Entry-level MCU offers high security capability for use in IoT end points

Renesas Electronics has announced an innovative new family of bi-directional four-switch synchronous buck-boost controllers.

The ISL81601 and ISL81401 are the industry’s only true bi-directional controllers that sense peak current at both ends and provide cycle-by-cycle current limiting in both directions while in buck or boost mode. They generate Point-Of-Load (PoL) power supplies at a peak efficiency of up to 99%. The ISL81601 has a wide input voltage range of 4.3V to 60V and produces a 0.8V to 60V output.

This is compatible with most industrial batteries, which typically operate at 12V, 24V, 36V or 48V. Available is the ISL81401, which has a 4.5V to 40V input range and 0.8V to 40V output range, and is unidirectional, the ISL81401A. The ISL81601 and ISL81401’s bi-directional peak current-sensing capability eliminates the complex external circuitry required for charging and discharging a battery that supplies power to loads. Their proprietary algorithm provides smooth transitions between buck, boost and buck-boost modes, while reducing low frequency ripple at the output. This produces minimal disturbance during line or load transients. The algorithm also maintains a predictable ripple voltage under all conditions. Designers can easily expand system power by parallelizing an unlimited number of controllers. The ISL81601 and ISL81401 operate two switches at a time to minimize power loss and achieve higher efficiency.

Precise chip resistors offer stable current-sensing performance

Yageo’s PA series of metal current-sense chip resistors offer very stable performance over a broad operating-temperature range from -55°C to 170°C. They are suitable for all types of current sensing, voltage division and pulse applications.

AEC-Q200 qualified for use in automotive equipment, the PA series resistors feature a robust all-welded construction which offers superior resistance to assembly stresses. The devices exhibit a temperature coefficient of resistance, as low as ±0.50%pm, makes it suitable for use in industrial equipment, and a multitude of applications from industrial equipment to automotive and aerospace. These resistors are ideally suited for a wide temperature variations. The PA series resistors are available in case sizes from 0201 to 2512, and in resistance values from 0.5Ω to 100Ω. Designers can specify the resistance value with a tolerance of ±5%, ±1%. jumper chip resistors are also available in the PA series.

Component focus

Integrated power modules provide point-of-load power at high efficiency

The ISL8212M and ISL8210M from Renesas are analog power modules which provide a single-channel, point-of-load power at high efficiency and low thermal resistance allow for full-power operation without a heat-sink. Low thermal resistance allows for high density, miniaturized PCBs, and high thermal performance. The modules also feature excellent efficiency and peak current at both ends and provide cycle-by-cycle current limiting in both directions while in buck or boost mode. The algorithm generates Point-Of-Load (PoL) power supplies at a peak efficiency of up to 99%. The ISL81601 and ISL81401 operate two switches at a time to minimize power loss and achieve higher efficiency.

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New true bi-directional synchronous buck-boost controllers for industrial battery-powered applications

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Poke-in wire connectors make wall-mounting easy

TE Connectivity’s (TE) BUCHANAN WireMate two-piece poke-in series of connectors provides designers with a three-directional solution for wall-mounting a device. Terminations are easy to make, and present no difficulties even to the novice installer.

Ethernet jacks with integrated magnetics save board space

Ethernet jacks from TE Connectivity (TE) with integrated magnetics and Power over Ethernet (PoE) capability offer a highly integrated connectivity solution for industrial Ethernet applications.

New heavy-duty connector products extend design flexibility and add CAN bus support

The Heavy Duty Sealed Connector Series (HDSCS) of connector products from TE Connectivity (TE) meets the rigorous demands of the commercial vehicle industry and of off-road applications which require the highest standards of performance. They can also be used whenever environmentally sealed circuit protection is needed in applications subject to high levels of vibration.

Shorting caps provide long-lasting method for closing or opening circuits in outdoor lighting fixtures

TE Connectivity’s (TE) LUMAWISE Endurance N Shorting Caps provide a safe, convenient and economical method to close or open the primary circuit path across a NEMA-compliant receptacle on an outdoor light.
Thin-film precision resistor series sets new standard for reliability

Susumu’s new URG series of thin-film chip resistors offers an improvement in reliability as well as in the linearity of its Temperature Coefficient of Resistance (TCR) compared to the high standard set by the existing RG series.

The URG series offers better absolute tolerance of resistance, at ±0.01%, than any other thin-film chip resistor on the market. It also offers the lowest TCR of ±2ppm/°C. It offers all the advantages of the thin-film type of resistor, such as low noise of -25dB to -35dB, and support for high frequencies up to 1GHz. In addition, the linearity of the URG series’ TCR makes it easy to develop an appropriate compensation algorithm.

