

# Washing Machine and Dryer Solutions Guide



TI's diverse expertise helps designers deliver the next generation of appliances while conserving power, increasing intelligence and cutting costs.



# Washing machine and dryer solutions

## Design considerations

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#### TI Designs

12 TI Designs

### Energy efficiency

The electric motors used in washing machines have to provide very dynamic torque profiles during washing cycles. The motors are often oversized to account for the load torque changes and transients. Scalar techniques for control can result in inefficient systems and noisy operation. This, in turn, leads to mediocre energy efficiency that hovers in the 40 to 50 percent range. By implementing the control system with TI's digital signal controllers, designers can implement smaller, quieter motors with energy efficiency as high as 85 to 90 percent.

### Power factor correction (PFC)

PFC is a technique for counteracting the undesirable effects of electric loads that create a power factor less than one. In washing machines, PFC is necessary because of the continuous transients and surge currents exhibited by the electric motor during the wash cycle. With TI products, PFC can occur externally with a separate integrated circuit or in software on a microcontroller, eliminating the need for a separate external PFC controller.

### IEC 60730 compliance

White-goods manufacturers continually introduce new design enhancements to their automatic electronic controls that ensure safe, reliable and efficient operation of the equipment. Washing machines are one of the examples where the International Electrotechnical Commission (IEC) 60730 functional safety standard is applicable. The IEC 60730 specification discusses mechanical, electrical, electronic, electromagnetic compatibility (EMC) and abnormal operation of alternating current (AC) appliances. For microcontrollers, the specification details new test and diagnostic methods for the real-time embedded software to ensure the safe operation of embedded control hardware and software. Many TI microcontrollers offer software libraries to assist with IEC 60730 class compliance. For more information, see [ti.com/safeti](http://ti.com/safeti).

### Power management

TI offers AC/DC converters, DC/DC converters and linear regulators that convert power from the line power to various DC power supplies required by indoor and outdoor units, as well as the remote controllers and such as 15 V, 12 V, 5 V, 3.3 V or 1.8 V typically.

### High-voltage isolation

For larger, higher-performance products where reliability and motor-control accuracy are key concerns, TI offers isolation products that block high voltage, isolate grounds, and prevent noise currents from entering the local ground.

### Smart washing machines

A home mesh network consists of home appliances connected wirelessly and controlled via a remote control. TI provides customers with ZigBee-compliant solutions, proprietary radio-frequency integrated circuits (RFICs), Wi-Fi and near-field communication (NFC). TI has proven software and hardware solutions supporting each of these communication interfaces.

### Touch control

The use of touch control has moved beyond the high-end market to a wide range of applications. Touch controls typically take the form of a button or a slider, but touch controls on electronic displays are increasing. Haptic feedback can provide touch interfaces with the tactile response that users are accustomed to from mechanical controls. TI provides a wide range of touch solutions with reliable and excellent radio-frequency (RF) noise immunity.

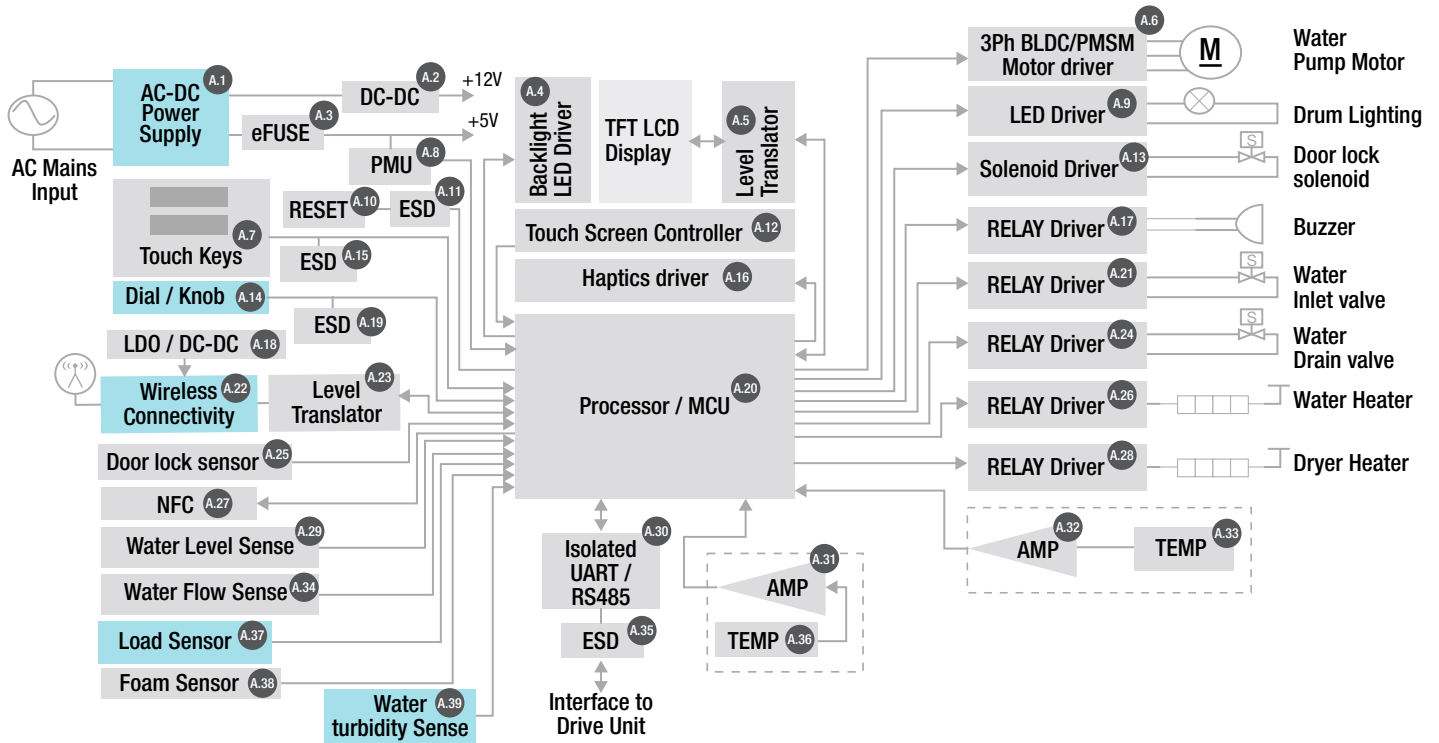
### Advanced sensing

Washing machines use several sensors such as temperature, water level, water flow, water quality, water hardness sense, lid sensor, load sensing and vibration detection. TI provides integrated circuit (IC) products and solutions that cover accurate temperature sensing, humidity sensing, proximity detection using capacitive sensing, inductive sensing-based touch on metal and ultrasonic sensing for various purposes.

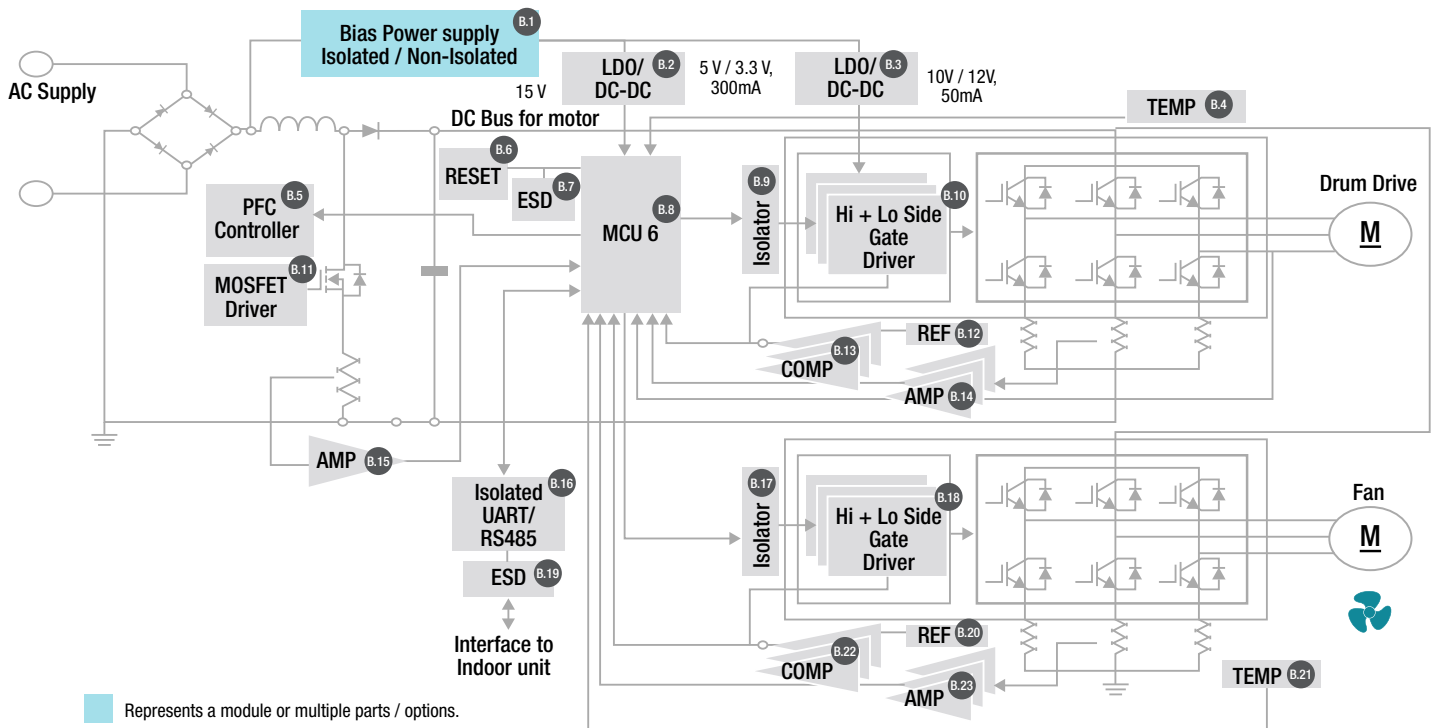
# Washing machine and dryer solutions

## System block diagrams

### Washing machine controller



### Washing machine drum and dryer fan drive



Represents a module or multiple parts / options.

