

Wide V_{IN} Power Solutions for Industrial Automation



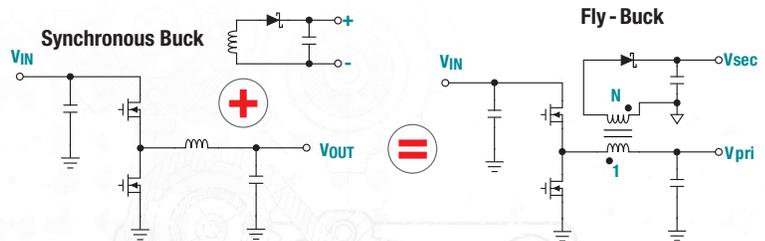
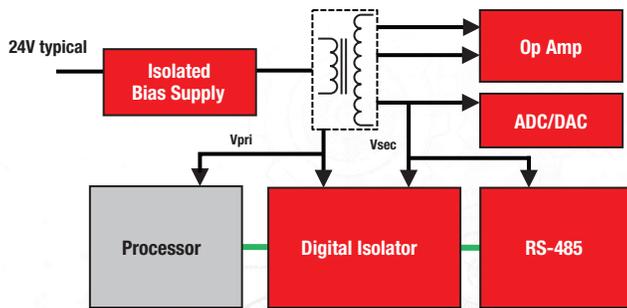
Multi-Output Fly-Buck™ Topology

Well-Regulated Isolated Outputs without Optocouplers

Galvanic isolation is a common requirement for many power supply designs in industrial factory automation, building automation, and other applications requiring compliance to noise and/or safety standards. It could be mandated by safety standards to isolate the user from the hazardous voltage of a power supply, or the isolation is installed to break the ground loop interference for noise-sensitive applications.

The isolated output voltage can also conveniently be configured as a negative or level-shifted voltage rail. PLCs and I/O modules are widely used in factory automation. Today there is an increasing number of I/O channels in a system and requirements for higher sensing accuracy. Therefore, galvanic isolation is typically needed to provide digital/analog signal isolation or channel-to-channel isolation to prevent noise interference from a common ground.

Isolated Signal and Power Path



What is a Fly-Buck?

- Cost-effective solution for generating multi-output bias supplies $\leq 15W$
- Evolves from a synchronous buck converter by adding coupled windings to the inductor for flyback-like isolated outputs

Benefits

- Easy to generate isolated positive and negative supplies
- Primary side supply available to power load(s) not requiring isolation from V_{IN}
- Simplifies design compared with traditional flyback approach
- Fewer components and smaller solution size compared with flyback

Applications

Industrial PLC & I/O Module

- MCU
- Op Amp/ADC
- Digital Isolator
- RS485

AC Motor Drive

- Gate Driver Bias
- Phase V/I Sense Op Amp



More Resources

- Application Note: AN-2292 Designing an Isolated Buck (Flyback) Converter
- EDN Article: Fly-Buck adds well-regulated isolated outputs to a buck without optocouplers

Programmable Logic Controllers (PLC)