For applications that require extreme precision and reliability, Susumu now offers a wide choice of resistor families, providing in addition to the URG series:
- The RG-PV series offering tolerance of ±0.02% and TCR of ±5ppm/°C
- The RG-LL series with tolerance of ±0.01% and TCR of ±2ppm/°C

They are suitable for use in a wide range of use cases, from generic consumer navigation to high-precision positioning.

Many TE antennas support more than one frequency band or wireless technology, enabling the system designer to reduce total volume by integrating multiple antenna functions into a single device. The resulting reduction in component count also helps to reduce bill-of-materials and assembly costs, and cuts the operating expense and effort associated with inventory management.

### Standard GNSS antennas enable designers to reduce system size and cost

TE Connectivity’s (TE) new standard portfolio of Global Navigation Satellite System (GNSS) antennas satisfies the most important requirements for the performance of a positioning antenna: efficiency and bandwidth.

#### APPLICATIONS
- Tracking devices
- Navigation devices
- Security applications
- Remote controls
- Autonomous driving
- Infotainment
- Unmanned vehicles
- Smart home equipment
- Wireless handheld devices

### TO BUY PRODUCTS OR DOWNLOAD DATA
FUTUREELECTRONICS.COM/RESOURCES/FTM

#### Part Number | Supported Technologies | Description
--- | --- | ---
2118900-1 | GNSS, GPS and Glonass | Surface-mount chip antenna
2195760-1 | Dual-band Wi-Fi and GNSS | Single-feed antenna
2195761-1 | GNSS | 25mm x 25mm surface-mount patch antenna
2195762-1 | GNSS | 35mm x 35mm surface-mount patch antenna
2195763-1 | GNSS | 35mm x 35mm surface-mount patch antenna with cable feed
2195764-1 | GPS and Glonass | Surface-mount chip antenna
2195765-1 | GPS and ArRak | Surface-mount chip antenna
2195766-1 | GNSS L1, GPS L2 | Surface-mount PCB module
2195767-1 | GNSS L1, GPS L2 | Surface-mount PCB module
2195768-1 | GNSS global active | Includes u.fl connector

### NICHIA’s Optisolis™

**757 Series**

- **COB Series “NEW”**

**APPLICATIONS**
- **No UV emission**
- **Full spectrum close to natural sunlight**
- **Less disruptive circadian rhythm**
- **High color fidelity (RF)**
- **Full color gamut (Rg)**
A comparison of control techniques for three-phase induction motors

By Gianluigi Forte and Andrea Spampinato, STMicroelectronics

The three-phase induction motor is one of the most reliable types of electric machine. Induction motors are known to work for many years with very little maintenance effort. They also offer great operational flexibility.

Today, induction motors are the industrial sector’s most widely used electric machines, and so are responsible for a very high proportion of the industrial sector’s total electricity consumption. This means that improvements to the energy efficiency of induction motor systems, resulting from a reduction in energy losses will have enormous benefits, both in cutting operating expenses and in supporting compliance with efficiency regulations.

This has led to a growth in the adoption of variable-speed drive technology in preference to fixed-speed drives. STMicroelectronics provides a complete solution for controlling a variable speed induction motor using either scalar or vector controls. This Design Note describes how an efficient variable-speed drive design may be developed quickly on the basis of a combination of ST boards which implement control and power functions.

ST boards for induction motor control

The proposed solution can be evaluated by assembling a system composed of the following:

• A NUCLEO-F303RE control board based on the STM32F303RE, a 32-bit microcontroller which includes an Arm® Cortex®-M4F processor core.
• An STEVAL-PM110B power board based on an STGB1T00M6T5 second-generation SiLUM® Intelligent Power Module (IPM). It is an easy-to-use demonstration board for driving electric motors up to 1.2kW supplied by a 12V to 400V DC bus voltage. The board is provided with bootstrap and snubber capacitance, short-circuit protection, a fault event signal, and temperature monitoring.
• A motor control connector expansion board, the XNUCLEO-IHM09M1.

With the architecture shown in Figure 1, it is possible to assemble a full inverter system which is simple, cheap and flexible, and fits the requirements of the chosen application in terms of computational and electrical power, using the appropriate STM32 microcontroller and IPM. In addition, the NUCLEO board supports the STM32CubeMx system, which provides a full array of expansion elements for functions such as sensors and communication channels. It also provides a graphical configuration tool and project generator, and enables the user to set up peripherals in just a few steps.

Induction motors: control techniques

An induction motor can provide torque only if the frequency of the three-phase stator voltages and currents, ωe, is higher than the electrical shaft rotation frequency, ωr. This difference is called the slip frequency, ωs, and the value of its normalisation with respect to ωe is the slip ratio, s = ωs/ωe.