# Components selection

Operational amplifiers / current shunt monitor / comparator / isolated amplifier / isolated delta-sigma

## Operational amplifiers

Item	Part Number	# of Channels	Supply Voltage (Min) (V)	Supply Voltage (Max) (V)	GBW (Typ) (MHz)	Slew Rate (Typ) (V/μs)	CMRR (Min) (dB)	Vn at 1 kHz (Typ) (nV/√Hz)	Vio (25°C) (Max) (mV)	IIB (Max) (pA)	Iq per Channel (Max) (mA)	Price* (US\$)
A.31, A.32	OPA170	1	2.7	36.0	1.2	0.5	104	19	2	15	145.0	0.40
A.31, A.32	LMV321	1	2.7	5.5	1.0	1.0	50	39	7.0	250000	0.3	0.20
A.31, A.32, B.14, B.15, B.23	LM324	4	3	32	1.2	0.5	80	35	7	250000	0.175	0.07
B.14, B.15, B.23	LM2904	2	3	26	0.7	0.3	80	40	2	250000	0.35	0.07
A.31, A.32	TL3472	2	4	36	4	10	97	49	10	500000	3.5	0.2
A.31, A.32, B.14, B.15, B.23	TLC2274A	4	4.4	16	2.2	3.6	75	9	0.95	60	1.1	0.8
A.31, A.32, B.14, B.15, B.23	TLV2772	2	2.5	6	5.1	10.5	96	17	2.5	60	1	1.18
B.14, B.15, B.23	OPA4348	4	2.1	5.5	1	0.5	82	35	5	10	0.045	0.5
B.14, B.15, B.23	OPA171	1	2.7	36	3	1.5	120	14	1.8	15	0.475	0.4
B.14, B.15, B.23	LM6142	2	1.8	24	17	25	107	16	1	280000	0.65	1.58
B.14, B.15, B.23	LM6144	4	1.8	24	17	25	107	16	1	280000	0.65	2.93

## Current shunt monitor

Item	Part Number	Input Offset (+/-) (Max) (μV)	Input Offset Drift (+/-) (Typ) (μV/Degrees Celsius)	Iq (Max) (mA)	Gain (V/V)	Small-Signal Bandwidth (Typ) (MHz)	CMRR (Min) (dB)	Vs (Min) (V)	Vs (Max) (V)	Common Mode Range (Min)	Common Mode Range (Max)	Special Features	Package Group	Price* (US\$)
B.14, B.15, B.23	INA216	100	0.1	0.0	25/50/100/200	0.0	90	2	5.5	2	5.5	Analog Output	DSBGA UQFN	0.35
B.14, B.15, B.23	INA210	35	0.1	0.1	200.0	0.0	105	3	26.0	-0.3	26.0	Bi-directional Low-side Capable Analog Output	SC70 UQFN	0.75
B.14, B.15, B.23	INA211	35	0.1	0.1	500.0	0.0	105	3	26	-0.3	26.0	Bi-directional Low-side Capable Analog Output	SC70	0.75
B.14, B.15, B.23	INA212	35	0.1	0.1	1000.0	0.0	105	3	26.0	-0.3	26.0	Bi-directional Low-side Capable Analog Output	SC70	0.75
B.14, B.15, B.23	INA213	100	0.1	0.1	50.0	0.1	100	3	26	-0.3	26.0	Bi-directional Low-side Capable Analog Output	SC70 UQFN	0.75
B.14, B.15, B.23	INA214	60	0.1	0.1	100.0	0.0	105	3	26.0	-0.3	26.0	Bi-directional Low-side Capable Analog Output	SC70 UQFN	0.75
B.14, B.15, B.23	INA215	60	0.1	0.1	75.0	0.0	105	3	26	-0.3	26.0	Bi-directional Low-side Capable Analog Output	SC70	0.75
B.14, B.15, B.23	INA199	150	0.1	0.1	50/100/200	0.1	100	3	26	-0.3	26.0	Analog Output Bi-directional Low-side Capable	SC70 UQFN	0.50

## Comparator

Item	Part Number	# of Channels	Supply Voltage (Min) (V)	Supply Voltage (Max) (V)	tRESP Low - to - High (us)	Input Bias Current (+/-) (Max) (nA)	Rail-to-Rail	VICR (Max) (V)	VICR (Min) (V)	Vos (25°C) (Max) (mV)	Output Type	Iq per Channel (Max) (mA)	Price* (US\$)
B.13, B.22	LM2903	2	2	30	1.3	50	Out	28.5	0	7	Open Collector, Open Drain	0.5	0.07
B.13, B.22	LM393	2	2	36	0.3	50	Out	34.5	0	5	Open Collector, Open Drain	0.5	0.07
B.13, B.22	TLV3202	2	2.7	5.5	0.047	0.05	-	5.2	-0.2	5	Push-Pull	0.05	0.5

## Isolated amplifier

Item	Part Number	Isolation Mode Rejection 60Hz (Typ) (dB) CMRR (Typ.) (dB)	Isolation Voltage Cont Peak (DC) (V)	Isolation Voltage Pulse/ Test Peak (V)	Small Signal Bandwidth (Typ) (kHz)	Working Voltage Peak (V)	Gain Non-Linearity (+/-) (Max) (%)	CMTI (Min) (kV/μs)	Operating Temperature Range °C	Gain Error % (Max)	Shunt Input Range (mV)	Price* (US\$)
B.14, B.15, B.23	AMC1100	108	4250	5100	100	1200	0.015	2.5	-40 to 105	1%	±250	2.0
B.14, B.15, B.23	AMC1200B	108	4250	5100	100	1200	0.015	10	-40 to 105	1%	±250	2.2
B.14, B.15, B.23	AMC1200	108	4000	4800	100	1200	0.015	10	-40 to 105	1%	±250	2.2
B.14, B.15, B.23	AMC1204	108	4250	5100	-	1200	-	15	-40 to 125	2%	±250	3.45

## Isolated delta-sigma modulator

Item	Part Number	Resolution (Bits)	Sample Rate (max) (SPS)	# Input Channels	Input Range	Interface	Isolation (kV peak)	CMTI (Min) (kV/μs)	INL (Max) (+/- LSB)	SNR (dB)	THD (Max) (dB)	Power Consumption (Typ) (mW)	Architecture	Analog Voltage AV/DD (Min) (V)	Analog Voltage AV/DD (Max) (V)	Digital Supply (Min) (V)	Digital Supply (Max) (V)	Operating Temperature Range (°C)	Pin/ Package	Price* (US\$)
B.14, B.15, B.23	AMC1204	16	78KSPS	1	±250mV	Serial	4.25	15	9	84%	-80	88.0	Delta-Sigma	4.5	5.5	3	5.5	-40 to 125	8/16SOIC	3.45
B.14, B.15, B.23	AMC1304L05	16	20MSPS	1	±50mV	LVDS	7	15	4	77	-80	58	Delta-Sigma	4	18	3	5.5	-40 to 125	16SOIC	3.8
B.14, B.15, B.23	AMC1304L25	16	20MSPS	1	±250mV	LVDS	7	15	4	85	-80	58.9	Delta-Sigma	4	18	3	5.5	-40 to 125	16SOIC	3.8

# Components selection

Isolated delta-sigma / sensor / AC/DC power supply / PFC controller

## Isolated delta-sigma modulator (continued)

Item	Part Number	Resolution (Bits)	Sample Rate (max) (SPS)	# Input Channels	Input Range	Interface	Isolation (kV peak)	CMTI (Min) (kV/μs)	INL (Max) (+/- LSB)	SNR (dB)	THD (Max) (dB)	Power Consumption (Typ) (mW)	Architecture	Analog Voltage AV/DD (Min) (V)	Analog Voltage AV/DD (Max) (V)	Digital Supply (Min) (V)	Digital Supply (Max) (V)	Operating Temperature Range (°C)	Pin/Package	Price* (US\$)
B.14, B.15, B.23	AMC1304M05	16	20MSPS	1	±50mV	Serial CMOS	7	15	4	77	-80	58	Delta-Sigma	4	18	3	5.5	-40 to 125	16SOIC	3.8
B.14, B.15, B.23	AMC1304M25	16	20MSPS	1	±250mV	Serial CMOS	7	15	4	85	-80	58.9	Delta-Sigma	4	18	3	5.5	-40 to 125	16SOIC	3.8
B.14, B.15, B.23	AMC1305L25	16	20MSPS	1	±250mV	LVDS	7	15	4	85	-83	49.3	Delta-Sigma	4.5	5.5	3	5.5	-40 to 125	16SOIC	3.5
B.14, B.15, B.23	AMC1305M05	16	20MSPS	1	±50mV	Serial CMOS	7	15	4	76	-83	38.4	Delta-Sigma	4.5	5.5	3	5.5	-40 to 125	16SOIC	3.8
B.14, B.15, B.23	AMC1305M25	16	20MSPS	1	±250mV	Serial CMOS	7	15	4	85	-83	36.1	Delta-Sigma	4.5	5.5	3	5.5	-40 to 125	16SOIC	3.5

