White Paper

Neousys Technology

The Need for Extreme Rugged Computing

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Has the traditional industrial embedded computer met its match?

The embedded computer has always been a mission and purpose-specific hardware that has coincided with the software, down to every single component. To minimize maintenance, it employs a fanless design; to overcome higher than usual temperatures, it utilizes the external chassis for maximum surface-area heat dissipation; to ensure system longevity, it uses wide-temperature and minimize mechanical storage components (such as flash drives in place of mechanical hard drives for higher heat, shock and vibration tolerance); to be embedded into field solutions, it has been shrunken down in size by using mini-ITX or customized motherboards; to cope with local data computation needs, the embedded computer houses powerful CPUs, the latest DRAM technology for swift data processing. But is this enough for the complex and heavily digitized world we live in today?

Early days of factory embedded computer Modern compact embedded computer

Edge AI computing

Generally categorized into standard embedded, fanless box PC, and military/ aerospace grades, the embedded and fanless box PC computer were initially designed to replace workers on production lines that brought unprecedented efficiencies and consistencies over an extended period of working hours where human laborers get fatigued, and this was just for simple pick-and-place tasks. What if we wanted machines that can be taught and learn like a human being to identify and distinguish differences while executing tasks?

Fast forward to today, the industrial computer is no longer in a server room, a data management center or situated in a specific oversized cabinet. By moving the computer and the data processing work to the edge, it can dramatically reduce data traffic, offer reduced latencies, faster decision-making and execution speed. By incorporating AI technology, edge systems can learn from existing databases or experiences like a normal human operator would, adjust on the fly to new data inputs and react to the processed data just like a human operator, if not with better consistency, efficiency and efficacy. To replace human decision-making operations, it means the embedded system needs to be deployed at the data source. This deployment serves several purposes.

One, for safety reasons, often times operators are placed in hazardous environments and replacing the operators with AI machines, it can reduce any long-term ill effects.

Two, fast and accurate decision making, being able to learn from databases or from past experiences allows for onsite decision-making capabilities that are no less than a human, if not with better consistency and accuracy as the machine is not affected by fatigue or emotional factors.

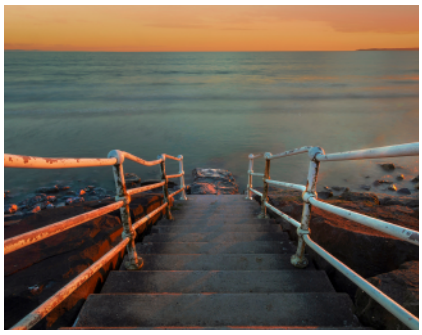
Three, minimize data traffic, with data processed locally, the amount of data traffic traveling back to the server/ central computer is dramatically minimized.

Environment and climatic factors

The environment around the world is ever-changing, from every element constituent in water, air, soil, etc. and they all inadvertently affect their surroundings, slowly causing degradation over time. For example, the use of stainless steel is specific in certain chemical production processes. The application of stainless steel in such instances is to fend off or localize chemical or by-product corrosion effects.

While there are many types of corrosions, atmospheric corrosion is the most predominant form of all corrosions. The atmospheric corrosion process is defined as the degradation of materials caused by air and pollutants contained in the air. It is an electrochemical process where a thin film of electrolytes (rain, dew humidity, etc.) acts as a solvent on the metal surface, when the relative humidity exceeds the equilibrium relative humidity, and the rusting process is then aggravated by chloride deposition and sulfur dioxide absorption. There rate of corrosion is affected by the time of wetness, temperature and electrolyte composition. There is no escaping from the devastation of atmospheric corrosion, it can be seen all around us. From your everyday nuts, bolts, buildings, skyscrapers, bridges and even megastructures aren't exempt from the corrosive process.

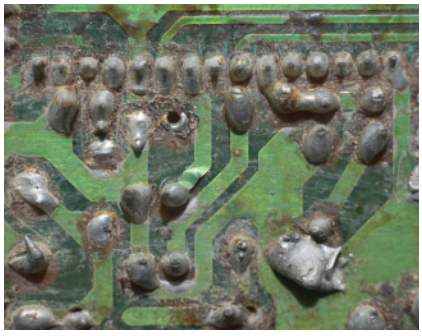
One of the most environment-specific material applications is the use of stainless steel hardware at marine and seaports. The use of stainless steel material at marine and seaports may include anything from main building structures to nuts and bolts. Needless to say, the use of stainless steel, in this case, is due to the high atmospheric salinity content in and around the seaport area that may further accelerate metallic corrosion. Though the geo-placement also plays an important factor in the speed of corrosion, such as if the placement is on water, near surf, calm waters, temperatures and even wind speed and direction can all play a factor in seaport atmospheric corrosion.