In an induction motor, both the magnetization field and the stator field are provided by the stator windings, so it is more difficult to control them independently than it is in a DC motor. FOC enables such control, but requires continuous information about the rotor flux position.

In fact, FOC is based on the co-ordinate transformation theory, which transforms vectors from a 2D-abc (wave) reference frame to a 3D-øst (electrical shaft angle) reference frame. But unlike a permanent magnet synchronous motor, in an induction motor the rotor flux angle does not coincide with the shaft electrical angle because of the slip frequency. This means that when FOC is implemented in an induction motor, regardless of the speed control loop, the rotor flux angle must be known.

In practice, to save cost the rotor flux angle is normally estimated rather than measured. Once the angle is known, the currents in the stator, Ist, will control respectively the electromagnetic torque and the magnetizing flux. To perform this type of FOC, the STM32 MCU only requires two or three ADCs for measuring the motor phase currents, one ADC for measuring the DC bus voltage, one PWM timer to generate the gate commands, and if needed, a timer for decoding the shaft speed sensor output.

The indirect FOC technique estimates the rotor flux angle by using the rotor speed information from a speed sensor. The technique is indirect since the flux vector is not directly estimated but only its momentary position. The speed sensor enables the indirect FOC technique to work at zero speed.

It is possible to change the rotor speed by varying the synchronous speed: the ST solution is a Model Reference Adaptive System (MRAS) algorithm ready to use once the STM32 peripherals are configured to match the topology of the hardware sensing network. What is more, the dynamic performance and efficiency of the indirect FOC technique are clearly better than that of a scalar method such as the closed-loop control scheme, as shown in Figure 3.

Demonsrated performance of the ST system

The performance of an induction motor running ST’s control algorithms on an STM32F333 MCU board was tested on a three-phase induction motor with the following specifications:

- 1.9A rms nominal current
- 380V nominal voltage
- 50kHz frequency
- 750W nominal power
- 2,650rpm maximum speed

Figure 2 shows the speed step response from standstill to 2,500rpm when the closed-loop V/f control technique is in action. Although no mechanical load is applied to the shaft, the graph shows that, as expected, the response time is longer than when using the FOC technique.

Nevertheless, this closed-loop control technique is suitable for any application that requires a cheap and simple implementation and that can tolerate relatively low dynamic performance.

Available at FutureElectronics.com
Innovations in MOSFET technology bring new value to low-voltage motor-drive applications

To address this problem, Nexperia has developed MOSFETs that provide improved current-sharing capability. When used in parallel configuration, these devices remove the need for matched threshold voltage values. These are evidence that the parts which support improved current sharing offer important benefits when used in hot-swap linear mode and in motor drives. In fact, more potential for optimization has been discovered, and new products in the pipeline will implement these additional improvements to bring yet more benefit to these applications.

The optimizations for improved current sharing complement the superjunction trench technology used in the latest generation of power MOSFETs, which gives outstanding linear-mode performance. This leads to the next innovation in this industry segment.

The 100V, 120A-rated PSMN3R7-100BSE MOSFET from Nexperia is an ideal choice in high-current, battery-powered applications in which the battery voltage must be isolated under certain fault conditions. In this case, the battery-protected MOSFET must sometimes operate in linear mode until the battery voltage is isolated. Nexperia has developed parts in several package styles which give superior linear-mode performance, as much as six times better than leading competitors’ products. They also provide high current capability up to 380A. Parts are available to provide the increased spacing required by the UL2595 standard.

The Nexperia 100V-rated MOSFETs are notable for their low reverse-recovery charge, and provide excellent EMC performance. Other parts under development include 40V, 425A-rated half-bridge and dual MOSFETs supplied in an LFPAK88 package. These parts will be available in several voltage ratings.

Some high-power motor-control systems include multiple MOSFETs connected in parallel. Such circuits are often called for MOSFETs that have a matched gate-source threshold voltage. Even when a MOSFET’s production facility is very tightly controlled, however, there is inevitably a spread of threshold voltage values across each wafer. Any attempt to provide parts with matched threshold voltage values might require special screening and sorting procedures. This in turn will tend to reduce production yield, thus increasing the unit cost of the product.