## Sensor

Item	Part Number	Sensor type	Supply Voltage (Max)	Supply Voltage (Min)	Resolution (Bits)	Special Features	Interface	Operating Temperature Range (C)	Feature	Time Sensing Accuracy (Typ)(Ps)	Price* (US\$)
A.14, A.25, A.34	LDC0851	Inductive	3.3	1.8	-	Differential Inductive Switch	Push/Pull	-40 to 125	4ksps	-	2.5
A.7, A.14, A.37	LDC1314	Inductive	3.6	2.7	12	Contactless	I2C	-40 to 125	13.3ksps	-	3.5 / 4.75
A.7, A.14	LDC1614	Inductive	3.6	2.7	28	Reliable/Water resistant	I2C	-40 to 125	4ksps	-	0.5
A.12	FDC2214	Capacitive	3.6	2.7	28	EMI-resistant	I2C	-40 to 125	4ksps	-	4.75
A.29	FDC1004	Capacitive	3.6	2.7	24		I2C	-40 to 125	4 Channels	-	2.38
A.38	FDC2112	Capacitive	3.6	2.7	12	EMI-resistant	I2C	-40 to 125	13.3ksps, 2 Channels	-	2.5
A.29, A.34, A.39	TDC1000	Ultrasonic	5.5	2.7	N/A	Fully integrated analog front end, LNA and PGA	SPI	-40 to 125	1.8uA at 2SPS, 50ps rms jitter	-	2.5
A.34, A.39	TDC7200	Time	2	3.6	-	5 STOP Signals	SPI	-	-	52	2.25
A.33, A.36, B.4, B.21	LMT84	Temp	5.5	1.5	N/A	-5.5mV/C	Voltage Output	-50 to 150	2.7C Accuracy over entire temp range	-	0.18
A.33, A.36, B.4, B.21	LMT85	Temp	5.5	1.8	N/A	-8.2mV/C	Voltage Output	-50 to 150	2.7C Accuracy over entire temp range	-	0.18
A.33, A.36, B.4, B.21	LMT86	Temp	5.5	2.2	N/A	-10.9mV/C	Voltage Output	-50 to 150	2.7C Accuracy over entire temp range	-	0.18
A.33, A.36, B.4, B.21	LMT87	Temp	5.5	2.7	N/A	-13.6mV/C	Voltage Output	-50 to 150	2.7C Accuracy over entire temp range	-	0.18
A.33, A.36, B.4, B.21	LMT01	Temp	5.5	2	N/A	2-Pin Digital Temp Sensor	Pulse Count Output	-50 to 150	-	-	0.79
A.33, A.36, B.4, B.21	TMP102	Temp	3.6	1.4	12	Programmable Alert, Fault Queue, One-Shot Conversion, Shutdown Power Mode	I2C / SMBUS	-40 to 125	-	-	0.5
A.33, A.36, B.4, B.21	TMP75B	Temp	3.6	1.4	12	Programmable Alert, Fault Queue, One-Shot Conversion, Shutdown Power Mode	I2C / SMBUS	-55 to 125	-	-	0.47
A.25	DRV5023	Hall Sensor	38	2.5	-	Protected digital switch Hall effect sensor	Open Drain	-	-	-	0.26

## AC/DC power supply

Item	Part Number	No-Load Power (mW)	Output Regulation (Max) (%)	Constant Current (%)	Frequency (Max) (kHz)	Green (Mode)	Soft Start	700-V Start-up	Cable Compensation	Price* (US\$)
A.1, B.1	LM5023	10mW	1%	5%	130-KHz	Yes	Yes	-	-	0.38
A.1, B.1	UCC28700	30mW	5%	5%	132-KHz	Yes	Yes	-	Yes	0.35
A.1, B.1	UCC28710	10mW	5%	5%	100-KHz	Yes	Yes	Yes	Yes	0.42
A.1, B.1	UCC28740	30mW	3%	5%	100-KHz	Yes	Yes	Yes	-	0.42
A.1, B.1	UCC28630	30mW	5%	10%	120-KHz	Yes	Yes	Yes	-	0.60
A.1, B.1	UCC28730	Zero/5mW	5%	5%	83-KHz	Yes	Yes	Yes	Yes	0.42
A.1, B.1	UCC28911	30mW	5%	5%	115-KHz	Yes	Yes	Yes	-	0.82

## PFC controller

Item	Part Number	Recommended Power Range (W)	# of Phase	Frequency Range (kHz)	Operating Supply Voltage (Max) (V)	Vref Tolerance (%)	Duty Cycle (Max) (%)	Practical Operating Frequency (Max) (MHz)	UVLO Thresholds On/Off (V)	Price* (US\$)
B.5	UCC28070A	> 800	Dual	10 to 300	21	3	99	0.3	10.2/9.2	1.95
B.5	UCC28019A	200 to 800	Single	57 to 71	21	2	-	-	10.5/9.5	0.75
B.5	UCC2818A	200 to 800	Single	6 to 220	18	1.5	100	0.25	10.5/10	1.25

# Components selection

## Power management unit / DC/DC switching regulator

### Power management unit

Item	Part Number	MCU/processor attached	Vin (V)	No. of Regulator Outputs	DC/DC Step-down Converter	DC/DC Step-Down Controller	DC/DC Step-Up Converter	DC/DC Buck-Boost Converter	LDO	Communication Interface	Description	Package(s)	Price* (US\$)
A.8, B.2, B.3	TPS65217	AM335x	2.7 to 6.5V	7.00	3	–	–	–	4	I2C	Power Management IC (PMIC) w/ 3 DC/DCs, 4 LDOs, Linear Battery Charger & White LED Driver	QFN-48	3.45
A.8, B.2, B.3	TPS65910x	AM335x	2.7 to 5.5V	13.0	3	–	1	–	9	2 x I2C	Integrated Power Management IC (PMIC) w/ 4 DC/DCs, 8 LDOs and RTC	QFN-48	3.30
A.8, B.2, B.3	TPS650250	AM335x	2.5 to 6V	6.00	3	–	–	–	3	I2C	Integrated Power Management IC (PMIC) w/ 3 DC/DCs, 3 LDOs	QFN-32	2.20
A.8, B.2, B.3	TPS65218	AM335x, AM437x	2.7 to 5.5V	7.00	5	–	–	1	1	I2C	Power Management IC (PMIC) w/ 6 DC/DC, 1 LDO, Load Switches	QFN & QFP	3.45
A.8, B.2, B.3	TPS65320-Q1	General Purpose	3.6 to 40V	2.00	1	–	–	–	1	–	Integrated Power Management IC (PMIC) w/1 DC/DC and 1 LDO	14HTSSOP	\$1.45
A.8, B.2, B.3	TPS650061	C2000, General Purpose	2.3 to 6V	3.0	1	–	–	–	2	–	Power Management IC (PMIC) w/ 1 DC/DC, 2 LDOs, Supply Voltage Supervisor	QFN-20	1.40
A.8, B.2, B.3	TPS65023	AM335x, General Purpose	1.5 to 6.5V	6.00	3	–	–	–	3	I2C	6-channel Power Management IC (PMIC) with 3DC/DCs, 3 LDOs, I2C Interface and DVS	QFN-40	2.95
A.8, B.2, B.3	TPS65053	General Purpose	1.5 to 6.5V	5.0	2	–	–	–	2	–	5-Channel Power Management IC (PMIC) with two step down converters and 3 low-input voltage LDOs	QFN-20	1.65

### DC/DC switching regulator

Item	Part Number	Topology	Vin (Min) (V)	Vin (Max) (V)	Vout (Min) (V)	Vout (Max) (V)	Iout (Max) (A)	Switch Current Limit (Typ)(A)	Synchronous	High Light-Load Efficiency	Duty Cycle (Max) (%)	Special Features	Price* (US\$)
A.18	LM2770/71	Switched Capacitors	2.7	5.5	1.2	1.575	0.25	–	–	–	–	Sleep mode; soft start	0.30
A.2, A.18, B.2, B.3	TPS562200/9	Buck	4.5	17	0.76	7	2	3.2	y	y(2200)	80	–	0.47/0.47
A.2, A.18, B.2, B.3	TPS54231/331	Buck	3.5	28	0.8	25	2 / 3	3.5 / 5.8	–	y	90	–	0.70/0.75
A.2, A.18, B.2, B.3	TPS563200/9	Buck	4.5	17	0.76	7	3	4.2	y	y (3200)	80	–	0.52/0.52
A.2, A.18, B.2, B.3	TPS56628	Buck	4.5	18	0.76	5.5	6	7.3	y	y	85	–	1.45
A.2, A.18, B.2, B.3	TPS54335A/336A	Buck	4.5	28	0.8	25	3	5	y	y	90	–	0.9
A.2, A.18, B.2, B.3	LM25007/10/11	Buck	9	42	2.5	37	0.5 / 1 / 2	0.7 / 1.2	–	–	90	–	1.05/1.15/1.30
A.2, A.18, B.2, B.3	LM25011	Buck	6	42	2.51	40	2	3.5	–	–	99	–	0.95
A.2, A.18, B.2, B.3	LM25017/LM5017	Buck	7.5	48/100	1.23	40/90	0.65	1.02	y	–	90	–	1.25/1.57
A.2, A.18, B.2, B.3	LMR12010	Buck	3	20	0.8	16	1	1.7	–	–	92	–	0.79
A.2, A.18, B.2, B.3	LMR14203/06	Buck	4.5	42	0.8	34	0.3 / 0.6	0.5 / 1.15	–	–	87	–	0.90/1.01
A.2, A.18, B.2, B.3	LMR24210/20	Buck	4.5	42	0.8	24	1 / 2	1.8 / 2.8	y	–	85	–	1.50/2.00
A.2, A.18, B.2, B.3	TLV62565	Buck	2.7	5.5	0.6	5.2	1.5	–	–	y	95	–	0.56
A.2, A.18, B.2, B.3	TLV62080/4/5	Buck	2.5	5.5	0.5	4	1 / 2 / 3	4 / 4 / 5.5	–	y	100	–	0.46 / 0.59 / 0.67
A.2, A.18, B.2, B.3	TLV62130/50	Buck	4	17	0.9	5	3 / 1	4.2 / 1.7	y	y	100	–	0.75/0.90
A.2, A.18, B.2, B.3	TLV62160	Buck	3	17	0.9	6	1	1.8	y	y	100	–	0.8
A.18, B.2, B.3	LMZ10501	Buck	2.7V	5.5V	0.6	3.6	1	–	y	–	–	Module; Low EMI/PG; Small size and high efficiency	1.55
A.2, A.18, B.2, B.3	LMR14020	Buck	4V	40V	1	36	2	3.2	–	y	98	Adjustable UVLO, Enable, Frequency Synchronization, Light Load Efficiency, Power Good, Pre-Bias Start-Up, Spread Spectrum, Tracking	1.46
A.2, A.18, B.2, B.3	LMR14030	Buck	4V	40V	1	36	3.5	5.5	–	y	98	Adjustable UVLO, Enable, Frequency Synchronization, Light Load Efficiency, Power Good, Pre-Bias Start-Up, Spread Spectrum, Tracking	1.68
A.2, A.18, B.2, B.3	LM46000	Buck	3V	60V	1	28	0.5	1.35	y	y	99	Enable, Frequency Synchronization, Light Load Efficiency, Power Good, Tracking, Synchronous Rectification	1.65

