

## NEWS RELEASE

PR0721E

### **Alps Alpine Develops Isolated “TriMagiC Converter™” On/On & On/Off Type Isolated DC-DC Converter Circuit Technology**

*Power Electronics for Space Savings and Reduced Power  
Consumption in EVs*

Munich, Germany, December 13, 2021 – Alps Alpine has developed a new high-performance isolated DC-DC converter<sup>1</sup> circuit technology, Isolated TriMagiC Converter™. The technology uses Licalloy™<sup>2</sup> – an original magnetic material developed by Alps Alpine – instead of ferrite<sup>3</sup> for magnetic components in transformers<sup>4</sup> and resonant coils<sup>5</sup>. Use of the material here in a circuit that operates in On/On & On/Off mode simultaneously enables both high peak conversion efficiency of 96.8% and compact size – the total size of magnetic components comes to one third compared to existing methods – even with high output power of 3.3kW. High output power ensures compatibility with the high power requirement for autonomous driving and in-vehicle entertainment systems while compact size and high conversion efficiency contribute to space efficiency and reduced power consumption in electric vehicles. Samples are to be made available for the purpose of researching the market and evaluating performance with a view to commencing sales of components using Licalloy™, including magnetic cores, transformers and resonant coils, around October 2023.

#### **Background to the Development**

Home appliances and other electronics use different types of electricity (alternating current, AC, or direct current, DC) and voltages depending on what is best for the function they are performing. They therefore need to convert electrical power in a manner suited to the application and purpose. Power conversion is implemented using power electronics technology. As virtually all electronic devices run off a direct current, DC-DC converters play a vital role in converting the supplied DC power voltage into an optimal DC voltage that varies with the application. Given heat generation during power conversion results in power loss, improving power conversion efficiency to reduce that power loss leads to energy efficiency in all kinds of electronics, and by extension, contributing to preservation of the global environment.

Specifically in regard to electric vehicles, lithium-ion batteries are frontrunners to become the dominant type of main battery. They employ a direct current with a high voltage of around 400V, while electronic devices drawing from that power supply, including navigation systems, headlights and power windows, run off low-voltage DC of around 12V. The voltage conversion from one to the other is performed by an automotive DC-DC converter (also known as an auxiliary converter).

As efforts to achieve carbon neutrality gather momentum, controls on vehicle exhaust emissions are becoming more stringent. It is critical that electric vehicles are put to practical use and popularized. For electric vehicles to become widespread, infrastructure needs to be put in place. It also demands that batteries have larger capacity, vehicles are lighter, and power conversion efficiency is improved, allowing for longer driving ranges. Not only that, power consumption by vehicles is on the rise due to greater sophistication of automated driving systems and in-vehicle entertainment systems. As a solution to these issues, there are urgent calls for technological innovation of power electronics products, including DC-DC converters.

### **Outline of the Development**

For safety reasons, automotive DC-DC converters are generally isolated types to prevent electric shock. Existing isolated DC-DC converters are broadly categorized as either On/Off type converters with low output power but compact size due to a small number of parts, or On/On type converters with high output power but more parts and therefore larger dimensions. In automotive applications, On/On type converters have been used since large loads demand high output power (at least 1kW). Issues with using On/On type converters are the need for higher operating frequencies to enable compact dimensions and the problem of diminishing power conversion efficiency.

Isolated TriMagiC Converter™, the isolated DC-DC converter circuit technology newly developed by Alps Alpine, uses Licalloy™ – the company's original magnetic material with characteristically low permeability, high saturation flux density and low loss – for magnetic components in transformers and resonant coils instead of ferrite. Use of the material here in a circuit that operates in On/On&On/Off mode simultaneously enables both high peak conversion efficiency of 96.8% (Fig.1) and compact size – the total size of magnetic components comes to one third compared to existing methods – even with high output power of 3.3kW (Fig. 2).

Fig.1 Efficiency Curve

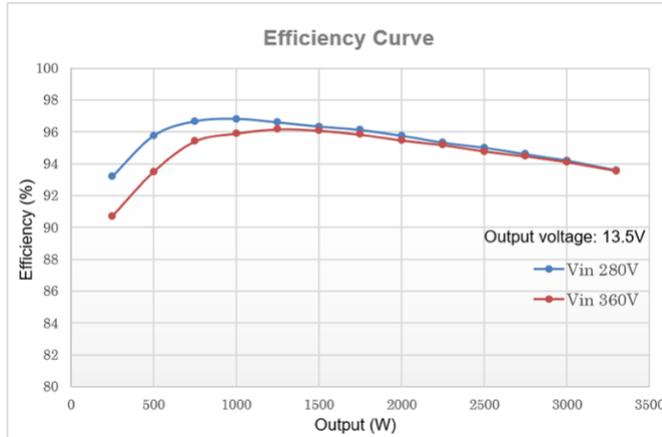


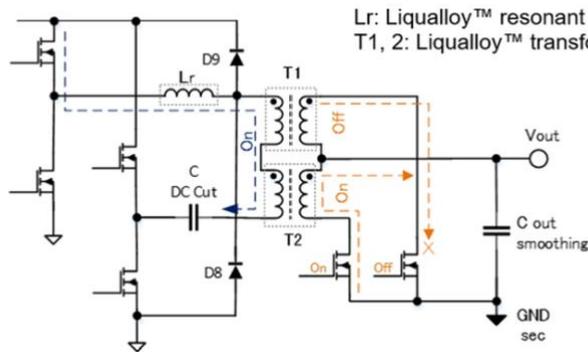
Fig. 2 Total Size of Magnetic Components – A Comparison

