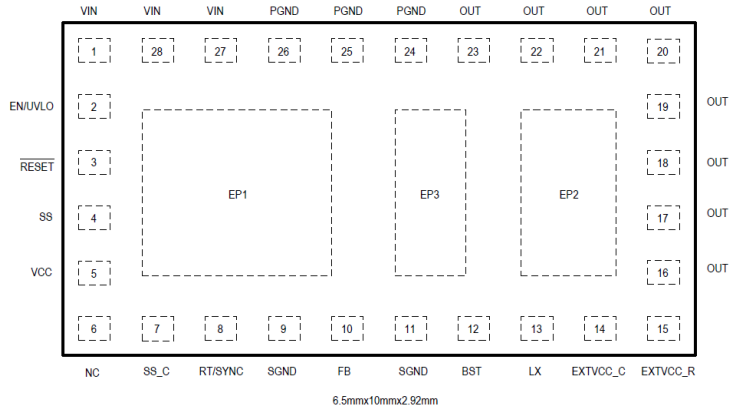
4.5V to 60V, 1.5A Integrated FET Synchronous Step Down Converter

NEW



Features

- 4.5V to 60V operating supply
- 3A continuous current
- Internal compensation
- Adjustable Frequency
- PWM/PFM/DCM modes
- Bootstrap LDO for higher efficiency
- External Synchronization



Benefits

- Compact Module solution
- Simple Layout and Ease of design
- 92% efficiency at 1.5A, 24V → 12V
- -40C to 125C operating temp

Applications

- PLCs
- Motion Control
- General purpose Industrial
- Distributed supply regulation

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Competitive Analysis

Specification	MAXM17575	LMZ36002
Input voltage	4.5V to 60V	4.5V to 60V
Output voltage	**0.9V to 12V**	2.5V to 7.5V
Max output current	1.5A	2A
Feedback voltage accuracy (-40°C to 125°C)	±1.2%	±0.9%
Built-in output-voltage monitoring	Yes	Yes
External sync frequency	Yes	Yes
Adjustable switching frequency	0.4 to 2.2MHz	0.3 to 1.0MHz
Efficiency (V_{IN}=24V) @ 5V/1.5A@900kHz	**86%**	81%
Minimum external components	2C +3R	2C +1R
Package size (mm^3)	6.5 x 10 x 2.8 – SIP	10 x 10 x 4.3

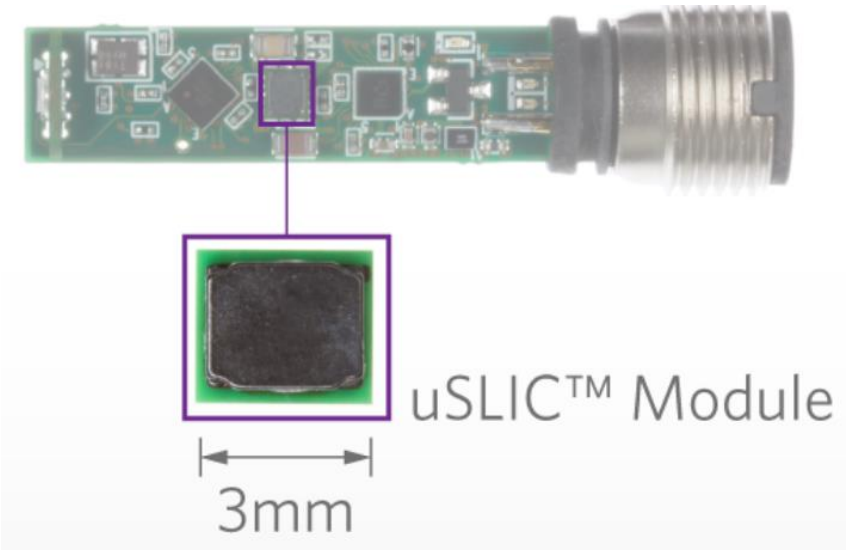
Green = advantage, **Red** = disadvantage

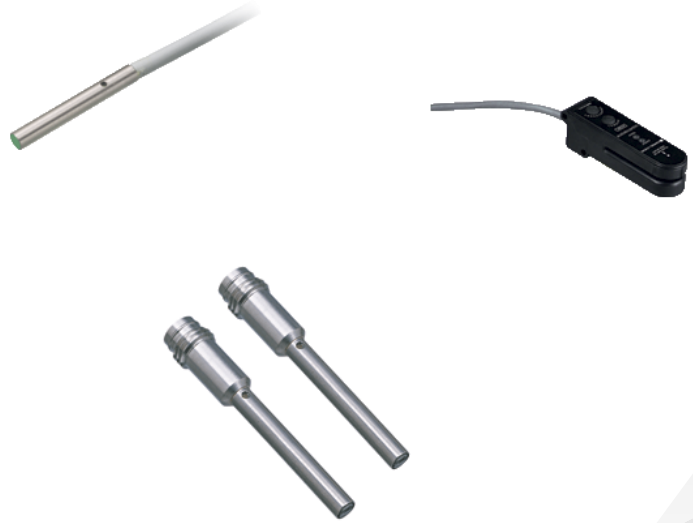
Much Better Efficiency in a smaller package

