

# New trends in wide input range DCDC converters for Railway applications

## Gaia-converter's MGDD series:

The new trends in railway applications are definitively oriented to more portability, highest efficiency and easy to use solutions. To address those requirements that became inevitable, Gaia-Converter has released an unequalled ultra-wide input range DC/DC converters concept to combine universality and flexibility. The MGDDI06R –MGDDI20R-MGDDI60R are 3 families of isolated dc/dc with a 12 to 160Vdc input range, and featuring flexible output channels.



MGDDI06R



MGDDI20R



MGDDI60R

## More portability with universal DC/DC converters:

The complexity of the railway industry lies in the lack of a universal DC bus such as the standard 28V in avionics or the 48V in telecom. Each country defines its own input bus voltage, ranging from 24Vdc to 110Vdc. The EN50155 standard defines all possible values, including minimum (0.6x Vnom.) and maximum (1.4x Vnom.) limit voltages. With these parameters, a system designed to work in any country would require an input voltage range between 14.4V and 154V to ensure interoperability between countries. Such a wide input range requires a permanent 10:1 input voltage ratio which is beyond the capability of most DCDC converters on the market.

| EN50155 batteries characteristics |                                      |                                                                |                                    |
|-----------------------------------|--------------------------------------|----------------------------------------------------------------|------------------------------------|
| Nominal battery voltage<br>Vnom   | Minimum<br>brownout voltage<br>100ms | Steady state<br>battery voltage<br>range<br>(0,7 to 1,25)xVnom | Maximum<br>overvoltage<br>up to 1s |
| 24V                               | 14.4V                                | 16.8 to 30V                                                    | 33.6V                              |
| 48V                               | 28.8V                                | 33.6 to 60V                                                    | 67.2V                              |
| 72V                               | 43.2V                                | 50.4 to 90V                                                    | 100.8V                             |
| 96V                               | 57.6V                                | 67.2 to 120V                                                   | 134.4V                             |
| 110V                              | 66V                                  | 77 to 137.5V                                                   | 154V                               |

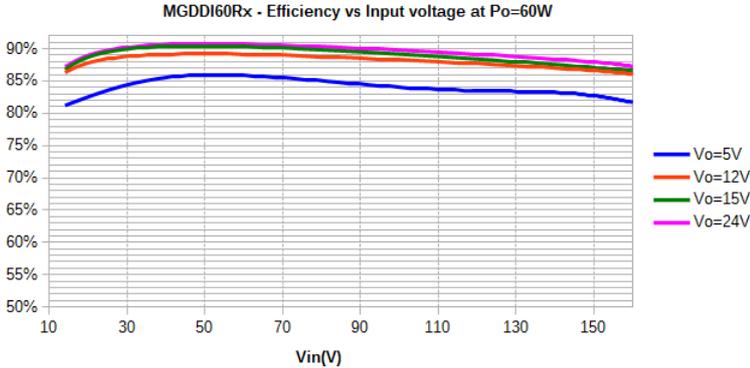
Each country defines its own input bus voltage

Until recently, the typical way to achieve this requirement was to use 4:1 DCDC converters, implementing a 9-36V input range DCDC for the 24V bus (Gaia’s H input range for example) and a 36-140V for the higher voltage batteries (72V and 110V ; Gaia’s Q input range). This approach led to the use of two different part numbers for the DCDC and, as a consequence, two different sets of boards, making it highly inconvenient to manage for system integrators and ineffective from a purchasing and logistics perspective. Also, as a consequence to these narrow standard input ranges, it was often necessary to provide for a front-end voltage limiter to clamp incoming surges out of the range of the selected converters.

However, improvements in semiconductor performance over the last few decades, combined with a new converter architecture, we now introduce a new generation of DCDCs that provide smarter solutions to address these issues. The latest GAIA Converter MGDDI series have been specifically designed with a 12-160V input voltage range to comply with the extreme voltage limits and remove the need for a voltage limiter. With such a wide input range, the same converter can operate on all EN50155 batteries, immediately simplifying configuration management. A second benefit being with only a single part number required, the quantities ordered are doubled, allowing a further reduction in purchasing costs.

**Challenging efficiency performances over input range:**

Indeed, the challenge to overcome is maintaining a good efficiency over the full input voltage range. This allows the converter's temperature to remain within acceptable limits, whether it is operated at one end or the other of the input range while extending life expectancy. Thanks to topology improvements, the efficiency remains high and varies very little over the full input voltage range, as illustrated in the graphs and table below.

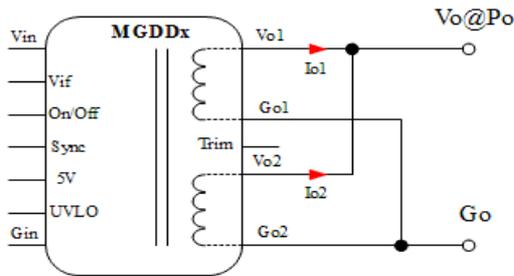


| Module ID. | Power | Output voltage | Max. efficiency |
|------------|-------|----------------|-----------------|
| MGDDI06RC  | 6W    | 2X 5V          | 80%             |
| MGDDI06RE  | 6W    | 2X 12V         | 83%             |
| MGDDI06RF  | 6W    | 2X 15V         | 83%             |
| MGDDI06RI  | 6W    | 2X 24V         | 85%             |
| MGDDI20RC  | 20W   | 2X 5V          | 86%             |
| MGDDI20RE  | 20W   | 2X 12V         | 89.8%           |
| MGDDI20RF  | 20W   | 2X 15V         | 90%             |
| MGDDI20RI  | 20W   | 2X 24V         | 90%             |
| MGDDI60RC  | 60W   | 2X 5V          | 86 %            |
| MGDDI60RE  | 60W   | 2X 12V         | 89 %            |
| MGDDI60RF  | 60W   | 2X 15V         | 91 %            |
| MGDDI60RI  | 60W   | 2X 24V         | 92 %            |

