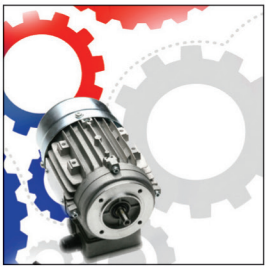
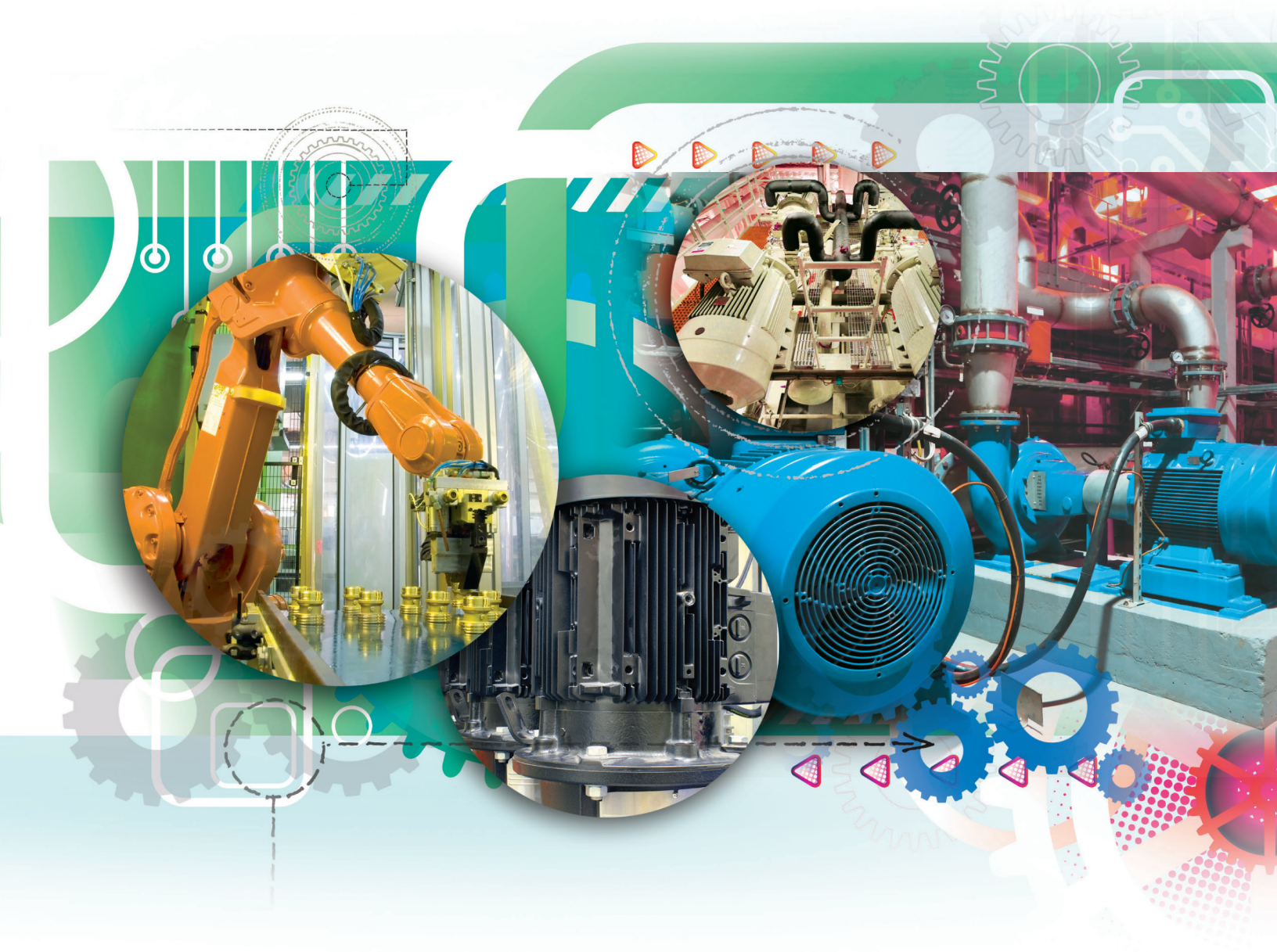
Industrial Motor Drive Solution Guide



Texas Instruments

Industrial Automation Solutions



www.ti.com/automation

2015

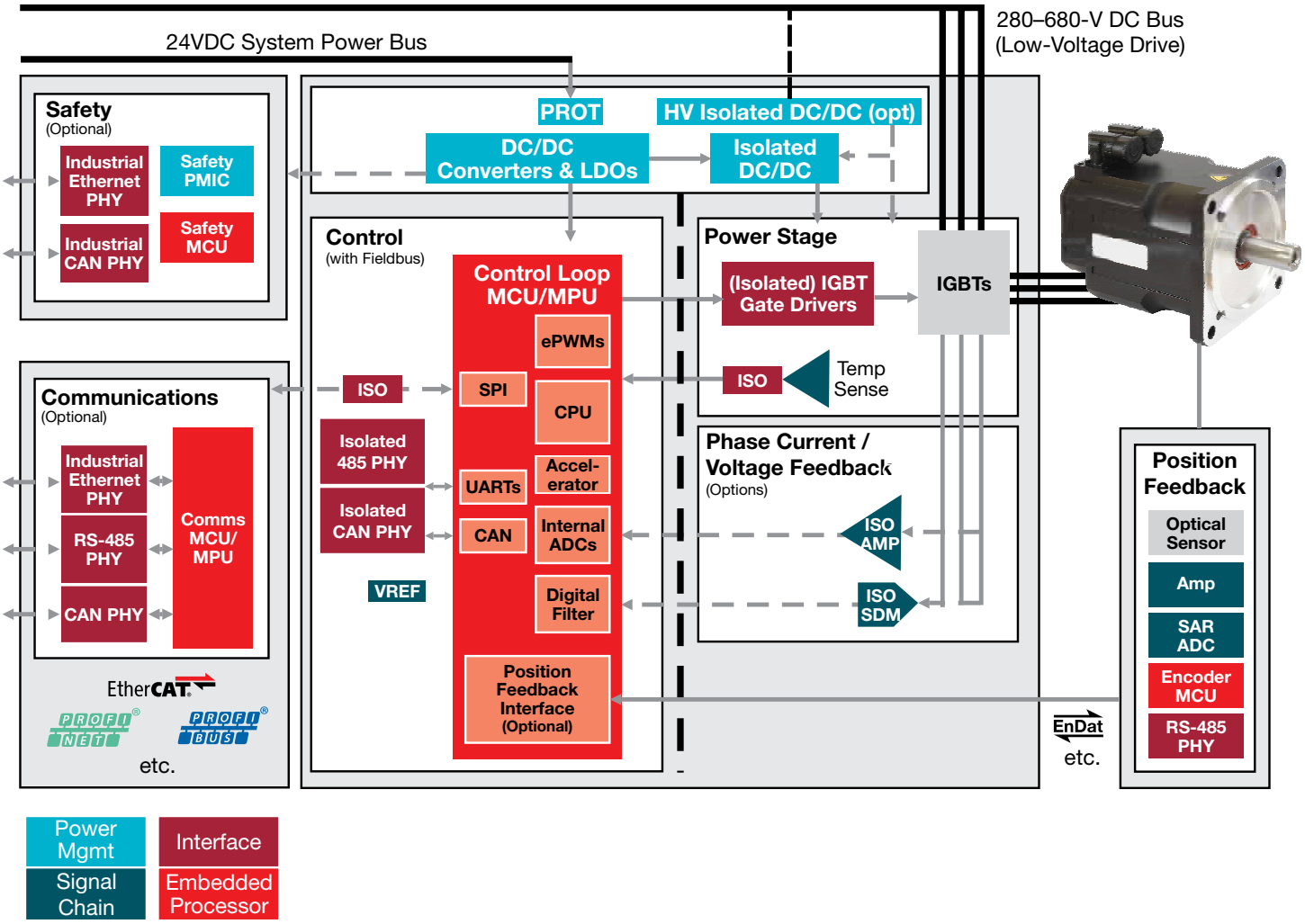
Industrial Motor Drive
Overview

With the increasing demand for energy efficiency, safety, reliable connectivity and precise control, industrial drives for factory automation systems are becoming more and more sophisticated, requiring cutting-edge technologies.

