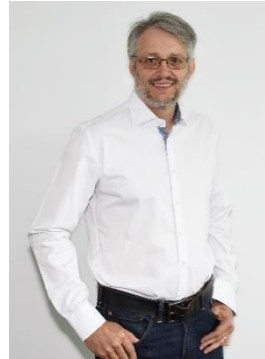


The background of the slide is a dark grey illustration of a factory floor. A central perspective shows a long aisle with several robotic arms on both sides, each positioned over a circuit board on a conveyor belt. The scene is lit from above, creating soft shadows and highlights on the floor and components.

Rutronik TechTalk Power Supplies for Advanced Robotics

5 July 2022

Introduction



Steve Roberts, Innovation Manager, RECOM

The RECOM group of companies is a power supply manufacturer headquartered in Austria with over four decades of experience in developing and manufacturing up-to-date standard and custom power converter technology, from sub-1W up to tens of kW.

We specialize in industrial, medical and E-mobility power solutions.

With Rutronik, our customers have access to our vast selection of on-board and off-board DC/DC converters and AC/DC power supply solutions, all of which comply with international safety standards and carry the latest certifications.

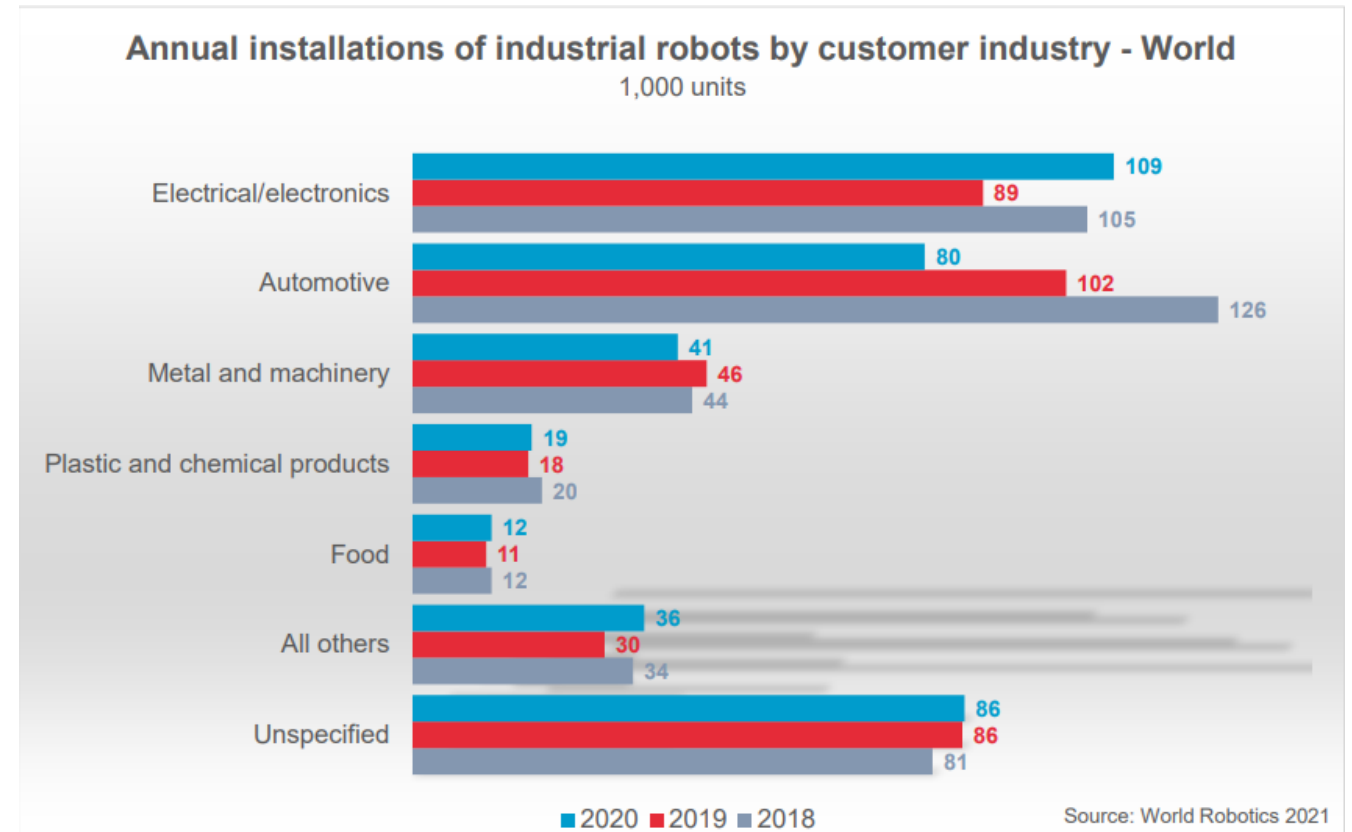


Advanced Robotics – a growing market



According to the IFR (International Federation of Robotics), the current market for industrial robots is growing strongly, with the half-million mark due to be reached in 2024.

Worldwide, the number of installed units in 2021 increased by 27% compared to the previous year, with the number used in electrical/electronics production now exceeding the traditionally strong automotive sector as the largest customer of industrial robots.