Transient and Ground Loop Protection

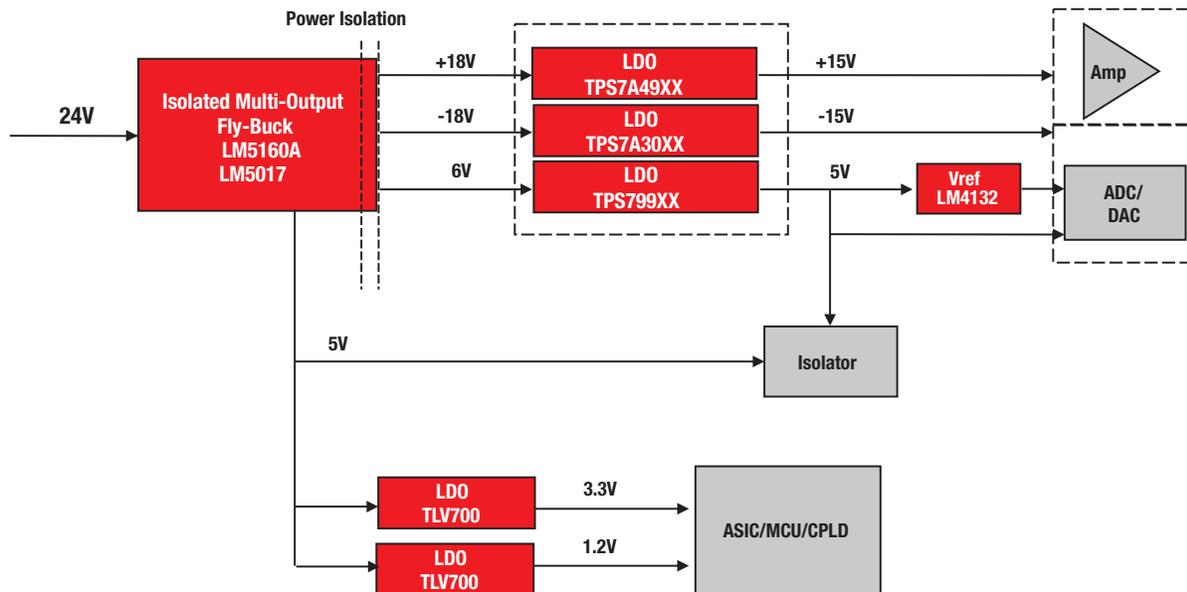
The PLC is the workhorse of industrial control systems. It uses digital and analog I/O modules to interface sensors, actuators and other equipment. These I/O modules must meet stringent electrical specifications and designers face challenges in conditioning and converting these signals.

To protect against transients and ground loops, the field side which interfaces to sensors is electrically isolated from the control side. The design can be customized for performance and cost by using a multi-output Fly-Buck.

Then, using LDOs with good PSRR (power supply rejection ratio) to supply the precision analog circuitry will reduce the power supply ripple and preserve system accuracy resolution.

Wide V_{IN} solutions from TI increase system robustness against input transients. With operating voltages up to 100V, the Wide V_{IN} portfolio eliminates input protection components to reduce cost and solution size. Extra margin is provided for robustness of un-characterized system conditions to increase system reliability.

PLC Analog in / Analog Output Module Power Block



Device	Type	V_{IN} (V)	I_{OUT} (mA)	Package	Comment
LM5160A	Fly-Buck bias power buck converter	4.5 to 65	1500	WSO-12	Constant On-Time control
LM(2)5017	Fly-Buck bias power converters	(7.5 to 48)	100	SO-8 PwrPAD, WSO-8	Pin-to-pin compatible
LM(2)5018		7.5 to 100	300		
LM(2)5019			600		
LM46000	Synchronous buck regulator	3.5 to 60	500	eTSSOP-16	High light load efficiency, low I_{q} 30 μ A
TPS7A4901	Linear regulator	3 to 36	150	MSOP8-PowerPAD	Ultra-low-noise 15 μ Vrms
TPS7A3001	Linear regulator	-3 to -36	-200	MSOP8-PowerPAD	Ultra-low-noise 15 μ Vrms
TLV713/733	Linear regulator	1.4 to 5.5	150 / 300	SOT-23, 1x1SON	Various V_{OUT} options from 1.0 to 3.3V
LM4132	Voltage reference	$V_{REF} +0.4$ to 5.5	20	SOT-23	V_o (V) 1.024, 1.25, 2.048, 2.5, 4.096
LM4120	Voltage reference	2 to 12	5	SOT-23	20 μ Vpp Noise
TPS799	Linear regulator	2.7 to 6.5	200	SOT23-5, SON-6, WCSP	Low noise 30 μ Vrms, V_{OUT} from 1.2 to 6.5V
LP38798	Linear regulator	3 to 20	800	WSO-12	Low noise 5 μ Vrms