# Components selection

DC/DC switching regulator / linear regulator / voltage supervisors / gate driver

## DC/DC switching regulator (continued)

Item	Part Number	Topology	Vin (Min) (V)	Vin (Max) (V)	Vout (Min) (V)	Vout (Max) (V)	Iout (Max) (A)	Switch Current Limit (Typ)(A)	Synchronous	High Light-Load Efficiency	Duty Cycle (Max) (%)	Special Features	Price* (US\$)
A.2, A.18, B.2, B.3	LMR16006	Buck	4V	60V	0.8	55	0.6	1.2	–	y	97	Adjustable UVLO, Enable, Light Load Efficiency, Pre-Bias Start-Up	1.2
A.2, A.18, B.2, B.3	LMR62014	Boost	2.7V	14V	3	20	–	2	–	–	93	–	0.55
A.18	TPS62590	Buck	2.5	6	1	0.75	5.5	1	y	y	100	Enable, Light Load Efficiency, Synchronous Rectification	0.015
A.18	TPS57112-Q1	Buck	2.95	6	2	0.8	4.5	5.3	y	–	100	Adjustable UVLO, Enable, Frequency Synchronization, Power Good, Tracking, Synchronous Rectification	0.515
A.18	TPS61046	Boost	1.8	6	4.5	28	–	0.9	–	y	–	Enable, Light Load Efficiency, Load Disconnect	0.7
A.18	TPS61040	Boost	1.8	6	1.8	28	–	0.4	–	–	88	Enable	0.6

## Linear regulator

Item	Part Number	Output Options	Vin (Min) (V)	Vin (Max) (V)	Vout (Min) (V)	Vout (Max) (V)	Iout (Max) (A)	Fixed Output Options (V)	Comments	Price* (US\$)
A.18, B.2	LP5907	Fixed	2.2	5.5	–	–	0.25	1.2, 1.5, 1.8, 1.9, 2.2, 2.5, 2.7, 2.75, 2.8, 2.85, 2.9, 3, 3.1, 3.2, 3.3, 3.7, 4, 4.5	Enable; Output Discharge; Overcurrent Protection	0.14
A.18, B.2, B.3	TLV1117	Adjustable	2.7	15	1.25	13.7	0.8	–	Overcurrent Protection, Thermal Shutdown	0.18
A.18, B.2	UA7805	Fixed	7	25	–	–	1.5	5	Overcurrent Protection, Thermal Shutdown	0.18
A.18, B.2	TPS735	Fixed, Adjustable	2.7	6.5	1.2	6.0	0.5	1.2, 1.5, 2.5, 2.85, 3.3	–	0.49
A.18, B.2	LM2936	Fixed	5.5	60	–	–	0.05	3, 3.3, 5	Enable, Overcurrent Protection, Thermal Shutdown	0.62
A.18, B.2, B.3	LP2951-N	Fixed, Adjustable	1.3	30	1.24	29	0.1	3, 3.3, 5	Enable, Overcurrent Protection, Thermal Shutdown, Power Good	0.25
A.18, B.2	LP2985-N	Fixed	2.2	16	–	–	0.15	1.8, 2.5, 2.6, 2.7, 2.8, 2.9, 3, 3.1, 3.2, 3.3, 3.5, 3.6, 3.8, 4, 4.5, 5, 6.1	Enable, Overcurrent Protection, Thermal Shutdown	0.24
A.18, B.2, B.3	TPS7B67xx-Q1	Adjustable	4	40	1.5	18	0.45	–	Enable, Overcurrent Protection, Thermal Shutdown, Power Good	0.8
A.18, B.2	TPS7B69xx-Q1	Fixed	4	40	–	–	0.15	2.5, 3.3, 5	Overcurrent Protection, Thermal Shutdown	0.45
A.18, B.2	LP2989	Fixed	2.1	16	–	–	0.5	2.5, 2.8, 3, 3.3, 3.8, 5	Enable, Overcurrent Protection, Thermal Shutdown, Power Good	0.89
A.18, B.2	TPS709	Fixed	2.7	30	–	–	0.15	1.2, 1.35, 1.5, 1.6, 1.8, 1.9, 2.5, 2.7, 2.8, 3, 3.3, 3.6, 3.8, 3.9, 5, 6	Enable, Overcurrent Protection, Reverse Current Protection, Thermal Shutdown	0.39

## Voltage supervisors

Item	Part Number	Output Options	Vin (Min) (V)	Vin (Max) (V)	Threshold Voltage 1 (Typ)(V)	Fixed Output Options (V)	Output Driver Type / Reset Output	Time Delay (ms)	Price* (US\$)
A.10, B.6	TLV803	Fixed	1.1	6.0	–	2.25, 2.64, 2.93, 4.38	Active-low, Open-drain	200	0.18
A.10, B.6	TPS3831	Fixed	0.6	6.5	–	0.9, 1.12, 1.52, 1.67, 2.63, 2.93, 3.08, 4.38	Active-low, Push-pull	200	0.30
A.10, B.6	TL7759	Adjustable	1	7	4.55	–	Active-high, Active-low, Open-drain	Programmable	0.24
A.10, B.6	TL7700	Adjustable	1.8	40	0.5	–	Active-low, Open-drain	Programmable	1.47

## Gate driver

Item	Part Number	Drive configuration	Drive current (A)	VCC (Min) (V)	VCC (Max) (V)	Rise time (ns)	Fall time (ns)	Propagation delay (ns)	Special features	Other features	Operating Temperature Range	Packages	Price* (US\$)
B.11	UCC27531	Non-Inverting Single	5	10	35	15	7	17	Negative voltage handling (-5V) at input pins	UVLO, Enable pin	-40 to 140C	6SOT-23, 8SOIC	0.75
B.11	UCC27532	Non-Inverting Single	5	10	35	15	7	17	Negative voltage handling (-5V) at input pins	UVLO, Enable pin	-40 to 140C	6SOT-23	0.75
B.11	UCC27533	Single Inverting Non-Inverting	5	10	35	15	8	15	Negative voltage handling (-5V) at input pins	UVLO, Enable pin	-40 to 140C	5SOT-23	0.75
B.11	UCC27517A	Single Inverting Non-Inverting	8	4.5	18	9	7	13	Negative voltage handling (-5V) at input pins	UVLO, Enable pin	-40 to 140C	5SOT-23	0.49
B.11	UCC27511	Single Inverting Non-Inverting	8	4.5	18	9	7	13	TTL Threshold	UVLO, Enable pin	-40 to 140C	6SOT-23	0.49
B.10, B.18	UCC27714	600V Non-Inverting High side low side	4	8	18	15	15	90	Negative voltage handling at HS pin	UVLO, Enable pin	-40 to 125C	SOIC14	1.75

# Components selection

Motor driver / relay and LED drivers / backlight LED driver/ LED driver / switch mode LED driver / touch screen controller

## Motor driver

Item	Part Number	Motor Type	Special Features	Vs (Min) (V)	Vs (Max) (V)	Peak Output Current (A)	RMS Output	Control I/F	Price* (US\$)
A.6	DRV10983	3-phase BLDC	100mA Step Down Buck; Rotor Lock Protection	8	28	3	2	PWM, Analog, or I2C	1.95
A.6	DRV8313	Brushless DC	2.5A 3-Phase BLDC motor driver	8	60	3 A	1.75 A	PWM	2.25

## Relay and LED drivers

Item	Part Number	Vs (V) (Min / Max)	Switching Voltage (Max) (V)	Peak Output Current (mA)	Iout/ch (Max) (mA)	Drivers Per Package	Operating Temperature Range (°C)	Vol@Lowest Spec Current (Typ)(mV)	Delay Time (Typ)(ns)	Price* (US\$)
A.13, A.17, A.21, A.24, A.26, A.28	ULN2003B	–	50	500	500	7	-40 to 105	900	250	0.14
A.4, A.9, A.13, A.17, A.21, A.24, A.26, A.28	TPL7407L	–	40	500	500	7	-40 to 125	200	350	0.2
A.9, A.17, A.21, A.24, A.26, A.28	DRV8860	8 / 38	–	566	566	8	-40 to 85	–	150	1.5

## Backlight LED driver

Item	Part Number	Description	Vin (Min) (V)	Vin (Max) (V)	Vout (Min) (V)	Vout (Max) (V)	Switching Frequency (Max) (kHz)	Switch Current Limit (Typ) (A)	Dimming Method	Price* (US\$)
A.4	TPS61040	Switch boost converter for white LED	1.8	6	1.8	28	1000	0.4	PWM	0.70
A.4	LM3410	High-brightness white LED driver	2.5	5.5	3	24	1600	2.8	PWM	1.11
A.4	TPS61165	High-brightness white LED driver	3	18	3	38	1200	1.2	PWM	1.10
A.4	LM3406	Constant current buck regulator for driving LEDs	4.5	30	0.45	27	1000	0.35	PWM	1.41

## LED driver

Item	Part Number	Output Channels	Supply Voltage (Min) (V)	Supply Voltage (Max) (V)	LED Voltage (Max) (V)	Data Input	Data Transfer Rate (Typ) (MHz)	Per Ch Drive (mA)	Price* (US\$)
A.9	TLC5916	8	3	5.5	17	Serial	30	120	0.47
A.9	TLC59213	8	4.5	13.2	13.2	Serial	1	500	0.70
A.9	TLC5973	3	3	6	21	Single-Wire	3	50	0.45
A.9	TLC59731	3	3	5.5	21	Single-Wire	0.6	50	0.28
A.9	TPS92630-Q1	3	5	40	40	PWM	–	0.15	0.9
A.9	TPS92638-Q1	8	5	40	40	PWM	–	0.07	1.2
A.5	TLC6C598-Q1	8	3	5.5	40	Serial	–	50	0.34
A.5	TLC6C5912-Q1	12	3	5.5	40	Serial	–	50	0.5

