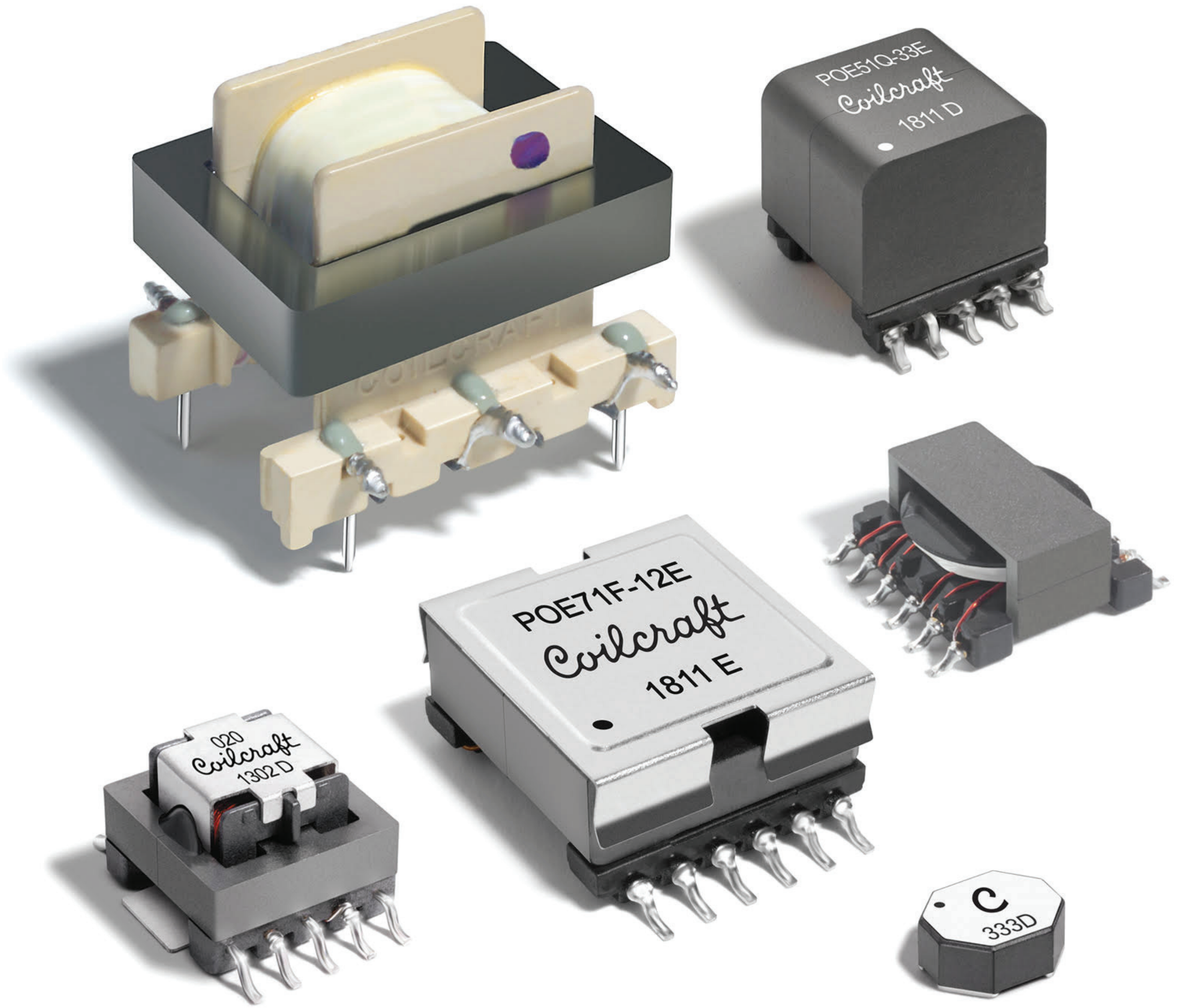


Getting Started with
Transformers for Switchmode Power Supplies, Gate Drivers, and Industrial Applications

Coilcraft®

Getting Started with Transformers

CONTENTS

Coilcraft

Introduction

Transformers are widely used to transfer both power and data efficiently in switching power supplies, MOSFET gate drivers, and isolation circuits of many kinds.

To serve myriad applications, transformers come in a potentially bewildering array of sizes and shapes, often accompanied by datasheets with esoteric terms seemingly known only to an accustomed few.

Nevertheless, all transformers must work from the same fundamental principles, and this guide provides a map to the beginning of the journey to understanding how to find the right transformers for the most popular applications.

Coilcraft®

CHRISTOPHER HARE

Technical Marketing Engineer

Coilcraft, Inc.

TECHNICAL ARTICLE

A Guide to Flyback Transformers

What are flyback transformers?

A flyback transformer is a coupled inductor, almost always with a gapped core. During each cycle, when the input voltage is applied to the primary winding, energy is stored in the gap of the core. It is then transferred to the secondary winding to provide energy to the load. Flyback transformers are used to provide voltage transformation and circuit isolation in flyback converters.

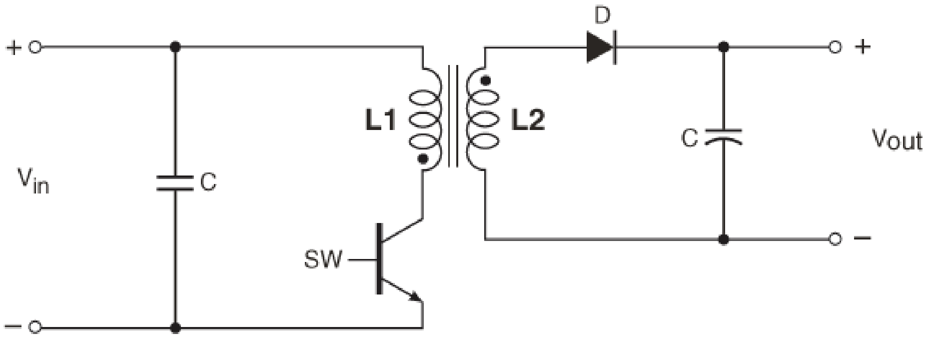
Flyback transformers are the most popular choice for cost-effective, high-efficiency isolated power supply designs up to approximately 120 watts. They provide circuit isolation, the potential for multiple outputs, and the possibility of positive or negative output voltages. They can also be regulated over a wide range of input voltage and load conditions. The transformer inductance helps to smooth the current ripple, so the flyback topology does not typically require a separate output filter inductor like the other isolated topologies. This reduces the component count, simplifies the circuit requirements, and reduces cost. This article discusses flyback transformers and applications for which they are best suited.