<table>
<thead>
<tr>
<th>LFPAK56-packaged parts</th>
<th>Part Number</th>
<th>On-resistance at a Gate-source Voltage of 10V</th>
<th>Maximum Drain Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMN0R9-30YLH</td>
<td>0.60mΩ</td>
<td>380A</td>
<td></td>
</tr>
<tr>
<td>PSMN1R0-30YLH</td>
<td>0.70mΩ</td>
<td>380A</td>
<td></td>
</tr>
<tr>
<td>PSMN1R2-30YLH</td>
<td>1.0mΩ</td>
<td>380A</td>
<td></td>
</tr>
<tr>
<td>PSMN2R4-30YLH</td>
<td>1.2mΩ</td>
<td>100A</td>
<td></td>
</tr>
<tr>
<td>PSMN1R0-40YLD</td>
<td>1.1mΩ</td>
<td>380A</td>
<td></td>
</tr>
<tr>
<td>PSMN1R4-40YLD</td>
<td>1.4mΩ</td>
<td>100A</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>LFPAK56-UL2595- packaged parts</th>
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<th>Maximum Drain Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMN0R9-30ULD</td>
<td>0.97mΩ</td>
<td>300A</td>
<td></td>
</tr>
<tr>
<td>PSMN1R0-40YLD</td>
<td>1.1mΩ</td>
<td>280A</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<th>LFPAK33-packaged parts</th>
<th>Part Number</th>
<th>On-resistance at a Gate-source Voltage of 10V</th>
<th>Maximum Drain Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMN0R6-30MLH</td>
<td>1.90mΩ</td>
<td>100A</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<th>Wide SOA Linear Mode part</th>
<th>Part Number</th>
<th>On-resistance at a Gate-source Voltage of 10V</th>
<th>Maximum Drain Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMN6R9-300YSF</td>
<td>5.6mΩ</td>
<td>120A</td>
<td></td>
</tr>
<tr>
<td>PSMN5R5-60YS</td>
<td>5.5mΩ</td>
<td>100A</td>
<td></td>
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How to implement field-oriented control for PMSMs with a dynamic speed observer

Permanent Magnet Synchronous Motors (PMSMs) are widely used in electric vehicles, robots, home appliances and other products. For good dynamic response and motor performance, engineers normally use a form of vector control method to drive a PMSM.

Vector control requires a means to measure the speed and position of the rotor. Optical quadratic sensors or Hall effect magnetic position sensors are the most common types of sensor used for this function, but they are expensive components. A promising alternative technique for driving a PMSM is to use a combination of a low-cost magnetic angular sensor and a dynamic observer to estimate the rotor speed. The motor control module from Monolithic Power Systems (MPS) implements this technique. It includes a motor-control ASIC, a magnetic angular sensor, and a three-phase observer to estimate the rotor speed. The motor control module from the MPS Motor Control Module, designed for 57mm NEMA 23 motors, can be directly mounted on the motor, as shown below.

The electromagnetic torque, \( T_e \), is the product of the magnetic flux, \( \lambda \), and the rotor speed, \( \omega_r \).

The electromagnetic torque is estimated with the equation:

\[
T_e = \frac{3}{2} P \left( \lambda_{dq} i_{dq} + (L_d - L_q) i_{dq} i_{dq} \right)
\]

Following the transformation steps performed in the four equation sets, the magnetic flux can be directly controlled by the q-axis current. With a constant \( \omega_r \), the torque, \( T_e \), can be controlled directly by manipulating the q-axis current. If \( \omega_r \) is variable, then the electromagnetic torque is directly proportional to \( \omega_r \).

Figure 1 shows the PMSM FOC technique in schematic form.

The system estimator can be based on the mechanical PMSM model using the equation:

\[
\begin{align*}
\dot{x}_s &= A_m x_s + B_m u_m + \nu_s, \\
\dot{x}_s &= C_m y_m + \nu_m
\end{align*}
\]

Where:
- \( x_s \) is the vector of state variables of the mechanical model system.
- \( \dot{x}_s \) is the derivative of state vector.
- \( A_m \) is the mechanical system matrix.
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Unlike the classic state observer using a constant gain matrix, a dynamic observer recursively updates its estimator gain \( k \) with each iteration. Compared to the FOC schematic shown in Figure 1, the dynamic speed observer schematic uses machine measurements as the system input, as shown in Figure 2. The dynamic observer outputs the filtered/estimated rotor speed.

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200V high-/low-side gate drivers produce high performance from standard low-profile SO-8 package

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Source Current (A)</th>
<th>Sink Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DGD2003SSB</td>
<td>0.29</td>
<td>0.60</td>
</tr>
<tr>
<td>DGD2005SSB</td>
<td>0.29</td>
<td>0.80</td>
</tr>
<tr>
<td>DGD2012SSB</td>
<td>1.9</td>
<td>2.3</td>
</tr>
</tbody>
</table>

The new DGD2003SSB, DGD2005SSB and DGD2012SSB are 200V gate-driver ICs for driving two external N-channel MOSFETs in a half-bridge configuration.