Railing at seaport

Stainless bolts at ports

When speaking of corrosion, people tend to think about external rust formation and degradation, but the atmospheric corrosion does not stop at the surface, the humidity in the air seeps through gaps and holes. This means components within are not safe from corrosion effects, and with copper, lead, plated tin and nickel, all can be found on the printed circuit board assembly (PCBA), being some of the most susceptible to corrosion effects, computers deployed in extreme environments ultimately fails electrically. This is more problematic than external structural damage from corrosion, for embedded computers. It can be seen across all industries, from pharmaceutical, food, chemical processing, general industrial, military, defense, micro precision and even the electronic industry itself is not safe atmospheric corrosion.



PCBA corrosion

Overcoming environment and climatic factors

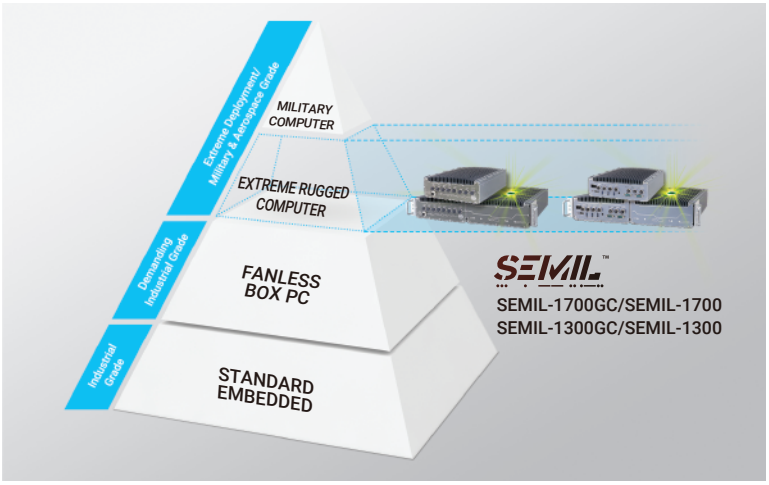
The structural integrity of current embedded systems limits their deployment capabilities. With edge AI deployment becoming more common and popular in the past decade, embedded systems deployed at the edge put them in hazardous environments that we once avoid putting laborers in. Such hazardous conditions include, high chemical content, chemical by-product concentration or atmospheric conditions that may cause significant harm over time.

Laborer working in hazardous environment

Edge AI robotics takes over from laborer

Sure enough, manufacturers in recent years started developing systems geared towards harsh environment deployments with more stringent testing procedures, the use of military-grade materials, adding seal to provide IP67 protection, extra padding to withstand external force, etc., each aimed at providing extra durability in a specific area. In reality, to cover most if not all characteristics for extreme deployments, there is no doubt that a full-on military-grade computer will be the only ideal choice over “reinforced” embedded systems for extreme edge deployments.

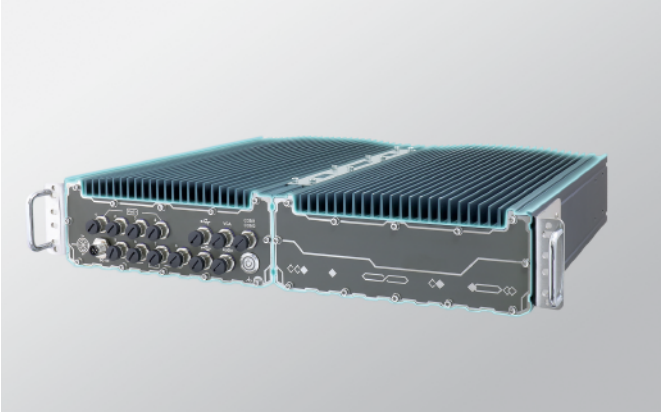
For extreme industrial deployments, the use of military-grade computers seem like overkill and yet, they do share very similar specification needs. Nevertheless, holding back integrators from utilizing military-grade computers is its cost and specification availability to the public. But what if there is a computer that meets the ultra-rugged construction to withstand water, dust, connectivity, corrosion inside and out, at a fraction of the cost of a military-grade computer.