What is a flyback?

In the flyback topology, energy is stored in the magnetic field of the transformer during the first half of the switching cycle and then released to the secondary winding(s) connected to the load in the second half of the cycle. Flyback transformers feature a gapped-core construction, which allows high energy storage without saturating the core. This energy storage aspect distinguishes flybacks from other topologies, such as forward-mode, where energy transfers immediately from primary to secondary. Flyback transformers are also known as coupled inductors, because they couple energy from one winding into the core, and then couple the energy from the core to a second winding in a separate step, as opposed to transforming the energy in a single step like other transformers.

How does a flyback controller work?

The flyback circuit is based on buck-boost topology, with the transformer providing isolation and, if needed, voltage transformation by turns ratio. The schematic shown in **Figure 1**, shown on the following page, represents a typical flyback circuit.



Typical Flyback Converter Schematic

Figure 1

The most commonly used switch (SW) in a flyback converter is a MOSFET (Metal Oxide Semiconductor Field Effect Transistor), but occasionally a bipolar transistor and sometimes GaN (gallium nitride) or SiC (silicon carbide) are used. The flyback controller opens and closes the switch with the appropriate duty cycle to achieve the required output voltage. The duty cycle of flyback transformers typically does not exceed 0.5. Various combinations of turns ratios and duty cycles can be used to achieve the required output voltage according to this equation:

$$\mathbf{V_{out} = V_{in}*(N_s/N_p)*(D/(1-D))} \text{ where:}$$

V_{out} is the output voltage

Vin is the input voltage

Ns = secondary turns

Np = primary turns

D = duty cycle = $t_{on}/(t_{on} + t_{off})$

The basic flyback cycle includes the following portions:

1. When the FET (Field Effect Transistor) SW is closed (ON), current is conducted through the transformer primary. This sets up a magnetic field in which energy is stored in the core. The combination of winding polarity (identified by the polarity dots) reverse biases the output diode to ensure that no energy is transferred to the secondary (load) when the switch is closed. During this portion of the cycle, current in the primary is ramping up over time to store energy (= ½LI^2).
2. When the FET is opened (OFF) the magnetic field collapses, transferring the stored energy to the secondary winding and, ultimately, the load. At the close of the switch, current in the secondary is at its peak and ramps downward as the stored energy is transferred to the load.

If the secondary current does not reach zero before the FET is turned back on, not all the stored energy is transferred to the load. This is referred to as continuous conduction mode (CCM). An example of a CCM waveform is shown in **Figure 2**. If the stored flyback energy is completely emptied to the secondary before the FET is turned back on, the secondary current reaches zero before the end of the period, creating an "idle time" (tidle) during the cycle. This is called discontinuous conduction mode (DCM). An example of a DCM waveform is shown in **Figure 3**. Transformers may be designed for CCM, DCM, or both. Flyback transformers may operate in both CCM and DCM modes, depending on the input voltage and load conditions.

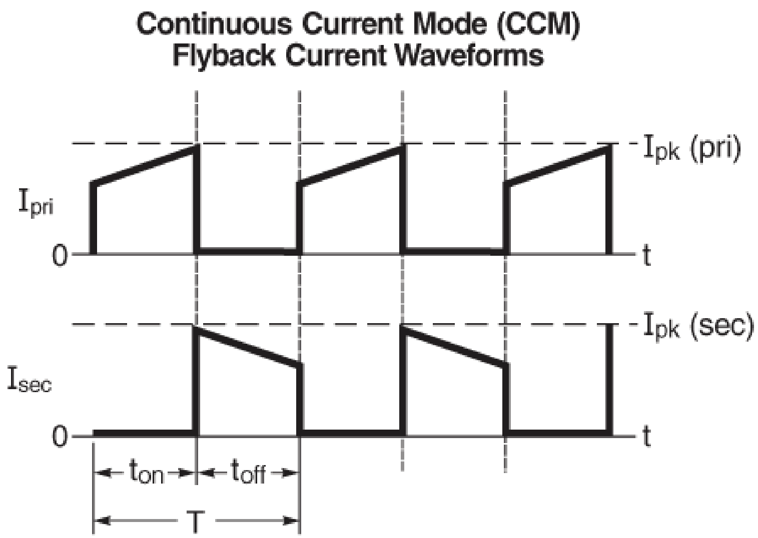


Figure 2

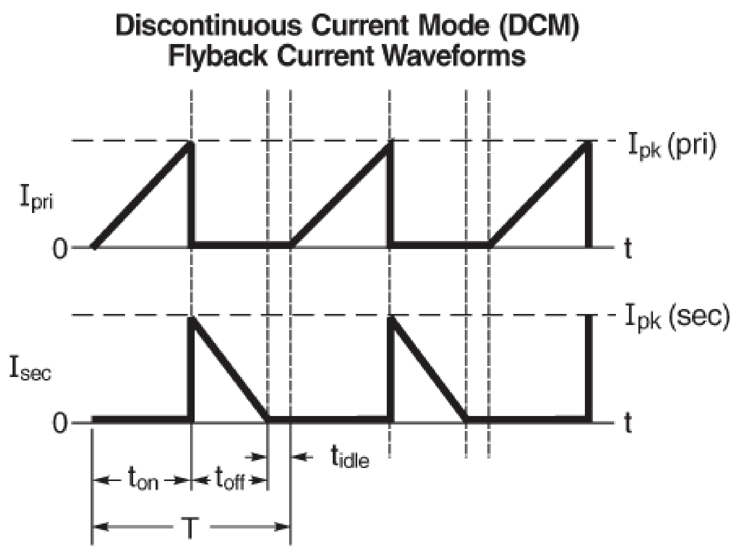


Figure 3

When designing a flyback transformer, the condition of maximum output load at the minimum input voltage creates the highest (peak) primary current requirement. Select a transformer that has a peak primary current (Ipk) or primary saturation current (Isat) that is sufficiently above the expected primary current peak for your application. If the application's peak primary current draw exceeds the transformer rating, core saturation will cause the primary inductance to drop. If the load requires more energy at this point, the energy storage capability of the transformer will be exceeded and the load will not receive the required energy. This will lead to loss of regulation, therefore the peak primary current (Ipk) or primary saturation current (Isat) of a flyback transformer is a critical parameter.

