# TN 2

# Using TM NASCENTechnology, Inc. Low Power Series Transformers with the Maxim 845 Isolated Transformer Driver

By George Slama, February 1, 2002

## General:

TM NASCENTechnology, Inc. Low Power Series transformers used in conjunction with the Maxim 845 isolated transformer driver can provide a low power isolated supply that is low cost, low profile and low in board area.

TM NASCENTechnology, Inc. transformers are built using a LTCC (Low temperature Co-fired Ceramic) process. Their windings are not made of wire and the core is an integral part of the finished monolithic block. Automated processing helps ensure consistent construction and performance. The rugged units are easy to handle, have excellent co-planarity and solder well in a reflow oven process.

The Maxim 845 isolated transformer driver is a complete driver circuit that only requires adding a transformer, rectifier circuit and few filter capacitors. Its high frequency (450kHz to 900kHz) operation allows for the use of small transformers.

Typical applications include isolated data acquisition, isolated interface power supply, noise-immunity communications interface, bridging ground differences, medical equipment and process control.

TM NASCENTechnology, Inc. Low Power Series transformers are rated for 250mW of power transfer and 250Vac dielectric breakdown. Future models will include higher power ratings and dielectric breakdowns up to 1500Vac. The power rating can be safely exceeded provided adequate cooling is provided. Since the parts are designed to withstand the over 800°C firing temperature, any practical application circuit is likely to be limited by other things like the maximum pcb temperature rating or the melting point of solder. It is worth noting that the Curie temperature of the ferrite (the point where it loses its permeability and hence the transformer's inductance) is around 120°C. So keep things below 100°C.

Ideal circuits for TM NASCENTechnology, Inc. transformers are those that require the fewest turns. This is because the cost of transformers built with low temperature co-fired ceramics is directly related to the complexity of the winding configuration and number of turns which translates into layers, and layers add cost. Although full bridge drive circuits and full bridge secondary rectifier circuits make the best use of transformer windings, the forward voltage drop of two switches on the primary and two diodes on the secondary circuit make it less practical for low source voltage applications. However the Maxim 845, with its push-pull true circuit, is such a complete and easy to use package for low power applications that a less efficient transformer design may be warranted.



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TMNASCENTechnolocy, Inc. Low Power Series transformers are built with split primary and secondary windings that provide for versatile prototyping. They are intended as technology demonstration pieces applicable over a wide range of circuits. The series includes turns ratios from 1:1 to 1:4. By creative series and/or parallel connection of the windings the ratio range possible is 1:0.25 to 1:9. The main limitation is likely to be primary inductance since all parts have the same number primary turns.

Basic transformer parameters are listed in the following two tables, the first being basic magnetic properties, the second being parameters for the complete series.

Table 1. Basic Transformer Properties

| | |
|---|---|
| Effective Core Area (Ae) | 0.047 $cm^2$ |
| Effective Magnetic Path (Le) | 1.010 cm (95006,95007,95009) |
| | 1.053 cm (95008,95010 thru 95013) |
| Primary Turns | 6 + 6 |
| Dielectric Rating | 250 Vac |
| Power Rating | 250mW |
| Absolute Maximum Power | 500mW |
| Maximum Primary Current | 500mA |
| Maximum Secondary Current | 300mA |
| | 500mA (95008) |
| Operating Temperature | 0 - 70°C |
| Dimensions | 0.300” X 0.300” X 0.070” ± 0.010” |



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Table 2. Transformer Parameters

| Part No. | Turns Ratio | Pri Res Ω | Sec Res Ω | Pri Ind µH | Sec Ind µH | Leakage Inductance | Coupling K (2) |
|---|---|---|---|---|---|---|---|
| | | ± 20% (1-4) | ± 20% (5-8) | ± 20% (1-4) | ± 20% (5-8) | µH | |
| 95006 | 1:1 | 0.75 | 0.75 | 19.0 | 19.0 | 2.6 | 0.93 |
| 95007 | 1:1.5 | 0.75 | 2.15 | 20.0 | 47.5 | 2.2 | 0.94 |
| 95008 (1) | 1:2 | 0.75 | 1.35 | 15.0 | 57.5 | 1.6 | 0.95 |
| 95009 | 1:2 | 0.75 | 3.65 | 20.0 | 82.0 | 1.9 | 0.95 |
| 95010 | 1:2.5 | 0.75 | 3.00 | 16.0 | 98.5 | 1.6 | 0.95 |
| 95011 | 1:3 | 0.75 | 4.30 | 16.0 | 145.0 | 1.5 | 0.95 |
| 95012 | 1:3.5 | 0.75 | 5.65 | 17.0 | 210.0 | 1.4 | 0.96 |
| 95013 | 1:4 | 0.75 | 7.10 | 17.0 | 270.0 | 1.4 | 0.96 |

NOTES:
(1) This transformer has a low resistance secondary winding
(2) Coupling factor k = sqrt( 1 – (Leakage Ind / Pri Ind))



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**Application Information:**

**MAX 845 IC**
The IC implements an open loop push-pull converter which requires a center tapped primary winding on the transformer. One draw back of the MAX845 IC is the high on resistance of the switches. This high resistance (4.6Ω) contributes significantly to the reduced efficiency.

