RECOM

SUPPLY CHAIN ASSESSMENT

A subsequent white paper will expand on the identified items and offer guidance on managing the supply chain resources mentioned in the preceding document. It was developed alongside another related white paper that delves into supply chain topics.

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PREFACE

This white paper was created in conjunction with another, complementary white paper focused on supply chain topics. While the two may have a similar look and feel on related topics, it should be noted one (this one) focuses on identifying factors and providing guidance for what to look for when considering and assessing a vendor and their capabilities. **NOTE:** the term "vendor" is used loosely here and could easily apply to an organization's internal resource assessment.

A follow-on white paper will take many of the items identified here and go a step further to provide direction on how to manage the supply chain resources identified in this preceding document. In other words, one doc focuses on the tools for performing feasibility, while the follow-on doc focuses more on the execution aspects. Again, though there may be some overlap in key topic areas, the content of each takes on differentiating and meaningful context and should therefore be treated as such.

ASSURANCE OF SUPPLY

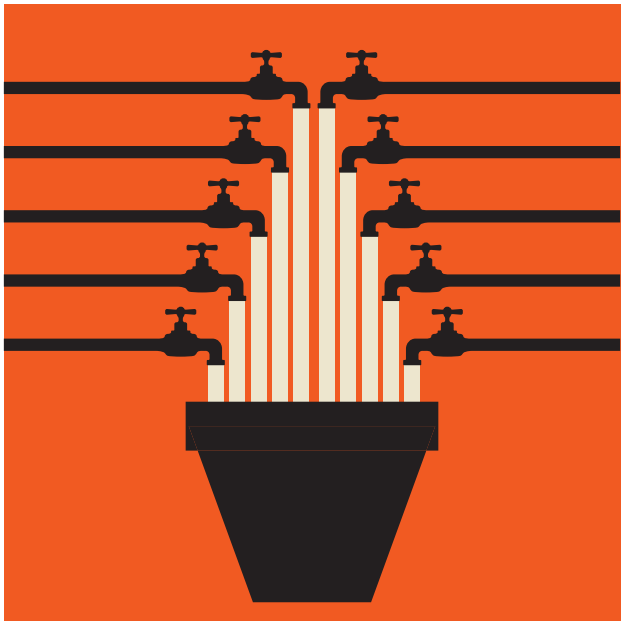
The overall goal of any supply chain is to guarantee assurance of supply (AOS), but what provides this assurance and how is it accomplished? Many different stakeholders may have numerous interpretations so all will be focused on the perspective of the design engineer responsible for delivering a system's power solution(s) for the context of this white paper. Please bear in mind concepts like AOS and associated metrics are really statistical approaches to risk mitigation so all considerations and decisions in this regard should be viewed through this lens as well.

AOS (and its close cousin, enterprise resource planning or ERP) for a power design engineer is only accomplished when a system successfully ships and operates in the field to specification and within warranty constraints. Of course, this is far easier said than accomplished because merely having the necessary components in hand may not enable these goals. If a power supply bill-of-materials (BOM) item is not available, then the power supply cannot be delivered to the system and no power means no system for anything that is powered, which is everything in the world of electronics. As obvious as this sounds, it is important to emphasize and internalize these high-level points because it trickles into every aspect of the successful delivery of power solutions (and therefore systems), technical or otherwise. To make the extreme point, if a particular 0402 resistor is not available (because of special packaging, tight tolerances, higher quality, or just plain long lead times), then it does matter if it costs $0.001 or how small and trivial it seems if it prevents you from building and shipping a $100,000 system in a qualified design. The emphasis on a qualified design is made here because shortcuts (i.e. – aftermarket components, unqualified seemingly equivalent components, improperly multisourced components, etc.) can be taken in desperation, but rarely work out for the better...no field recall and long-term brand damage is worth the short-term relief and revenues.

Especially for power supplies and powered solutions, AOS will typically come from a well-vetted vendor (or equivalent, internal resources in the case of larger enterprises). There are far too many technical, logistical, manufacturing, and business dependencies to thoroughly cover at a low-level in this white paper. But high-level categories, identification of key stakeholders, and methodologies for how to vet such resources can get one well down the path, particularly at the appropriate level of invasiveness a design engineer will directly have (as opposed to the management of delegated tasks that fall directly to other stakeholder groups such as Commodity Managers, Component Engineering, and Project Management).