Sliding in to fill the gap between fanless box PCs and military/ aerospace grade computers is Neousys' SEMIL, extreme rugged embedded/ GPU computers. Neousys Technology research & product development recognized this niche market, a gap-to-be-filled, specifically the structural integrity of current embedded systems that limits their deployment capabilities. The fact is that the "gap" is also applicable to various other deployments, whether it is for digitization or edge application deployments. This is where Neousys Technology's SEMIL series extreme-rugged computer aims to resolve the environmental or climatic factors. The SEMIL is several classes above traditional rugged-embedded computers and fanless box PCs, it is near-military grade. It belongs to the segment which seeks to address some of the most basic but overlooked and yet, hard-to-achieve solutions.

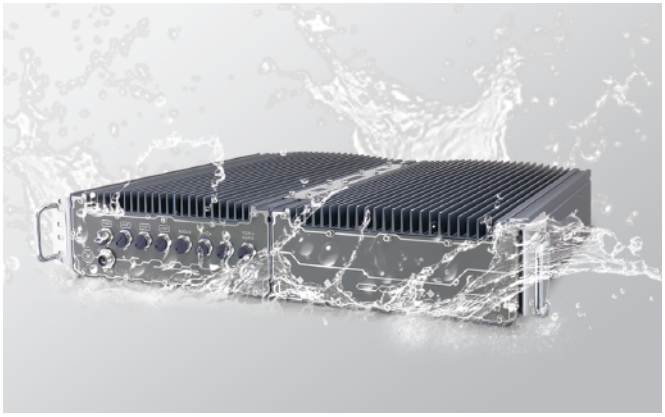
The Neousys Technology SEMIL is an extreme-rugged embedded computer featuring stainless steel and aluminum reinforced enclosure to fend off environmental factors/ climatic corrosion, completely O-ring sealed IP67 water and dustproof capabilities to prevent internal corrosion, commercial off the shelf (COTS) M12 connectors for rugged connectivity, true fanless GPU inference acceleration computing up to 62°C and patented SuperCAP UPS backup technology to protect hardware and data integrity during unforeseen power outages.

Stainless steel and aluminum reinforced enclosure



The application of stainless steel and aluminum to reinforce the SEMIL's enclosure is rarely seen in the world of industrial embedded computers. Foregoing the rugged traditional anodized metallic chassis, the use of stainless steel and aluminum can reinforce and fend off environmental or chemical effects. It is not uncommon to see stainless steel used in structural constructions such as the exterior cladding for large high-impact buildings and interior surface décors such as handrails, kitchen countertops and more. It is favored due to its strength, flexibility and resistance to environmental and climatic corrosion. With an attractive finish and only minimum maintenance, stainless steel is often comprised of 90% recycled metal in a polished or grain finish, making it also a green material.

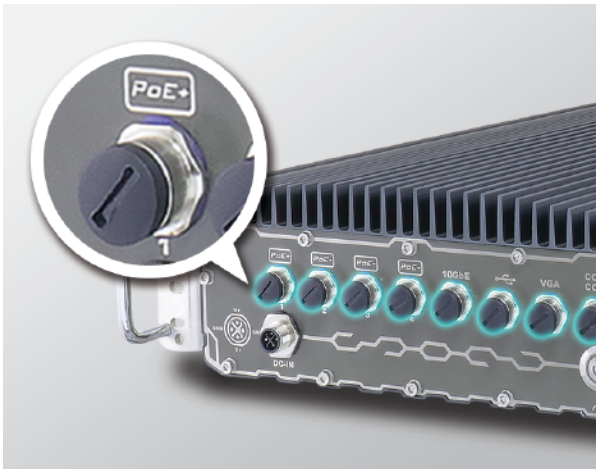
Internal corrosion resistant, IP67 water and dustproof



Waterproof capability in watches is a dime a dozen due to the minimal area and the ease of application the waterproofing seal needs to be applied. But what if you wanted to waterproof an industrial embedded computer with multiple enclosure panels and gaps that water may seep through? Not to mention the multitude of input and output connectors, how does one go about waterproofing the connectors? We'll get to the connectors later but to seal the system enclosure for waterproof capabilities, the Neousys SEMIL utilizes a customized o-ring and combines that with a stainless steel monoblock as the main chassis. There is a small service door opening at the bottom of the monoblock enclosure for maintenance purposes. The opening is concealed with stainless steel screws tightened in specific order and torque to ensure IP67 waterproof rating while retaining serviceability. The completely water-tight seal and construction not only provide water and dustproof capabilities, but it also fends off humiditiy from seeping into the enclosure, minimizing if not deterring metallic corrosion on the PCBA board that may eventually lead to system failure.