## Switch mode LED driver

Item	Part Number	Input Voltage (Type)	Vin (Min) (V)	Vin (Max) (V)	Iout (Max) (A)	Vout (Min) (V)	Vout (Max) (V)	Topology	Features	Price* (US\$)
A.4, A.9	TPS61165	DC/DC	3.0	18.0	0.4	3	38	Boost	Load Disconnect During Shutdown, Synchronous Rectification	0.75
A.9	TPS92512HV	DC/DC	4.5	60	2.5	0.2	58	Buck	PWM & Analog Dimming, Programmable UVLO, Frequency Synchronization	0.8
A.9	TPS92314A	AC/DC	13	35	2	6	60	Flyback, Buck	Primary Side Regulation Power Factor Correction Soft Switching	0.5
A.9	TPS92411	AC Linear	8	94	0.35	0	93	Floating Switch	Soft Switching	0.23
A.9	TPS92690	DC/DC	4.5	75	5	3	72	Boost, Buck-Boost, SEPIC, Flyback, Cuk	PWM & Analog Dimming Soft Start Shutdown	1.45

## Touch screen controller

Item	Part Number	Supply Voltage (Max)	Supply Voltage (Min)	Resolution (Bits)	Special Features	Interface	Operating Temperature Range	Direct Battery Measurement	On-Chip Temperature Measurement	Touch-Pressure Measurement	Other Features	Price* (US\$)
A.12	TSC2046E	5.25	2.2	12	Extended ESD protection	SPI	-40 to 85	Yes	Yes	Yes	–	0.8
A.12	TSC2003	5.25	2.5	12	Command-Based User Interface	I2C	-40 to 85	Yes	Yes	Yes	–	2.25
A.12	TSC2013-Q1	3.6	1.6	12	Support 2-finger Gestures	I2C	-40 to 125	No	No	Yes	Qualified for Automotive Applications; Register-Based Programmable; Preprocessing to Reduce Bus Activity	1.35

# Components selection

Touch screen controller / haptics / shunt reference / voltage reference / eFuse / isolator

## Touch screen controller (continued)

Item	Part Number	Supply Voltage (Max)	Supply Voltage (Min)	Resolution (Bits)	Special Features	Interface	Operating Temperature Range	Direct Battery Measurement	On-Chip Temperature Measurement	Touch-Pressure Measurement	Other Features	Price* (US\$)
A.12	TSC2007	3.6	1.2	12	Command-Based User Interface	I2C	-40 to 85	No	Yes	Yes	Preprocessing to Reduce Bus Activity	1.75
A.12	TSC2006	3.6	1.2	12	Register-Based Programmable	SPI	-40 to 85	No	Yes	Yes	Preprocessing to Reduce Bus Activity	1.75
A.12	TSC2004	3.6	1.2	12	Register-Based Programmable	I2C	-40 to 85	No	Yes	Yes	Preprocessing to Reduce Bus Activity	1.75
A.12	TSC2008	3.6	1.2	12	Command-Based User Interface	SPI	-40 to 85	No	Yes	Yes	Preprocessing to Reduce Bus Activity	1.5

## Haptics

Item	Part Number	Haptic Actuator Type	Special Features	Input Signal	Supply Voltage (Min) (V)	Output (Max) (Vpp)	Shutdown Current (Typ)(uA)	Pin/Package	Price* (US\$)
A.16	DRV2605L	ERM, LRA	Smartloop Architecture, Built-In Waveform Library	PWM Analog I2C	2.5	11	4	10 VSSOP, 9 DSBGA	1.65
A.16	DRV2603	ERM, LRA	Auto Resonance Detection (LRA), Optimized Drive (ERM)	PWM Analog	2.5	10.4	0.3	10 QFN	0.7
A.16	DRV2667	Piezo	Digital Front End, Boost, Internal Waveform Memory	PWM Analog I2C	3	200	10	20 QFN	2.95

## Shunt reference

Item	Part Number	Description	VO Adj (Min) (V)	VO Adj (Max) (V)	Initial Accuracy @ 25°C (%)	Initial Accuracy (Max) (%)	Min Iz for Regulation (uA)	Iout/Iz (Max) (mA)	Temp Coeff (Typ) (ppm/°C)	Temp Coeff (Max) (ppm/°C)	Price* (US\$)
B.12, B.20	TLV431	Low-voltage adjustable shunt reference	1.24	6	1.5	1.5	55	15	39	129	0.23
B.12, B.20	LMV431	Low-voltage adjustable shunt reference	1.24	30	0.5/1.0/1.5	0.5/1.0/1.5	55	15	39	129	0.23
B.12, B.20	TL431	Adjustable shunt reference	2.495	36	1	1	400	100	34	92	0.11
B.12, B.20	LM431	Adjustable shunt reference	2.495	36	0.4/1.0/2.2	0.4/1.0/2.2	400	100	17	50	0.11

## Voltage reference

Item	Part Number	Description	Supply Voltage (Min) (V)	Supply Voltage (Max) (V)	Output Voltage (V)	Iout/Iz (max) (mA)	Iq (Typ) (uA)	Operating Temperature Range (°C)	Temp Coeff (Max) (ppm/ degree C)	Price* (US\$)
B.12, B.20	REF5025A-Q1	Low Noise, Very Low Drift, Precision Voltage Reference	2.7	18	2.5	10	800	-40 to 125	8	1.6
B.12, B.20	REF3320	30ppm voltage reference	2.248	5.5	2.048	5	3.9	-40 to 125	30	0.85
B.12, B.20	REF3312	30ppm, 3.9uA voltage reference	1.800	5.5	1.250	5	3.9	-40 to 125	30	0.85
B.12, B.20	REF3120	20ppm, 100uA Voltage Reference	2.098	5.5	2.048	10	100.0	-40 to 125	20	0.99
B.12, B.20	REF3112	20ppm, 100uA Voltage Reference	1.800	5.5	1.250	10	100.0	-40 to 125	20	0.99

## eFuse

Item	Part Number	Vin (Min) (V)	Vin (Max) (V)	Abs. Max (Cont) (V)	Current Limit Threshold (Typ) (A)	Current Limit Accuracy	Over Voltage Protection	Internal FET RON (mOhm)	Special Features	Fault Response	Package	Price* (US\$)
A.3	TPS25921	4.5	18	20	0.4 to 1.6	+/-2% (1A @ 25C)	+/-3% Adjustable	90	No RSENSE Required	Auto Retry (A) or Latch Off (L)	SOIC-8 ( 4mm x 5mm )	0.50
A.3	TPS25924	4.5	13.8	20	2 to 5	+/-15%	15V VOUT Clamp	28	No RSENSE Required BLK FET Driver	Auto Retry (A) or Latch Off (L)	VSON-10 ( 3mm x 3mm )	0.55
A.3	TPS25925	4.5	5.5	20	2 to 5	+/-15%	6.1V VOUT Clamp	30	No RSENSE Required	Auto Retry (A) or Latch Off (L)	VSON-10 ( 3mm x 3mm )	0.55
A.3	TPS25927	4.5	18	20	2 to 5	+/-15%	None	28	No RSENSE Required BLK FET Driver	Auto Retry (A) or Latch Off (L)	VSON-10 ( 3mm x 3mm )	0.55

## Isolator

Item	Part Number	Description	# of Channels	Forward/Reverse Channels	VCC (Min) (V)	VCC (Max) (V)	Vpeak Isolation (kV)	Vrms Isolation (kV)	Transient Immunity (kV/us) (typ)	Pin/Package	Price* (US\$)
A.30, B.9, B.16, B.17	ISO7131CC	Quad channel, 3/1, 25 Mbps, digital isolator	3	2/1	3.00	5.50	4242	2.5	50	16 QSOP	1.60
A.30, B.9, B.16, B.17	ISO7140CC	50Mbps Quad and Triple Digital Isolators	4	4/0	3.00	5.50	4242	2.5	50	16 QSOP	1.90
A.30, B.9, B.16, B.17	ISO7141CC	50Mbps Quad and Triple Digital Isolators	4	3/1	3.00	5.50	4242	2.5	50	16 QSOP	1.90
A.30, B.9, B.16, B.17	ISO7142CC	50Mbps Quad and Triple Digital Isolators	4	2/2	3.00	5.50	4242	2.5	50	16 QSOP	1.90