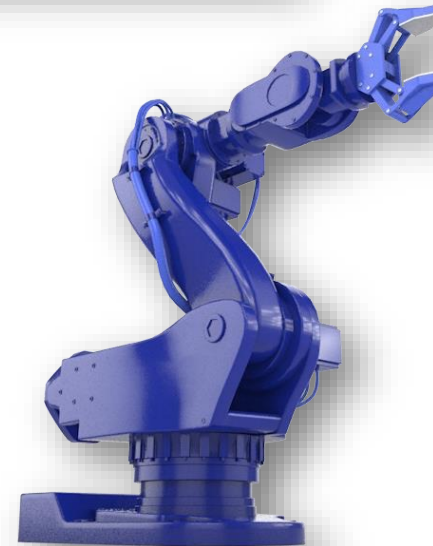




Types of Advanced Robotics

Applications:

- Light duty fixed/mobile
- Cobots
- Heavy duty robotics
- Factory assembly systems



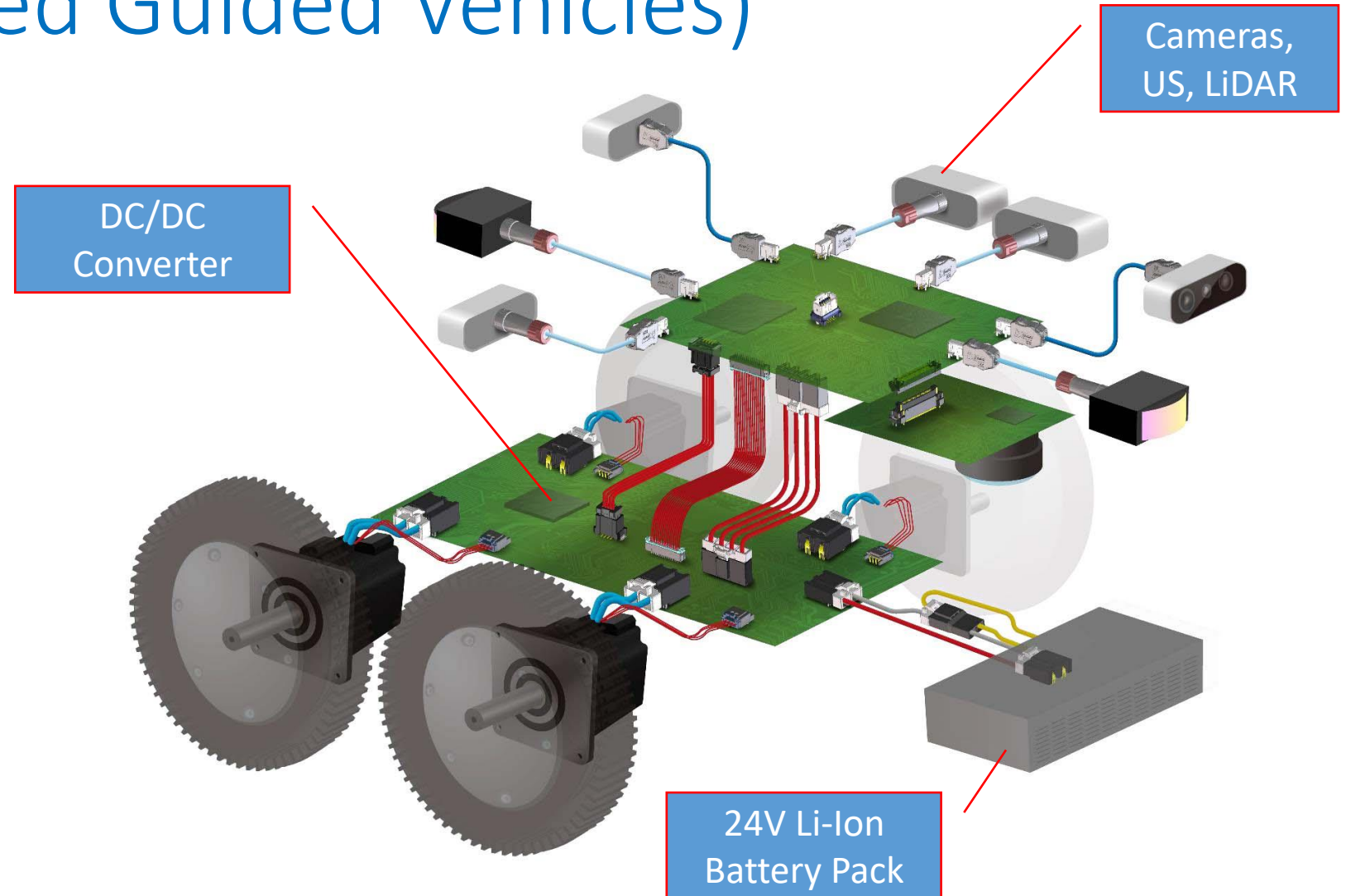
Power Supply Requirements for AGVs (Automated Guided Vehicles)



RECOM



Source: Hirose Electric



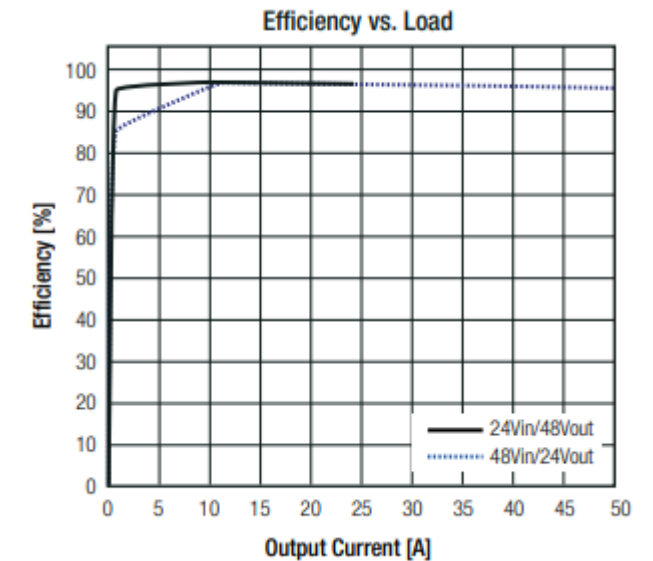
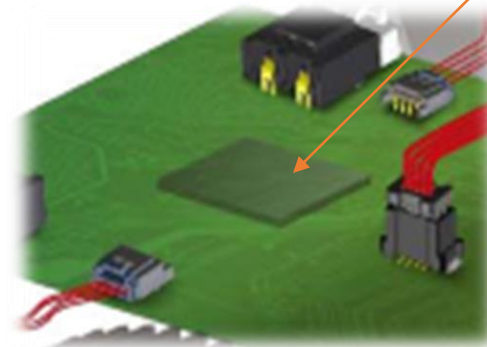
Power Supply Requirements for AGVs (Automated Guided Vehicles)



