# Technical Bulletin
# TX1 Series Push-Pull Isolation Transformers
## Optimized for use with Texas Instruments SN6507 High Frequency Drivers

### Introduction

Push-pull isolated switching power supplies are able to utilize the smallest possible transformers. Using push-pull switching drives the transformer primary in alternating directions and therefore utilizes the core very efficiently and reduces peak magnetizing current with less inductance than unipolar excitation. Low peak current means small transformer size, low conduction loss and inherently low EMI.

With push-pull supplies being forward-mode converters, Vout in an output-regulated supply depends on the transformer turns ratio and the regulation scheme. In a non-regulated push-pull supply, Vout depends only on Vin and the transformer turn ratio. Therefore, even without output regulation the output voltage is inherently well regulated if Vin is from a tight-tolerance voltage source. In any case, push-pull switching power supplies offer simplicity of design, small transformer size, and excellent power density.

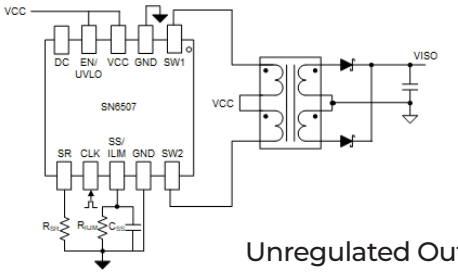
### Selecting a Transformer

While push-pull architecture has been in use for a long time and these benefits are well documented, Coilcraft TX1 Series transformers represent an advancement in transformer optimization for high-frequency 1 MHz switching. Combined with SN6507 transformer drivers from Texas Instruments, TX1 transformers offer a low EMI solution, with capability to operate over a much wider voltage range and offer higher power density.

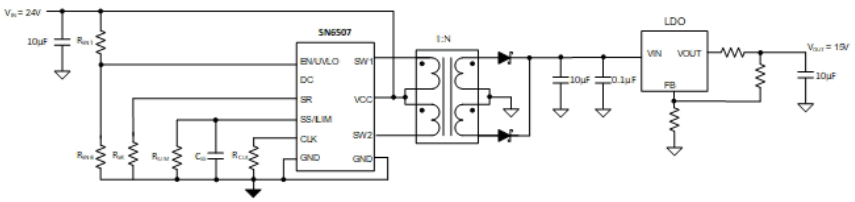
Coilcraft's current lineup of TX1 Series Transformers for Texas Instruments SN6507 is show below.

### Typical Push-Pull Schematics for Texas Instruments SN6507

Courtesy of Texas Instruments Company

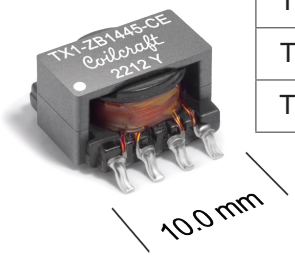



Unregulated Output




Regulated Output

| | Typ. Application | Turns Ratio | Volt-time Product | Power |
|---|---|---|---|---|
| TX1-ZB1445-CED | 12 V to 15 V | 1:1.4 | 22 V-µsec | 7.5 W |
| TX1-ZC1892-AED | 12 V to 30 V | 1:2.8 | 22 V-µsec | 15 W |
| TX1-ZB1459-BED | 24 V to 15 V | 1:0.7 | 30 V-µsec | 7.5 W |
| TX1-ZC1891-AED | 24 V to 30 V | 1:1.4 | 30 V-µsec | 15 W |



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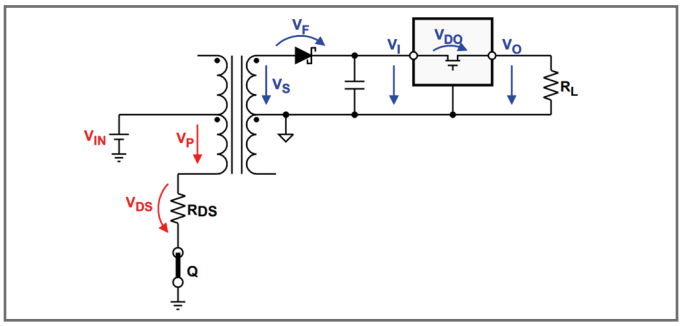
There are three main considerations for selecting a transformer.