Integrated commutation encoder provides accurate angle measurements for BLDC motors

CUI Inc.'s AMT31 series is a rugged, high-accuracy commutation encoder which generates standard U/V/W communication signals for commuting Brushless DC (BLDC) motors.

APPLICATIONS
- Power tools
- Garden tools
- Home appliances
- Robotics
- Drones
- Small electric vehicles
- Consumer devices
- Industrial equipment

FEATURES
- Dead time and matched delays to eliminate shoot-through
- Schmitt-triggered inputs
- Resistant to negative transient voltages
- Under-voltage lock-out for high-side and low-side drivers

AMT31's design also simplifies the assembly such as dirt, dust, and oil which typically plague the series is not susceptible to contaminants. Thanks to its innovative capacitive platform, the series is not susceptible to contaminants such as dirt, dust, and oil which typically plague the series is not susceptible to contaminants.

APPLICATIONS
- Renewable energy equipment
- Robotics
- Industrial equipment
- Small electric vehicles
- Drones
- Home appliances
- Garden tools
- Power tools

Current Sense Transformers

CST1000 Series Low Frequency

- Monitors current: 5A to 30A (depending on model)
- Frequency: 50Hz to 400Hz
- Turns: 16.67 to 500
- Integral primary
- Potted version for 4000V isolation
- UL recognized

CSE180L Series Low Frequency

- Monitors current: 0.1A to 30A (depending on model)
- Frequency: 50Hz to 400Hz
- Turns: 16.67 to 500
- Integral primary
- Potted version for 4000V isolation
- UL recognized

CST206/306 High Frequency

- Monitors current: 25A to 110A
- Frequency: 20kHz to 200kHz
- Turns: 50 to 125
- Secondary impedance 8μH to 300μH
- Maximum secondary DCR: 55mΩ to 8500mΩ

Custom Design Sensors

We've designed custom current sense transformers for power supplies, instrumentation, aerospace systems, medical devices, motor speed controls and many more unique applications. The creative minds at Triad will find a powerful custom solution that meets your design requirements, as well as helping you to improve performance, increase reliability, extend life and manage costs.

California Design Center
Our innovative California design center speeds your custom transformer, inductor or power supply from design to prototype to testing to production within weeks.

Expert Engineering Staff
With decades of expertise, our design engineers work directly with you. They know the complexities of combining cores, laminations and bobbins into custom transformers and magnetic components. Let our engineers suggest changes in design or materials to optimize your custom magnetic component.

Quality and Reliability
Our system of in-process inspection, pre-ship audits and failure analysis has allowed many of our customers to eliminate their incoming inspection process while our continuous improvement protocol provides the highest levels of product quality and reliability.
Infineon Technologies has announced that it has begun volume production of discrete 1,200V CoolSiC™ MOSFETs in a TO247 package, with on-resistance ratings ranging from 30mΩ to 350mΩ. The new devices will help satisfy fast-growing demand for energy-efficient Silicon Carbide (SiC) MOSFETs in power conversion applications. They provide new system design flexibility in power factor correction circuits, bi-directional topologies, and any hard- or soft-switching power factor correction circuits, bi-directional topologies, and any hard- or soft-switching.

**APPLICATIONS**
- Solar inverters
- Battery-charging infrastructure
- Energy storage solutions
- Uninterruptible power supplies
- Motor drives
- Data center and telecoms power supplies

**FEATURES**
- Low device capacitance
- Temperature-independent switching losses
- Integral diode with low reverse-recovery charge
- Threshold-free on-state characteristics

**Power Rating**
- SIP-1
- IRAM136-0760A
- 5A/600V
- IRAM136-1061A
- iRAM Equivalent
- PSS50S71F6
- IRAMX16UP60B-2
- SPM
- SIP-1A
- IRAM256-1067A
- 16A/600V
- 15A/600V
- SIP-1A
- 10A/600V
- 50A/650V
- SPM
- 30A/650V
- 10A/600V
- IRAMS10UP60A
- IRAMX16UP60B
- **iRAM replacement modules**

Infineon has introduced a new power module in a low-profile SIP-P package which shares the same footprint, pinout and mounting screw locations with legacy International Rectifier iRAM series power modules.

The new SIP-P package, based on the SIP-05 module style, integrates Field Stop 3 short-circuit rated IGBT technology and a new high-voltage driver IC. These improvements decrease the losses inside the module, and increase efficiency. In addition, the dies inside the module are smaller. Infineon also supplies a wider range of iRAM-replacement single-in-line modules for use in brushless DC motors. There are two mounting options: vertical, or horizontal with pins bent at 90°. The modules include six IGBTs and three half-bridge drivers with bootstrap diodes.