RECOM

DC/DC Converter: RBBA3000

- Wide input voltage range (Buck or Boost)
 - $V_{in} = 9-60V$ DC, V_{out} = programmable up to 60V DC
 - UVLO to avoid battery deep discharge damage
- Handles high peak currents (incl. temporary overload)
 - $I_{out} = 50A$ max.
 - Programmable current limit
 - Load current monitor pin (stall selection)
- Highly efficient over entire load range
 - 96% conversion efficiency
- Compact and Lightweight
 - ½ brick format (61x63x13mm), only 155g
- Standard and PMBus versions



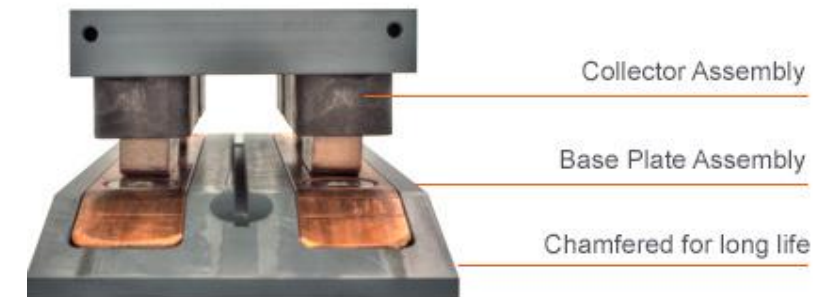
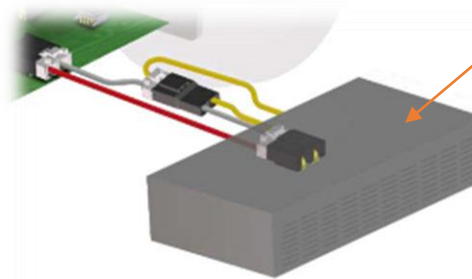
Power Supply Requirements for AGVs (Automated Guided Vehicles)



RECOM

DC/DC OBC: RMOD360

- Wide input voltage range (reverse polarity protected)
 - $V_{in} = 18-106V$ DC (36-60V for SELV)
 - $V_{out} = 24.5V$ DC, isolated
- Handle high charging current
 - $I_{out} = 15A$ max. (360W)
 - Parallelable
- IP67 waterproof/dustproof
- Baseplate cooling ($-40^{\circ}C$ to $+75^{\circ}C$ operation, no fans)
- Compact, robust package
 - 190 x 76 x 44 mm



Source: Conductix-Wampfler

Power Supply Requirements for AGVs (Automated Guided Vehicles)



RECOM

AC/DC OBC (in development)

- Wide AC input voltage range
 - $V_{in} = 85 - 265V$ AC, single phase
- Fast charging
 - 700W max. (24, 36 or 48V DC)
- Intelligent:
 - Built-in Lead-Acid, AGM, Li-Ion, LMO or LiFePO battery charging profiles, battery temp sensor.
 - CAN-bus interface
- Compact
 - 240 x 150 x 74mm.
 - Passive cooling (no fans)



Power Supply Requirements for Advanced Robotics - cobots



Cobots (collaborative robots) are designed to work alongside human workers, sharing the same space:

- Ideal for repetitive or heavy lifting tasks
- Built-in safety (rounded edges, force sensors, limited speeds, keep-out areas, sophisticated real-time software)
- Easy programming, good repeatability
- Flexible toolheads
- 10%-50% increase in productivity, fast ROI.



Power Supply Requirements for Advanced Robotics - cobots



RECOM

Stepper motors are commonly used in many cobot robotics applications:

- Precise stepping control
- High torque at startup/standstill
- Accurate speed control
- Precise positioning (no gear backlash)
- Long life (brushless)
- Compact, so easily incorporated inside the robot arm joints.