1. Turns ratio must be selected to achieve desired output voltage.
2. Volt-time product rating to be greater than the expected volt-seconds applied to transformer primary.
3. Transformer power rating is greater than the desired supply output.

### Turns Ratio

Transformer turns ratio must be chosen to provide the correct output voltage, while accommodating switch and rectifier losses.




Courtesy of Texas Instruments Company

For the transformer:

$$V_S = V_P \times (N_S/N_P \times \eta$$

(assume transformer efficiency $\eta \approx .97$)

From the schematic:

$$V_{IN} = V_P + V_{DS}$$

$$V_{OUT} = V_S - V_F - V_{DO}$$

The required turns ratio is then calculated:

$$\frac{N_S}{N_P} = \frac{(V_{OUT} + V_F + V_{DO})}{(V_{IN} - V_{DS})\,(0.97)}$$

Notes:

1. $V_{DS} = R_{DS} \times I_{DS}$ and the SN6507 datasheet must be consulted to determine $R_{DS}$ for the intended application.
2. See output component datasheets to determine $V_F$ and $V_{DO}$.

### Volt-time Rating

The required volt-time product is calculated from $V_{IN}$ and $T_{ON}$. The alternating excitation of a push-pull converter essentially halves the switching frequency. At $f_{SW}$ = 1 MHz, the frequency for each direction is 500 kHz and the max $T_{ON}$ = .5 µsec.

For a 1 MHz push-pull with $V_{IN}$ = 15 V:

*min Volt-time = (15 volts) x (.5 µsec) = 7.5 volt-µsec*

### Power Rating

The required output power $V_{OUT} \times I_{OUT}$ should be less than the transformer power rating. Push-pull transformer ratings are generally established based on allowable conduction losses for a specific set of expected input/output conditions, but may often be used for higher power depending on the specific combination of input/output conditions. For applications requiring more power than listed on the datasheet, bench testing is required to verify suitable performance, or contact Coilcraft directly to discuss.

## Isolation

Coilcraft TX1 Series transformers provide 2.5 kVrms isolation (Hi Pot) between primary and secondary windings. This galvanic isolation provides an important safety measure, helps prevent dangerous ground loops, and reduces EMI, especially common mode noise.

## Other Considerations

Coilcraft TX1 transformer datasheets contain a full range of specifications to ensure proper suitability for any application (see specification table on page 3).

DCR of each winding can be used to calculate conduction losses for any combination of input/output current.

Windings have been optimized to minimize parasitic parameters and leakage inductance is minimized, resulting in operation with the lowest possible EMI.

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### TX1 Series Specification Table

| Part number[1] | Pri / sec voltage | Inductance[2] min (µH) | DCR max (Ohms)[3] pri | DCR max (Ohms)[3] sec | Leakage inductance[4] max (µH) | Volt-time product[5] (V-µsec) | Power[6] (W) | Turns ratio pri : sec |
|---|---|---|---|---|---|---|---|---|
| TX1-ZB1445-CED | 12 V to 15 V | 24.9 | 0.087 | 0.135 | 0.25 | 22 | 7.5 | 1 : 1.40 |
| TX1-ZC1892-AED | 12 V to 30 V | 24.9 | 0.102 | 0.240 | 1.0 | 22 | 15.0 | 1 : 2.80 |
| TX1-ZB1459-BED | 24 V to 15 V | 48.9 | 0.115 | 0.098 | 1.0 | 30 | 7.5 | 1 : 0.71 |
| TX1-ZC1891-AED | 24 V to 30 V | 48.9 | 0.134 | 0.163 | 1.0 | 30 | 15.0 | 1 : 1.43 |

Coilcraft TX1 transformers are designed to be used in a wide range of industrial environments and are suitable for processing in high-speed automated PCB assembly.

- Maximum part temperature of +165°C (ambient + temp rise)
- Resistance to soldering heat Max three 40 second reflows at +260°C
- Moisture Sensitivity Level (MSL) 1 (unlimited floor life at <30°C / 85% relative humidity)

In addition to providing high performance levels, Coilcraft TX1 Series transformers are designed to meet or exceed all environmental standards:

RoHS/ REACH COMPLIANT

Halogen Free

## Transformers for Your Application

Prototypes of TX1 Series transformers are available to support development needs. Coilcraft also welcomes you to contact us regarding purpose-designed versions if you don't see what you need in the standard series.