What are typical flyback transformer applications?

You can use Flyback transformers in many applications, including:

- DC-DC power supplies
- Telecom
- LED lighting
- Power over Ethernet (PoE)
- Capacitor charging
- Battery charging
- Solar microinverters
- AC-DC power supplies

Off-the shelf flyback transformers are available for many applications where low cost, small size, and high-efficiency are required. They are typically used in DC-DC controllers in the telecommunications (telecom) voltage range of 37 – 72Vdc, sometimes at extended voltages ranging from 2 – 400 Vdc, and also within the universal AC line input voltage range (85 – 265 Vac).

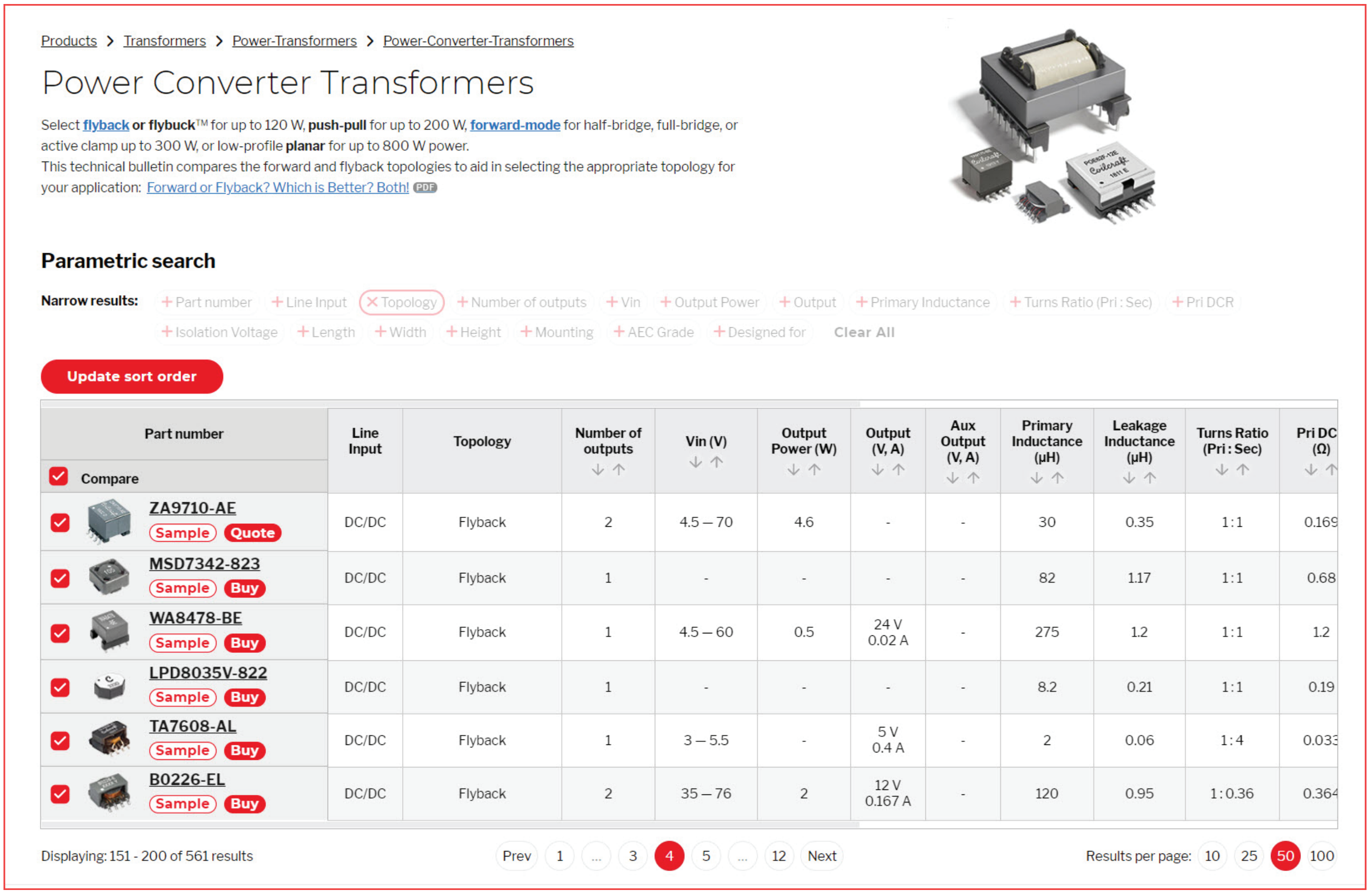
Flyback transformers are commonly used for output current below about 10 Amps and output power below about 100 watts. Coilcraft offers standard, off-the-shelf flyback transformers with power capabilities ranging from a few Watts to up to around 120 watts. When higher current and power is required, forward-mode, push-pull, or half-bridge/full-bridge topologies become more efficient alternatives.

How do I select the Coilcraft flyback transformer that best fits my application requirements?

As with any electronic component, selecting flyback transformers involves a multitude of competing trade-offs in performance, size, efficiency, cost, and weight. Careful selection of core size is required to achieve high energy storage without core saturation. Wire size (diameter) must be chosen carefully to provide high output current without overheating the wire insulation. Core shape and bobbin selection must be optimized to minimize the winding length and achieve the lowest possible DCR. High switching frequency can be used to reduce transformer size, but care must be taken to avoid increased AC losses from core loss, proximity effect, and skin effect.