Source: Wikipedia

Power Supply Requirements for Advanced Robotics - cobots

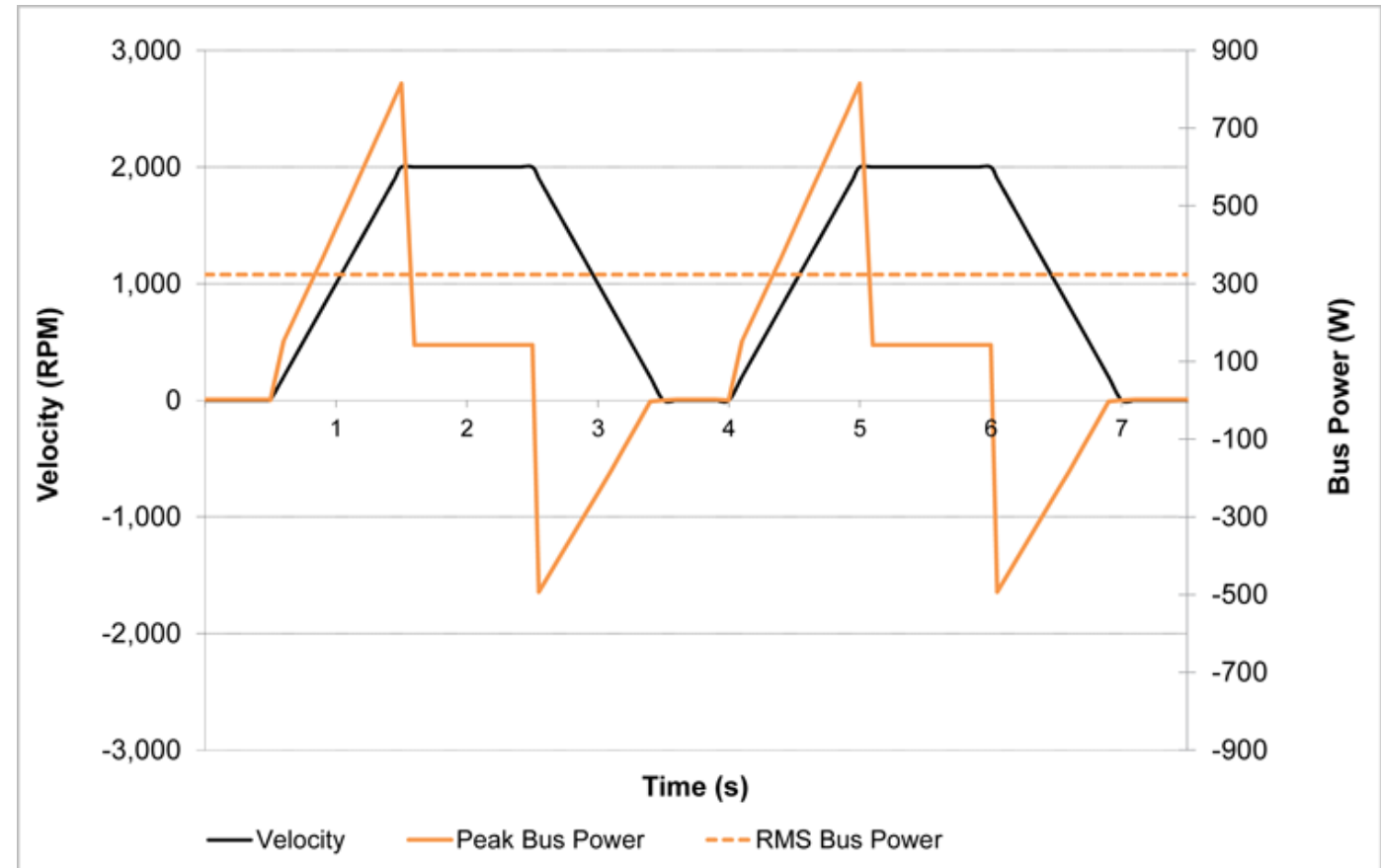


Stepper motors draw high currents during acceleration and during deceleration generate high back EMF or ,regen' voltages, so peak power can easily exceed RMS power:

In the example shown here, RMS Bus Power is **325W**, but peak power is **800W** and the peak regen power is **-500W**.

You can add bus capacitors to absorb regen energy, but they are bulky and can have low reliability when stressed.

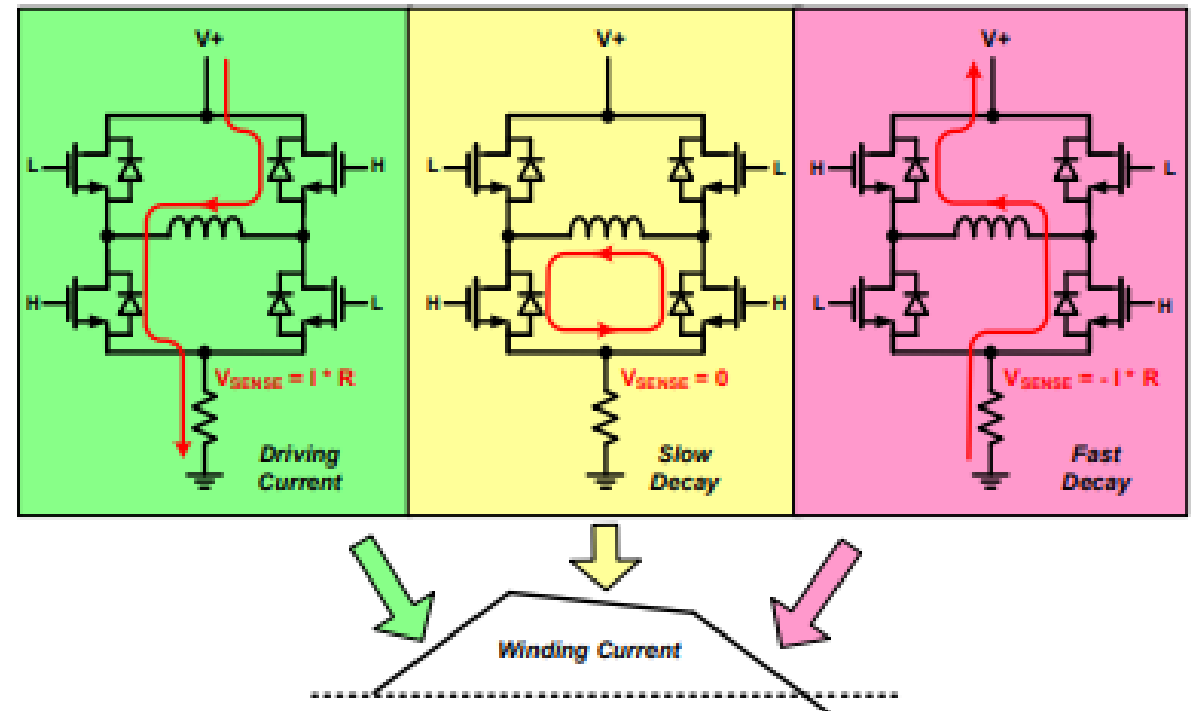
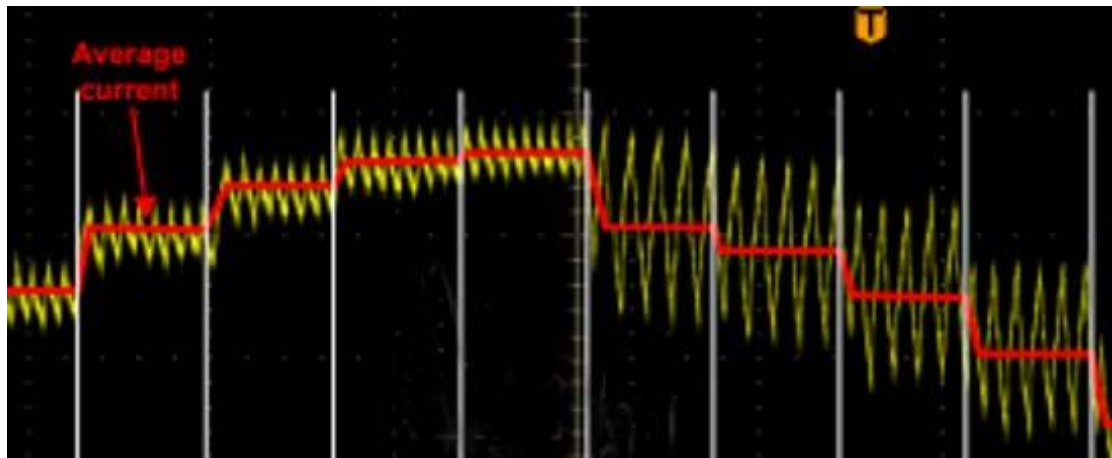
The power supply has to be able to handle high capacitive loads as well as the high inductive load of the motor.