Texas Instruments (TI) provides a broad range of analog products, digital controllers and software to precisely control the position, velocity and torque of mechanical drives.

A robust process technology and a long-standing commitment to the industrial market needs enable TI to meet stringent customer requirements for reliability and continuity of supply. TI's commitment to the industrial automation industry also includes an extensive, reliable solution portfolio and strong local customer support.

- Close partnership with the industrial ecosystem
- Dedicated system solutions
- Development tools
- Energy efficiency
- Flexibility and future-proof product roadmaps
- Leading-edge technology
- Policy of ensuring long product life
- Reliable and dedicated portfolio for industrial temperature ranges
- SafeTI offerings for IEC 61508, IEC 61800, IEC 13849
- Strong portfolio with industrial feature set



Analog Temperature Sensors

Part Number	Description	Operating Temperature Range (°C)	Accuracy Over Operating Temp Range (Max) (±°C)	Supply Voltage (Min) (V)	Supply Voltage (Max) (V)	Supply Current (Max) (µA)	Sensor Gain (mV/°C)	Output Impedance (Typ) (Ω)	Shutdown	Interface	Special Features	Pin/ Package	Price*
LM50C	SOT-23 single-supply centigrade temperature sensor	–40 to 125	4	4.5	10	180	10.3	2000	No	Analog	Industry standard pinout	3/SOT-23	0.32
LM61C	2.7V, SOT-23 or TO-92 temperature sensor	–30 to 100	4	2.7	10	155	10	800	No	Analog	UL recognized	3/SOT-23, 3/TO-92	0.25
LM94022	1.5V, SC-70, multi-gain analog temperature sensor with Class-AB output	–50 to 150	2.7	1.5	5.5	9	–5.5 to 13.6	5.2	No	Analog	Selectable gain setting, Push-pull output with 50-µA source current	5/SC-70	0.37
LMT87	SC-70, Analog temperature sensor with class-AB output	–50 to 150	2.7	2.7	5.5	9	–13.6	—	No	Analog	Industry standard pinout, Push-pull output with 50-µA source current	5/SC-70	0.20

Precision Amplifiers

Device	Description	Input Offset (±) (Max) (µV)	Input Offset Drift (±) (Typ) (µV/°C)	Slew Rate (Typ) (V/µs)	Iq per channel (Max) (mA)	CMRR (Min) (dB)	Vs (Min)(V)	Vs (Max) (V)	GBW (Typ) (MHz)	Input Bias Current (Max) (nA)	Operating Temp. Range (°C)	Pin/ Package	Price *
LMP8671	Single 40V low-noise precision amplifiers	750	0.1	20	6	105	5	44	55	95	–40 to 125	8/SOIC	1.50
LMP7701	Precision, CMOS input, RRIO, wide sup range amps	200	1	1.1	1.3	130	2.7	12	2.5	0.4	–40 to 125	5/SOT-23, 8/SOIC	1.24
OPA188	Precision, low-noise, rail-to-rail output, 36V zero-drift operational amplifier	25	0.03	0.8	0.51	120	4	36	2	8	–40 to 125	5/SOT-23, 8/SOIC, 8/VSSOP	0.80
OPA140	11-MHz, single supply, low noise, precision, rail-to-rail output, JFET amplifier	120	1	20	2	126	4.5	36	11	3	–40 to 125	5/SOT-23, 8/SOIC, 8/VSSOP	1.55
OPA827	Low-noise, high-precision, JFET-input operational amplifier	150	2	28	4.8	114	4	36	22	5	–40 to 125	8/SOIC	3.75

Analog-to-Digital Converters

Part Number	Description	Resolution (Bits)	Sample Rate (Max)	# Input Channels	DNL (Max) (±LSB)	INL (Max) (±LSB)	SNR (dB)	Power Consumption (Typ) (mW)	Interface	Analog Voltage AV_{DD} (Min) (V)	Analog Voltage AV_{DD} (Max) (V)	Reference Mode	Integrated Features	Operating Temp. Range (°C)	Pin/ Package	Price*
ADS7223	12-bit 1-MSPS 4×2/2×2 simultaneous sampling SAR ADC	12	1MSPS	4	0.5	0.5	73	47.2	Serial	2.7	5.5	Int, Ext	Internal reference	–40 to 125	32/VQFN	3.95
ADS7263	14-bit 1-MSPS 4×2/2×2 simultaneous sampling SAR ADC	14	1MSPS	4	–0.5/ +1	2	85	47.2	Serial	2.7	5.5	Int, Ext	Internal reference	–40 to 125	32/VQFN	6.95
ADS8363	16-bit 1MSPS 4×2/2×2 simultaneous sampling SAR ADC	16	1MSPS	4	–0.99/ +2	3	93	47.2	Serial	2.7	5.5	Int, Ext	Internal reference	–40 to 125	32/VQFN	9.95

Current Sense Amplifiers

Device	Description	Input Offset (±) (Max) (µV)	Input Offset Drift (±) (Typ) (µV/°C)	Slew Rate (Typ) (V/µs)	Iq per channel (Max) (mA)	Gain (V/V)	Gain Error (%)	Common-Mode Range (Min)	Common-Mode Range (Max)	CMRR (Min) (dB)	Vs (Min) (V)	Vs (Max) (V)	Small Signal Bandwidth (Typ) (kHz)	Input Bias Current (Max) (µA)	Special Features	Operating Temp. Range (°C)	Pin/ Package	Price*
INA282	Wide common-mode range, Bidirectional, High-accuracy current shunt monitor	70	0.3	—	0.9	50	0.4	–14	80	120	2.7	18	10	25	Bi-directional, Low-side capable, Analog output	–40 to 125	8/SOIC	1.25
LMP8640	Precision high-voltage current sense amplifier	900	2.6	1.8	0.722	20, 50, 100	0.51	–2	42	103	2.7	12	450	28	Low-side capable, Analog output	–40 to 125	6/SOT	0.85
LMP8645	Precision high-voltage current sense amplifier	1000	4	0.6	0.61	1 to 100	2	–2	42	60	2.7	12	260	23	Low-side capable, Analog output	–40 to 125	6/SOT	0.85
LMP8646	Precision current limiter	1000	4	0.6	0.61	1 to 100	2	~2	76	55	2.7	12	35	23	Low-side capable, Analog output	–40 to 125	6/SOT	1.01

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Isolated Current Shunt Amplifiers

Device	Description	Input Offset (±) (Max) (µV)	Input Offset Drift (±) (Typ) (µV/°C)	Gain (V/V)	Gain Error (±) (Max) (%)	Gain Non-Linearity (±) (Max) (%)	Common-Mode Range (Min)	Common-Mode Range (Max)	CMRR (Min) (dB)	V_{DD1}, V_{DD2} (Min) (V)	V_{DD1}, V_{DD2} (Max) (V)	Small Signal Bandwidth (Typ) (kHz)	Special Features	Isolation Voltage Cont Peak (DC) (V)	Working Voltage (Vpk)	Transient Immunity (Min) (kV/µsec)	Operating Temp. Range (°C)	Pin/ Package	Price* (US$)
AMC1200B	4kV peak isolated amplifier for current shunt measurements	1.5	10µV/K	8	1	0.015	–0.16	5.5	108	4.5, 2.7	5.5, 5.5	100	Differential inputs	4250	1200	10	–40 to 125	8/SOIC, 8/SOP	2.20