Coilcraft offers a helpful **selector tool** for finding the right off-the-shelf flyback transformer based on:

- Whether you power your application by a DC source or by an AC line input source
- The required transformer input voltage range (Vmin is worst case)
- The required output voltage(s)
- The required output rms current or power. Approximate output power: $P_{out} = V_{out} * I_{out}$



Products > Transformers > Power-Transformers > Power-Converter-Transformers

Power Converter Transformers

Select **flyback** or **flybuck**™ for up to 120 W, **push-pull** for up to 200 W, **forward-mode** for half-bridge, full-bridge, or active clamp up to 300 W, or low-profile **planar** for up to 800 W power.
This technical bulletin compares the forward and flyback topologies to aid in selecting the appropriate topology for your application: Forward or Flyback? Which is Better? Both! PDF

Parametric search

Narrow results: + Part number + Line Input ✕ Topology + Number of outputs + Vin + Output Power + Output + Primary Inductance + Turns Ratio (Pri : Sec) + Pri DCR + Isolation Voltage + Length + Width + Height + Mounting + AEC Grade + Designed for Clear All

Update sort order

Part number (Compare)	Line Input	Topology	Number of outputs	Vin (V)	Output Power (W)	Output (V, A)	Aux Output (V, A)	Primary Inductance (µH)	Leakage Inductance (µH)	Turns Ratio (Pri : Sec)	Pri DC (Ω)
ZA9710-AE Sample Quote	DC/DC	Flyback	2	4.5 – 70	4.6	-	-	30	0.35	1:1	0.169
MSD7342-823 Sample Buy	DC/DC	Flyback	1	-	-	-	-	82	1.17	1:1	0.68
WA8478-BE Sample Buy	DC/DC	Flyback	1	4.5 – 60	0.5	24 V 0.02 A	-	275	1.2	1:1	1.2
LPD8035V-822 Sample Buy	DC/DC	Flyback	1	-	-	-	-	8.2	0.21	1:1	0.19
TA7608-AL Sample Buy	DC/DC	Flyback	1	3 – 5.5	-	5 V 0.4 A	-	2	0.06	1:4	0.033
B0226-EL Sample Buy	DC/DC	Flyback	2	35 – 76	2	12 V 0.167 A	-	120	0.95	1:0.36	0.364

Displaying: 151 - 200 of 561 results Prev 1 ... 3 4 5 ... 12 Next Results per page: 10 25 50 100

References

Mammano, Robert A., 2017. *Fundamentals of Power Supply Design*. Texas Instruments.

Colonel Wm. T. McLyman, 1988. *Transformer and Inductor design Handbook.* 2nd ed., Marcel Dekker.

TECHNICAL ARTICLE

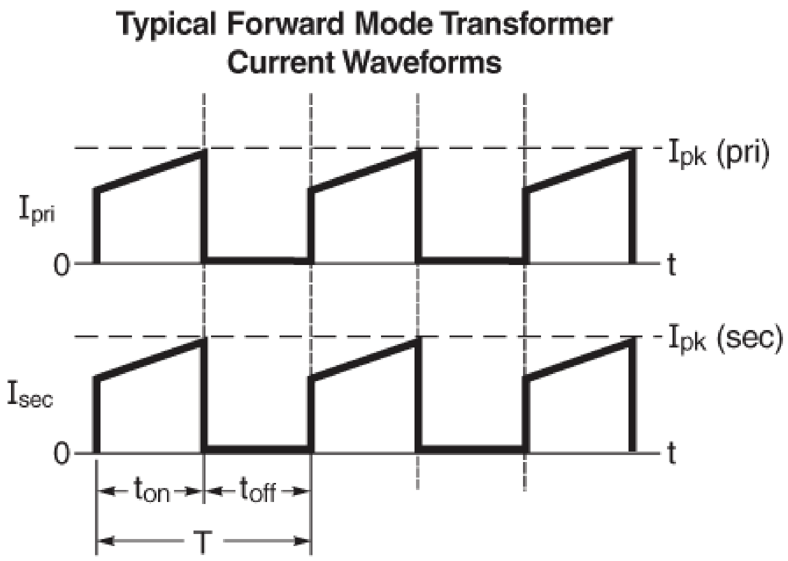
A Guide to Forward-Mode Transformers

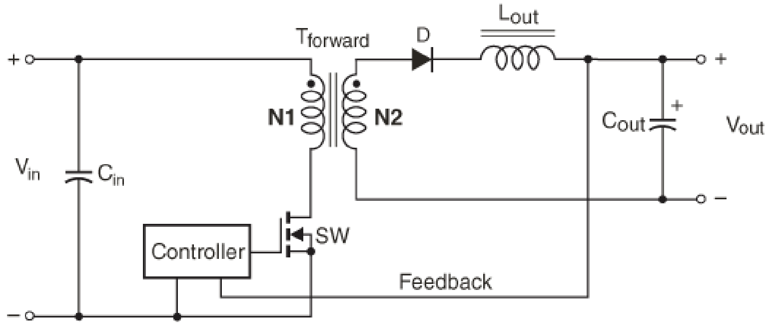
Transformers are used to provide circuit isolation and voltage transformation in forward-mode switching power supplies. Forward-mode includes simple forward converters, as well as half-bridge, full-bridge, and active-clamp circuit types.

Forward-mode converters are used for output current requirements up to approximately 15 Amps, or when high efficiency is required. The forward-mode topology is preferred for high output power levels. Traditionally, this meant 100 watts and higher, but as devices and topologies change, it is not rare to see forward mode converters as the preferred choice down to about 50 watts. Forward-mode transformers are attractive because they allow you to achieve efficiencies up to 95 – 97% over a wide range of power levels. This article discusses forward-mode transformers and applications for which Coilcraft forward-mode transformers are best suited.

What is a forward-mode transformer?

A forward converter transformer converts a voltage pulse at the input (primary) winding to a voltage at the output (secondary) by means of the turns ratio Ns/Np. The secondary current is driven simultaneously with the primary current as shown in the diagram.





Typical Single Switch Forward Mode Converter Schematic

How does a forward-mode controller work?

Forward converters are essentially buck converters that use a forward-mode transformer for isolation and voltage conversion.