Power Supply Requirements for Advanced Robotics - cobots



Active braking (reversing the current through the stepper motor winding rather than simply shorting it to stop the motor faster) makes the regen voltage problem worse and increases the stress on the power supply:



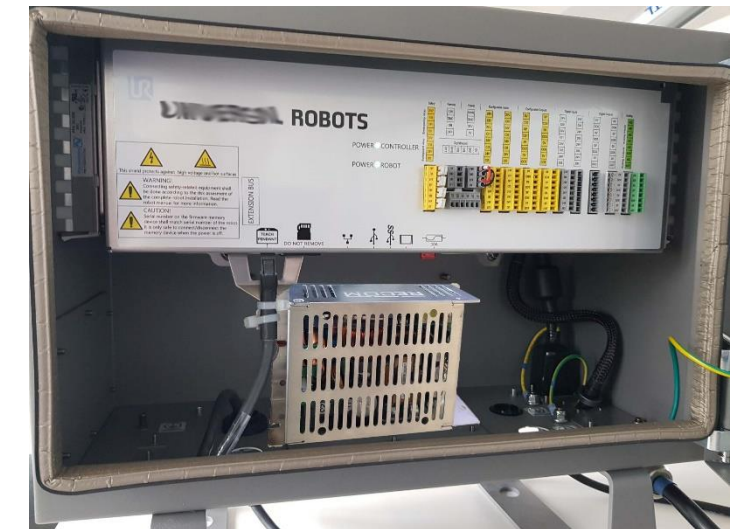
Source: MPS AN120 App Note



Power Supply Requirements for Advanced Robotics - cobots

AC/DC Power Supply: RACM550-G

- Handle peak currents well (incl. temporary overload and highly inductive or capacitive loads)
 - 300W continuous, 550W peak (10s)
- Highly efficient over entire load range (green)
 - 93% efficiency
- Fan-less operation
- Enable + Always-On 5V aux. output
- Heavy duty / Harsh Environment certified
 - UL/IEC/EN 62368-1, 60601-1, 60335-1, 61558-1, 68558-2-16
- Compact and Lightweight
 - 5"x3" format (150x87x45mm), 0.5kg
- Built-in Class B EMC filter with 0.99 PFC



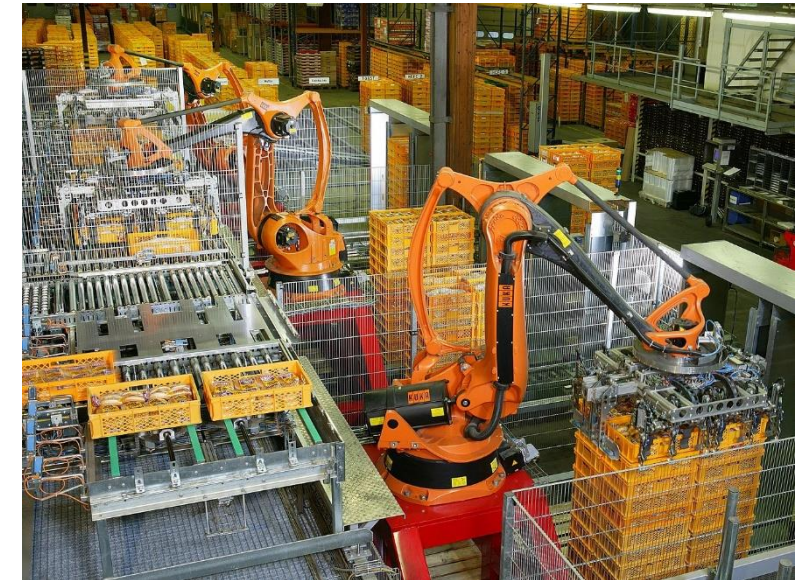
Power Supply Requirements for Advanced Robotics – heavy duty



RECOM

- Application specific

- Industrial
- Assembly Lines
- Warehouse Automation
- Medical
- Military



Source: Wikipedia

- More powerful, but less flexible than cobots
- More complex programming
- Do not share same work space with human operators

Power Supply Requirements for Advanced Robotics – heavy duty



Medical Robotics:

- European MDR (Medical Device Regulation) requires pre-warning of overload/overtemp events that could lead to the power supply shutting down.
- Medical grade power supplies need to meet strict UL/IEC/EN 60601-1 safety and UL/IEC/EN 60601-1-2 EMC standards
- Power supplies are usually built-in to reduce cabling and to make disinfection easier (sealed housings). This means that air-flow is restricted.



