

Payton Planar Magnetics - An Innovative Technology for Modern SMPS

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Compact and high efficient power conversion is critical to the continued profitable growth and miniaturization of the telecommunication, computer, vehicle and other host industrial and military systems. The creation of any high-efficiency power supply, and especially of a Switch Mode Power Supply (SMSP) requires a proper selection of many components and materials. A key element of any SMPS is its magnetic elements – the transformer and the inductor.

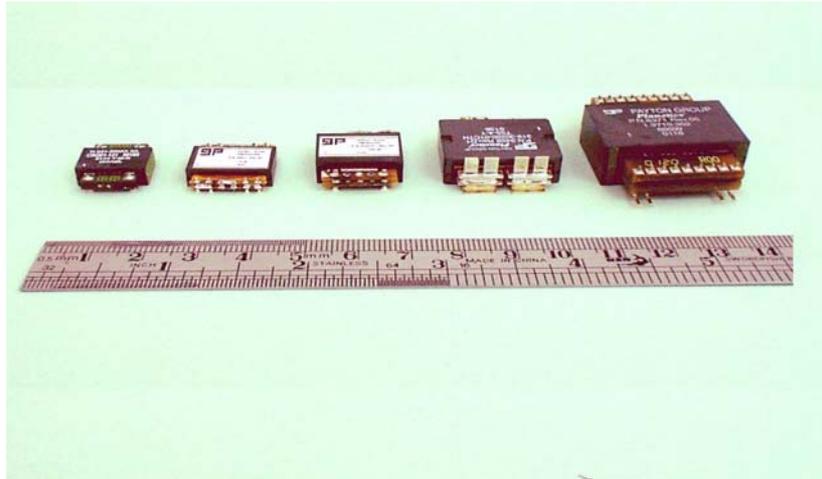
Planar Magnetic Technology is now growing in popularity as an efficient way to achieve benefits of electrical and mechanical performance of an SMPS, including:

- **High Power Densities** – Planar transformers tend to have a higher surface-to-volume ratio than conventional magnetic designs. As a result, they are more effective at conducting heat and tend to have low thermal sensitivities compared to conventional wire wound parts. Therefore, it is possible to achieve very high power densities, particularly at frequencies ranging from 100 kHz up to 2.5 MHz.
- **Highly Constant Parasitics** – the leakage inductance and capacitance of wire wound magnetics are highly dependent on the placement of the wire. As a result, a significant lot-to-lot variation in these electrical parameters is typical. Inconsistent parasitics effect the operation of the power supply and can even cause failure due to voltage and current spiking. With planar magnetics the windings are highly regular and the variations in the parasitics from lot-to-lot is extremely low.
- **Low Profile** – Planar magnetics have intrinsically much lower profile than conventional wire wound devices. Typically, the height of a planar magnetic device will be 25% to 50% less than its wire wound counterpart.

Payton’s innovative Planar Magnetic Technology is based on a new set of flat ferrite cores (see table 1), suitable for high frequency operations and thin, flex and pre-tooled circuits. As a result, Payton’s transformers for Quarter and Half Brick SMPS have the smallest dimensions corresponding to the output power range.

Table 1: Various flat ferrite cores

Core Size	20	32	40	55	80
Power range (W)	10-30	20-75	25-100	50-360	200-1400
Dimensions LxWxH (mm)	17x15x6	19x18.5x7	23x20x10	30x26x10	40x32x12
Weight (gr)	5	8	12	25	50



Picture 1: Transformers of Various core sizes: 20, 32, 40, 55 and 80 (left to right).

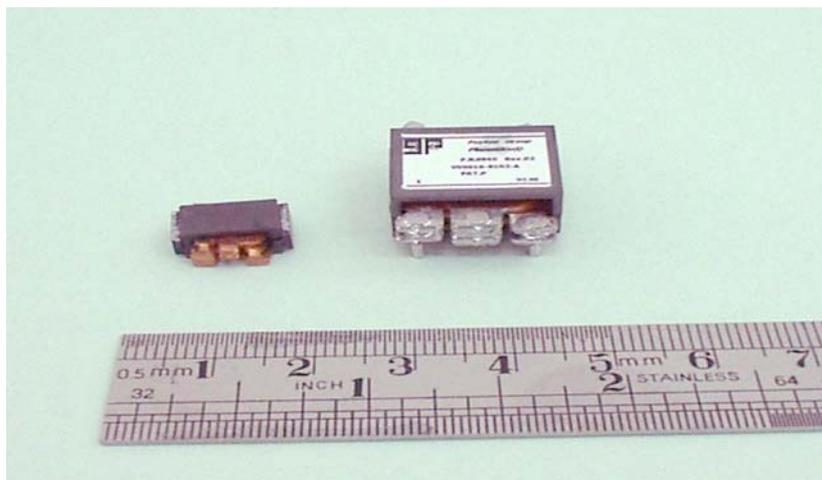
Welding and Induction Heating Applications

Planar transformers are the ideal for welding and industrial heating applications. It is well known that welding SMPS are generating extremely high output current. The number of the secondary turns in most of the cases is only a few. Therefore, a flat planar winding which is the best for high currents has all the advantages and should be used in welding applications. Developing welding SMPS using planar magnetics can dramatically reduce its size, weight and cost. The planar transformer is also the preferred option for induction heating applications. It is now possible to imagine a 20 kW induction heating transformer for a 200 kHz resonant SMPS with dimensions as $L \times W \times H = 142 \times 90 \times 40 \text{mm}$.

Reducing Output Inductor Size

A newly patented Pre-Magnetized Ferrite Technology introduced a new approach in designing of DC planar chokes (see Picture 2), providing:

- Double inductance with the same current, or Double current with the same inductance.
- Up to four times decrease of the power losses, or 30%-40% smaller footprint with the same DC current and inductance.



Picture 2: A pre-magnetizing choke of $0.33 \mu\text{H}/40 \text{A}_{\text{dc}}$ (left), compared to a regular choke of $0.4 \mu\text{H}/40 \text{A}_{\text{dc}}$ (right).

Although the idea of a pre-magnetized ferrite inductor is very well known, so-far it was not widely used due to the following shortcomings:

1. A high price of the special magnets.
2. A high frequency limitation.
3. Performance degradation due to demagnetization of the magnet.

Payton's chokes overcome all these obstacles: Payton is using ferrite-based magnets, which are inexpensive. The parts were tested at operating frequencies of up to 1 MHz and no degradation related to the magnet was observed. There was no degradation of the choke's inductance due to the demagnetization of the magnet when it was tested at field levels up to 10 times higher than the operational field.

Resonant Chokes – Hybrid Planars

For high frequency Resonant Chokes, Payton developed a new family of Hybrid Planar Inductors: A special "6-legs" planar ferrite combined with a litz wire winding. This combination enables obtaining a high Quality Factor (Q) at high frequencies. For example, a 40 μH /3Arms Resonant Choke has a Quality Factor of 500 at 1 MHz operating frequency.

Planar Common Mode Chokes

Planar Common Mode Chokes provide extremely high attenuation of noises. The ratio between leakage inductance and their self-inductance can be reduced down to 0.005%. Due to the high self-capacitance, Planar Common Mode Choke can incorporate the input and output capacitors in the choke itself. Thus, a Planar Common Mode Choke can operate as a Common Mode Filter. It is now also possible to design a Planar Common Mode Choke with low losses that will operate at currents up to 200 A.