**Transformers**
Any of the $_{TM}$NASCENTechnology, Inc. Low Power Series transformers will work with the MAX845 driver IC. Connect pins 2-3 to form a center tap which is connected to Vcc. Terminals 1 & 4 are then connected to D1 & D2 on the driver IC. Select a turns ratio to give the desired output voltage. The tables following give examples of what can be expected from the various rectifier circuits and turns ratios.

**Rectifier Circuits**
The flexibility of the winding configuration in the $_{TM}$NASCENTechnology, Inc. Low Power Series transformers allows for numerous rectifier arrangements. Since the input is push-pull, a full wave center tapped circuit is the most efficient with only one diode drop. Although this circuit does not make efficient use of the transformer windings since only one half is used each half cycle, it does match the drive circuit and this duality is important. Other usable circuits could be a full wave bridge which has two diode drops, requiring more secondary turns or a voltage doubler circuit. The doubler also has two voltage drops but this is less of a concern because it is a lower percentage of the total output. In all cases it is recommended to use Schottky diodes for the lowest forward voltage drop

**Filter Capacitors**
Ceramic capacitors with low ESR can be used because of the low output ripple noise.

**Output Regulator**
Since the output voltage is not regulated, some form of series regulator may be desired to maintain a fixed voltage. Discrete solutions like a zener diode or programmable shunt regulator like a TL431 may be an option, but by far the most simple choice is to use a low drop out series regulator available from many different IC manufacturers.

The tables below illustrate the output voltages that can be expected for the various circuits with the output loaded such that the maximum input current to the IC is 200mA. Source voltage (Vcc) is 5 volts.

Table 3. Output Voltages for Low Power Series Transformers


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Full center tapped

| Part No. | Ratio | Vout | Iout | Power |
|---|---|---|---|---|
| | | VDC | mA | mW |
| 95006 | 1:1 | 2.4 | 96 | 230 |
| 95007 | 1:1.5 | 4.7 | 72 | 338 |
| 95008 | 1:2 | 6.5 | 54 | 351 |
| 95009 | 1:2 | 5.2 | 65 | 338 |
| 95010 | 1:2.5 | 9.0 | 43 | 387 |
| 95011 | 1:3 | 11.2 | 36 | 403 |
| 95012 | 1:3.5 | 13.4 | 33 | 442 |
| 95013 | 1:4 | 15.2 | 27 | 410 |

Figure 1
Full wave center tapped

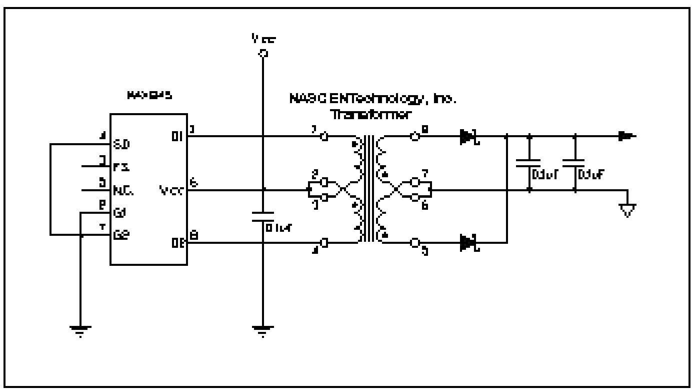



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Table 4. Output Voltages for Low Power Series Transformers
Full wave bridge

| Part No. | Ratio | Vout | Iout | Power |
|---|---|---|---|---|
| | | VDC | mA | mW |
| 95006 | 1:1 | 5.2 | 61 | 317 |
| 95007 | 1:1.5 | 9.7 | 41 | 397 |
| 95008 | 1:2 | 12.2 | 30 | 366 |
| 95009 | 1:2 | 13.7 | 31 | 425 |
| 95010 | 1:2.5 | 16.6 | 25 | 415 |
| 95011 | 1:3 | 20.7 | 20 | 414 |
| 95012 | 1:3.5 | 26.8 | 16 | 428 |
| 95013 | 1:4 | 30.6 | 13 | 397 |