Source: Wikipedia

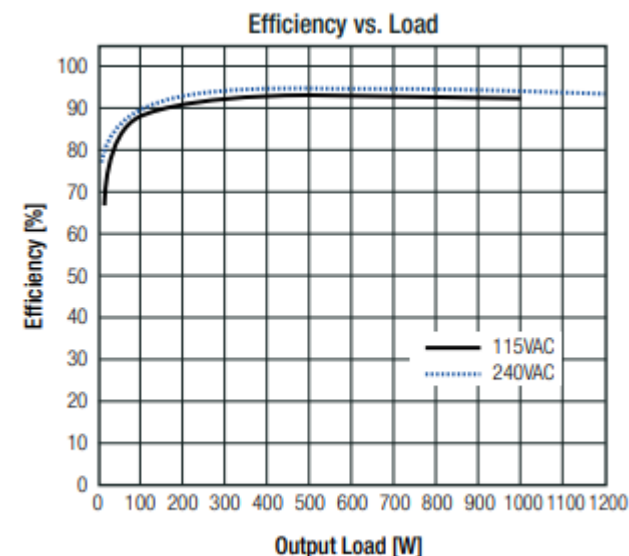
Power Supply Requirements for Advanced Robotics – heavy duty

AC/DC power supply: RACM1200-V

- Handle high peak currents (incl. temporary overload)
 - 24V @ 50A max. – **programmable overload performance**
 - (customized part delivers 2200W peak)
- Fan-less, system fan or smart-fan operation
- Highly efficient over entire load range (green power)
- 80 – 265V AC input, OVC III, 4kV AC Reinforced isolation
- Status reporting (AC OK, DC OK, OT warning, OT, OL)
- Suitable for heavy duty / harsh environment/ medical
- Compact and Lightweight (228 x 96 x 44mm, 1kg)
- Excellent EMC performance with 0.99 PFC
- PM-Bus version available



RECOM

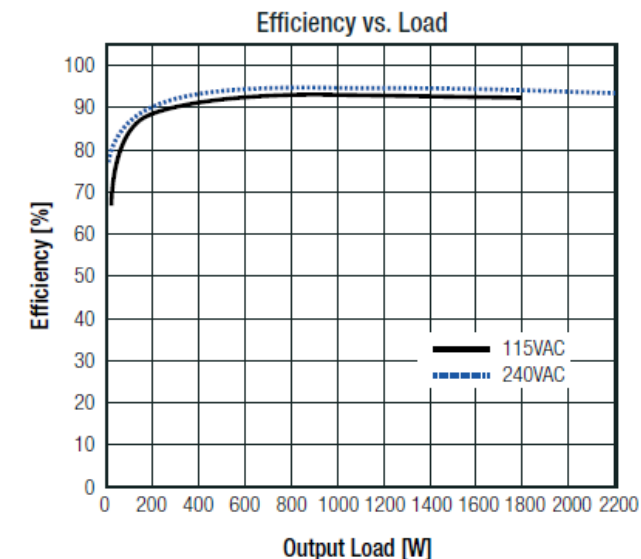
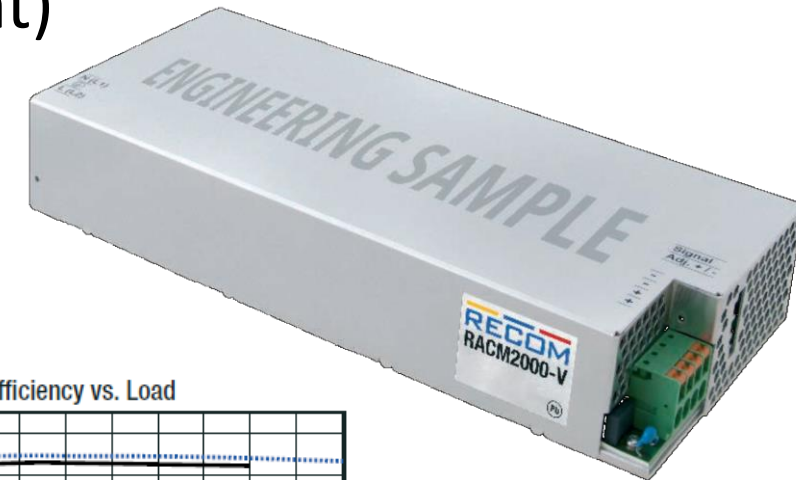


Power Supply Requirements for Advanced Robotics – heavy duty



AC/DC power supply: RACM2400-V (in development)

- Handle high peak currents (incl. temporary overload)
 - 24V @ 82A (2000W continuous, 2400W peak)
- Fan-less or smart-fan operation
- Highly efficient over entire load range (green)
- 80 – 265V AC input, OVC III, 4kV AC Reinforced isolation
- Status reporting (AC OK, DC OK, OT warning, OT, OL)
- Suitable for heavy duty / harsh environment/medical
- Compact and Lightweight (273 x 122 x 50mm, 1.2kg)
- Excellent EMC performance with 0.99 PFC
- PM-Bus version





Power Supply Requirements for Advanced Robotics – assembly line robots

Production line assembly robots are commonplace in repetitive manufacturing, welding, screw assembly or glue dispensing tasks.

Complex procedures involving the assembly of many parts cannot be easily stopped or interrupted – an unplanned power outage can mean up to four hours of lost production while each robot is manually reset