Digital Isolators

Part Number	Description	Isolation Rating (Vrms)	Peak Isolation Rating (Vpk)	Working Voltage (Vpk)	Forward / Reverse Channels	Speed (Max) (Mbps)	V_{CC} (Min) (V)	V_{CC} (Max) (V)	Default Output	Propagation Delay (Typ) (ns)	Operating Temperature Range (°C)	Pin/Package	Price*
ISO7842	High-immunity, 5.7kVRMS reinforced quad-channel 2/2 digital isolator, 100Mbps	5700	8061	2121	2/2	100	2.25	5.5	High	11	–55 to 125	16/SOIC	3.49
ISO7342C	Robust EMC, low power, quad-channel 2/2 digital isolator	3000	4242	1414	2/2	25	3	5.5	High/Low (F)	31	–40 to 125	16/SOIC	1.80
ISO7140/1(F)CC ISO7142CC	4242-VPK Small-footprint and low-power quad channel digital isolators with noise filter	2500	4242	560	4/0, 3/1, 2/2	50	2.7	5	High/Low (F)	23	–40 to 125	16/SSOP	1.90
ISO7131CC	4242-VPK Small-footprint and low-power 2/1 triple channel digital isolator with noise filter	2500	4242	560	2/1	50	2.7	5	Low	23	–40 to 125	16/SSOP	1.60

Three-Phase Drivers

Part Number	Description	Vs (Min) (V)	Vs (Max) (V)	Peak Source/ Sink Output Current (A)	# of Half-bridges	RDS(ON) (HS+LS) (mΩ)	Current Sense Amps	Control I/F	Additional Features	Operating Temperature Range (°C)	Pin/ Package	Price*
DRV8301	Three-phase brushless motor pre-driver with dual current sense amps and buck converter (PWM Ctrl w/ SPI)	6	60	1.7/2.3	3	—	2	PWM	On-chip 1.5A buck converter, SPI I/F, Prog dead time, Drives up to 60A external FETs	–40 to 125	56/HTSSOP	2.50
DRV8302	Three-phase brushless motor pre-driver with dual current sense amps and buck converter (PWM Ctrl)	6	60	1.7/2.3	3	—	2	PWM	On-chip 1.5A buck regulator, Hardware management I/F, Prog dead time, Drives up to 60A external FETs	–40 to 125	56/HTSSOP	2.50
DRV8303	Three-phase brushless motor pre-driver with dual current sense amps (PWM Ctrl w/ SPI)	6	60	1.7/2.3	3	—	2	PWM	SPI I/F, Prog dead time, Drives up to 60A external FETs	–40 to 125	56/HTSSOP	2.50
DRV8313	2.5A Three-phase brushless DC motor driver with inrush protection (PWM Ctrl)	8	60	2.5/2.5	3	480	Ext	PWM	On-chip comparator	–40 to 85	28/HTSSOP	2.25
DRV8312	6.5A Three-phase brushless DC motor driver with inrush protection (PWM Ctrl)	0	52.5	6.5/6.5	3	160	Ext	PWM	Needs +12V gate drive supply	–40 to 85	44/HTSSOP	3.30
DRV8332	13A Three-phase brushless DC motor driver with inrush protection (PWM Ctrl)	0	52.5	13/13	3	160	Ext	PWM	Needs +12V gate drive supply and heatsink	–40 to 85	36/HSSOP	4.70

Industrial Interface Transceivers

Part Number	Description	Bus Fault Voltage (V)	I_{CC} (Max) (mA)	Number of Nodes	Date Rate	Duplex	ESD	Supply Voltage(s) (V)	Special Features	Operating Temperature Range (°C)	Pin/Package	Price*
SN65HVD257	CAN transceiver with fast loop times for highly loaded networks and features for functional safety	–27 to 40	85	—	10kbps to 1Mbps	Half	±12kV HBM protection	4.5 to 5.5	High-speed, Turbo short prop delay, Redundancy and functional safety	–40 to 125	8/SOIC	0.60
SN65HVD72/75/78	3.3V, Half-duplex RS-485, high IEC ESD	–13 to 16.5	1	256	250kbps, 20Mbps, 50Mbps	Half	+12kV IEC and +15kV HBM protection	3 to 3.6	High IEC ESD, Large receiver hysteresis (80mV)	–40 to 125	8/SOIC, 8/SON, 8/MSOP	0.70
SN65HVD76/1476 SN65HVD77/1477	3.3V, Half-duplex RS-485, high IEC ESD	–13 to 16.5	1.1	256	400kbps, 20Mbps, 50Mbps	Full	+16kV IEC and +30kV HBM protection	3 to 3.6	High IEC ESD, Large receiver hysteresis (70mV)	–40 to 125	8/SOIC, 14/SOIC, 8/MSOP, 10/MSOP	1.90 / 2.25
SN65HVD1176	PROFIBUS® RS-485 transceiver	–9 to 14	6	160	40Mbps	Half	+10kV HBM	4.75 to 5.25	Optimized fro PROFIBUS® networks	–40 to 85	8/SOIC	1.54
SN65HVD1780/1/2	70-V Fault-protected RS-485 transceiver	–70 to 70	6	256	115kbps, 1Mbps, 10Mbps	Half	+16kV HBM	3.15 to 5.5	High fault protection	–40 to 85	8/SOIC, 8/DIP	1.85

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**.*

Delta-Sigma Modulators and Filters

Device	Description	Input Voltage Range (mV)	Isolation Rating (Vpeak)	Min Transient Immunity (kV/uS)	Supply Voltage (V)	Interface	Package	Price*
AMC1204/1204B	Isolated 20 MHz $\Delta\Sigma$ modulator	±250	4000/4250	15	3.3 / 5	Serial CMOS	SOIC-16	3.45
AMC1304/05	Isolated 20 MHz $\Delta\Sigma$ modulator with reinforced isolation	±50 or ±250	7000	15	4.0-18.0 / 3.0-5.5	Serial CMOS and LVDS	SOIC-16	TBD / 3.50