It is very important to internalize the point that the relationship between the engineer and power resource is a two-way relationship. Power solutions can be incredibly complex, have BOM component counts that rival the entire systems they are integrated into, can fail certifications with the slightest discrepancy from an established process (i.e. – fail electromagnetic compatibility, or EMC, targets because a power transformer wire crosses over another wire instead of under) and are the most critical component for allowing your system to turn on and operate properly. Pricing can also be just as prohibitive to your AOS as we will see in a moment in the subsequent discussion on multisourcing. The customer is not always right if a different customer is willing to pay more for your resource!

MULTISOURCING



A more controversial strategy for ensuring AOS in recent years is the push for multisourcing. The theory is that by procuring solutions/components that are form/fit/function equivalents from competing sources, this enhances AOS by mitigating the risk of depending on a single supplier (a.k.a. – sole-sourcing). The exception to this is when there is only a sole source of a component, such as with a specialized, application-specific integrated circuit (ASIC).

Just take a moment to consider all that is involved in designing and qualifying a power solution, both standalone and in the end-application or system. From a design standpoint, does your design require considerable tolerance stack-up analyses? What of the vigorous accelerated life, stress, and long-term qualification testing done on assemblies and systems? How many cycles did Engineering need to put into deciding on a single component and getting it entered onto the company's approved vendor list (AVL)? Now take just this handful of considerations (let alone the many left out) and consider how these will all be accomplished when there is more than a single option for each BOM component!

Even in a relatively low-count BOM and only dual-sourced parts, one can quickly see how the permutations of plausible manufacturing scenarios can quickly get out of hand. Even if an organization has the time/resources to perform virtual assessment (e.g. – Monte Carlo analysis [1]), the number of combinations must typically be constrained to perform the assessment in a reasonable amount of time, hopefully also with a reasonable degree of confidence. To address this conundrum, a design engineer (typically in conjunction with Component/Reliability Engineering) might identify what they consider "critical" components as candidates for multisourcing to try and keep the validation work reasonable for a realistic number of permutations. But then this begs the question of "What is a critical component?" so this strategy is likely to end up being a far more subjective than anyone will prefer.

From a financial standpoint, Supply Chain Management groups and stakeholders tend to be big fans of multisourcing because it can greatly increase the leverage a customer has to drive favorable pricing (including periodic price reduction over time). In particular, this is typically accomplished via what is known as a "share split" or established ratio of what volume of a specific component will be procured from VENDOR A vs. VENDOR B (or A through M), and that ratio can be quite disproportionate (think more 70/30 or 80/20 instead of 50/50). Vendors may also spend quite a bit of money and resources to qualify a power solution so this can sometimes leave them feeling scorn if splits are not equitable so when the vendor with the 80 % share has an issue and cannot deliver, the leverage has suddenly flipped and the vendor with the 20 % share can decide to your savior, charge a major premium, or simply leave you hanging to twist in the wind with no solution.

Hopefully, it is now clear why multisourcing can be a somewhat controversial topic. Do you hear a clear argument for whether multisourcing helps or hurts AOS? Maybe both?!? We did not even broach the topic of how multisourced components are evaluated and considered equivalent to a primary source, which is yet another risky and costly process, potentially also at the detriment of AOS. Or even worse, what happens when your Component Sourcing department wants to cut-in a new component source to a shipping design with many units already in the field?

Now to focus on the key part, which is how to assess a vendor's/resource's abilities to accomplish AOS.

THE QUALITY MANAGEMENT SYSTEM (QMS)

While many of the assessment suggestions and tasks outlined here may formally come under the charter of Supply Chain Management, Component Engineering, and Manufacturing/Process Engineering team members, it is highly disadvantageous for the power stakeholder to fully delegate these tasks. Auditing the quality management system (QMS) can be taxing for all, but no better well to test the vigor, thoroughness, traceability, consistency, and flexibility (paradox intended) of an organization. **NOTE:** a stakeholder of any sort, let alone the power stakeholder, can benefit enormously from physically traveling to a power solution manufacturing operation. Do not just do a document review. Walking that manufacturing line from incoming inspection through shipment in the order of flow to live and breathe every process step, the same as the power supply will for the actual build, yields all kinds of nuances and issues that are highly unlikely to be caught elsewise (or even worse, via a field recall).