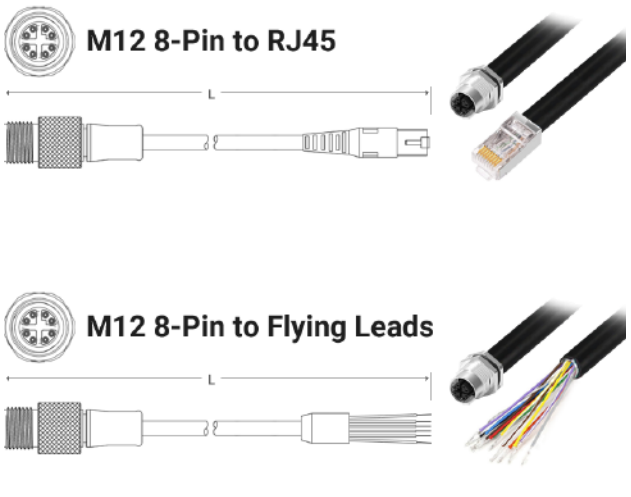
COTS M12 connectivity

As mentioned previously, how does one keep input/ output connectors waterproofed? One such method is the application of military-grade D38999 connectors that is water and dustproof. But, the cables need to be pre-ordered, can cost anywhere from 100 to 200 USD per cable and there may be a significant lead time once you've placed an order.

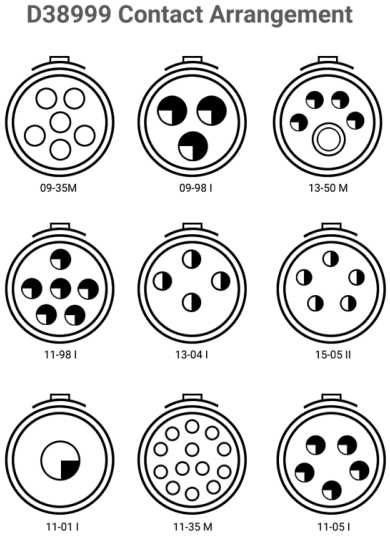


Neousys Technology SEMIL with conformed M12 connectors

The Neousys SEMIL utilizes commercial off-the-shelf (COTS) M12 connectors. Providing the same waterproof capability, with prices range from 5 to 10 USD and they are readily available unless specific or rare specifications are required. One of the reasons for M12's COTS availability is that it has pre-defined standards for different connectivity. On the SEMIL, Neousys utilizes threaded-coupling A-coded M12 connectors for USB and COM port connections, X-coded M12 connectors for 10Gb/ Gb Ethernet connections and S-coded M12 connectors to power connectivity to provide up to 20 amps of power.

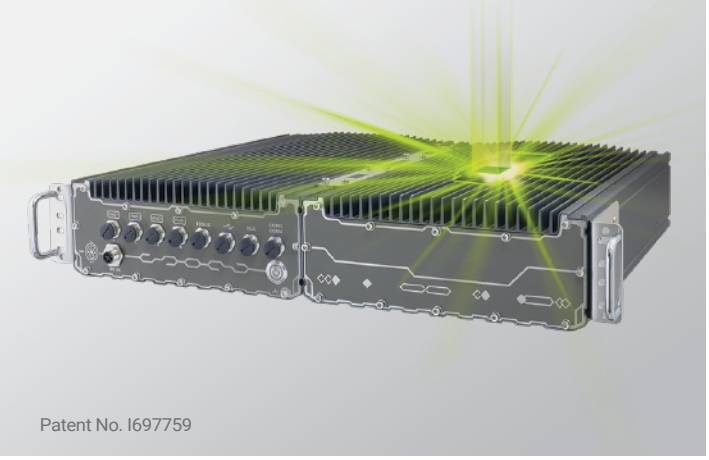


M12 connectors are of conformed standards, making them COTS and economical in pricing



D38999 cables are complex, require customization, leading to higher costs

True fanless GPU inference computing



The popularity of edge AI GPU computing has gained traction in recent years with NIVIDA® releasing a series of inference accelerators to meet performance and power-efficient ends. Nevertheless, most edge AI GPU solutions have one thing in common, which is the inclusion of a massive heatsink and fans or a dedicated air induction cooling method to keep the GPU cooled and operational. The need for operation cooling is due to mainstream graphics card's power consumption which may exceed 300W and edging towards if not surpassing the 400W mark. And the reason many edge AI GPU platforms continue to implement mainstream graphics cards is due to their availability but at the same time, the graphics cards suffer an extremely short lifecycle of 12 months.