Non-Isolated Gate Drivers

Part Number	Description	Driver Configuration	Peak Source/ Sink Output Current (A)	V_{CC} (Min) (V)	V_{CC} (Max) (V)	Rise Time (ns)	Fall Time (ns)	Prop Delay (ns)	Input Threshold	Operating Temperature Range (°C)	Pin/ Package	Price*
UCC27511	4A/8A Single-channel high-speed low-side gate driver	Single inverting, Non-inverting	4/8	4.5	18	9	7	13	TTL	–40 to 140	6/SOT-23	0.52
UCC27517A	4A/4A Single-channel high-speed low-side gate driver with 5V negative input voltage handling ability	Single inverting, Non-inverting	4/4	4.5	18	9	7	13	TTL	–40 to 140	5/SOT-23	0.49
UCC27518/19	Single-channel 4A high-speed, low-side gate driver with CMOS input	Inverting (18), Non-inverting (19)	4/4	4.5	18	9	7	13	CMOS	–40 to 140	5/SOT-23	0.49
UCC27524A	Dual-channel 5A high-speed, low-side gate driver with negative input voltage capability	Dual, Non-inverting	5/5	4.5	18	7	7	14	TIL	–40 to 140	8/MSOP, 8/SOIC	0.75
UCC27531/32	Single-channel 2.5A/5A, 35V max V_{DD} FET and IGBT gate driver with split output and with 5V negative input voltage handling ability (32 includes CMOS input)	Non-inverting	2.5/5	10	35	15	7	17	TIL / 31 CMOS / 32	–40 to 140	6/SOT-23	0.75
LM5112	Tiny 7A single channel MOSFET gate driver	Inverting, Non-inverting	3/7	3.5	14	14	12	25	TIL	–40 to 125	6/WSON	0.45
UCC27201A/211A	120V boot, 3A/4A peak (201A/211A), High frequency, high-side/low-side driver with negative voltage handling	High side, Low side	3/3 / 201A 4/4 / 211A	8 / 201A 7.8 / 211A	20	8	7	20	TTL	–40 to 140	10/WSON / 201A, 8/SOIC / 201A/211A, 8/SO PowerPAD / 201A, 8/VSON/201A / 211A, 9/SON / 201A	1.30/ 201A 1.50/ 211A
LM5104/5/6	High voltage bridge gate drivers with programmable dead-time control	Bridge	2	7.5	14	10 / 4/5 15 / 6	10	35 / 4/5 32 / 6	TTL	–40 to 125	8/SOIC, 8/WSON	1.10 / 4 0.90 / 5 0.64 / 6
LM5109	100V boot, 1A peak, high frequency, high-side/low-side driver	High side, Low side	1/1	7.5	14	15	15	25	TTL	–40 to 125	8/SOIC, 8/WSON	0.50

Isolated IGBT Gate Drivers

Part Number	Description	Isolation Rating (Vrms)	Input V_{CC} (Min) (V)	Input V_{CC} (Max) (V)	Output V_{CC} (Min) (V)	Output V_{CC} (Max) (V)	Output Current (Min)(A)	Propagation Delay (Max) (ns)	Operating Temperature Range (°C)	Pin/Package	Price*
ISO5500	2.5-A isolated IGBT/MOSFET gate driver	3	3	5.5	15	30	2.5	300	–40 to 125	16/SOIC	3.00

Isolated Industrial Interface

Part Number	Description	Integrated Transformer	Duplex	Isolation Rating (kVrms)	V_{CC1} (Min) (V)	V_{CC1} (Max) (V)	V_{CC2} (Min) (V)	V_{CC2} (Max) (V)	Datarate (Mbps)	Number of Nodes	ESD (kV)	Fail Safe	Operating Temperature Range (°C)	Pin/Package	Price*
ISO1176	Isolated PROFIBUS® RS-485 transceiver	No	Half	2500	3.15	5.5	4.75	5.25	40	256	16	Idle, Open, Short	–40 to 85	16/SOIC	3.00
ISO1176T	Isolated PROFIBUS transceiver with integrated transformer driver	Yes	Half	2500	3	5.5	4.75	5.25	40	256	10	Idle, Open, Short	–40 to 85	16/SOIC	3.30
ISO1050	Isolated 5-V CAN transceivers	No	Half	2500, 5000	3	5.5	4.75	5.25	1	—	4	Idle, Open, Short	–55 to 105	16/SOIC, 8/SOP	1.55

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**. Preview products are listed in **bold teal**.*

Ethernet PHY

Part Number	Interface	Cable Length (m)	LED (#)	Supply Voltage (V)	Datarate (Mbps)	JTAG IEEE 1149.1	Port Count	Special Features	Operating Temperature Range (°C)	Pin/Package	Price*
DP83620	MII, RMII	150	3	3.3	10/100	Yes	Single	FX support, Cable diagnostics	–40 to 85	WQFN	1.52
DP83630	MII, RMII	150	3	3.3	10/100	Yes	Single	IEEE 1588 PTP, FX support, Cable diagnostics, P2P upgrade from the DP83620	–40 to 85	WQFN	4.78
DP83640	MII, RMII	150	3	3.3	10/100	Yes	Single	IEEE 1588 PTP, FX support, Cable diagnostics	–40 to 85	LQFP	4.98
DP83848I	MII, RMII, SNI	150	3	3.3	10/100	Yes	Single	Deterministic delay	–40 to 85	LQFP	2.20
DP83848K	MII, RMII	137	2	3.3	10/100	No	Single	Deterministic delay	–40 to 85	WQFN	0.95
DP83849IF	MII, RMII, SNI	137	6	3.3	10/100	Yes	Dual	FX support, Cable diagnostics, Flexible port management	–40 to 85	TQFP	4.75

Input Power Protection

Part Number	Description	V_{IN} (Min) (V)	V_{IN} (Max) (V)	Current Limit Threshold (A)	Enable	Fault Response	Special Features	Operating Temperature Range (°C)	Pin/Package	Price*
LM5060	High-side protection controller with low quiescent current	5.5	65	Externally adjustable	Yes	Latch off	No external RSENSE	–40 to 125	10/VSSOP	1.09
LM5069	—	9	80	Externally adjustable	Yes	Latch off/Retry	Reverse hookup protection	–40 to 125	10VSSOP	1.47
TPS24750/1	—	2.5	18	Externally adjustable	Yes	Latch off/Retry	Programmable fault timer	–40 to 85	36VQFN	1.65

Window Comparator

Part Number	Description	Vs (Min) (V)	Vs (Max) (V)	t_{RESP} Low-to-High (µs)	Vos (Offset Voltage @ 25°C) (Max) (mV)	Iq per Channel (Max) (mA)	Output Type	Input Bias Current (±) (Max) (nA)	Number of Channels	Special Features	Rail-Rail	Operating Temperature Range (°C)	Pin/Package	Price*
LMV762	Low voltage, precision comparator with push-pull output	2.7	5	0.12	1	0.7	Push-pull	0.005	2		—	–40 to 125	8/SOIC, 8/VSSOP	0.85
TPS3700	High-voltage (18V) window comparator with over- and undervoltage detection	1.8	18	29	5.5	0.013	Open drain	25	1	Hysteresis, Internal reference, Window comparator	In	–40 to 125	6/SOT, 6/WSON	0.70

Voltage Monitor and Reset ICs

Part Number	Description	# of Supplies Monitored	V_{CC} (min) (V)	V_{CC} (max) (V)	Iq (typ) (uA)	Threshold Voltage (typ) (V)	Operating Temperature Range (°C)	Output Driver Type/Reset Output	Special Features	Time Delay (ms)	Pin/Package	Price*
TPS3700	Window comparator for over- and undervoltage detection	2	1.8	18	5.5	Adjustable	–40 to 125	Active-low/ Open-drain	Over voltage sense	0	6SOT/6WSON	0.69
TPS3847085	18-V, 380-nA Voltage monitor	1	4.5	18	0.38	Fixed: 8.5	–40 to 85	Active-low/ Push-pull	Manual reset	5	5SOT-23	0.79
TPS386000	Quad supply voltage supervisor with adjustable delay and watchdog timer	4	1.8	6.5	12	Adjustable	–40 to 125	Active-low/ Open-drain	Manual reset/ Negative voltage monitoring/Over voltage Sense/ Watchdog timer	20/300/ Programmable	20QFN	0.95
TPS3808	Low quiescent current, programmable-delay	1	1.7	6.5	2.4	Adjustable, Fixed: 0.84, 1.12, 1.16, 1.40, 1.67, 1.77, 2.33, 2.79, 3.07, 4.65	–40 to 125	Active-low/ Open-drain	Manual reset	Programmable	6SON/6SOT-23	0.68
TPS3831A09	Supervisory circuit	1	0.6	6.5	0.15	Fixed: 0.9, 1.1, 1.52, 1.67, 2.63, 2.93, 3.08, 4.38	–40 to 85	Active-low/ Push-pull	Manual reset	200	4X2SON	0.30

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**.*

- Subscribe to TI's Motor Control Newsletter at **www.ti.com/newsletter**
- Read TI's Motor Blog at **www.ti.com/motorblog**
- Visit **www.ti.com/motor** for more information.