The forward-mode controller opens and closes the switch with the appropriate duty cycle to achieve the required output voltage. The switch (SW) is commonly a silicon MOSFET, and GaN and SiC devices are becoming increasingly popular. Various combinations of turns ratios and duty cycles can be used to achieve the required output voltage according to this equation:

$$V_{out} = V_{in} \times N_{sec} / N_{pri} \times D$$

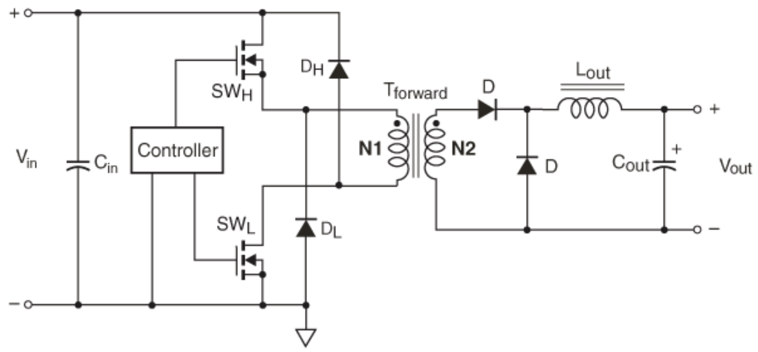
Vout = output voltage
Vin = input voltage
Nsec / Npri = N2 / N1 = transformer secondary to primary turns ratio
D = duty cycle = $t_{on} / (t_{on} + t_{off})$

The basic single-switch forward cycle includes the following portions:

- When the FET switch (SW) is closed (ON), the DC source is connected and current travels through the transformer primary. This immediately creates a magnetic field that couples to the secondary winding. During this portion of the cycle, current in both the primary and secondary is ramping up over time.

- When the FET switch is opened (OFF), the magnetic field collapses and no additional current flows to the primary or secondary. Just before the switch opens, current in the secondary is at its peak. This peak is about half that of a similar flyback transformer with half the number of secondary turns, therefore stress on the FET is lower for a forward-mode transformer.

The lower rms secondary current in the forward-mode design compared to a similar flyback design can mean lower losses in the secondary winding, even if the flyback design has a higher number of turns. This lower secondary loss is one reason forward-modes typically provide higher efficiency than similar flyback designs. Another reason is the flyback output capacitor must also handle higher current than the forward-mode design, adding capacitor losses to the equation.



Typical Two Switch Forward Mode Converter Schematic

A two-switch forward-mode converter (also called an asymmetrical half-bridge forward converter) has two FET switches which are sometimes integrated into a single controller IC. One advantage of a two-switch forward converter is the voltage across the switches is clamped to the input voltage, allowing a wider input voltage range. The maximum operating voltage of a two-switch forward converter approaches the FET voltage rating, whereas the maximum operating voltage of a single-switch forward converter is only half of the FET voltage rating.

Another advantage is the two-switch topology does not require an auxiliary reset winding in the transformer, thus it can utilize a simpler (and lower-cost) forward-mode transformer design.

What are typical forward-mode transformer applications?

Forward-mode transformers are appropriate for many applications, including:

- DC-DC power supplies
- Portable electronics
- Telecom
- LED lighting
- Power over Ethernet (PoE)
- AC-DC power supplies

Off-the-shelf forward-mode transformers are available for many applications where low cost, small size, and high efficiency are required. They are typically used in DC-DC controllers in the telecommunications (telecom) voltage range of 36 – 72 Vdc, sometimes at extended voltages ranging from 9 – 36 Vdc.

Forward-mode transformers are commonly used for output current up to about 15 Amps and output power up to approximately 300 watts. Coilcraft offers standard, off-the-shelf forward-mode wirewound transformers with power capabilities ranging from a few watts to up to 60 watts. When higher current and power is required, Coilcraft also offers standard planar transformers for forward-mode, push-pull, or half-bridge/full-bridge topologies in power ratings from 30 watts to 800 watts.

How do I select the Coilcraft forward-mode transformer that best fits my application requirements?

As with any electronic component, selecting forward-mode transformers requires you to evaluate and balance a variety of competing trade-offs in component performance, size, efficiency, cost, and weight.

Higher power current applications generally require larger transformers. High output current requires large wire size to avoid overheating the wire insulation. Large cores require large bobbins with a longer winding length, resulting in higher DCR. High switching frequencies can reduce component size due to a lower inductance requirement, but core losses may increase as frequency increases, leading to lower efficiency. Core and winding losses typically increase as size decreases, therefore, attempts to use a transformer that is too small for a given application may lead to overheating.

SMT Forward Mode Transformers

All transformers feature 1500 Vrms primary to secondary isolation.