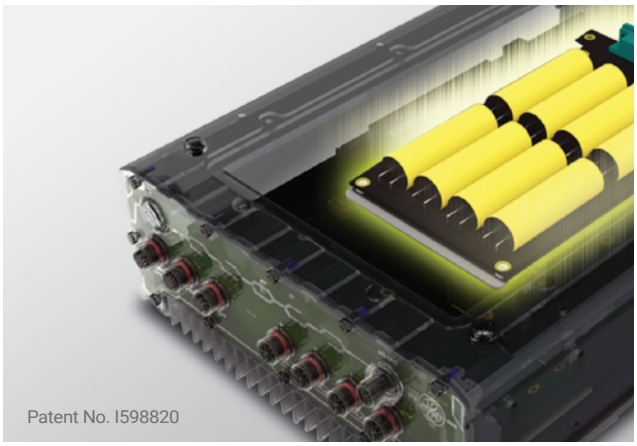
The SEMIL GPU features an NVIDIA® Tesla T4 or Quadro P2200 inference accelerator with a 36 months lifecycle. They are extremely power-efficient in that they offer performances close to a 200W GPU at only a fraction of the power consumption at approximately 70W. The reduced power consumption brings a variety of benefits such as less heat production, less power requirement and the size of the card is also smaller, making it easier to accommodate.

However, making a water-tight edge AI GPU computing platform completely fanless is no easy task itself. On top of cooling a water-tight system with no airflow going in or coming out of the system, the system must solely rely on the heat sink to deal with the heat generated from both the CPU and the GPU at the same time, under heavy workloads. For SEMIL, Neousys designed and created a patented thermal solution that is capable of drawing heat produced from the CPU/ GPU, inductors and other components with extremely high efficiency and dissipation with effectiveness. The result is a SEMIL system that is capable of operating up to 62°C with the CPU and GPU working under full load, without failure-prone mechanical fans.

Patented SuperCAP UPS power backup technology

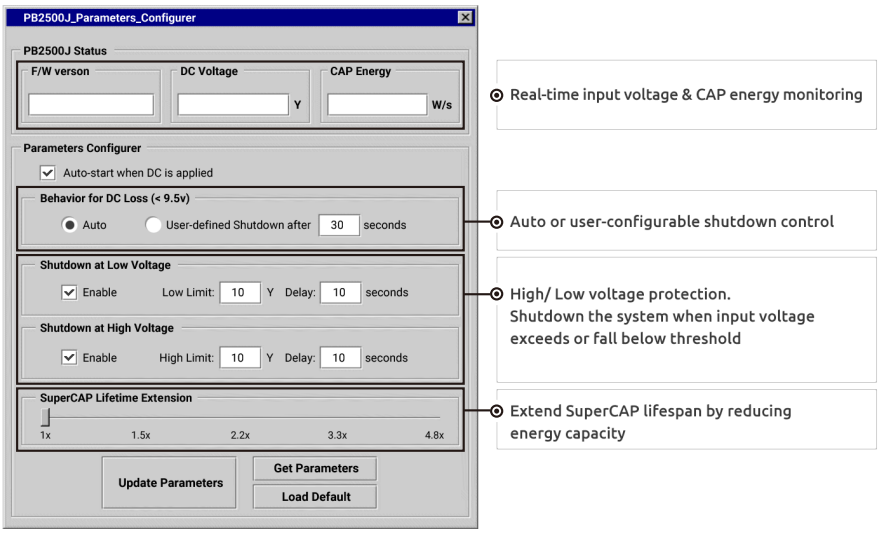
The uninterruptible power supply or source (UPS) is an electrical energy storage medium that is connected to the back end of a system (between the system and the main power source). Should the main power source suffer an unforeseen power outage, the UPS takes over and continues to supply power to the connected system to sustain the system's operations and the user has the chance to manually save and shut down the system to avoid hardware damage or data loss.

The downside of the traditional UPS is the battery life expectancy. The optimum operating temperature for a lead-acid battery is 20 to 25°C (68-77°F) but approximately for every 8°C elevated temperature, it may reduce the battery life up to 50% when exposed long-term. For example, when a battery operating at 25°C with 2 years of battery life is deployed into an industrial environment operating constantly at 33°C or higher temperature, the battery's lifespan is reduced to 1 year. And we know in certain industrial working environments, 33°C is just a walk in the park for true industrial-grade machinery operating environment temperature.


