Re: Resistor vs transformer

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* *From*: John Fields <jfields@xxxxxxxxxxxxxxxxxxxxx>
* *Date*: Wed, 08 Feb 2006 08:40:31 −0600

On 8 Feb 2006 04:37:27 −0800, "lemonjuice" <exskimos@xxxxxxxxxxxx>
wrote:

> On Wed, 08 Feb 2006 06:09:44 −0600, John Fields
> <jfields@xxxxxxxxxxxxxxxxxxxxx> wrote:
>
>> Sloman's trick of using the 120V primaries in series and having your device connected in parallel across the primaries causes the transformer to become an autotransformer, which would work.
>>
>> Using the scheme with a transformer with dual 240V secondaries likely wouldn't work well because of the much higher winding resistance you'll encounter causing,
>
> Winding resistence doesn't depend ONLY on input voltage range. You can get dual 115V's with higher resistence then dual 230V's
>
>> I would expect, _very_ poor
>> regulation.
>
> as far as I know neither does regulation ... unless you have some good reasoning to prove that.

For the same core, to get the same flux density with a 240V input would require twice the number of turns as for a 120V input.

The voltage on the secondary is related to the voltage on the primary by:

Es Ns
−−−− = −−−− (1)
Ep Np

Where Es and Ep are the primary and secondary voltages, respectively, and Ns and Np are the number of turns wound on the secondary and on the primary, respectively.

Since the transformer is tranferring power, the current in the secondary has to be related to the current in the primary by:

Is Np
−−−− = −−−− (2)
Ip Ns

So, for, say:

120V>−−+ || +−−>120V>−−+
P || S |
R || E [120R]
I || C |
120V>−−+ || +−−>120V>−−+

With 120V out of the secondary and a 120 ohm load, we'll have a load current (in the secondary) of:

Es 120V
Is = −−−− = −−−−−− = 1 ampere
Rl 120R

Now, since the voltage across the primary and the voltage across the primary, and:

Np Ep 120V
−−−− = −−−− = −−−−−−,
Ns Es 120V

then there must be the same number of turns on the primary as there are on the secondary.

Rearranging (2) to solve for the primary current will give us:

Ns
Ip = Is −−−− = 1A * 1 = 1.0 ampere
Np

Now, with that behind us, let's take a look at a transformer with dual 120V primaries and connect them in series so we can use it as an autotransformer with a 240V input and a 120V output and see what happens:

```
240V>−−−−−−+
|
||P
||R
||1
|
+−−>120V>−−+
| |
||P |
||R [120R]
||2 |
| |
240V>−−−−−−+−−>120V>−−+
```

Since we have twice the voltage across the inductance of the primary, we'll need twice the number of turns to keep the flux density in the core the same as it was for the 120V case, and that criterion is satisfied with the two windings in series.

Now, just assume, for the sake of the argument, that our first transformer:

```
120V>−−+ || +−−>120V>−−+
P || S |
R || E [120R]
I || C |
120V>−−+ || +−−>120V>−−+
```

Really had two 120V primaries which were connected in parallel:

```
120V>−−+−−−+ ||
| P ||
| R ||
| 1 ||
120V>−−|−+−+ || +−−>120V>−−+
| | || S |
| | || E [120R]
| | || C |
+−|−+ || +−−>120V>−−+
| P ||
| R ||
| 2 ||
+−+ ||
```

In which case each primary would be rated for 500mA and, in parallel, the combination could carry 1 amp.

Now, though, since we're not using the secondary and taking advantage of the current sharing we'd get with both primaries in parallel feeding the load on the secondary, we're forcing one of the primaries to supply the entire load, which is going to cause twice the voltage drop across it than would occur with with the windings in parallel. That, in and of itself, will cause the regulation to be poorer than it would be with a conventional transformer with the same amount of iron in the core.

Finally, consider another autotransformer wound on the same core, but with two _240V_ primaries wired in series with 240V across the ends. 120V will still appear from the center tap to either end, but because the primaries were wound with smaller diameter (higher resistance) wire, and exhibit a higher resistance than the other autotransformer, the drop across the 240V primary with the 120 ohm load connected across it will be even greater than across the other autotransformer, resulting in even poorer regulation.

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