Electronic Design and the Post-Pandemic Supply Chain

(ARTICLE)

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"Let our advance worrying become our advance thinking and planning." -Winston Churchill

SUMMARY

This article was the result of a critical component sourcing issue for a client in the robotics field. *Electronic Design and the Post-Pandemic Supply Chain* uses a case study for a robotics Inertial Measurement Unit (IMU) to explain the current state of the electronics supply chain and recommend important checks for PCB design and manufacturing for this year -and years to come.

Electronics Supply Chain

Before the pandemic, very few people were acquainted with the term 'Supply Chain Management'. After experiencing toilet paper shortages and being bombarded with pictures of container ships waiting to get into port, it's now clear that a smooth chain of events is required to get from raw materials to finished goods in the hands of the customer.

The Beer Game

The Beer Distribution Game is a popular role-playing exercise and management learning tool designed to simulate a complex and dynamic supply chain. Participants assume the roles of managers in beer production and distribution operations. Managers throughout the supply chain react to changes in demand and the results to those decisions ripple through the chain, often resulting in over-amplified reactions, called the bullwhip effect.

Just like the Beer Distribution Game, the pandemic interrupted the electronics supply chain, resulting the bullwhip effect. Interruptions in raw materials had an impact on component production, interruptions in component production and delivery had an impact on PCB manufacture. Manufacturers couldn't get parts, resulting in hoarding and global price increases.

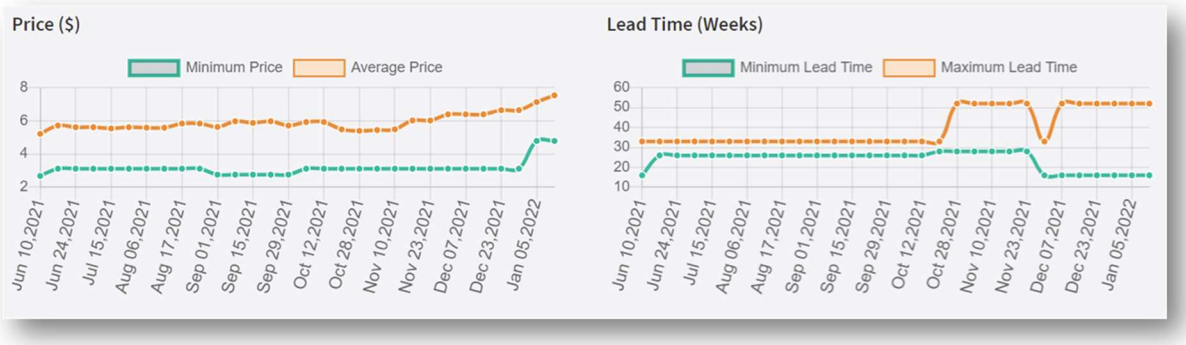
Case Study: TDK Invensense ICM-20948

An Inertial Measurement Units (IMU) is used to determine movement and position, by measuring acceleration, angle, and the earth's magnetic field for compass headings. They are commonly used in devices such as automobiles for traction control, phones for attitude and direction, and smart watches for determining steps. They are an important part of many modern devices.

A customer's robot utilizes IMUs at each joint for tracking acceleration and angle. The customer is planning a new design utilizing the TDK ICM-20948, 9-axis IMU. The component was introduced in 2017 and is mid-way through lifecycle, but the customer is being told that there is no stock available and the part is not recommended for new design

Market Availability -January 2022-

A look at ICM-20948 market availability using the SiliconExpert part tool confirms that there are six authorized distributors, all with zero stock, and that distributor lead time has increased to 52 weeks.



Global Supply

Although the ICM-20948 is produced by TDK MEMS Sensors division in San Jose, CA, the component is manufactured in Tiawan and uses a magnetometer produced by Asahi Kasei Microdevices (AKM) in Japan. In November 2020, AKM experienced a significant fire at their manufacturing facility in Miyazaki Prefecture and continued to face pandemic-related supply issues in 2021. Having to make important decisions about what products to

produce, AKM decided to End-of-Life the magnetometer used by TDK in the ICM-20948. Although TDK purchased all remaining wafers, the supply is limited and will eventually run out.