# Components selection

## Isolator / ESD protection / level translator / processor/MCU

### Isolator (continued)

Item	Part Number	Description	# of Channels	Forward/Reverse Channels	VCC (Min) (V)	VCC (Max) (V)	Vpeak Isolation (kV)	Vrms Isolation (kV)	Transient Immunity (kV/μs) (typ)	Pin/Package	Price* (US\$)
A.30, B.9, B.16, B.17	<b>ISO7310C</b>	25Mbps Quad and Triple Digital Isolators	1	1/0	3.00	5.50	4.242	3.0	70	16 SOIC	0.90
A.30, B.9, B.16, B.17	<b>ISO7310FC</b>	25Mbps Quad and Triple Digital Isolators	1	1/0	3.00	5.50	4.242	3.0	70	16 SOIC	0.90
A.30, B.9, B.16, B.17	<b>ISO7320C</b>	25Mbps Quad and Triple Digital Isolators	2	2/0	3.00	5.50	4.242	3.0	70	16 SOIC	1.05
A.30, B.9, B.16, B.17	<b>ISO7320FC</b>	25Mbps Quad and Triple Digital Isolators	2	2/0	3.00	5.50	4.242	3.0	70	16 SOIC	1.05
A.30, B.9, B.16, B.17	<b>ISO7321C</b>	25Mbps Quad and Triple Digital Isolators	2	1/1	3.00	5.50	4.242	3.0	70	16 SOIC	1.05
A.30, B.9, B.16, B.17	<b>ISO7321FC</b>	25Mbps Quad and Triple Digital Isolators	2	1/1	3.00	5.50	4.242	3.0	70	16 SOIC	1.05
A.30, B.9, B.16, B.17	<b>ISO7330C</b>	25Mbps Quad and Triple Digital Isolators	3	3/0	3.00	5.50	4.242	3.0	70	16 SOIC	1.40
A.30, B.9, B.16, B.17	<b>ISO7330FC</b>	25Mbps Quad and Triple Digital Isolators	3	3/0	3.00	5.50	4.242	3.0	70	16 SOIC	1.40
A.30, B.9, B.16, B.17	<b>ISO7331C</b>	25Mbps Quad and Triple Digital Isolators	3	2/1	3.00	5.50	4.242	3.0	70	16 SOIC	1.40
A.30, B.9, B.16, B.17	<b>ISO7331FC</b>	25Mbps Quad and Triple Digital Isolators	3	2/1	3.00	5.50	4.242	3.0	70	16 SOIC	1.40
A.30, B.9, B.16, B.17	<b>ISO7340C</b>	25Mbps Quad and Triple Digital Isolators	4	4/0	3.00	5.50	4.242	3.0	70	16 SOIC	1.80
A.30, B.9, B.16, B.17	<b>ISO7340FC</b>	25Mbps Quad and Triple Digital Isolators	4	4/0	3.00	5.50	4.242	3.0	70	16 SOIC	1.80
A.30, B.9, B.16, B.17	<b>ISO7341C</b>	25Mbps Quad and Triple Digital Isolators	4	3/1	3.00	5.50	4.242	3.0	70	16 SOIC	1.80
A.30, B.9, B.16, B.17	<b>ISO7341FC</b>	25Mbps Quad and Triple Digital Isolators	4	3/1	3.00	5.50	4.242	3.0	70	16 SOIC	1.80
A.30, B.9, B.16, B.17	<b>ISO7342C</b>	25Mbps Quad and Triple Digital Isolators	4	2/2	3.00	5.50	4.242	3.0	70	16 SOIC	1.80
A.30, B.9, B.16, B.17	<b>ISO7342FC</b>	25Mbps Quad and Triple Digital Isolators	4	2/2	3.00	5.50	4.242	3.0	70	16 SOIC	1.80
A.30, B.9, B.16, B.17	<b>ISO7810</b>	100Mbps Quad and Triple Digital Isolators	1	1/0	2.25	5.50	8	5.7	100	16 SOIC	–
A.30, B.9, B.16, B.17	<b>ISO7810F</b>	100Mbps Quad and Triple Digital Isolators	1	1/0	2.25	5.50	8	5.7	100	16 SOIC	–
A.30, B.9, B.16, B.17	<b>ISO7820</b>	100Mbps Quad and Triple Digital Isolators	2	2/0	2.25	5.50	8	5.7	100	16 SOIC	2.10
A.30, B.9, B.16, B.17	<b>ISO7820F</b>	100Mbps Quad and Triple Digital Isolators	2	2/0	2.25	5.50	8	5.7	100	16 SOIC	2.10
A.30, B.9, B.16, B.17	<b>ISO7821</b>	100Mbps Quad and Triple Digital Isolators	2	1/1	2.25	5.50	8	5.7	100	16 SOIC	2.10
A.30, B.9, B.16, B.17	<b>ISO7821F</b>	100Mbps Quad and Triple Digital Isolators	2	1/1	2.25	5.50	8	5.7	100	16 SOIC	2.10
A.30, B.9, B.16, B.17	<b>ISO7830</b>	100Mbps Quad and Triple Digital Isolators	3	3/0	2.25	5.50	8	5.7	100	16 SOIC	–
A.30, B.9, B.16, B.17	<b>ISO7830F</b>	100Mbps Quad and Triple Digital Isolators	3	3/0	2.25	5.50	8	5.7	100	16 SOIC	–
A.30, B.9, B.16, B.17	<b>ISO7831</b>	100Mbps Quad and Triple Digital Isolators	3	2/1	2.25	5.50	8	5.7	100	16 SOIC	–
A.30, B.9, B.16, B.17	<b>ISO7831F</b>	100Mbps Quad and Triple Digital Isolators	3	2/1	2.25	5.50	8	5.7	100	16 SOIC	–
A.30, B.9, B.16, B.17	<b>ISO7841</b>	100Mbps Quad and Triple Digital Isolators	4	3/1	2.25	5.50	8	5.7	100	16 SOIC	3.49
A.30, B.9, B.16, B.17	<b>ISO7841F</b>	100Mbps Quad and Triple Digital Isolators	4	3/1	2.25	5.50	8	5.7	100	16 SOIC	3.49
A.30, B.9, B.16, B.17	<b>ISO7842</b>	100Mbps Quad and Triple Digital Isolators	4	2/2	2.25	5.50	8	5.7	100	16 SOIC	3.49
A.30, B.9, B.16, B.17	<b>ISO7842F</b>	100Mbps Quad and Triple Digital Isolators	4	2/2	2.25	5.50	8	5.7	100	16 SOIC	3.49

### ESD protection

Item	Part Number	Description	# of Channels	IEC 61000-4-2 Contact (± kV)	IEC 61000-4-2 Air-Gap (± kV)	IO Capacitance (Typ) (pF)	Breakdown Voltage (Min) (V)	IO Leakage Current (nA)	Price* (US\$)
A.11, B.7	<b>TPD1E10B06</b>	Single Channel ESD in 0402 package with 10pF Capacitance and 6V Breakdown	1	30	30	12	6	100	0.05
A.15, A.19	<b>TPD1E05U06</b>	1 Channel Ultra Low Capacitance IEC ESD Protection Diode	1	12	15	0.4	6.5	10	0.05
A.35	<b>TPD4E1U06</b>	Quad Channel High Speed ESD Protection Device	4	15	15	0.8	6.5	10	0.08
B.19	<b>TPD2E007</b>	2-Channel ESD Protection Array for AC Signal Data Interface	2	8	15	15	14	50	0.20

### Level translator

Item	Part Number	Bits(#)	VCCA (Max) (V)	VCCA (Min) (V)	VCCB (Max) (V)	VCCB (Min) (V)	Max Drive (mA)	Operating Temperature Range	Price (U.S. \$)*
A.5, A.12, A.23, A.30, B.16	<b>SN74LVC8T245</b>	8	5.5	1.65	5.5	1.65	32	-40 to 85	0.45
A.5, A.12, A.23, A.30, B.16	<b>SN74LVC1T45</b>	1	5.5	1.65	5.5	1.65	32	-40 to 85	0.17
A.5, A.12, A.23, A.30, B.16	<b>LSF0108</b>	8	4.5	1	5.5	1.8	64	-40 to 125	0.73
A.5, A.12, A.23, A.30, B.16	<b>LSF0204</b>	4	4.5	1	5.5	1.8	64	-40 to 125	0.45
A.5, A.12, A.23, A.30, B.16	<b>TXS0108E</b>	8	3.6	1.2	5.5	1.65	50	-40 to 85	0.77
A.5, A.12, A.23, A.30, B.16	<b>TXS0104E</b>	4	3.6	1.65	5.5	2.3	24	-40 to 85	0.47
A.5, A.12, A.23, A.30, B.16	<b>TXS0102</b>	2	3.6	1.65	5.5	2.3	–	-40 to 85	0.23

### Processor/MCU

Item	Part Number	MHz	Non-volatile Flash/FRAM (KB)	RAM	Capacitive Touch I/O	ADC	Serial Communications	Additional Features	Price* (US\$)
A.20	<b>MSP430FR4133</b>	16	16	2	Yes	10-bit SAR	SPI, I2C, UART	LCD, IR Logic, FRAM	1.55
A.20	<b>MSP430FR6972</b>	16	64	2	Yes	12-bit SAR	SPI, I2C, UART	LCD, AES, FRAM	2.55
A.20	<b>MSP430G2553</b>	16	16	0.5	Yes	10-bit SAR	SPI, I2C, UART	N/A	0.90

# Components selection

## Processor/MCU / wireless connectivity / NFC transceiver / I2C/IO expander

### Processor/MCU (continued)

Socket	Part Number	Description
A.20	AM335x	Up to 1GHz Cortex-A8 32-bit RISC microprocessor; LCD Display option; 3D Graphics acceleration; Extensive peripheral set (2x Gbit-Ethernet, CAN, USB, 8x UARTs extended from PRU, ...); Flexible communication protocols
A.20	AM437x	Up to 1GHz POWERVR SGX Graphics Accelerator subsystem for 3D graphics acceleration to support display and gaming effects Single-cycle vector floating point (VFP) Dual camera and display processing subsystem Cryptographic acceleration and secure boot PRU-ICSS enables simultaneous industrial Ethernet protocols and motor feedback protocols Support for 32 bit LPDDR2/DDR3/DDR3L Low power: ~5mW deep sleep and < 0.1mW RTC-only Simplified power sequence for flexible power designs