LDO Linear Regulators

Part Number	Description	Output Options	I_{OUT} (Max) (A)	V_{IN} (Min) (V)	V_{IN} (Max) (V)	V_{OUT} (Min) (V)	V_{OUT} (Max) (V)	Iq (Typ) (mA)	Vdo (Typ) (mV)	Noise (uVrms)	Additional Features	Operating Temperature Range (°C)	Pin/ Package	Price*
TPS7A3001	V_{IN} 3V to 36V, 150mA, ultra-low noise, high PSRR, low-dropout linear regulator	Adjustable output, Negative output	0.2	–36	–3	–33	–1.2	0.05	216	15	Enable, Overcurrent protection, Soft start, Thermal shutdown, Fast transient response	–40 to 125	MSOP-PowerPAD	1.50
TPS7A4901	V_{IN} –3V to –36V, –200mA, ultra-low noise, high PSRR, low-dropout linear regulator	Adjustable output	0.15	3	36	1.2	33	0.06	260	15	Enable, Overcurrent protection, Soft start, Thermal shutdown, Fast transient response	–40 to 125	MSOP-PowerPAD	1.10
TPS70933	150-mA, 30-V, 1-µA IQ Voltage regulator with enable	Fixed output	0.15	2.7	30	3.3	3.3	0.001	300	—	Enable, Overcurrent protection, Soft start, Thermal shutdown, Fast transient response	–40 to 125	SON/ SOT-23	0.39
TLV73333P	Capacitor-free, 300-mA, low-dropout regulator with foldback current limit	Fixed output	0.3	1.4	5.5	3.3	3.3	0.034	122	—	Enable, Foldback overcurrent protection, Output discharge, Thermal shutdown	—	—	—
TPS75005	Dual, 500mA low-dropout regulators and triple voltage rail monitor	Adjustable output, Fixed outputs 1.8, 1.9, 3.3	0.5	4	6.5	Fixed outputs	Fixed outputs	0.175	300	—	Enable, Over current protection, Thermal shutdown, PG, Sequencing and monitoring, Soft start	–40 to 125	20/VQFN	1.90
LP5907	250mA, Ultra-low noise low-dropout regulator	Fixed output	0.25	2.2	5.5	1.2	4.5	0.012	50	6.5	Enable, Overcurrent protection, Thermal shutdown, Output discharge	–40 to 125	DSBGA/ SOT-23/ X2SON	0.14
LP38691	500mA Low dropout CMOS linear regulators	Fixed output	0.5	2.7	10	1.8	5	0.055	250	—	Enable,Overcurrent protection, Thermal shutdown, Foldback overcurrent protection	–40 to 125	TO-252/ WSON	0.50

DC/DC Regulators

Part Number	Description	V_{IN} (Min) (V)	V_{IN} (Max) (V)	V_{OUT} (Min) (V)	V_{OUT} (Max) (V)	I_{OUT} (A)	Topology	Switch Current Limit (Typ) (A)	Iq (Typ) (mA)	Duty Cycle (Max) (%)	Soft Start	Compensation	Special Features	Operating Temperature Range (°C)	Pin/ Package	Price*
TPS55010	2.95V to 6V Input, 2W, Isolated DC/DC converter with integrated FETs	2.95	6	3.3	20	0.4	Fly-buck	2.75	0.575	—	Adjustable	External	Enable, Synchronous rectification, Isolated, Power good, Frequency synchronization	–40 to 150	16/WQFN	0.99
TPS62404	Dual, 400mA and 600mA, 2.25MHz step-down converter with 1-wire interface in QFN	2.5	6	1.2	1.9	0.4	Buck, Synchronous buck	1	0.032	100	Fixed	Internal	Enable, Light load efficiency	–40 to 85	10/SON	0.90
TPS62150	3V to 17V 1A Step-down converter with DCS-control™	3	17	0.9	6.3	1	Buck, Synchronous buck	1.7	0.017	100	Adjustable	Internal	Enable, Light load efficiency, Power good, Tracking, Voltage margining	–40 to 85	16/QFN	0.98
LMZ34002	4.5V to 40V Input, up to 15W negative-output integrated power solution	4.5	40	–3	–17	2	Boost, Synchronous buck module	3	—	—	Adjustable	External	Integrated inductor, EMI tested, Negative output, Soft start, Overcurrent protection, Remote sense, External clock sync	–40 to 85	41B1QFN	6.75
TPS40210	Wide input range current mode boost controller	4.5	52	5	260	6	Boost	N/A	1.5	95	Adjustable	Internal	Enable, Frequency synchronization	–40 to 125	10/MSOP-PowerPAD, 10/SON	0.80
TPS54160A	3.5V to 60V Input, 1.5A Step-down converter with eco-mode	3.5	60	0.8	58	1.5	Buck, Inverting buck boost	1.8	0.116	98	Adjustable	External	Enable, Frequency synchronization, Light load efficiency, Power good, Tracking	–40 to 150	10/MSOP-PowerPAD, 10/SON	1.58
TPS54061	4.7V to 60V Input, 200mA Synchronous step-down converter	4.7	60	0.8	58	0.2	Buck, Inverting buck boost	0.35	0.09	98	Fixed	External	Adjustable UVLO, Enable, Frequency synchronization, Light load efficiency, Synchronous rectification	–40 to 150	8/SON,	1.04
TPS54260	3.5V to 60V Input, 2.5A step-down converter with eco-mode	3.5	60	0.8	58	2.5	Buck, Inverting buck boost	3.5	0.138	98	Adjustable	External	Enable, Frequency synchronization, Light load efficiency, Power good, Tracking	–40 to 150	10/MSOP-PowerPAD, 10/SON	1.86
TPS54361	4.5V to 60V Input, 3.5A step-down converter	4.5	60	0.8	59	3.5	Buck	5.5	0.152	98	Adjustable	External	Enable, Frequency Synchronization, Light load efficiency, Power good, Tracking, Adjustable UVLO	–40 to 150	10/WSON	2.60
TPS55340	Wide input range boost/SEPIC/ flyback DC/DC converter with integrated FET	2.9	32	3	38	2	Boost, SEPIC, Flyback	6.6	0.5	90	Adjustable	External	Enable, Frequency synchronization, Light load efficiency	–40 to 150	14/HTSSOP, 16/WQFN	1.85
LM5017	Family of 100V regulators enhance reliability for high-voltage systems	7.5	100	1.25	90	0.6	Fly-buck	1.3	1.75	90	External	No compensation needed	Intelligent current limit, Primary-side fly-buck regulation	–40 to 125	8/SO PowerPAD, 8/WSON	1.57

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*Preview products are listed in **bold teal**.*