Power (W)	Input range (V)	Output	Turns ratio pri : sec	Turns ratio pri : bias	Part number *Click for details*	Designed for	W × L × H *Mouse over for image*
4	9 – 18	3.3 V, 1.2 A	1 : 1.0	1 : 2.8	FCT1-33K28L	TI LM5015	13.21 x 10.92 x 9.02
4	9 – 18	5 V, 0.8 A	1 : 1.4	1 : 2.8	FCT1-50K28L	TI LM5015	13.21 x 10.92 x 9.02
4	9 – 18	9 V, 0.44 A	1 : 2.3	1 : 2.8	FCT1-90K28L	TI LM5015	13.21 x 10.92 x 9.02
4	9 – 18	12 V, 0.33 A	1 : 3.0	1 : 2.8	FCT1-120K28L	TI LM5015	13.21 x 10.92 x 9.02
4	9 – 18	15 V, 0.27 A	1 : 3.7	1 : 2.8	FCT1-150K28L	TI LM5015	13.21 x 10.92 x 9.02
8	18 – 36	3.3 V, 2.4 A	1 : 0.5	1 : 1.39	FCT1-33L28L	TI LM5015	15.24 x 12.7 x 11
8	18 – 36	5 V, 1.6 A	1 : 0.72	1 : 1.39	FCT1-50L28L	TI LM5015	15.24 x 12.7 x 11
8	18 – 36	9 V, 0.89 A	1 : 1.17	1 : 1.39	FCT1-90L28L	TI LM5015	15.24 x 12.7 x 11
8	18 – 36	12 V, 0.67 A	1 : 1.56	1 : 1.39	FCT1-120L28L	TI LM5015	15.24 x 12.7 x 11
8	18 – 36	15 V, 0.53 A	1 : 1.89	1 : 1.39	FCT1-150L28L	TI LM5015	15.24 x 12.7 x 11
13	28 – 60	3.3 V, 4 A	1 : 0.029	1 : 1.3	B0863-BL	Maxim MAX5941B	21.97 x 17.2 x 8.64
15	36 – 75	3.3 V, 4.6 A	1 : 0.24	1 : 0.67	FCT1-33M28L	TI LM5015	17.75 x 13.46 x 12.32
15	36 – 75	5.0 V, 3.0 A	1 : 0.33	1 : 0.67	FCT1-50M28L	TI LM5015	17.75 x 13.46 x 12.32
15	36 – 75	9.0 V, 1.67 A	1 : 0.57	1 : 0.67	FCT1-90M28L	TI LM5015	17.75 x 13.46 x 12.32
15	36 – 75	12 V, 1.25 A	1 : 0.71	1 : 0.67	FCT1-120M28L	TI LM5015	17.75 x 13.46 x 12.32
15	36 – 75	15 V, 1.0 A	1 : 0.90	1 : 0.67	FCT1-150M28L	TI LM5015	17.75 x 13.46 x 12.32
18	36 – 72	12 V, 1.5 A	1 : 0.88	1 : 0.44	C0984-CL	Maxim MAX5074	21.97 x 17.2 x 8.5
25	10 – 57	5 V, 5 A	1 : 0.80	1 : 1.9	JA4249-CL	TI TPS23756	30 x 20.57 x 10.92
25	10 – 57	12 V, 2.0 A	1 : 1.9	1 : 1.9	JA4667-AL	TI TPS23756	30 x 20.57 x 10.92
25	33 – 57	3.3 V, 7.2 A	1 : 0.16	1 : 0.63	FCT1-33M220L		17.75 x 13.46 x 12.7
25	33 – 57	5.0 V, 4.8 A	1 : 0.26	1 : 0.63	FCT1-50M220L		17.75 x 13.46 x 12.7
25	33 – 57	12 V, 2.0 A	1 : 0.53	1 : 0.53	FCT1-120M220L		17.75 x 13.46 x 12.7
30	36 – 72	3.3 V, 9 A	1 : 0.33	1 : 1	FCT1-33D38L		30 x 20.57 x 11.43
30	36 – 72	5 V, 6 A	1 : 0.44	1 : 1	FCT1-50D38L		30 x 20.57 x 11.43
30	36 – 72	12 V, 2.5 A	1 : 1	1 : 1	FCT1-120D38L		30 x 20.57 x 11.43
30	36 – 72	19.5 V, 1.55 A	1 : 1.44	1 : 0.88	FCT1-195D38L		30 x 20.57 x 11.43
30	36 – 72	24 V, 1.25 A	1 : 1.78	1 : 0.88	FCT1-240D38L		30 x 20.57 x 11.43
30	36 – 57	12 V, 2.5 A	1 : 0.923	—	GA3291-AL	Akros AS1130	29.15 x 20.57 x 11.43
40	18 – 36	12 V, 3.3 A	1 : 1.125	1 : 0.375	RA6998-BL	Maxim MAX17599	23.37 x 20.57 x 9.14
40	18 – 36	12 V, 3.3 A	1 : 1.125	1 : 0.375	RA6999-AL	Maxim MAX17599	25.90 x 23.11 x 10.66
60	36 – 75	12 V, 5 A	1 : 0.91	1 : 1	C0972-AL	ON NCP1216A	32.51 x 26.92 x 14.22
60	36 – 72	3.3 V, 18.18 A	6 : 1	6 : 3.5	POE600F-33L		30.0 x 20.57 x 11.43
60	36 – 72	5.0 V, 12 A	4 : 1	6 : 2.3	POE600F-50L		30.0 x 20.57 x 11.43
60	36 – 72	12 V, 5.0 A	2 : 1	2 : 1	POE600F-12L		30.0 x 20.57 x 11.43
60	36 – 72	24 V, 2.5 A	1 : 1	1 : 0.5	POE600F-24L		30.0 x 20.57 x 11.43

Coilcraft offers a helpful ***selection tool*** *for finding the right off-the-shelf forward-mode transformer based on the converter requirements.*

Coilcraft off-the-shelf forward transformers are designed to optimize these competing requirements, resulting in a compact, efficient, and cost-effective transformer.

Don't Forget the Output Inductor - L_{out}

All forward converters need an output inductor (L_{out}), as shown in the schematics above. Coilcraft offers inductor selection guides and tools, such as the Power Inductor Finder tool, to help you find the inductor you need based on inductance value and current rating. Try our **Power Inductor Finder** now.

References

Mammano, Robert A., 2017. *Fundamentals of Power Supply Design*. Texas Instruments.

Dixon, Lloyd H., 2001. *Magnetics Design for Switching Power Supplies*. Unitrode Magnetics Design Handbook.

Colonel Wm. T. McLyman, 1988. *Transformer and Inductor design Handbook*. 2nd ed., Marcel Dekker.

TECHNICAL ARTICLE

A Guide to Gate Drive Transformers

What is a gate drive transformer?

Current through a MOSFET between drain and source is controlled by a drive voltage applied to the MOSFET gate. In switching power supplies a pulsed gate drive voltage turns the drain-source current on and off, operating the MOSFET as a current switch. Gate drive transformers are used to deliver the controlling pulses while providing isolation between the MOSFET and the controlling drive circuit. This article discusses gate drive transformers and applications for which Coilcraft off-the-shelf gate drive transformers are best suited.

The LPH8045 Series is a coupled inductor/transformer that can be wired as a gate drive transformer

Gate driver circuits need an isolated (floating) bias supply to maintain the required turn-on bias when the FET source rises to the input voltage. A gate drive transformer isolates the controlling gate drive circuit from the switch node when driving the MOSFET gate, and may also scale the output voltage via an appropriate primary-to-secondary turns ratio.

In some applications, digital isolators or opto-couplers may provide the means to drive MOSFET's directly, but gate drive transformers are preferred for higher-voltage requirements and have the advantage of much lower turn-on and turn-off delay times, as well as the capability to scale voltage by turns ratio. Therefore, gate drive transformers are often the best performing solution for high-voltage and high-frequency applications where fast and accurate signal timing is critical.

In what applications are gate drive transformers used?

Figure 1 shows a simplified single-output, transformer-coupled (AC-coupled), high-side gate drive circuit for lower power applications. Depending on duty cycle and other circuit conditions, additional components (capacitors, diodes and resistors) may be used, to prevent:

1. The development of a DC voltage across the transformer which would cause it to saturate
2. The magnetizing inductance and coupling capacitance from resonating with sudden changes in duty cycle

For single-ended (AC coupled) circuits the highest duty cycle is 0.50.