Motor Control: AC Induction

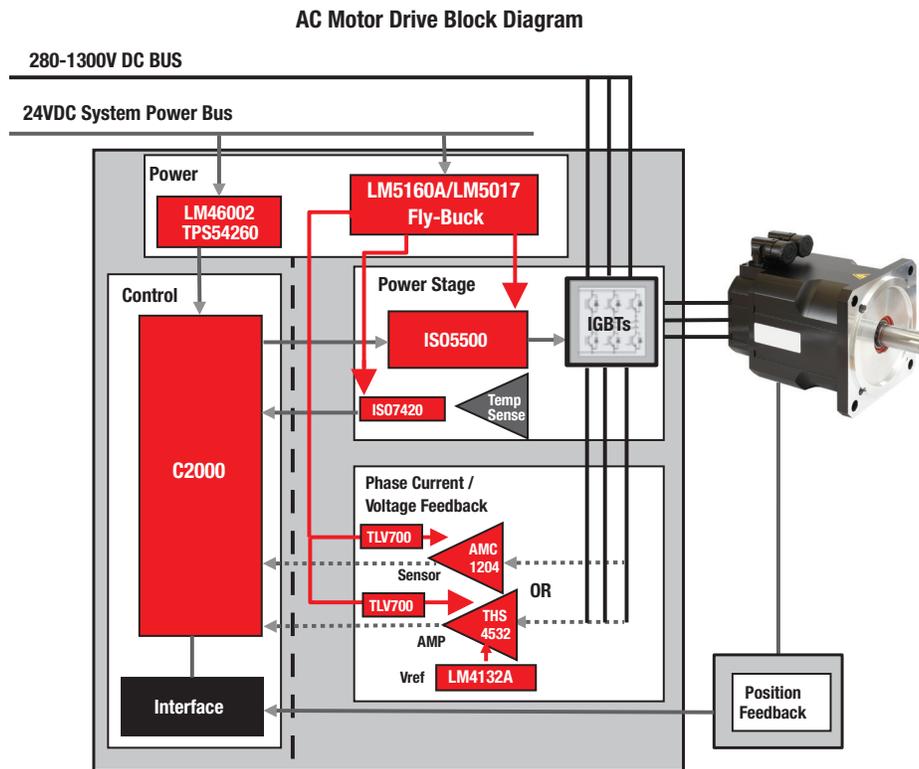
Tightly Regulated Bias Power Solution

The ACIM is the industrial “muscle motor” that enabled the industrial revolution. This rugged motor is used in a vast array of applications from home appliances to high-horsepower factory automation.

For robust operation, ACIM systems require a bias power solution with tight regulation for multiple critical components, including IGBT driver, digital isolator, isolated sensor (V/I), op amp, and MCU.

Especially for IGBT driver bias supply, multiple isolated output rails with stringent regulation are necessary to guarantee reliable IGBT turn-on/-off.

By providing stringent regulation across line/load transients, Wide V_{IN} Fly-Buck bias power solutions significantly increase system reliability. Without external compensation, it simplifies the design and reduces solution size to improve system robustness.