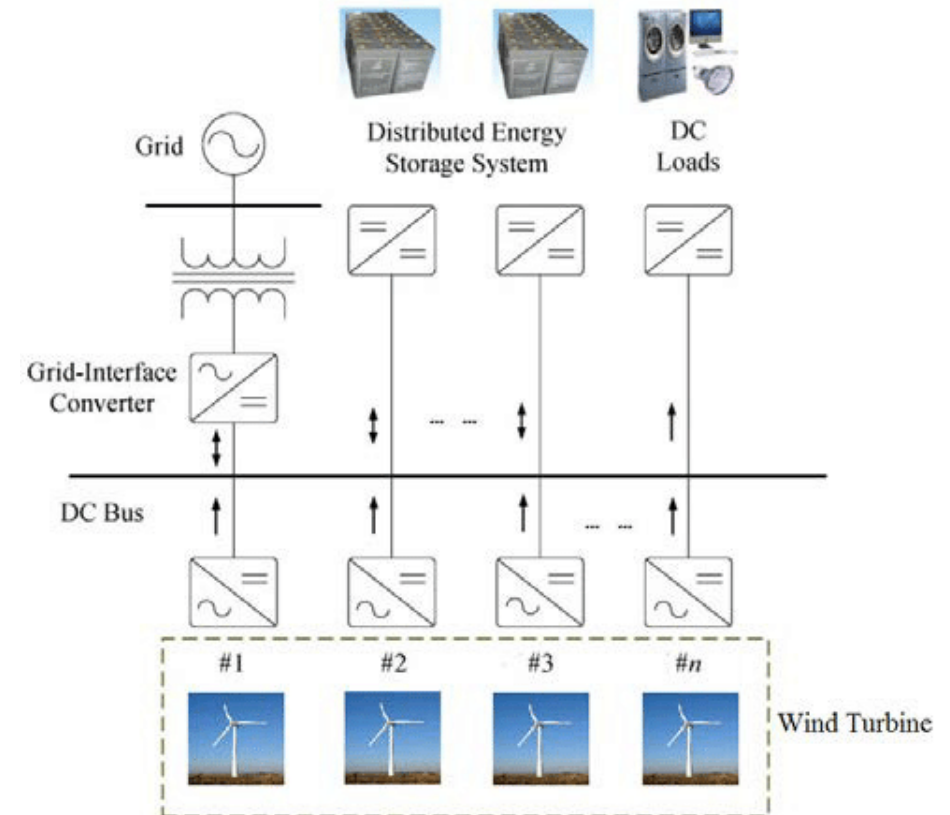
(source: Mercedes-Benz engineer)

Power Supply Requirements for Advanced Robotics – assembly line robots



Ensuring factory line robot power reliability means installing self-contained local power grids capable of allowing each assembly robot to complete its assigned task and move to its base position before shutting down.

A **DC Microgrid** allows battery back-up supply and easier integration of multiple renewable energy resources (Solar, wind, etc.) for a **green** power solution

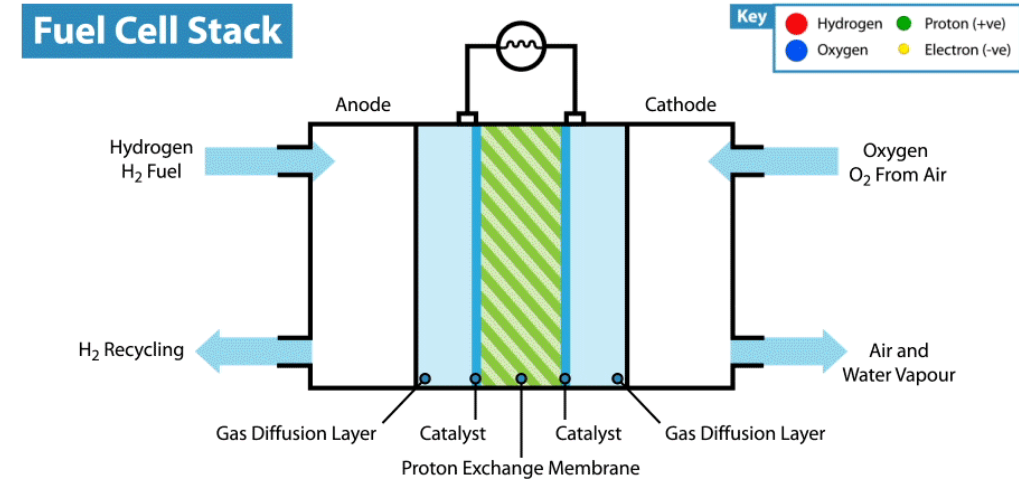
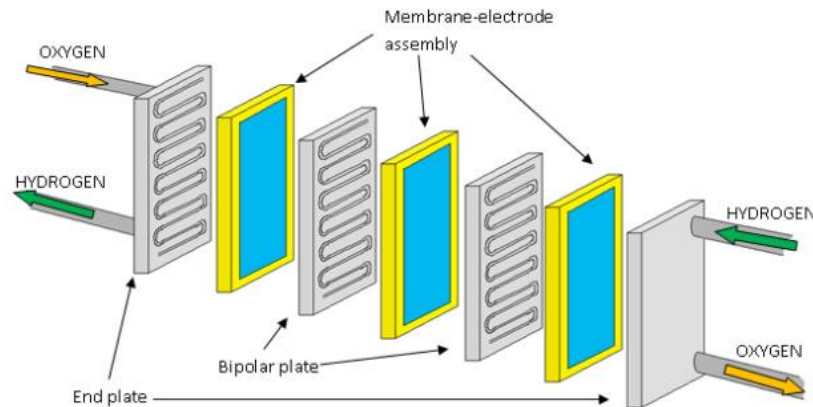


Source: Energy Research

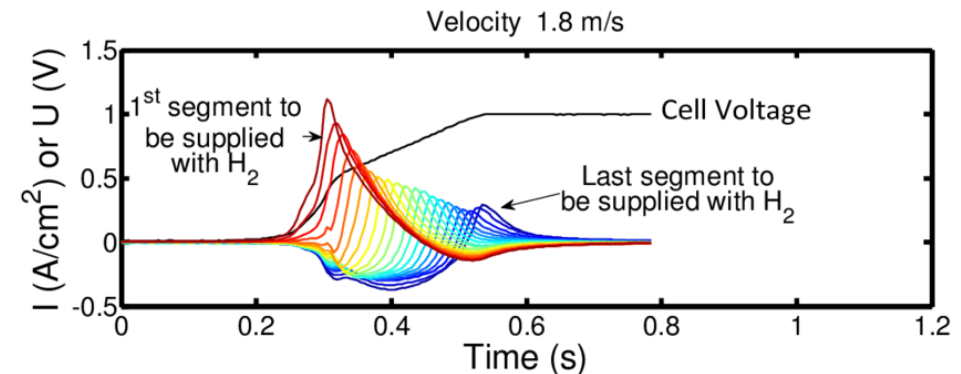
Power Supply Requirements for Advanced Robotics – assembly line robots



Batteries supply instantaneous back-up power while other high energy sources such as fuel-cells start up.