**INTEGRATED Power modules offer more efficient alternative to legacy products from International Rectifier and Mitsubishi**

**ON Semiconductor®**

ON Semiconductor has announced that it has begun volume production of a new range of power modules for motor driving which are pin-compatible with legacy Mitsubishi Mini DIP series. The ON Semiconductor SPM-K package, based on the SIP-05 module style, integrates Field Stop 3 short-circuit rated IGBT technology and a new high-voltage driver IC. These improvements decrease the losses inside the module, and increase efficiency. In addition, the dies inside the module are smaller. Infineon also supplies a wider range of iRAM-replacement single-in-line modules for use in brushless DC motors. There are two mounting options: vertical, or horizontal with pins bent at 90°. The modules include six IGBTs and three half-bridge drivers with bootstrap diodes.

**Replacement modules for Mitsubishi parts**

**ON Semiconductor** offers two new ranges of power modules for motor drivers which are pin-compatible with legacy Mitsubishi parts.

The ON Semiconductor SPM-K package has the same footprint as the Mitsubishi Large DIP modules. The SPM-K31 series is compatible with the Mitsubishi Mini DIP series.

The new ON Semiconductor modules offer superior thermal performance and higher power ratings than the equivalent Mitsubishi modules. Mitsubishi are the Domestic Bonded Copper (DBC) substrate which improves heat conduction from the module. Mitsubishi modules utilise a DBC and the same heat sinks as earlier devices run cooler and can carry a higher motor current in the same package.

ON Semiconductor modules in the SPM-P31 package can handle motor current up to 50A in 650V IGBTs, and up to 20A in 1,200V IGBTs. Modules in the SPM-P40 package support up to 75A with 650V IGBTs and up to 50A with 1,200V IGBTs.

**Motor Control**
1,200V power modules offer best power density in their class

Infineon’s high-performance CIPOS™ Maxi Intelligent Power Modules (IPMs) provide a highly integrated inverter power stage for electric motors, helping system designers to achieve high reliability while optimizing PCB size and system costs.

The CIPOS Maxi products may be used to control three-phase AC motors and permanent magnet motors with a variable-speed drive. They support motor power loads up to 1.8kW in systems rated for up to 1,200V. The small size of the CIPOS Maxi IPMs – they are housed in a thermally-efficient DIP package measuring 36mm x 23mm – means that users benefit from the highest power density as well as the best performance in the 1,200V IPM class.

The devices are also the first 1,200V IPMs to include an optimized six-channel Silicon-On-Insulator (SOI) gate driver to provide built-in dead-time, which prevents the risk of damage from high transient voltages.

### FEATURES
- Direct Bonded Copper (DBC) substrate offers excellent thermal conductivity
- Six 1,200V TRENCHSTOP™ IGBTs
- Allows negative supply voltage up to -1V for signal transmission at 11V
- Integrated bootstrap functionality
- Over-current shutdown
- Under-voltage lock-out on all channels
- All six switches turn off when a protection function is activated
- Cross-conduction prevention
- Low-side emitter pins accessible for phase-current monitoring
- Enable input
- UL-certified thermistor

### APPLICATIONS
- Pumps
- Blowers
- Fan motors
- Active power factor correction for HVAC systems
- Low-power general-purpose drives
- Servo drives

### MOTOR CONTROL

**Part Number**
- IM818-MCC
- IM818-SCC

**Maximum Operating Temperature at 25°C**
- 150°C

**Maximum Operating Temperature at 80°C**
- 130°C

**Maximum Junction Temperature at 25°C**
- 150°C

**Maximum Junction Temperature at 80°C**
- 130°C

**Operating Characteristics:**
- No noise
- No bounce
- Low power consumption
- No arcing
- No contact wear
- Long life and low power consumption

### Panasonic INDUSTRY

Panasonic’s patented PhotoMOS® optically isolated MOSFET relays have an LED at the input which transmits light when activated to a series of photocells that, in turn, charge a pair of MOSFETs on the output side. The PhotoMOS technology produces solid-state relays which offer superior operating characteristics:
- Low power consumption
- No contact wear
- No arcing
- No bounce
- No noise