Patent No. I598820

This is where Neousys Technology's patented SuperCAP UPS comes in for industrial applications. The supercapacitor has a wide operating temperature range (-40°C~85°C) and an exceptionally long operating life of 10 years or 500,000 charge-discharge cycles. These two traits help make it a reliable industrial power backup solution.

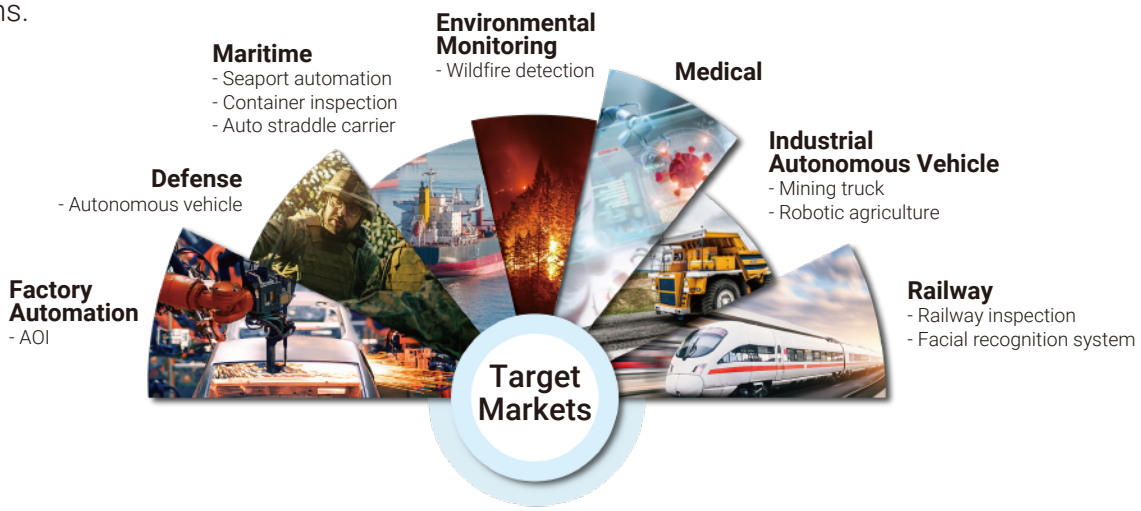
In addition to the long life expectancy and wide operating temperature, Neousys also incorporated a micro-processor into the charge and discharge controller. The proprietary firmware embedded in the MCU not only monitors energy levels continuously, it also automatically initiates soft-shutdown to prevent data loss/ corruption. The patented architecture provides sophisticated features such as real-time energy monitoring, high/ low voltage protection and auto/ manual shutdown control. Users can also extend the lifespan of supercapacitors up to 4.8x via the parameter configuration utility.



Conclusion

The industrial embedded computer is more or less a purpose-built computer that is designed to survive in industrial working environments. From the traditional manual labor, the first conveyor belt, basic automation, floor system and now the Neousys SEMIL, perhaps it is not the exact course of industrial automation evolution but, is definitely a step in the right direction. The ability to utilize deep learning AI computing power at the data source offers diverse and flexible field applications by reducing data upload/ download, computing latencies to bring processing efficiencies and operation efficacies.

Suitable for a variety of field deployments such as food/ beverage/ chemical factory automation, military/ defense deployments, maritime seaport/ container/ straddle carrier applications, mining fleet/ robotic agriculture, railway inspection, medical applications, etc., the true fanless, dust and waterproof nature of the SEMIL stands apart from general embedded and fanless box PC platforms.



However, the Neousys Technology SEMIL was never designed to replace industrial embedded computers but rather, they were created to be deployed into places where the industrial embedded computer can't or not able to durably and reliably operate on a long term basis. Deployments to fields such as maritime seaport automation (high humidity and salinity), military defense applications (extreme shock and vibration), environment field monitoring/ industrial autonomous vehicles (high temperature, dust, weather exposure) and even in medical healthcare applications (noiseless operation) where absolute silence is required for solution operations.

With the embodiment of innovations, the reinforced aluminum and stainless steel chassis to fend off corrosion and climatic factors, unibody monoblock construction, IP67 and dustproof for extreme edge deployments, COTS M12 connectors for waterproof and rugged connection, patented thermal design for true fanless GPU computing, patented SuperCAP UPS to ensure the system continues to operate till proper shutdown to protect the hardware and data, the Neousys SEMIL system aims for military-grade toughness, durability and reliability, making it several classes above industrial embedded systems and fanless box PCs.

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