Transformer coupled full-bridge and half-bridge configurations (see push-pull half-bridge gate drive circuit in **Figure 2**) are used for higher-power applications.

For double-ended (DC-coupled) bridge configurations, the maximum duty cycle is theoretically 1.0.

Figure 3 illustrates a typical gate drive transformer solution where a full-bridge power stage is driven by both high-side (Q1 and Q2) and low-side (Q3 and Q4) MOSFETs.

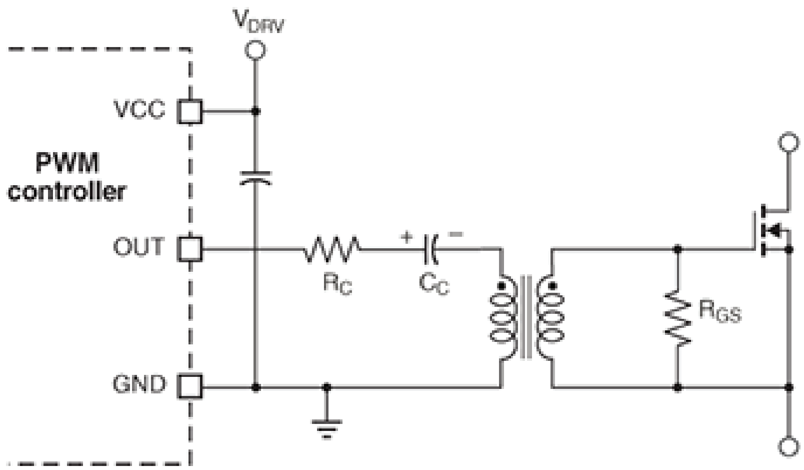


Figure 1: Simplified transformer-coupled single-ended gate drive circuit

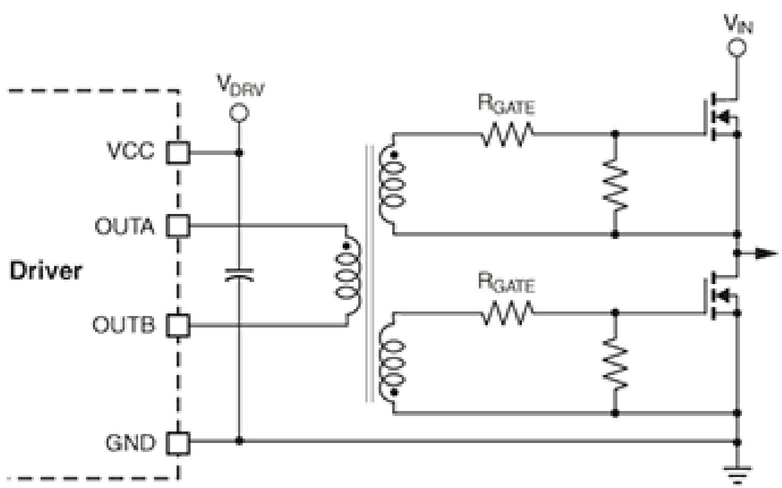


Figure 2: Transformer-coupled push-pull half-bridge gate drive circuit

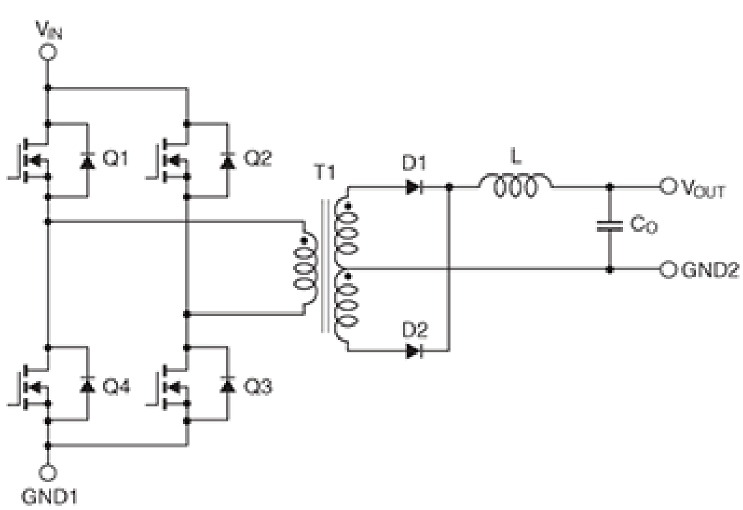
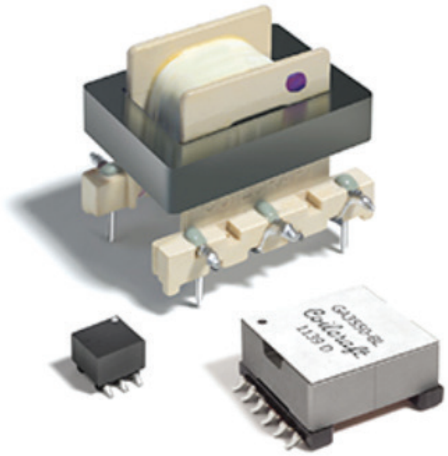


Figure 3: Full-bridge power stage with high-side and low-side primary MOSFETs

How do I select the best Coilcraft gate drive transformer



Coilcraft's off-the-shelf gate drive transformers simplify the design of your gate drive circuit and shorten design cycle time. Our designs typically utilize high-permeability ferrite cores to maximize magnetizing inductance and minimize magnetizing current.

The required transformer size is determined by the volt-time product of the application. Therefore, the first selection criterion for a gate drive transformer is the volt-time product (V-µsec) rating as shown on the transformer datasheet, and must be chosen greater than or equal to the expected highest applied voltage-time product to avoid core saturation.

Coilcraft gate drive transformers feature high volt-time ratings that are featured in this **selector tool.**

Turns ratio	Volt-time product (Vµs)	Isolation	Part number *Click for data*	Primary inductance	DCR Pri (Ω)	DCR Sec (Ω)	Leakage L (µH)
1:1	25.8	1500 Vdc	DA2319-AL	296 µH	0.795	0.655	1.5
	34.2	2250 Vdc	FA2659-AL	296 µH	0.795	0.655	1.5
	221	1500 Vrms	DA2099-AL	3.75 mH	2.30	2.85	13

Other important parameters to consider include:

1. Turns ratio: Pri:Sec turns ratio needed for voltage scaling, typically 1:1 for gate drive
2. Isolation: the isolation rating should be selected for worst-case conditions
3. Leakage inductance: the lowest leakage inductance translates to the greatest efficiency and reduced time delays in the gate drive circuit
4. PCB mount style required: through-hole (TH) or surface-mount (SM)

John Stevens. 2013. *Using a Single-Output Gate-Driver for High-Side or Low-Side Drive*. Texas Instruments Application Report SLUA669.