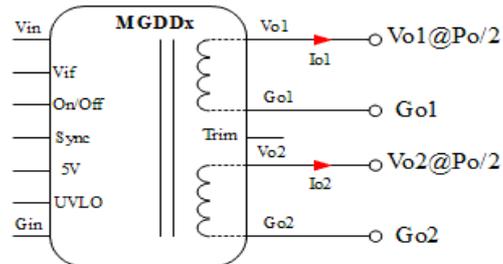
### Flexibility with versatile output voltages:

Along with the ultra wide input range capability, the output side of the converter has also undergone a transformation to gain versatility. Instead of delivering a single or dual + and - standard output, the MGDD series delivers 2 separate output channels, isolated from each other to allow 4 output arrangements. These channels can be paralleled, serialized or arranged as 2 symmetrical or independent power supplies.

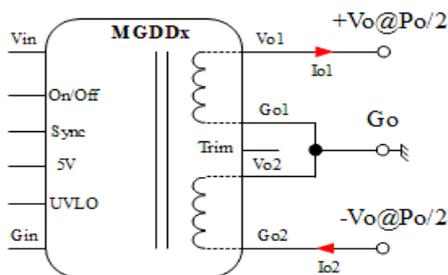
#### 4 output arrangements :



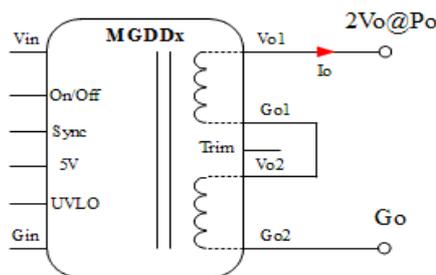
Parallel connection



Independent rails



symmetrical voltage

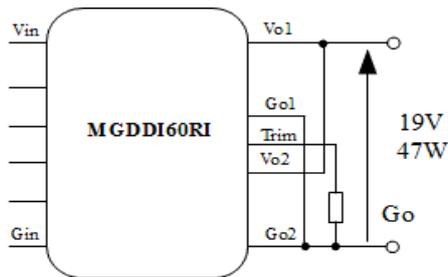


Double output voltage

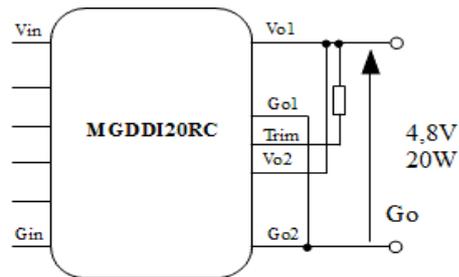
One example of the new possibilities allowed by this architecture is that it's now possible to make a 48V/60W output power supply with an ultra wide, 12-160V input range by serializing the two 24V outputs of the MGDDI60RI. Such a PSU can now supply telecom equipment embedded in a train. So far, the conflicting requirements between the wide input range and the high output voltage made this difficult, if not impossible, to build such a power supply. The dual channel topology has allowed this challenge to be overcome and provide the designer with a viable solution. This architectural evolution, combined with its trim capability, allows designing with nearly any output voltage necessary. Specific voltage requirements such as 19Vdc for Computer chargers, or various non standard voltages such 9.6Vdc or 7.2Vdc become possible by choosing the right reference out of the 5 existing output options. The following table shows the different possible output voltage ranges depending on output configuration.

| Output voltage ranges vs configuration |                                               |                                             |
|----------------------------------------|-----------------------------------------------|---------------------------------------------|
| Nominal output voltage                 | Output voltage range with outputs in parallel | Output voltage range with outputs in series |
| 5V                                     | 4-5.5V                                        | 8-11V                                       |
| 12V                                    | 9.6-13.2V                                     | 19.2-26.4V                                  |
| 15V                                    | 14-16.5V                                      | 28-33V                                      |
| 24V                                    | 19.2-26.4V                                    | 38.4-52.8V                                  |

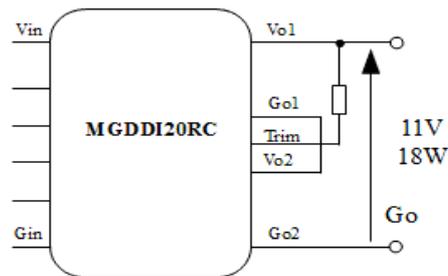
Various Specific voltage:



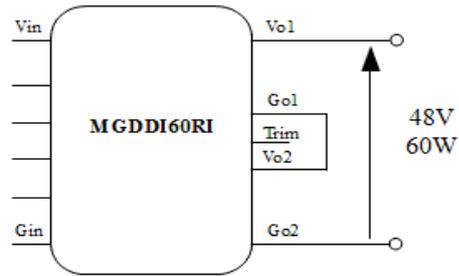
MGDDI60RI  
parallel



MGDDI20RC  
parallel



MGDDI20RC  
serie



MGDDI60RI  
serie

## Gaïa's MGDD families definitively simplify Railway Power Supply design:

Combining an ultra wide input range, a flexible output configuration and high efficiency, Gaïa's MGDDI06R, MGDDI20R and MGDDI60R series provide the designer with significant improvements over existing products. This original architecture is a new step forward which ultimately allows the design of a universal PSU with off-the shelf DCDC converters. The main performance of the power stage highlighted above provides the designer an overview of all the possibilities offered as well as other performance characteristics for comparative purposes. Additionally Gaïa-converter proposes filtering, RIA12 compliant front-end, smart hold up modules, RPP (reverse polarity protection) solutions to fulfill the complete designer needs.

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