### PhotoMOS Relays

**Panasonic general-purpose PhotoMOS relay range**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Form Factor</th>
<th>Rated Voltage (V)</th>
<th>Rated Current (mA)</th>
<th>On-Res. (Ron) Typ./Max. (Ohm)</th>
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<th>Turn-Off Time Typ./Max. (µS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQV212S</td>
<td>SOP-8</td>
<td>1A</td>
<td>30</td>
<td>100</td>
<td>0.3/2.5</td>
<td>0.6/2</td>
<td>0.008/0.2</td>
</tr>
<tr>
<td>AQV210S</td>
<td>SOP-8</td>
<td>1A</td>
<td>350</td>
<td>200/120</td>
<td>0.6/2</td>
<td>0.008/0.2</td>
<td></td>
</tr>
<tr>
<td>AQV214S</td>
<td>SOP-8</td>
<td>2A</td>
<td>400</td>
<td>300</td>
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<td>DIP-8</td>
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<td>120/120</td>
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<td>0.008/0.2</td>
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<td>DIP-8</td>
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### Panasonic’s patented PhotoMOS®

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- Low power consumption
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- No bounce
- No noise
Creative development board now supports FreeRTOS running on its FPGA’s RISC-V soft core

Future Electronics has announced that its Creative Board now offers developers the freedom to implement designs running the FreeRTOS kernel on the RISC-V CPU soft core embedded in the board’s FPGA.

The Creative Board is an integrated development platform for users of IGLOO®2 FPGAs or SmartFusion®2 SoC FPGAs from Microsemi, a Microchip company. The IGLOO2 and SmartFusion2 FPGAs are suitable for a wide array of functions, including PCIe Gen2 control planes, image processing, motor control, I/O expansion and bridging. They also address design requirements for advanced security, high reliability and low power consumption.

Future Electronics designed the Creative Board to provide customers with a ready-made operating environment for proofs-of-concept and prototypes based on the low-cost IGLOO2 or SmartFusion2 FPGAs. As well as the FPGA, it features power, memory, connectivity, signal-processing and user-interface components. Microsemi has implemented RISC-V, an open Instruction Set Architecture (ISA), as a soft CPU core in the IGLOO2 and SmartFusion2 FPGAs. Now Amazon has announced that RISC-V support is available in its FreeRTOS kernel.

This enables embedded developers to create IoT applications on the officially supported FreeRTOS kernel for microcontrollers that use the free, open and extensible RISC-V ISA. It gives them the flexibility to create applications that are portable across any device and architecture that supports the FreeRTOS kernel. RISC-V support in the FreeRTOS kernel is available for any RISC-V microcontroller that uses the base ISA, including Armtronics’ Renode emulator for the Creative Board.

Developers can also run the ThreadX or µC/OS operating systems on the Creative Board’s RISC-V core.

Reneses portfolio
- Microcontrollers (MCUs) and Microprocessors (MPUs)
- Automotive MCUs and MPUs
- Automotive Systems-on-Chip (SoC)
- Automotive Power Management
- Automotive Battery Management
- Automotive Video and Display
- Embedded System Platforms
- Analog ICs
- Power Management ICs
- Space and Harsh Environment ICs

IDT portfolio
- Clocks and Timing
- Memory and Logic
- Interface and Connectivity
- Power Management
- RF Products
- Sensor Products
- Wireless Power

Renesas and IDT are steering the future of innovation together. By joining forces, these leaders in embedded solutions and analog mixed-signal products will help customers succeed in developing fast-growing applications in the industrial, infrastructure, and automotive segments. Their combined portfolios will contribute to markets where high data-processing performance is crucial.
Choose your AC-DC converter topology in haste, regret it at your leisure: why detailed evaluation of topologies pays off

By Riccardo Collura Northern Europe Power Specialist Field Application Engineer Future Electronics

When power-system designers start a new design for an AC-DC power converter, they are faced straight away with the important choice of topology. Broadly seven different topologies at least are supported by suppliers of power controller ICs. Each offers a set of advantages and drawbacks. So what is the best way to choose the topology for any given application?

This article provides guidelines to help narrow down the range of topologies selected for detailed evaluation. Using guidelines such as these, designers will find that they can streamline their research and more effectively make a sound choice of topology at the outset of a new project.

As any experienced power designer will acknowledge, however, history is littered with examples of failed or delayed projects, the downfall of which may be attributed directly to decisions made at the start of the project. Before introducing the relative advantages and drawbacks of the topologies and providing guidance on topology evaluation, it is worth understanding first the factors that all power designers must consider, where the best topology has a score of five stars (***(*)*) and the worst a score of one (***()). The scores provide rough indication, and experienced power-system designers might dispute one score or another. Overall, however, the table provides a useful guide to orientate the evaluation process and to inform the designer’s discussion of trade-offs with colleagues.