Item	Part Number	Core	MHz	Flash (kB)	SRAM (kB)	USB	CAN	PWM Units (# of Output)	QEP	# of 12-Bit ADC	# of ADC channel	ADC Sampling (MSPS)	Other Communication Ports	Battery Backed Hibernation	LCD Controller	Price* (US\$)
A.20, B.8	TM4C123AE6	M4F	80	128	32	-	2	2 (16)	2	2	12-22	1	SPI, SCI, I2C	-	-	3.63
A.20, B.8	TM4C123BE6	M4F	80	128	32	-	2	2 (16)	2	2	12-22	1	SPI, SCI, I2C	Y	-	3.63 - 3.91
A.20, B.8	TM4C123FE6	M4F	80	128	32	OTG	2	2 (16)	2	2	12-22	1	SPI, SCI, I2C	-	-	4.79
A.20, B.8	TM4C123GE6	M4F	80	128	32	OTG	2	2 (16)	2	2	12-22	1	SPI, SCI, I2C	Y	-	4.8 - 4.28
A.20, B.8	TM4C123AH6	M4F	80	256	32	-	2	2 (16)	2	2	12-24	1	SPI, SCI, I2C	-	-	4.23
A.20, B.8	TM4C123BH6	M4F	80	256	32	-	2	2 (16)	2	2	12-24	1	SPI, SCI, I2C	Y	-	4.23 - 4.72
A.20, B.8	TM4C123FH6	M4F	80	256	32	OTG	2	2 (16)	2	2	12-24	1	SPI, SCI, I2C	-	-	5.43
A.20, B.8	TM4C123GH6	M4F	80	256	32	OTG	2	2 (16)	2	2	12-24	1	SPI, SCI, I2C	Y	-	5.44 - 5.26
A.20	TM4C129K6	M4F	120	512	256	OTG	2	1 (8)	1	2	24	2	SPI, SCI, I2C	-	Y	8.36
A.20	TM4C129XK6	M4F	120	512	256	OTG	2	1 (8)	1	2	24	2	SPI, SCI, I2C	-	Y	9.32
A.20	TM4C1297NC	M4F	120	1024	256	OTG	2	1 (8)	1	2	24	2	SPI, SCI, I2C	-	Y	8.07
A.20	TM4C1299NC	M4F	120	1024	256	OTG	2	1 (8)	1	2	24	2	SPI, SCI, I2C	-	Y	9.61
A.20	TM4C129LNC	M4F	120	1024	256	OTG	2	1 (8)	1	2	24	2	SPI, SCI, I2C	-	Y	10.27
A.20	TM4C129XNC	M4F	120	1024	256	OTG	2	1 (8)	1	2	24	2	SPI, SCI, I2C	-	Y	10.57
A.20, B.8	RM41L232	R4	80	128	32	-	2	1 (16)	1	1	16	1	SPI, SCI	-	-	4.74
A.20, B.8	RM42L432	R4	100	384	32	-	2	1 (16)	1	1	16	1	SPI, SCI	-	-	5.81
B.8	TMS320F28027F	C28x	60	64	12	-	-	4 (8)	-	2	13	4.6	SPI, SCI, I2C	-	-	4.66

### Wireless connectivity

Item	Part Number	Function	Category	Key Feature	Pin/Package	Price* (US\$)
A.22	CC3200MOD	Wi-Fi wireless microcontroller	wireless MCU	Low power, Cortex M4 integrated with Wi-Fi wireless network processor, easy to use. Wi-Fi certified module	-	12.99
A.22	CC3100MOD	Wi-Fi Network Processor	Network Processor	Connect easily Wi-Fi to any 8-bit, 16-bit, 32-bit MCU with a simple serial interface. Wi-Fi certified Module	-	9.99
A.22	CC2640	SimpleLink Bluetooth Low Energy ultra-low power Wireless microcontroller	wireless MCU	Ultra-low Power, Cortex M MCU, sensor-controller, small 4mmx4mm QFN package, robust and easy to use	-	2.5
A.22	CC2650	SimpleLink Multi-protocol ultra-low power Wireless microcontroller	wireless MCU	Ultra-low Power, supports BLE, 6LoWPAN or ZigBee by a software change Cortex M MCU, sensor-controller, small 4mmx4mm QFN package, robust and easy to use	0.5	3
A.22	CC2533	A True System-on-Chip Solution for 2.4-GHz IEEE 802.15.4 and ZigBee Applications	wireless MCU	support 2.4GHz protocol including RF4CE ideal for remote control	3.2	2.55

### NFC transceiver

item	Part Number	Description	Frequency	Standard	Output Power (mW)	Supply voltage (Vdc)	Operating Temperature Range (C)	Package Size (mm)	Package Type	Price* (US\$)
A.27	TRF7970	-	13.56 MHz	ISO 14443A, ISO 14443B, JIS X 6319-4, ISO 15693, ISO 18000-3, ISO 18092	100,200	2.7 to 5.5	-40 to 110	5 x 5	32QFN	3.10

### I2C/IO expander

Part Number	Voltage Nodes (V)	Max Frequency (kHz)	# of I/Os	Special Features	Operating Temperature Range (C)	Approx. Price (US\$)
TCA9535	1.8, 2.7, 3.3, 3.6, 5	400	16	5V Tolerant I/O, Configuration Registers, Interrupt Driven, Interrupt Output, Low Power, Low Voltage, Push-Pull I/O Type	-40 to 85	0.85
TCA6408A	1.8, 2.7, 3.3, 3.6, 5	400	8	5V Tolerant I/O, Configuration Registers, Interrupt Driven, Interrupt Output, Low Power, Low Voltage, Push-Pull I/O Type, Reset Input	-40 to 85	0.59
PCA9306	-	400	2	Enable Pin, Open-Drain I/O Type, 5V Tolerant I/O	-40 to 85	0.24



## Capacitive Touchscreen Display Reference Design



Capacitive touch-screen displays generally provide a higher quality and better user experience than traditional resistive touch-screen displays. This reference design shows how to interface a capacitive touch-screen display to the Sitara AM437x processors. The display has an integrated touch-screen controller that interfaces with the AM437x via its I<sup>2</sup>C port.

<http://www.ti.com/tool/TIDEP0015>

## Humidity & Temp Sensor Node for Sub-1GHz Star Networks Enabling 10+ Year Coin Cell Battery Life



This TI Designs reference design uses Texas Instruments' nanopower system timer, boost converter, SimpleLink™ ultra-low power sub-1-GHz wireless microcontroller unit (MCU) platform, and humidity sensing technologies to demonstrate an ultra-low power method to duty-cycle sensor end nodes leading to extremely long battery life. The reference design includes techniques for system design, detailed test results, and information to get the design up and running quickly.

<http://www.ti.com/tool/TIDA-00484>

## Humidity & Temp Sensor Node for Star Networks Enabling 10+ Year Coin Cell Battery Life Ref Design

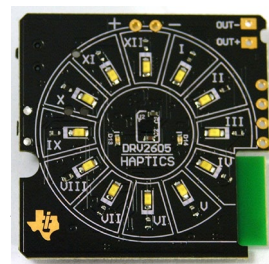


This TI Designs reference design uses a Texas Instruments, nanopower system timer, SimpleLink™ ultra-low power wireless MCU platform, and humidity-sensing technologies to

demonstrate an ultra-low power method to duty-cycle sensor end nodes. These technologies lead to an extremely long battery life: over 10 years with a standard CR2032 lithium-ion coin-cell battery. This reference design uses the HDC1000.

<http://www.ti.com/tool/TIDA-00374>

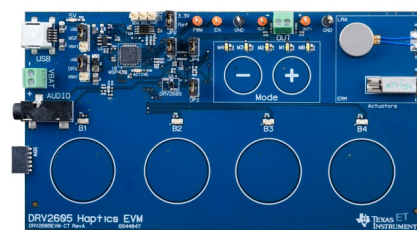
## Haptic Bluetooth® Kit



The haptic *Bluetooth*® kit is a complete evaluation and design kit for prototyping haptic feedback in any application. The board features the DRV2605 eccentric rotating mass motor (ERM) and linear resonant actuator (LRA) haptic driver with an integrated effect library licensed from Immersion. The board also includes an LRA, alkaline battery support, and can be programmed and controlled by the included iOS app via the SimpleLink *Bluetooth*® Low Energy CC2541 wireless MCU.

<http://www.ti.com/tool/DRV2605EVM-BT>

## DRV2605EVM-CT ERM/LRA Haptic Driver Evaluation



The DRV2605 is a haptic driver designed for LRA and ERM motors. The kit includes a microcontroller, linear actuator, ERM motor, sample waveforms and capacitive touch buttons that you can use to completely demonstrate and evaluate the DRV2605. You also have access to Immersion's royalty-free effect library.

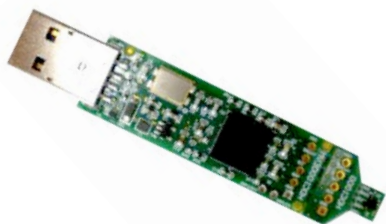
<http://www.ti.com/tool/DRV2605EVM-CT>

# Washing machine and dryer solutions

TI Designs



## Low-Power Humidity Sensor and Digital-Temperature Sensor Evaluation Module



The HDC1000EVM evaluation kit is a plug-and-play system to test and evaluate the HDC1000 humidity and temperature sensor. The evaluation module (EVM) is a breakable that consists of three sections. The first section is a USB to I<sup>2</sup>C converter based on the MSP430F5528 microcontroller, the second section is a conversion board (WCSP to SIL 100-mil pitch) with the HDC1000; and the third section is a narrow 5-mm by 5.5-mm PCB with the HDC1000 (WCSP to SIL 50-mil pitch), which allows a reduction in the thermal mass of the system (sensor plus PCB). Both the second and third sections can take remote measurements. The HDC1000EVM does not need additional hardware or calibration, nor does it require any software programming – only the HDC1000EVM graphical user interface (GUI) has to be installed. The software is able to configure the HDC1000's registers, display temperature and relative humidity in two graphs, and export data in comma-separated value (CSV) format.

<http://www.ti.com/tool/hdc1000evm>

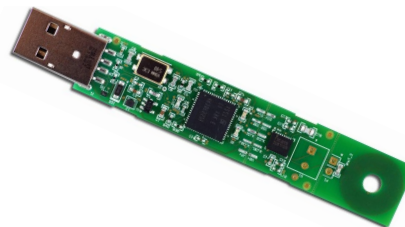
## 16-Button Inductive Keypad Reference Design Using the LDC1314 Inductance-to-Digital Converter



The LDC1314's unique inductive-sensing capability is used to implement a contactless, 16-button, multi-function keypad. It uses standard PCB technology and easily manufactured components to implement a low-cost solution. This reference design uses the LDC1314 but can also be used with the LDC1312, LDC1612 and LDC1614.