Figure 2
Full wave bridge

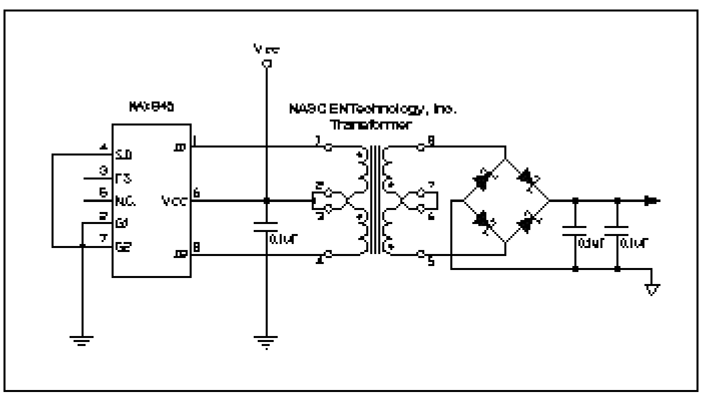


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Table 5. Output Voltages for Low Power Series Transformers
Voltage Doubler – Secondaries in series

| Part No. | Ratio | Vout | Iout | Power |
|---|---|---|---|---|
| | | VDC | mA | mW |
| 95006 | 1:1 | 12.7 | 28 | 355 |
| 95007 | 1:1.5 | 21.0 | 19 | 399 |
| 95008 | 1:2 | 27.6 | 14 | 386 |
| 95009 | 1:2 | 29.2 | 13 | 379 |
| 95010 | 1:2.5 | 37.6 | 10 | 376 |
| 95011 | 1:3 | 46.9 | 8 | 375 |
| 95012 | 1:3.5 | 60.2 | 6 | 361 |
| 95013 | 1:4 | 68.6 | 5 | 343 |

Figure 3
Voltage Doubler – Secondaries in series

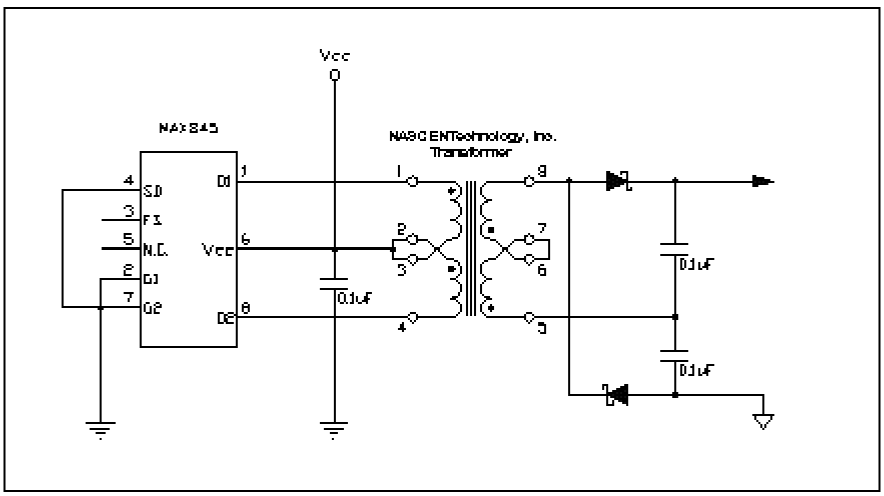




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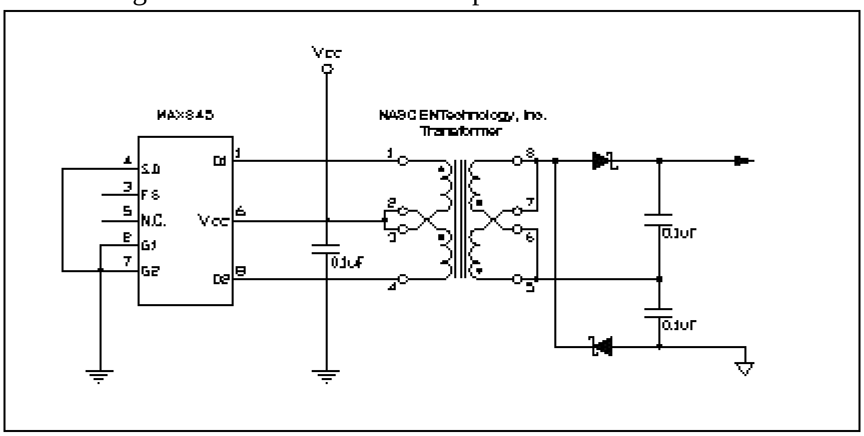
Table 6. Output Voltages for Low Power Series Transformers
Voltage Doubler – Secondaries in parallel

| Part No. | Ratio | Vout | Iout | Power |
|---|---|---|---|---|
| | | VDC | mA | mW |
| 95006 | 1:1 | 5.4 | 56 | 302 |
| 95007 | 1:1.5 | 9.6 | 37 | 355 |
| 95008 | 1:2 | 13.9 | 28 | 389 |
| 95009 | 1:2 | 13.6 | 29 | 394 |
| 95010 | 1:2.5 | 17.9 | 23 | 411 |
| 95011 | 1:3 | 22.4 | 19 | 425 |
| 95012 | 1:3.5 | 27.2 | 16 | 435 |
| 95013 | 1:4 | 31.1 | 14 | 435 |

Figure 4
Voltage Doubler – Secondaries in parallel




References:

- Maxim MAX845 ‘Isolated Transformer Driver for PCMCIA Applications’ Data Sheet
- MAXIM is a registered trademark of Maxim Integrated Products



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