uSLIC Modules

Maxim's New uSLIC Power Modules

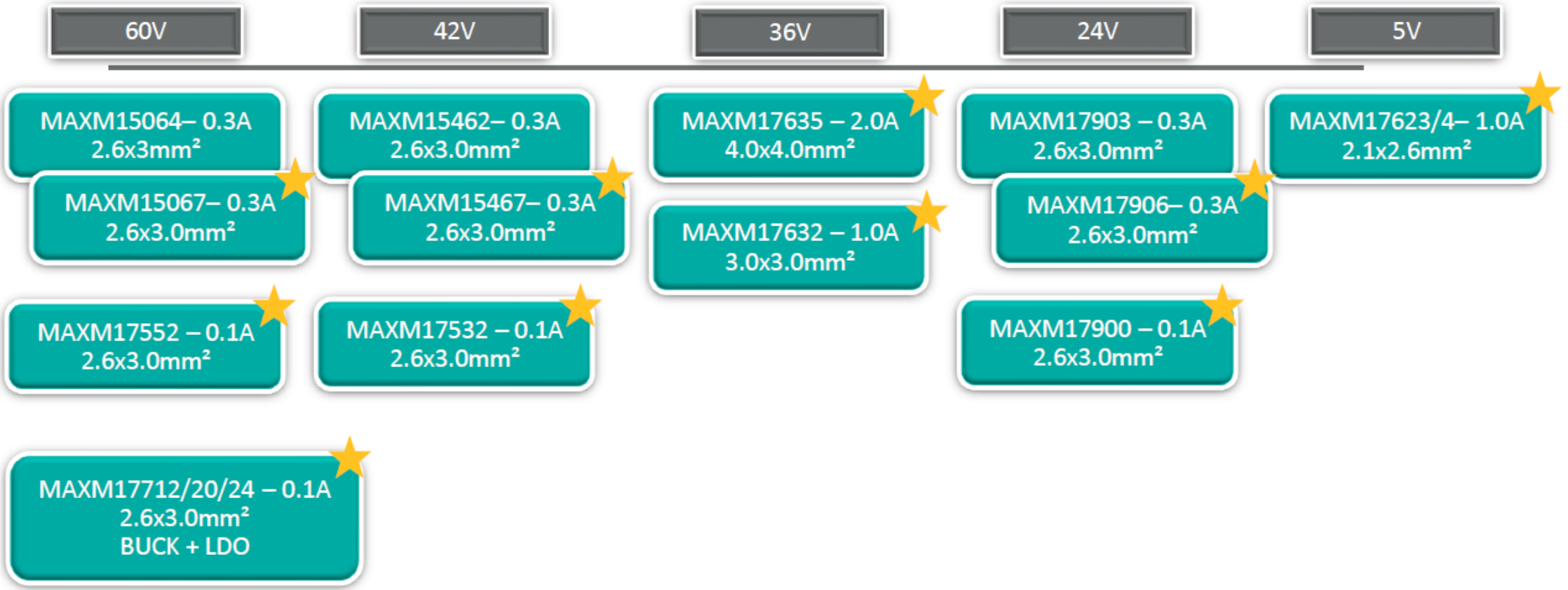
- Delivering ultra small solutions for space constrained designs
- Shrinks the power space, increases the intelligence space