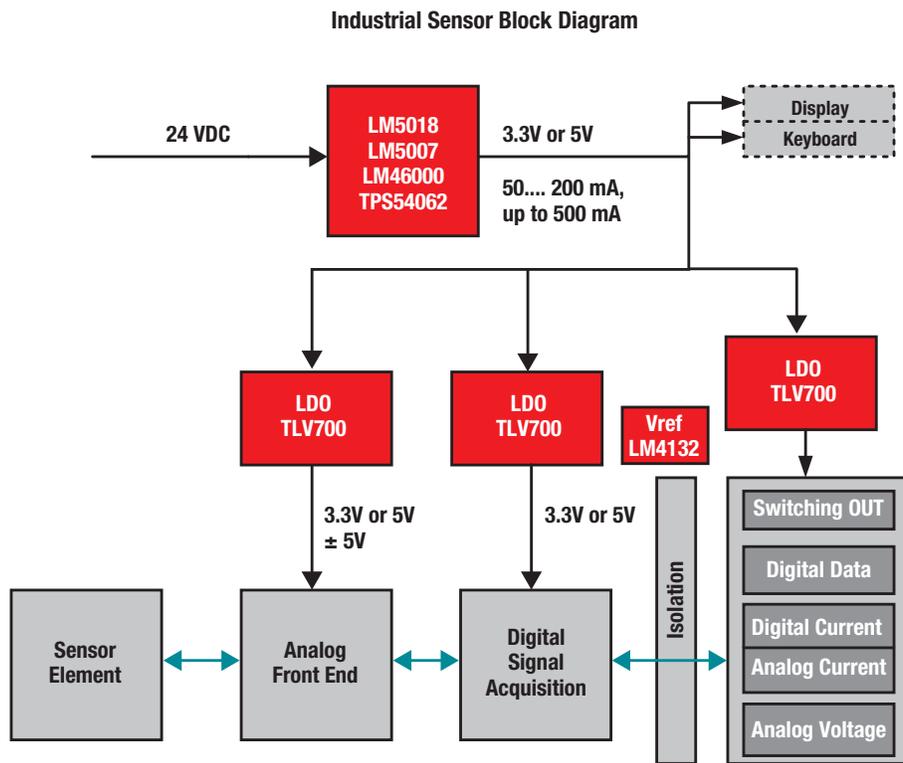
Device	Type	V_{IN} (V)	I_{OUT} (mA)	Package	Comment
LM5160A LM5017	Fly-Buck bias power converters	4.5 to 100	1500 / 600	SO-8 PwrPAD, WSON-8 WSON-12	Multiple-rails isolated converter with high regulation accuracy. System bias power for IGBT driver, sensor, isolator, Op Amp
LM46002	Synchronous buck regulator	3.5 to 60	2000	eTSSOP-16	High light load efficiency, low 30 μ A operating quiescent current
TPS54260	Synchronous buck regulator	3.5 to 60	2500	10/MSOP-PowerPAD 10/SOP	Eco-mode, 138 μ A operating I_q
TLV713/7333	Linear regulator	1.4 to 5.5	150 / 300	SOT-23, 1x1SON	Various V_{OUT} options from 1.0 to 3.3V
LM4132A	Precision voltage reference	$V_{REF} + 0.4$ to 5.5	20	SOT-23	0.05% initial output accuracy; 10 ppm.C temp drift;
LM4120	Voltage reference	2 to 12	5	SOT-23	20 μ Vpp Noise
LM2936HV	Linear regulator	5.5 to 60	50	3TO-92, SOT223-4, SOIC-8, VSSOP-8	Low I_q LDO
LP2950/51-N	Linear regulator	3 to 30	100	PDIP-8, SOIC-8, VSSOP-8, WSON-8	Adjustable V_{OUT} options from 1.24 - 29V

Industrial Sensors

Low Noise, High Efficiency for Line and Loop Power

Monitoring and maintaining process variables at the appropriate levels is crucial for industrial automation and process control. Sensors in industrial environments are either continuously or periodically measuring vital parameters such as temperature, pressure, flow, etc. The primary challenge of industrial sensing is conditioning low signal levels in the presence of high-noise and high-surge voltage.

TI offers a complete line of high performance power management products designed for industrial applications. Wide V_{IN} solutions increase system robustness against input transients. The devices shown are well-suited for powering sensors that may require low noise and high efficiency in both line- and loop-powered (4-20 mA) topologies.