Laszlo Balogh. 2002. *Fundamentals of MOSFET and IGBT Gate Driver Circuits*. Texas Instruments Application Report SLUA618-March 2017-Revised SLUP169.

Understanding and Selecting Isolation Transformers

What is an isolation transformer?

Isolation/data transformers are used for isolation and voltage scaling in data line and power supply applications. Isolation transformers typically serve three main purposes:

1. Connecting circuits with grounds at different potentials – to prevent ground loops
2. Galvanic isolation – to prevent the flow of direct current

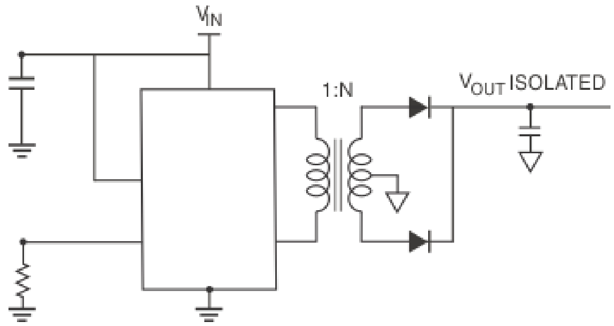


Figure 1
Isolation Transformer Circuit

3. Voltage transformation – to step up or step down from one voltage to another

You may also find isolation transformers labelled as power-supply transformers, signal transformers, data-line transformers, communications transformers, interface transformers, data-interface transformers, industrial-communications transformers, and miniature transformers. This article discusses isolation/data transformers and the wide range of applications in which Coilcraft off-the-shelf isolation/data transformers can be used.

In what applications are isolation transformers used?

Isolation transformers are very versatile and well suited for many commercial and industrial power supply and data communications applications, including:

- Low voltage (3.3 to 24 V) isolated DC-DC power supplies up to 7.2 Watts
- Isolated drivers for low-noise RS-485, RS-422, and RS-232 isolated serial communications data interfaces
- PCMCIA thin card drivers up to 750 mW
- Industrial and building automation and control systems
- Multipoint data transmission systems
- Isolated CAN interfaces
- Isolated 4 – 20 mA current loops for process control

- Transducer and actuator controls
- Data acquisition (DAQ) systems
- Isolated analog to digital conversion (ADC)
- Serial Peripheral interfaces (SPI)
- Inter-integrated Circuit (I2C) interfaces
- Half-bridge, full-bridge, and push-pull low voltage isolated DC-DC power supplies

A high noise immunity serial communications standard such as RS-485 is best used in industrial environments. Unlike Ethernet, which has no built-in method of packet collision avoidance, the master/slave topology of RS-485 leads to more reliable behavior by avoiding data packet collisions and maintaining data integrity, which is crucial in noisy industrial environments.

What range of isolation transformers does Coilcraft manufacture?

Coilcraft has a variety of off-the-shelf isolation transformers with:

- Input voltages of 3.3 to 24 Volts
- Power ratings up to 7.2 Watts
- Volt-time capabilities from 8.64 to 134 Vμs
- Inductance from 16 to 1000 μH
- Isolation from 1500 to 5000 Vrms

Isolation Transformers

Pri / Sec voltage	Power (W)	V × t (Vμs)	Turns ratio	Part number *Click for details*	L (μH)	Isolation (Vrms)	L × W × H (mm) *Mouse over for image*	Designed to work with:
3.3 / 3.3	7.2	34.4	1 CT : 1.5 CT	DA2303-AL	45.6	2500	12.07 × 10.0 × 5.97	TI ISO35T, SN6501
3.3 / 5	7.2	21.5	1 CT : 2.2 CT	DA2304-AL	17.8	2500	12.07 × 10.0 × 5.97	TI ISO3086T, ISO1176T, SN6501
3.3 / 5	7.2	17.6	1 CT : 2 CT	MA5632-AL	17.8	2500	12.07 × 10.0 × 5.97	TI SN6501
5 / 5	7.2	34.4	1 CT : 1.5 CT	DA2303-AL	45.6	2500	12.07 × 10.0 × 5.97	TI ISO3086T, ISO1176T, SN6501
5 / 5	2.0	22.7	1 : 1.33	WA8585-AL	136.86	1500	12.07 × 10.0 × 5.97	—
5 / 3.3-5	2.0	17.6	1 CT : 2 CT	PA6547-AL	63.75	2500	12.07 × 10.0 × 5.97	ADI ADuM347x
5 / 12-15	2.0	17.6	1 CT : 3 CT	PA6548-AL	63.75	2500	12.07 × 10.0 × 5.97	ADI ADuM347x
5 / 12-15	2.0	17.6	1 CT : 5 CT	PA6549-AL	63.75	2500	12.07 × 10.0 × 5.97	ADI ADuM347x
5 / 3.3-5	2.0	17.6	1 CT : 2 CT	JA4631-BL	63.75	2500	12.07 × 10.0 × 5.97	ADI ADuM347x
5 / 12-15	2.0	17.6	1 CT : 3 CT	JA4650-BL	63.75	2500	12.07 × 10.0 × 5.97	ADI ADuM347x
5 / 12-15	2.0	17.6	1 CT : 5 CT	KA4976-AL	63.75	2500	12.07 × 10.0 × 5.97	ADI ADuM347x
5 / 3.3-15	2.0	18	1 : 2	CR7983-CL	256	5000	29.15 × 21.85 × 10.8	ADI ADuM4070

Click here to view all of Coilcraft's Isolation Transformers

How do I select the Coilcraft isolation transformer that best fits my application requirements?

Coilcraft has developed a large selection of isolation transformers for general use in the applications discussed above and in the many IC reference documents listed in the section below.

Find your Coilcraft isolation transformer **here** to match it with the IC for your application.

Getting Started With Transformers