Embedded Processing Solutions for Industrial Motor Drives

Description	Device	Key Benefits
Industrial Communication Interfaces		
Sitara™ processors with ARM9™ core	**AM1810 OMAP-L138**	• Highly integrated system on chip • Certified PROFIBUS® solution in conjunction with the ISO1176(T)
Sitara processors with ARM® Cortex™-A8 core	**AM3357 AM3359**	• Highly integrated System on Chip (SoC) • Certified PROFIBUS solution with ISO1176(T) • Integrated industrial interfaces such as EtherCAT®, EtherNet/IP™ and Ethernet POWERLINK
Sitara processors with ARM Cortex-A9 core	**AM437x**	• Quad-code PRU industrial communication subsystem • Integrated industrial Ethernet communications support (10/100/1000) • Integrated motor control feedback communications support and sigma-delta current sensing
Sitara processors with ARM Cortex-A15 core	**AM5x**	• Highest performance in Sitara family with single- and dual-Cortex-A15 processors • Integrated industrial Ethernet communications support • Large on-chip memory and PCIe interfaces
Tiva™ C series with ARM Cortex-M4 MCU	**TM4C129x TM4C123x**	• Extensive serial connectivity options – I^2C, CAN, USB, UART (RS-485) and quad SPI • TM4C129x series includes integrated 10/100 Ethernet MAC and PHY with IEEE-1588v2 PTP support • Multiple TI wireless connectivity solutions • Temperature range from –40°C to 105°C
Hercules™ safety RM series with ARM Cortex-R4 MCU	**RM4x**	• Safety MCUs with integrated connectivity such as USB, Ethernet, CAN, UART
C2000 Real-time control series with Cortex-M3 MCU	**F28M3x**	• Integrated EMAC
Motor Control MCU and MPU		
C2000™ Real-time control series with Cortex-M3 MCU	**Delfino™ F2833x/ Piccolo™ F280x TMS320F28M3x TMS320F281x**	• Real-time C28x core with ability to process multiple control loops in sensored/sensorless motor control applications • Higher performance analog such as 12-bit, 12.5-MSPS ADC, integrated comparators, programmable gain amplifiers (PGA), etc. • Motor control application kits, libraries, and documentation along with system examples
Sitara™ processors with ARM Cortex-A8 core	**AM335x**	• Extensive set of integrated and flexible industrial-control and connectivity interfaces • Available in industrial temperature ranges
Sitara processors with ARM Cortex-A9 core	**AM437x**	• High-performance Cortex-A9-based control processor • Integrated industrial Ethernet communications support • Integrated motor control feedback communications support and sigma-delta current sensing
Sitara processors with ARM Cortex-A15 core	**AM5x**	• Highest performance in Sitara family with single- and dual-Cortex-A15 processors • Integrated industrial Ethernet communications support • Large on-chip memory and PCIe interfaces
C6000™ 32-bit real-time DSPs	**OMAP-L138 TMS320C6654**	• ARM9 and C674x DSP integrated into OMAP-L138 processor • C6654 DSP is a high performance real-time fixed- and floating-point DSP based on TI's KeyStone™ architecture and running at 850 MHz
Hercules™ safety RM series with ARM Cortex-R4 MCUs	**RM48x, RM46x, RM42x**	• Real-time Cortex-R core with up to 220 MHz for sensored/sensorless safety motor-control applications • Integrated 12-bit ADC, programmable timer modules, motor-control encoder interfaces • Motor control application kits, libraries and documentation
Safety MCU		
Hercules safety RM series with ARM Cortex-R4 MCUs	**RM46x, RM42x**	• Support for safety-critical applications up to IEC 61508 SIL-3 • Real-time Cortex-R4 fixed- and floating-point options • –40 to 105°C ambient operation

InstaSPIN™-FOC and -MOTION capable devices

	Processor					Memory			Control Interfaces										Communication Ports													
Device	Speed (MHz)	FPU	CLA co-processor	VCU accelerator	DMA	Flash (KB)	RAM (KB)	ROM (KB)	PWM ch.	High-resolution PWM ch.	Quadrature encoder	Event captures	HRCAP	Timers*	12-bit ADC ch.	ADC conversion time (ns)	Comparators	OpAmp/PGA	USB	McBSP	I^2C	UART/SCI	SPI	CAN	LIN	External memory interface	Core supply (V)	GPIO pins	On-chip oscillator	Voltage regulator	Package pin counts	1 kU pricing (U.S. $)
TMS320F28026F‡	60	–	–	–	–	32	12	Boot	9	4	–	1	–	9	13	217	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	48	4.45
TMS320F28027F‡	60	–	–	–	–	64	12	Boot	9	4	–	1	–	9	13	217	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	48	4.66
TMS320F28062F‡	90	Yes	–	–	Yes	128	52	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	6.70
TMS320F28068F‡	90	Yes	–	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	11.33
TMS320F28068M§	90	Yes	–	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	7.00
TMS320F28069F‡	90	Yes	Yes	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	10.03
TMS320F28069M§	90	Yes	Yes	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	12.56

†Prices are quoted in U.S. dollars and represent 2015 suggested retail pricing for baseline packages and device configurations. All prices are subject to change.

**Timers include CPU timers, PWM timers, eCAP timers and Watchdog timers*

‡InstaSPIN-FOC capable devices

§InstaSPIN-MOTION (and InstaSPIN-FOC) capable devices

TI Designs for Motor Drives

TI Design	Description	Key Features
Reference Design: Isolated IGBT Gate-Drive Fly-Buck™ Power Supply with 4 Outputs	The TIDA-00174 reference design is a 4-output isolated Fly-Buck power supply for IGBT gate drive bias. It generates two sets of (+16V, –9V) voltage output with 100mA output current capability. The positive/negtaive bias voltages are used to power the high power IGBT gate drivers, and the design is suitable to support driving IGBTs. The Fly-Buck having the nature of primary side regulation can achieve better regulation and line/load response over other open-loop or aux winding feedback topologies. It is capable of operating from a loosely regulated 24V input (±20%). The board comes with plug-in header pins, and it is compatible with the C2000 HV inverter kit.	• Fly-Buck power supply for IGBT gate drive bias, primary side regulation without opto or aux winding feedback • 2 pair of isolated positive/negative voltage rails suitable for biasing two IGBTs • Output 2x (+16V, –9V), 100mA each, 2.5W per IGBT driver • Operates from unregulated 24V ±20% input • 87% peak efficiency, <55mV output ripple • This design is compatible and tested with the C2000 HV inverter kit
Interface to a 5V BiSS Position Encoder Reference Design	This TI Design implements a hardware interface solution based on the BiSS standard for position or rotary encoders. It supports both BiSS Point-to-Point and BiSS Bus configurations. The building blocks include the power supply for a 5V BiSS encoder — with innovative smart e-Fuse technology — and robust full-duplex RS485 transceivers, including line termination and EMC protection. An auxiliary power supply and logic level interface with adjustable I/O voltage level is provided to connect to subsequent MCUs and MPUs that would run the BiSS (or SSI) Master protocol stack. This design is fully tested to meet EMC immunity requirements for ESD, Fast Transient Burst and Surge according to IEC61800-3.	• 3.3V RS-485 full-duplex transceivers with IEC-ESD meets BiSS clock frequency (10Mhz) • Design meets EMC immunity requirements for ESD, fast transient burst and surge according to IEC61800-3 • Wide input (15-30VDC) high-efficiency (>85%) DCDC power supply for 5V BiSS (or SSI) encoders with 350mA, lowest-ripple (<20mVpp) output • Protected power supply with innovative eFuse technology with inrush current limitation and protection against over-current, over- and under-voltage and disconnect in case of fault • Option to shut down encoder power supply in case of fault or to save power when no encoder is connected. • 3.3V interface with level shifter to also support 2.5V or 1.8V I/O interface to processors to run the BiSS (or SSI) Master
Isolated IGBT Gate-Drive Push-Pull Power Supply with 4 Outputs	This reference design provides isolated positive and negative voltage rails required for Insulated Gate Bipolar Transistor (IGBT) gate drivers from a single 24-volt DC input supply. IGBTs are used in three phase inverters for variable-frequency drives to control the speed of AC motors. This reference design uses a push-pull isolated control topology and provides isolation compliant to IEC61800-5 and is intended to operate from a pre-regulated $24V_{DC}$ input. With a regulated (within 5%) input source, a simple open-loop, free-running oscillator can be implemented with a push-pull PWM controller. This topology is essentially a forward converter with two primary windings used to create a dual-drive winding. This fully utilizes the transformer core's magnetizing current more efficiently than flyback or the forward topologies. Another advantage this configuration has over flyback and forward configurations is that the supply output can be scaled up for higher power drives. This reference design also takes advantage of another benefit of the push pull topology in that multiple transformers can be controlled in parallel from a single controller to generate all the isolated voltage rails required for 3-phase IGBT inverters. Lastly, larger IGBTs for higher power drives sometimes require more gate drive current than what is provided by a typical IGBT gate driver, for which designers often use additional transistors for gate current boosting. This reference design provides +16V on the positive outputs and –8V on the negative outputs to compensate for the added voltage drop in those transistors	• Supports 6 IGBT gate drivers for 3 arms of inverter (each arm in half-bridge configuration) • Push-pull topology enables parallel transformer stages from a single controller for 3-phase power • Operates with pre-regulated 24V input • Two reinforced isolated, low-ripple (<200mV) outputs for each IGBT: +16V (x2) and –8V (x2) • Output power: 2W per IGBT and scalable to support higher power IGBTs • Option to shut down the power supply to facilitate Safe Torque Off (STO) feature • Output capacitors rated to support up to 6A peak gate drive current • Designed to meet IEC61800-5