uSLIC Power Module Portfolio

Production



★ NEW Parts

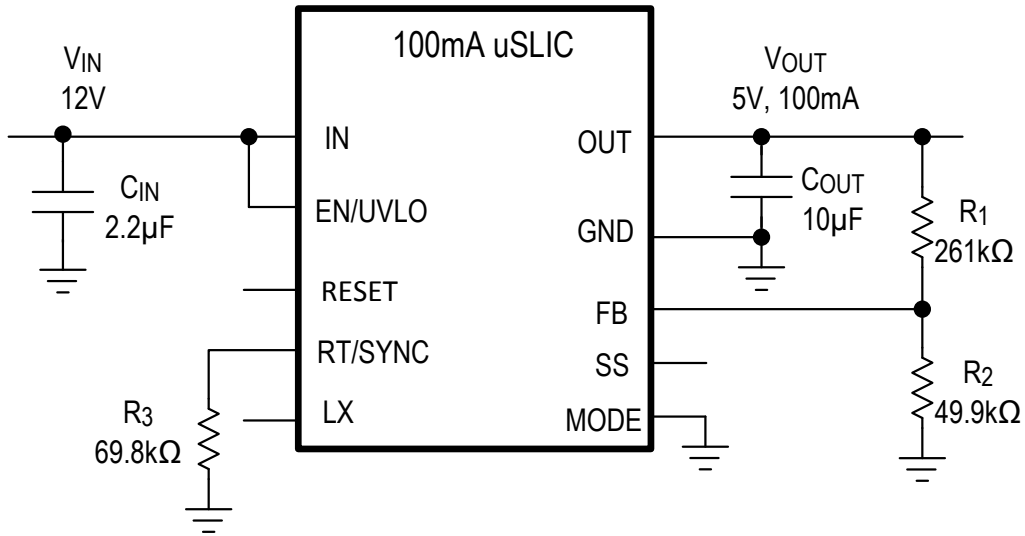
Wide Input Voltage, 100mA uSLIC Power Module Family

Benefits

- Ultra-small package size, uSLIC™
- 1.8% FB accuracy
- -40°C to 125°C operating temp
- Standard manufacturing/assembly flow

Features

- 2.6mm x 3mm x 1.5mm
- 4.0V to 24V/42V/60V V_{IN} range
- 0.9 – 5.5V V_{OUT} range
- 100mA continuous current



MAXM17900 – 4.0V to 24V V_{IN}
MAXM17532 – 4.0V to 42V V_{IN}
MAXM17552 – 4.0V to 60V V_{IN}

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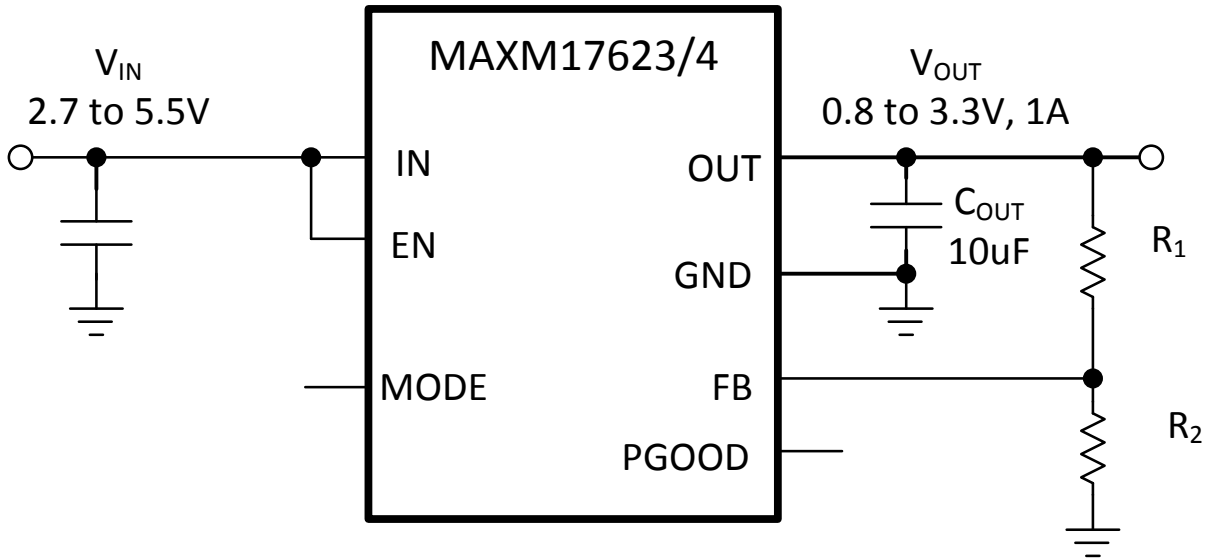
MAXM17623/4 – 5V V_{IN} 1A Power Module

NEW



MAXM17623 – 0.9 to 1.8V VOUT
MAXM17624 – 1.5V to 3.3V VOUT

Benefits

- Ultra Small Solution
  2.1 x 2.6 x 1.5mm³
- 1.0% FB Accuracy
- 0.1uA Shutdown Current
- -40C To 125C Operating Temp

Features

- 2.7V To 5.5V Operating Supply
- 0.8 to 3.3V Output Voltage
- 1A Continuous Current
- PGOOD signal
- PWM/PFM mode control
- Programmable VOUT of 0.8 to 3.3V

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Summary

- Exciting roadmap
- Performance, efficiency, and system solutions
- Easy to use
- Key functions for industrial power applications
- Highly reliable, customer-proven solutions