Device	Type	V_{IN} (V)	I_{OUT} (mA)	Package	Comment
TPS54062/61	Synchronous buck regulator	4.7 to 60	50 / 200	SON-8, MSOP-8	90 μ A operating I_q
LM46000	Synchronous buck regulator	3.5 to 60	500	eTSSOP-16	High light load efficiency, low 30 μ A operating quiescent current
LM(2)5019 LM(2)5018	Synchronous buck regulator	7.5 to 48	100 / 300	SO-8 PwrPAD, WSON-8	Pin-to-pin compatible
LM34919C	Synchronous buck regulator	4.5 to 60	600	WSON-12	2.6 MHz operation shrinks PCB area
TLV700	Linear regulator	2.5 to 5.5	200	SC-70, SOT-5, WSON-6	Various V_{OUT} options from 1.2 to 3.6V
LM4132	Voltage reference	$V_{REF} + 0.4$ to 5.5	20	SOT-23	V_o (V) 1.024, 1.25, 2.048, 2.5, 4.096
LM4120	Voltage reference	2 to 12	5	SOT-23	20 μ Vpp Noise
TPS727	Linear regulator	2 to 5.5	250	WCSP, WSON-6	Low I_q 8 μ A with 30 μ Vrms noise

Design Resources

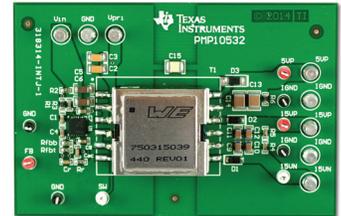


Featured Design: PMP10532

Isolated triple output Fly-Buck power supply for industrial PLC applications

Features

- Ideal for PLC and industrial applications requiring multiple bias supplies
- Three isolated outputs, 5V at 1A and $\pm 15V$ at 200 mA
- Fly-Buck converter design with primary side regulation
- Compact solution for multiple isolated output supplies
- $19 - 30V_{IN}$ range, $\pm 5\% V_{OUT}$ cross regulation

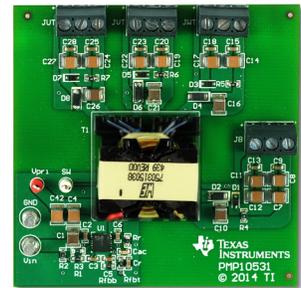


TIDA-00199

Wide input isolated IGBT gate drive Fly-Buck power supply for three-phase inverters

Features

- Isolated power supply with $24V \pm 20\%$ input range that supports six IGBT gate drivers for 3-phase inverter
- Low-ripple (< 200 mV) bias outputs (+15V and -8V) with output power of 2.3W for each IGBT
- Fly-Buck topology provides easy-to-design multi-output isolated power supply solution with primary side regulation
- Peak efficiency of 82% at balanced full-load

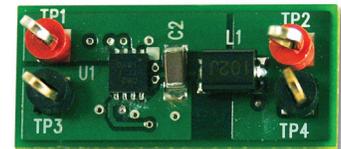


Featured Design: PMP6938

4-20 mA current loop two-wire sensor power supply

Features

- Small form factor 7 mm x 15.5 mm x 0.8 mm
- Input voltage withstands line transients up to 60V
- Configured to deliver 3.3V / 30 mA at 400 kHz
- Efficiency peaks at 70% at 20 mA from $12 V_{IN}$ to $3.3 V_{OUT}$



Additional Resources	Description
LM5160A product folder	EVM, WEBENCH support, Quick Start calculator, reference designs
LM5017 product folder	EVM, WEBENCH support, Quick Start calculator, reference designs
TIDA-00128	Low-power, low-noise Analog Front End design for Circuit Breakers
TIDA-00174	Motor Drive reference design
TIDA-00017	8-Channel digital input module for PLC Controllers
TIDA-00123	PLC I/O Module Front End controller design
TIDA-00119	Integrated analog input module for Programmable Logic Controllers
TIDA-00129	Small form factor 1W power supply with Isolated dual-outputs for PLC I/O modules
Literature # SLYY041	Programmable Logic Control (PLC) solutions guide
Literature # SLYY046	Industrial Motor Drive solutions guide
Literature # SLYY043	Field Transmitters guide

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com