*New products are listed in **bold red**.*

TI Designs for Motor Drives (continued)

TI Design	Description	Key Features
High Performance Bipolar Stepper Drive Stage Reference Design with 256 Microstep Support	The TIDA-00261-BOOST-DRV8711 is an 8-52V, 4.5A, bipolar stepper motor drive stage based on the DRV8711 Stepper Motor Pre-driver and CSD88537ND Dual N-Channel NexFET™ Power MOSFET. The module contains everything needed to drive many different kinds of bipolar stepper motors and can also be repurposed as a dual brushed DC motor driver. The BOOST-DRV8711 is ideal for those wishing to learn more about stepper motor control techniques and drive stage design. This kit was designed to be compatible with all TI LaunchPads following the LaunchPad Pinout Standard, with primary software/firmware support being provided for the MSP-EXP430G2 LaunchPad with a MSP430G2553.	• 8V to 52V supply input with up to 4.5A continuous output current from each H-bridge • Built in 1/256-step microstepping indexer for ultra-smooth movement • SPI interface for driver settings and status reporting • Complete stepper motor drive stage in ultra-small form factor (1.75" x 2.00") • Fully protected drive stage including overcurrent, overtemperature, and under voltage protection
Current Controlled Driver for AC Solenoids with Plunger Fault Detection for 24V DC Solenoids, with Plunger Fault Detection	This reference designs provide solutions to control AC or 24V DC solenoid current using a PWM based controller along with hall sensor techniques to detect plunger movement and switch from peak current mode to hold current mode.	• Uses DRV110 Power saving solenoid current controller with integrated supply regulation • Solenoid current is controlled during peak and hold mode for lower power and thermal dissipation using PWM technique with external MOSFET • Peak current, keep time at peak current, hold current and PWM clock frequency are adjustable through external components • Feature to interface HALL sensor to detect plunger movement and switch to hold mode • Provides logic EN pin for the PLC to activate/deactivate the solenoid • Provides 0V to 10V analog output, scaled to solenoid current to interface with PLC
Sercos III Communications Development Platform	The TIDEP0010 Sercos III communication development platform combines the AM335x Sitara processor family from Texas Instruments (TI) and the Sercos III media access control (MAC) layer into a single system-on-chip (SoC) solution. Targeted for Sercos III slave communications, the TIDEP0010 allows designers to implement the real-time Sercos III communication standard for a broad range of industrial automation equipment. The design is based on the TMDSICE3359 Industrial Communications Engine (ICE).	• Sercos III conformance tested • Sercos III firmware for PRU-ICSS with Sercos MAC compliant register interface • Board support package and industrial software development kit available from TI and 3rd party • Development platform which includes schematics, BOM, user guides, application notes, white paper, software, demos and more • Supports other industrial communications with the same hardware (e.g., EtherCAT, Profinet, Ethernet/IP and more)
Washing Machine Control Reference Design	This solution is designed for the inverter front-loading washing machine. It includes three parts: the main control board for the whole washing process control, the motor control board for DD VF motor control, and the user inference board. This solution can implement different washing programs and realize failure detection.	• Uses InstaSPIN™ estimator for sensorless PMSM control • Online parameter identification • The motor can continue to run in the same direction and with the same speed after the motor stall recovers • Includes agitate washing mode
Three-Phase Brushless/PMSM Low-Current Motor Control Solution with InstaSPIN™ Software	This reference design demonstrates a motor control solution for spinning three-phase brushless DC (BLDC) and brushless AC (BLAC) — often referred to as permanent magnet synchronous (PMSM) — motors featuring the C2000™ Piccolo™ microcontroller and the DRV8312 3-phase motor driver. The reference design features a high-performance, power-efficient, cost-effective sensorless field-oriented control (FOC) and sensored/sensorless trapezoidal commutation platform that speeds development for quicker time to market. This reference design is based on the DRV8312 evaluation kit.	• Full digital control of dual interleaved PFC power converter topology • Worldwide voltage input of $95V_{AC}$ to $265V_{AC}$ • $400V_{DC}$ bus operating up to 700W • C2000 Piccolo TMS320F28069M MCU digitally controls three-phase motors • Supports power metering of rectified input voltage, RMS input voltage, RMS input power, and input line frequency • Includes software, hardware design files, quick start graphical interface, and step-by-step documentation
Three-Phase Brushless/PMSM High-Current Motor Control Solution with InstaSPIN™ Software	This reference design demonstrates a motor control solution for spinning three-phase brushless DC (BLDC) and brushless AC (BLAC) — often referred to as "permanent magnet synchronous (PMSM)" — motors featuring the C2000™ Piccolo™ microcontroller enabled with InstaSPIN-FOC and InstaSPIN-MOTION in ROM and the DRV8301 three-phase motor driver. It provides three half-bridge drivers, each capable of driving two N-type MOSFETs, one for the high side and one for the low side. It supports up to 2.3A sink and 1.7A source peak current capability and only needs a single power supply with a wide range from 6V to 60V. The reference design features a high-performance, power-efficient, cost-effective platform that speeds development for quicker time to market. Applications include CPAP and pumps, e-bikes, e-scooters, medical pumps and drills, power tools, and robotics. This reference design is based on the DRV8301 evaluation kit.	• Operating supply voltage 6V to 60V • 2.3A sink and 1.7A source gate drive current capability • Integrated dual-shunt current amplifiers with adjustable gain and offset • Integrated buck converter to support up to 1.5A external load • Isolated SPI and CAN interfaces • Fully-functional evaluation board includes software, hardware design files, quick start graphical interface, and step-by-step documentation

*New products are listed in **bold red**.*

TI Designs for Motor Drives (continued)