Source: https://www.intelligent-energy.com/static/img/animations/fuel_cell_stack.gif



Source: LEMTA - University of Lorraine

Power Supply Requirements for Advanced Robotics – assembly line robots



RECOM

7 kW SD7008-X-48-2

Vin = 48V (30-70VDC) @ 220A max

Vout = 48V (36-60VDC adj.) @ 190A max

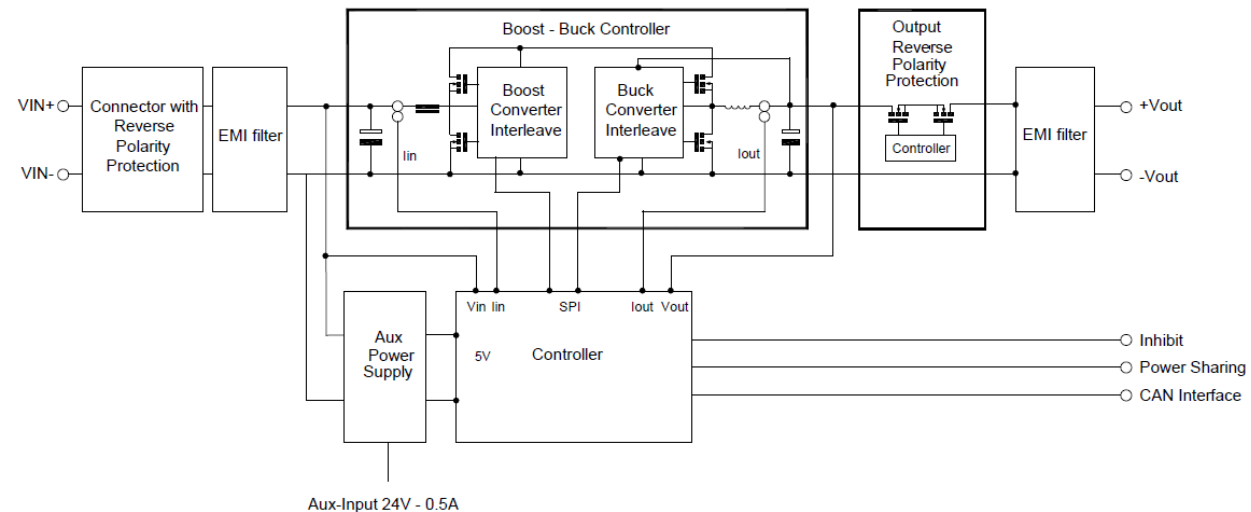
Buck/Boost with >97% efficiency

Reverse polarity + surge protection

MPP tracking

Liquid cooled baseplate

CAN J1939 bus interface



Power Supply Requirements for Advanced Robotics – assembly line robots



High Voltage DC/DC
15-75 kW (scalable)

$V_{in} = 25-280VDC @ 500A \text{ max}$

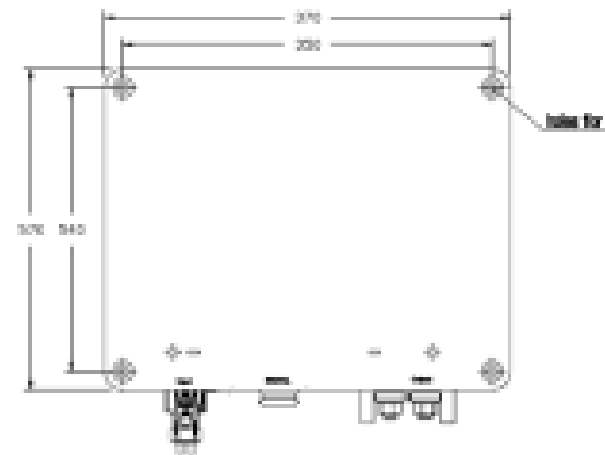
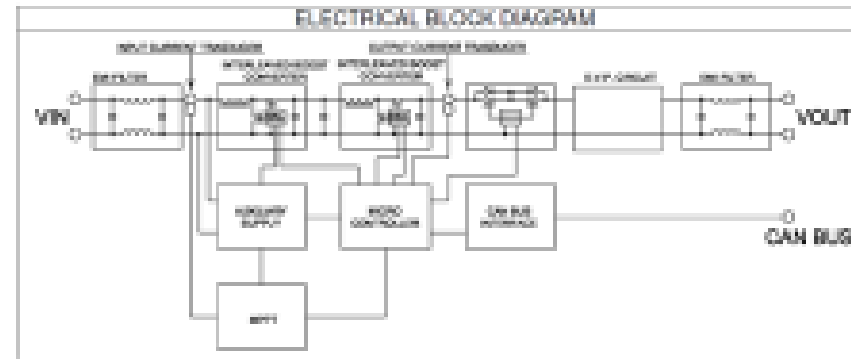
$V_{out} = 200-800 VDC$

>97% efficiency

Reverse polarity + surge protection built-in

MPP tracking (PV / fuel cell compatible)

Liquid cooled baseplate



Input:	500A@25 - 280V
Output:	200-800Vnom
	Battery charging or system supply
Power:	10-75kW



Power Supply Requirements for Advanced Robotics – summary

Power supplies for advanced robotics need to cope with highly inductive (regen) loads as well as fast load transients.

On-board DC/DC and battery chargers need to be efficient, lightweight and powerful

Cobot AC/DC power supplies need to be not just compact and reliable, but also certified for the applications they are used in.

Heavy duty robotic power supplies need to handle high peak loads reliably and be remote controllable with real-time monitoring (digital interface)

Robotic assembly lines need kW-scale uninterruptable supplies, best served from a factory scale DC microgrid with high power AC/DC and DC/DC converters.

RECOM and Rutronik can help you with all of these applications!

Power Supply Requirements for Advanced Robotics – summary



Thank you!