<http://www.ti.com/tool/TIDA-00509>

## LDC1000EVM - Evaluation Module for Inductance to Digital Converter with Sample PCB Coil



The LDC1000EVM demonstrates the use of inductive-sensing technology to sense and measure the presence, position or composition of a conductive target object. The module includes an example of a PCB sensor coil. An MSP430<sup>TM</sup> MCU interfaces the LDC 1000 to a host computer. This module is designed to provide the user with maximum flexibility for system prototyping. It is perforated at two locations: one, between the PCB sensor coil (inductor [LC] tank) and the LDC1000 integrated circuit (IC); and another, between the LDC1000 IC and the MSP430 interface. The first perforation gives the user the option to snap off the PCB coil from the module and experiment with custom sensor coils. The second perforation allows the user to connect the LDC1000 plus sensor to a different microcontroller system or use multiple such sensors in one system. An accompanying GUI allows for maximum flexibility and experimentation, but the EVM also indicates basic conductor detection with an onboard light-emitting diode (LED).

<http://www.ti.com/tool/LDC1000EVM>

## FDC1004EVM – Four-Channel Capacitive-to-Digital Converter Evaluation Module



The FDC1004EVM evaluation kit is a plug-and-play system to test and evaluate the FDC1004 four-channels capacitive-to-digital converter. The EVM is a breakable PCB that consists of three sections. The first section is a USB-to-I<sup>2</sup>C converter based on the MSP430F5528 microcontroller; the second section contains the FDC1004; and the third section is based on a touch less sensor (to demonstrate the sensitivity of the HDC1004). The third section can be removed and replaced with customized sensors according to the requirements of the application. The FDC1004EVM does not need additional hardware or calibration, nor does it require any software programming – only the FDC1004EVM GUI has to be installed. The software is able to configure the FDC1004's registers, display on four graphs (one for each measurement) the capacitive values and export data in comma-separated value (CSV) format.

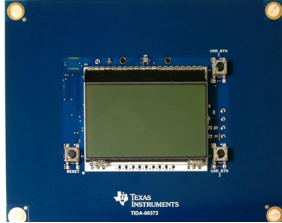
<http://www.ti.com/tool/FDC1004EVM>

# Washing machine and dryer solutions

TI Designs



## Backlight and Smart Lighting Control by Ambient Light and Proximity Sensor Reference Design



This system conserves power and extends backlight life by dynamically adjusting the backlight brightness relative to the environment's ambient light. A capacitive proximity sensor wakes up the system when the user is close, to save even more power. This reference design uses the HDC1000 but can also be used with the HDC1008.

<http://www.ti.com/tool/TIDA-00373>

## High-Voltage Motor Control Kit with InstaSPIN-FOC and InstaSPIN-MOTION Enabled Piccolo MCU



The InstaSPIN-FOC™ and InstaSPIN-MOTION™ technology-based high-voltage motor control kit provides an easy way to evaluate the Piccolo microcontroller and TI analog in a high-voltage environment for spinning three-phase induction, brushless DC (BLDC) and brushless AC

(BLAC), or permanent magnet synchronous (PMSM) motors. The motor-driver stage can be driven from either an onboard AC/DC rectifier or separate DC power and accepts up to 400 V and outputs up to 1.5 kW of power.

<http://www.ti.com/tool/TMDSHVMTRINSPIN>

## Piccolo F2805x High Voltage Motor Control Developer's Kit

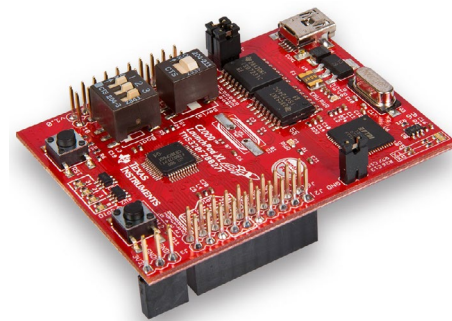


The Piccolo™ F2805x high-voltage motor control developer's kit provides a high-voltage development platform for Piccolo microcontroller unit (MCU) based digital control of high voltage motors. The kit has a universal alternating current (AC) input (110-240 VAC) and supports a rated output of 750 W, regulated by closed-loop control. All three common types of three-phase motors can be spun: AC induction (ACI), BLDC, PMSM. The Piccolo F2805x MCU controls (sensored or sensorlessly) each type of motor using closed loop control (trapezoidal, variable frequency, or field oriented control).

Software, support, example projects, libraries, and documentation for this kit are provided completely free through the C2000™ controlSUITE™ software platform. Motor-control libraries providing modular code blocks can greatly simplify the development process.

<http://www.ti.com/tool/TMDXHMTRKIT5X>

## InstaSPIN™-FOC Enabled C2000 Piccolo LaunchPad



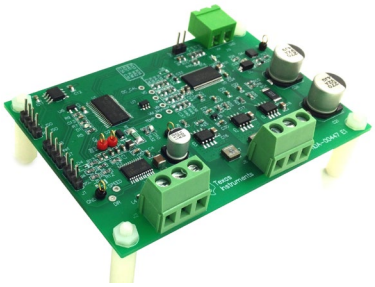
The C2000™ Piccolo™ LaunchPad is an inexpensive, modular, and fun evaluation platform, enabling you to dive into real-time, closed-loop control development with Texas Instruments' C2000™ 32-bit microcontroller family. This platform provides a great starting point for development of many common-power electronics applications, including motor control, digital power supplies, solar inverters, digital light-emitting diode (LED) lighting, precision sensing and more.

<http://www.ti.com/tool/launchxl-f28027f>

# Washing machine and dryer solutions

## TI Designs

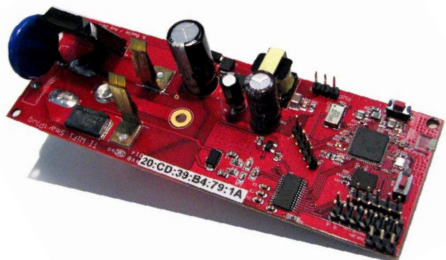
### 24 V Dual Brushless DC Motor Drive Reference Design for Dishwasher Pumps



This is a 24-V dual brushless DC (BLDC) motor-drive reference design that can drive low-voltage BLDC motors in home appliances such as pumps and fans. The power stages of the motor drive are designed for 100 W and 30 W of continuous operation, respectively. The 30-W drive is based on a single-chip, low-external-component count three-phase motor driver with integrated power MOSFETs and offers a proprietary sensorless control scheme to provide continuous sinusoidal drive. It also features an integrated buck/linear regulator to efficiently step down the supply voltage to either 5 V or 3.3 V for powering both internal and external circuits. The 100-W drive uses a discrete approach and has a microcontroller unit (MCU), external MOSFET driver with protections, and current-sensing and external power MOSFETs. This architecture offers the flexibility to scale the drive power level as needed. The MCU is programmed with InstaSPIN-BLDC™ software that implements sensorless trapezoidal control of BLDC motors using a back-electromotive force (EMF) integration method and is also used to configure and control the speed of the drain-pump stage. protections.

<http://www.ti.com/tool/TIDA-00447>

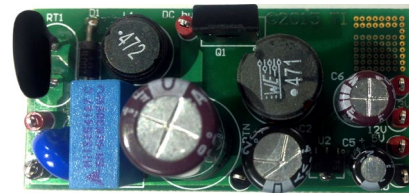
### Smart Plug with Remote Disconnect and Wi-Fi Connectivity



This design implements single-outlet energy measurement with remote connect/disconnect capability and Wi-Fi connectivity. Designers can quickly create networked load control devices for industrial building and home automation applications.

<http://www.ti.com/tool/TIDC-SMARTPLUG-WIFI>

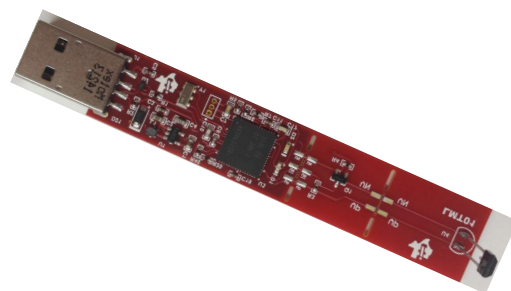
### Simple and Robust Bias Power Supply with Low Standby for Home Appliances



This reference design is a multiple output (12 V, 3.3 V/5 V), 2.4-W bias power supply for home appliances using a low-cost quasi-resonant pulse-width modulation (PWM) controller. The design supports conversion of wide-range direct current (DC) input ranging from 300 VAC to 425 VDC or alternating current (AC) inputs ranging from 85 VAC to 300 VAC to standard power rails of 12 V and 3.3 V/5 V. TIDA-00434 is able to achieve reduced switching losses using a buck power stage operating in discontinuous mode with valley switching. The design offers high efficiency (>70 percent) and low stand-by power of <100 mW when-system is in idle mode. The design uses-low-cost external 800 V bipolar junction transistor (BJT) as a switch, providing higher operating voltage margins. The PWM controller has an integrated safety feature that turns off the external switch in case of a loss of feedback, which helps prevent high-output voltages. Reconfiguring the design for different output-voltage and standby power-consumption levels is easier with simple resistor-value changes. Overall, the design offers a simple and rugged bias power supply with low standby power.

<http://www.ti.com/tool/TIDA-00434>

### LMT01 Evaluation Module



The LMT01 evaluation module (EVM) allows users to evaluate the performance of the LMT01 two-pin digital-temperature sensor. The EVM comes in a USB stick form-factor package with an onboard MSP430F5528 microcontroller that interfaces with the host computer's USB port and the LMT01 device. The EVM features perforated breakout slots that the user can break apart to separate the EVM and LMT01 device for remote measurements with long wires.

<http://www.ti.com/tool/LMT01EVM>

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Philippines	1-800-765-7404
Singapore	800-886-1028
Taiwan	0800-006800
Thailand	001-800-886-0010
International	+86-21-23073444
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