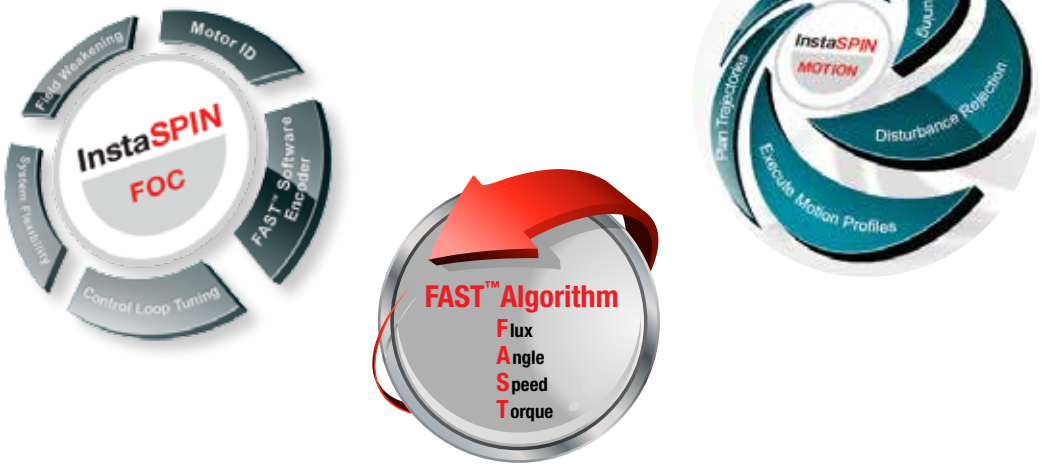
TI Design	Description	Key Features
Three-Phase Brushed and Stepper Motor Control Solution	This reference design demonstrates a motor control solution for spinning three-phase brushed DC or single stepper motor — featuring the C2000™ Piccolo™ microcontroller and the DRV8412 three-phase motor driver. This highly integrated, robust motor control and driver solution speeds development time for brushed and stepper motors running up to 6A continuous/12A peak at 50V. Typical applications include medical pumps, gate openers, stage lighting, textile manufacturing tools, and industrial or consumer robotics. This reference design is based on the DRV8412 evaluation kit.	• High-efficiency power stage (up to 97%) with low RDS(on) MOSFETs (110 mΩ at TJ = 25°C) • Operating supply voltage up to 52V • Integrated self-protection circuits including undervoltage, over-temperature, overload, and short circuit • Closed-loop digital control with feedback using the C2000's on-chip PWM and ADC peripherals • High precision low-side current sensing using the C2000's high-performance ADC, Texas Instruments OPA2350 high speed op-amps and Texas Instrument REF3025 high precision voltage reference chip • Fully-functional evaluation board includes software, hardware design files, quick start graphical interface, and step-by-step documentation
Three-Phase Brushless DC Motor Driver	The Thee-Phase Brushless DC Motor Driver reference design is a 10A, 3-phase brushless DC drive stage based on the DRV8301 pre-driver and CSD18533Q5A NextFET™ power MOSFET. It has three low side current sense amps (two internal to DRV8301, one external). The design also leverages a 1.5A step down buck converter, is fully protected with short circuit, thermal, and shoot-through protection, and is easily configured via a SPI interface. It is ideal for sensorless, brushless control techniques and drive stage design.	• Complete brushless DC drive stage in ultra-small form factor (2.2" x 2.3") • Supports up to 14A peak, 10A continuous current output • Supports voltage and current feedback for InstaSPIN-FOC sensorless control solution • 3x low side current sense amps, 6x Power FETs (< 6.5mΩ) and 1.5A step down buck converter • Drive stage is fully protected including short circuit, thermal, shoot-through, and under voltage protection • C2000™ Piccolo™ F28027F MCU with InstaSPIN™-FOC technology
Analog Front End for Motor Electronic Overload Relays with Enhanced Current Range	This reference design is the analog front end (AFE) for an electronic overload relay, used for monitoring and protecting motors from overcurrent or undercurrent events. It is an ideal tool for developers creating overload relays for senstive AC motors in industrial applications. This progrmmable gain amplifier (PGA) based analog front end is intended to be an easy evaluation platform for an accurate, industry-leading 10:1 full load ampere (FLA) range and is repeatible over a –10 to +70°C temperature range.	• Wide FLA of 10:1 which dramatically reduces the number of units required on-hand • Current measurement accuracies of <2% over entire 10:1 measurement range from no load to locked rotor current • Ambient insensitivity from –10 to +70°C • Robust design that prevents phase reversal in overdrive conditions and high electrostatic discharge (ESD) protection (3-kV HBM)
Speed-Controlled 24V Brushless DC Outrunner Motor Reference Design	This advanced motor implements closed-loop speed control to maintain an exact RPM across the load torque profile. The magnetic rotor position is sensed by the DRV5013 Hall-effect sensors, and the DRV8308 controller decides when to drive the CSD88537ND FETs that energize the coils. No microcontroller or firmware is used, and the intelligent sinusoidal current drive minimizes acoustic noise and torque ripple to maximize motor performance.	• Speed controlled at 2054 RPM for any torque load up to 118mNm (16.7 oz-in) • Power input supports 24V to 32V and more than 5A • Outrunner style provides good power density in 6x6x3 cm3 form • Easy to modify RPM and max current with resistor changes • Design features up to 71% efficiency
EN55011 Compliant, Industrial Temperature, 10/100Mbps Ethernet PHY Brick Reference Design	This Ethernet PHY reference design demonstrates the advanced performance of the DP83848K Ethernet PHY transceiver, supports 10/100 Base-T and is compliant with IEEE 802.3 standard. The design is also fully compliant to EN5501 Class A EMI requirements and operates from a single power supply (5V with On-Board regulator or 3.3V). The board has been designed in a small form factor (2 inches x 3 inches) which makes it easier to fit into existing products.	• Meets EN55011 class A radiated emission requirements • Low power consumption = 264mW • DP83848K Ethernet PHY configured for MII interface • Programmable LED support for link and activity • External isolation transformer with common-mode choke on PHY side for improved • EMI and EMC performance • HBM ESD protection on RD± and TD± of 4kV

*New products are listed in **bold red**.*

Unique motor control expertise on-chip with Piccolo™ Real-Time MCUs

- Select Piccolo devices include motor control software on-chip
- FAST™ premium software sensor (observer) to replace mechanical sensors and software estimators
- InstaSPIN™-FOC identifies motor parameters and tunes a sensorless field-oriented torque-control system
- InstaSPIN-MOTION adds premium position and speed control with full motion control suite

Learn more: **www.ti.com/instaspin**



TI Worldwide Technical Support

Internet

TI Semiconductor Product Information Center Home Page
support.ti.com

TI E2E™ Community Home Page
e2e.ti.com

Product Information Centers

Americas	Phone	+1(512) 434-1560
Brazil	Phone	0800-891-2616
Mexico	Phone	0800-670-7544
	Fax	+1(972) 927-6377
	Internet/Email	support.ti.com/sc/pic/americas.htm

Europe, Middle East, and Africa

Phone	
European Free Call	00800-ASK-TEXAS (00800 275 83927)
International	+49 (0) 8161 80 2121
Russian Support	+7 (4) 95 98 10 701

Note: The European Free Call (Toll Free) number is not active in all countries. If you have technical difficulty calling the free call number, please use the international number above.

Fax	+(49) (0) 8161 80 2045
Internet	www.ti.com/asktexas
Direct Email	asktexas@ti.com

Japan

Fax	International	+81-3-3344-5317
	Domestic	0120-81-0036
Internet/Email	International	support.ti.com/sc/pic/japan.htm
	Domestic	www.tij.co.jp/pic

Asia

Phone	Toll-Free Number
Note: Toll-free numbers may not support mobile and IP phones.	
Australia	1-800-999-084
China	800-820-8682
Hong Kong	800-96-5941
India	000-800-100-8888
Indonesia	001-803-8861-1006
Korea	080-551-2804
Malaysia	1-800-80-3973
New Zealand	0800-446-934
Philippines	1-800-765-7404
Singapore	800-886-1028
Taiwan	0800-006800
Thailand	001-800-886-0010
International	+86-21-23073444
Fax	+86-21-23073686
Email	tiasia@ti.com or ti-china@ti.com
Internet	support.ti.com/sc/pic/asia.htm

B021014

Printed in U.S.A. by (Printer, City, State)

Texas Instruments

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		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265