	Output (operating frequency)	Total volume of magnetic core	Volume per 1W (ratio)
<b>Alps Alpine Isolated TriMagiC Converter™</b>	<b>3.3kW (125kHz)</b>	<b>72264.4mm<sup>3</sup></b>	<b>21.9mm<sup>3</sup>/W (100%)</b>
<b>Company A Isolated DC-DC Converter</b>	<b>1.6kW (100kHz)</b>	<b>108696.8mm<sup>3</sup></b>	<b>67.9mm<sup>3</sup>/W (310%)</b>
<b>Company B Isolated DC-DC Converter</b>	<b>0.6kW (100kHz)</b>	<b>47521.4mm<sup>3</sup></b>	<b>79.2mm<sup>3</sup>/W (362%)</b>

The circuit contains three magnetic components – two transformers with the same properties and a resonant coil for zero voltage switching (ZVS). With current input from a bridge circuit, the two transformers repeatedly alternate between On/On and On/Off operations (Fig. 3). Because the transformers simultaneously output and store energy from the input side during both On/On and On/Off operations, flux density increases around half as much as with an ordinary On/Off type converter. As this storing operation performs a rectifying role in place of a smoothing coil, the latter is not required. In addition, the high saturation flux density of Licalloy™ allows for smaller magnetic components and, by extension, a more

compact circuit. Changes in flux density are smaller, too, enabling high output power and high conversion efficiency.

Fig. 3 Basic Circuit Configuration for On/On & On/Off Modes



In regard to power supply circuits, compact size and high conversion efficiency are considered the main forms of added value. Until now, compactness has been achieved using techniques of composition and miniaturization relating to power semiconductors and capacitors. Most recently, even smaller circuits have been realized without affecting high conversion efficiency by increasing operating frequency using silicon carbide (SiC), gallium nitride (GaN) or other next-generation transistors with low switching losses. However, there are limits to how well this method can improve conversion efficiency. In developing this On/On&On/Off mode circuit, Alps Alpine focused on magnetic components that could not be made smaller through their composition or miniaturization. Compact size and high conversion efficiency are realized without increasing operating frequency using original magnetic material Licalloy™.

Fig. 4 A prototype Isolated TriMagiC Converter™ (DC-DC converter) for evaluating functionality



## Outlook

Samples of magnetic components using Licalloy™ are expected to be made available in April 2022 (we are looking to accept custom requests from February 2022). In regard to the Isolated TriMagiC Converter™ product, we are currently planning to prepare for the supply of reference boards for functionality evaluation purposes based on customer needs between March and April 2022. Provision of samples will allow time for processes such as market research and performance evaluation prior to the sale of various components using Licalloy™, including magnetic cores, transformers and resonant coils, from around October 2023, in turn contributing to space savings and reduced power consumption in electric vehicles.

## Features

New isolated DC-DC converter circuit technology simultaneously achieving high output power, high conversion efficiency and compact size

1. Uses Licalloy™ in the primary transformer for low permeability, high saturation flux density and low loss in On/On&On/Off mode
2. Achieves 3.3kW high output power, 96.8% high peak conversion efficiency, and total size of magnetic components equivalent to one third of existing products.
3. Uses low-loss SiC to realize compact size and high efficiency at an elevated level without increasing operating frequency.

## Principal Applications

- Automotive DC-DC converters (auxiliary converters)
- Servers
- Base station power supplies

## Specifications

Prototype name (No.)	Isolated TriMagiC Converter™ (LTMCi330AA)
Dimensions (WxDxH)	230.0 × 115.0 × 30.0mm
Input	DC 360V (DC 270-450V)
Output	DC 13.5V 244A (3.3kW)
Auxiliary power supply for control circuit	DC 12V 0.4A (from outside secondary side)
Format	Open frame, forced air cooling

1. A device that converts DC voltage into the optimal DC voltage for each application.
2. An original magnetic material developed by Alps Alpine. Feature characteristics are low permeability, high saturation flux density and low loss. Visit the URL below for more information. [https://tech.alpsalpine.com/e/info/technology/tec\\_liqualloy/](https://tech.alpsalpine.com/e/info/technology/tec_liqualloy/)
3. The generic term for ceramic materials with iron oxide as the major component. Characteristics are high permeability, low saturation flux density and low loss. Ferrites are used widely as a magnetic material.
4. An electronic component that uses electromagnetic induction to change the voltage level of AC power.
5. Used for soft switching to reduce losses during power transistor switching.

**Alps Alpine Co., Ltd.** On January 1, 2019, Alps Electric Co., Ltd. and Alpine Electronics, Inc. integrated their businesses and started out afresh as Alps Alpine Co., Ltd with 42,289 employees. Alps Alpine will steadily bring about synergies by drawing on the two companies' advantages in core devices, system design and software development.

The new company will endeavour to create its own unique value for not only the automotive market, but also mobile devices and consumer electronics, as well as new sectors such as energy, healthcare and industry. For more information please visit [www.alpsalpine.com](http://www.alpsalpine.com)

**Alps Alpine Europe GmbH**, a subsidiary of Alps Alpine Co., Ltd., was established in 1979. Since 2013 the European Head Office has been located in Munich and as such co-ordinates the Sales, Marketing and Product Engineering activities of our offices in Dusseldorf, Stuttgart, Wolfsburg, Paris, Milton Keynes, Coventry, Gothenburg, Frolunda and Milan, as well as the production activities of our manufacturing site in Dortmund. Alps Electric Europe GmbH changed its name on 01.04.2020 to Alps Alpine Europe GmbH.

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