<table>
<thead>
<tr>
<th>Power Level</th>
<th>Topology</th>
<th>Efficiency</th>
<th>Complexity</th>
<th>CC</th>
<th>Size/Power Density</th>
<th>Cost</th>
<th>Power Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100W</td>
<td>Flyback</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td>Forward</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>100W to 150W</td>
<td>LLC</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>150W to 200W</td>
<td>LLC</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
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<tr>
<td>200W to 250W</td>
<td>LLC</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>250W to 300W</td>
<td>LLC</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
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<tr>
<td>300W to 400W</td>
<td>LLC</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>400W to 500W</td>
<td>LLC</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>500W to 600W</td>
<td>LLC</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>&gt;600W</td>
<td>Phase Shift</td>
<td>**</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
</tr>
</tbody>
</table>

When the design priority is to achieve small size and weight and high power density, these characteristics become especially attractive. SIC MOSFETs, available today in production volumes from suppliers such as STMicroelectronics, ROHM Semiconductor and Microchip, enable the use of smaller capacitors and inductors, reducing the size of the complete converter assembly. The higher maximum operating temperature of SIC devices makes it possible to reduce area in common a fault or a hardware sink that would have been required in a design using silicon MOSFETs, even in a densely populated enclosure with limited circulation of cooling air.

The causes of misjudgement about topology

In this author’s experience, the most common causes of design failure in AC-DC converter projects have their roots in either technical misjudgement or human behaviour.

On the technical side, inexperienced designers are prone to using a crude rule-of-thumb approach to power loading that the converter is required to support. Power rating is of course an important parameter, but it is by no means the only one that is affected by the choice of topology. System size and weight, system cost, power efficiency, thermal efficiency, complexity and EMI are all factors that the designer can optimize for with the right topology. It should also be recognised that these factors are inter-dependent. For instance, a complex Zero-Voltage Switching (ZVS) topology would produce far less severe EMI effects than a simpler hard-switched scheme. The choices made at the outset of a design should not only reflect the technical specifications of the product design, but also the capabilities of the development team and the design time available to it.

Impact of new technology options

Beyond the choice of topology, there is one other important element of a designer’s research before embarking on hardware implementation: the discovery of new components or technologies that have altered the landscape since earlier design projects were implemented.

Today, for instance, many AC-DC converter designers should be considering the use of new wide-bandgap Silicon Carbide (SiC) or Gallium Nitride (GaN) power components, which support much faster switching than silicon equivalents and can operate at higher temperatures.

Table 1 is intended to facilitate this first-level evaluation: it provides a score for each topology on each engineering factor that should be considered, where the best topology has a score of five stars (***(*)*) and the worst a score of one (***()). The scores provide rough indication, and experienced power-system designers might dispute one score or another. Overall, however, the table provides a useful guide to orientate the evaluation process and to inform the designer’s discussion of trade-offs with colleagues.

The availability of power controllers which integrate primary- and secondary-side control

A development team which has deep expertise in EMI mitigation and EMC compliance, for instance, might be happy to employ a hard-switched topology in place of the complex ZVS alternative.

The other factor which in practice undermines good topology selection is human nature. It is common, and all too understandable, to rush the initial topology choice in order to more quickly progress to hardware development. This is often because a manager can see, and potentially be impressed by, a working prototype: it is a visible sign of progress with the project. The truth is, as well, that designing circuits and building boards is more fun and interesting than doing paper research into topologies.

Another human failing common among engineers bedevis power-system design projects is a preference for simple technical problem-solving over collaborative activities and teamwork. A choice of topology normally calls for careful weighing of the various trade-offs at the system level. For instance, a decision which reduces Bill-of-Materials (BOM) cost but increases a converter’s size and weight might affect topologies arrangements and raise shipping costs for the end product as a whole. These factors go far beyond the management authority of the engineering department. A holistic view of all costs across the entire product life cycle could help the design engineer to make better and more informed component choices.

Overall, experience suggests that failure to take into account the wider commercial environment can lead to project delays or even cancellation.

Avoiding early mistakes in power design projects

The question that arises from the above discussion is, how best to avoid this kind of mistake?

For instance, a complex Zero-Voltage Switching (ZVS) topology would produce far less severe EMI effects than a simpler hard-switched scheme. The choices made at the outset of a design should not only reflect the technical specifications of the product design, but also the capabilities of the development team and the design time available to it.

The obvious answer is of course to do the reverse of the flawed approaches:

- Collaborate extensively with colleagues across departments to gain input relevant to all factors affected by the choice of topology
- Perform in-depth research into all applicable topologies, weighing up all the factors which are affected by the choice of topology

This second recommendation can appear challenging because there are so many choices of topology to evaluate. In fact, it is not as daunting as it might seem at first sight, because for any given power rating it is normally possible to narrow the choice down to two or three suitable topologies.

By Future Electronics
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  Only in 0.55” x 0.55” Package
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4.26x Power Density UP

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