Alternate Components

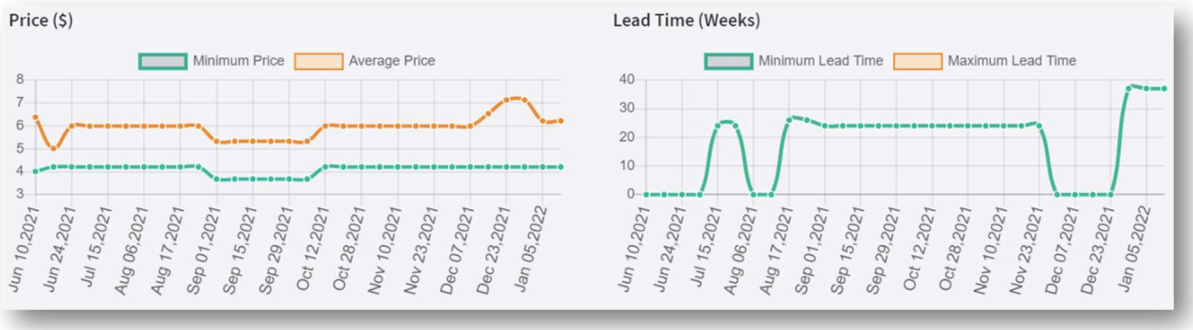
There are three major manufacturers of commercial 9-axis IMUs; TDK InvenSense, Bosch Sensortec, and STMicroelectronics. It should be noted that there is no direct cross for the ICM-20948 and any alternate will require significant software development to support a different device.

Bosch Sensortec BMX160

The BMX160 is commercially available 9-axis IMU. Similar to the TDK part, there is currently no stock available in approved distribution. Bosch was contacted regarding using the BMX160 in new designs. They stated that there were no plans to obsolete the part, however customer lead times for components were realistically 52 weeks and that lead time would need to be considered in any new design.

Data from SiliconExpert confirmed that there was no stock available and distributor lead times were increasing.

Distributor	Sku	Quantity
Digi-Key	828-1087-2-ND	0



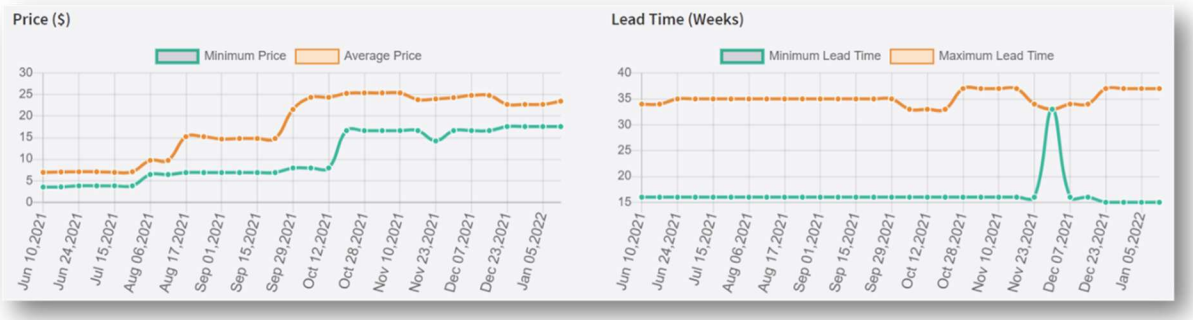
STMicro LSM9DS1TR

The STMicro LSM9DS1TR is also a commercially available 9-axis IMU with the potential to replace the ICM-20948. Like the other 9-axis IMUs, the LSM9DS1TR has no stock available in approved distribution and the distributor lead time is increasing.

STMicro was contacted regarding the use of the LSM9DS1TR and could only say that the part was active with no plans to obsolete but actual customer lead time was at the discretion of the market.

An item of note in the SiliconExpert market data is that the average price of the LSM9DS1TR has increased by a factor of four since July of 2021, indicating high demand and shortage in supply.

Distributor	Sku	Quantity
Newark	26Y5658	0
Farnell	2532383	0
Farnell	2532383RL	0
Digi-Key	497-14946-2-ND	0
Newark	83Y4306	0
Element14	2532383	0
Newark	29AC7702	0
Mouser Electronics	511-LSM9DS1TR	0

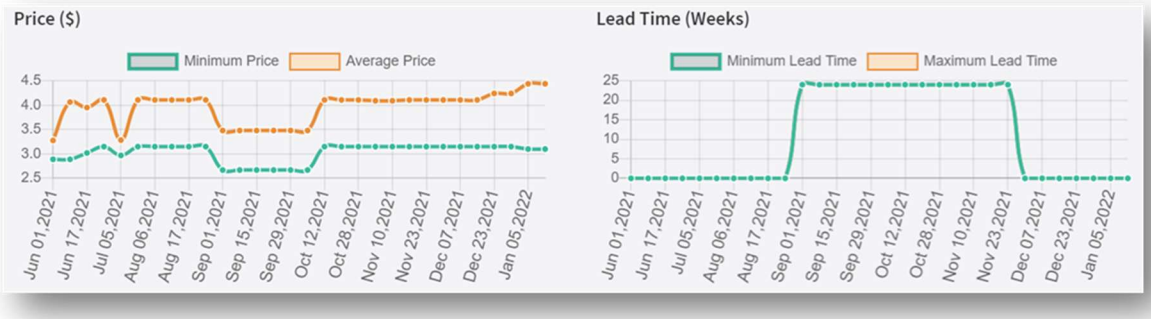


A Different Approach -Lower Tech-

Current market conditions for 9-axis IMUs make it very difficult to consider the components in new designs over the next year or more. An alternate approach is to use an older technology, 6-axis part, with an external magnetometer. An example of this approach is to use the Bosch BMI-270 IMU and the AKM AK09915C magnetometer (readily available from stock).

Although this approach relies on older technology and requires two components, rather than one, the parts are more available and prices are relatively stable compared to other parts.

Distributor	Sku	Quantity
Mouser Electronics	262-BMI270	0
Digi-Key	828-1091-2-ND	1528



The Broker Market

Something that is not regularly discussed when talking about the electronics supply chain is the impact the non-authorized distributors (brokers) are having on supply. Worldwide broker stocks can now easily be searched online, components purchased with a credit card and shipped the next day. High-risk parts have now become commodity for brokers to acquire, buying from authorized distributors in large quantities at stock price and selling back to manufacturers at 'market' price.

As an example, the ICM-20948 from the case study showed no authorized distributor stock and 52-week lead time. However, a search of the broker market shows hundreds of thousands of components available from dozens of world-wide broker sources. Reduction of continuous component supply results in the bullwhip effect; manufacturers purchase and warehouse large quantities of parts to continue making products without disruption, stripping supply and causing instability throughout the chain.

Jigo Technology (HK) limited.

Part #	Manufacturer	Description	Stock	Price
ICM-20948	INVENSENSE	New and original Rohs ; DC:1918+ ; QFN24	53000	
ICM-20948	INVENSENSE	New and original Rohs ; DC:1848+ ; QFN24	53000	

Easev semiconductor Limited Certificates

Part #	Manufacturer	Description	Stock	Price
ICM-20948	INVENSENSE	QFN24 ; DC:20+	1	
ICM-20948 ICM20948 ICM-42688-P	INVENSENSETDK	LGA ; DC:2020+	25600	
ICM-42605 ICM-20948 ICM-40607 AS5600	TDK INVENSENSE	LGA14 ; DC:2020+	36000	

Risk Reduction

Component Selection Process

At the beginning of the design process, it is typical to do design analysis to determine the best part for the application. Component lifecycles are often used to determine suitability for manufacture, depending on the intended product sales lifetime. Component *supply* may not be considered until the first run of PCB.

Due to current supply chain volatility and significant lead times, component supply evaluation needs to be included early in the design process -as part of the component selection process. A complete BOM scrub will reduce the risk that components for the design are unavailable for manufacture.

Sustaining Engineering

Component and sustaining engineering are typically thought of as functions that occur after a design is released to manufacturing. Addressing component risk early and implementing alternate measures into the design can mitigate production roadblocks.

As an example, in 2021, one of my customers was concerned that volatility in the supply of FET transistors (normally a 'jellybean' part) could shut down production on a very high-volume product line. By implementing a simple layout change that enables FETs of varying footprints to be used on the board, they gained supply flexibility and averted a line shutdown.

Alternate Components

Everyone knows that having alternate components for a design is important. In the past it was thought of primarily as a cost control measure. In the days of component supply volatility, it should now be important as a risk-reduction measure to prevent interruption of product manufacture.

Onshoring

In the wake of pandemic supply chain issues there is a lot of talk about onshoring to manage supply chain volatility. Unfortunately, onshoring your final products does little to reduce electronic supply risk because electronic components are produced globally and rely on global resources.

As illustrated by the ICM-20948 case study, chips that are designed locally may be produced globally and rely on multiple global resources for production. Even after tens of billions of dollars have been spent on fabs in the United States, manufacturing still relies on global resources. This was recently reinforced by the war in the Ukraine, which has reduced the global supply of industrial-grade Neon required for chip production by 40%, increasing prices by 900%.

The Future

From the perspective of Q2-2022, all indications are that supply chain issues are going to get worse before they get better. Personal experience shows unprecedented lead times for components, extending beyond 52 weeks. Many industry professionals are indicating supply shortages and significant price increases through 2023.

The following is advised for product management:

- Placing a higher priority on electronic components as a risk. Interruption of a single component could result in not shipping critical products.
- Include component supply (not just lifecycle) as part of the component selection process during the early part of design to reduce design risk.
- Consider critical supply issues as part of the product design, including alternate components and assemblies.