Integral to any manufacturing operation, and one could argue the single most important contributor to AOS, is the QMS in place. The QMS is where Design Engineering, Supply Chain Management, and ERP really all converge and is therefore an absolutely critical indicator of a resource's ability to meet the needs of a power solution's AOS. From documentation to process management to quality control to assessing impacts of multisourcing to failure analysis to equipment maintenance, all roads lead to the QMS. It is common for resources to state international certifications of compliance with QMS standards such as ISO 9001 and ISO 14001, but confirming an organization's ability to meet these needs far transcends the bare-minimum action of requesting a statement of conformity to a standard they claim to be certified for. Some common quality/environmental standards, their applicable industries/products, and how to find more info on them can be found in the table below.

STANDARD/REGULATION NAME	STANDARD/REGULATION DESCRIPTION	WEB LINK
ISO 9000:2015	**Quality management systems — Fundamentals and vocabulary** ■ There is actually a whole family of ISO 9000 standards, starting with this one. While not all listed here, ISO 9001 is captured below because of its ubiquity in the industry.	https://www.iso.org/standard/45481.html
ISO 9001:2015	**Quality management systems — Requirements**	https://www.iso.org/standard/62085.html
ISO 14000 Family	**Environmental Management** ■ Like ISO 9000, there is a whole family of ISO 14000 standards, starting with this one. While not all listed here, ISO 14001 is captured below because of its ubiquity in the industry.	https://www.iso.org/iso-14001-environmental-management.html
ISO 14001:2015	**Environmental management systems — Requirements with guidance for use**	https://www.iso.org/standard/60857.html
ISO 45001:2018	**Occupational health and safety management systems — Requirements with guidance for use** ■ Important ethical resources that emphasize an occupational health and safety (OH&S) management system, which ties directly to QMS health.	https://www.iso.org/standard/63787.html
ISO 13485:2016	**Medical devices — Quality management systems — Requirements for regulatory purposes** ■ Example of an industry/product-specific QMS guideline. The medical device industry equivalent of ISO 9001.	https://www.iso.org/standard/59752.html
AS9100D	**Quality Management Systems - Requirements for Aviation, Space, and Defense** ■ This standard includes ISO 9001:2015 quality management system requirements and specifies additional aviation, space, and defense industry requirements, definitions, and notes.	https://www.sae.org/standards/content/as9100d/

IATF 16949:2016	**Quality Management System Requirements for Automotive Production and Relevant Service Part Organizations** ■ This standard includes ISO 9001:2015 quality management system requirements and incorporates the latest global automotive standards.	https://www.aiag.org/store/publications/details?ProductCode=IATF-1
IPC-A-610H	**Acceptability of Electronic Assemblies** ■ In particular, very detailed guidance on soldering, which is a critical quality factor though also includes other factors.	https://shop.ipc.org/general-electronics/standards/a610-0-h-english

Table 1: Worldwide Quality/Environmental/Safety Standards

Naturally, there are more-obvious constituents of a QMS like an established process for component change management, wave soldering profiles, or equipment maintenance records. It is the little details that truly differentiate one power resource/vendor from others and how well the team responds to requests for process documentation and quality reports, with the buck typically stopping at the quality manager or equivalent stakeholder. When you test/stress these processes, how well do they hold up? For instance, one can take a subassembly or printed circuit assembly (PCA) that is suspect on an assembly line and bring it to the Failure Analysis (FA) bench, then bring it back to the line after inspection and/or rework. Were this movement, FA test results, rework notes, and reintroduction to the line captured somewhere? Ideally, this will be in a document (physical or electronic) e.g. a test report that literally follows the assembly, hence is a.k.a. a "traveler." Was this all accomplished in a reasonable amount of time (because rework and turnaround time are integral to warranty metrics)?

The best litmus test for a resource's QMS is how well it performs under pressure or in a crisis. When system failure rates exceed minimum quality thresholds, there should be documentation that can trace the assembly (via serial number) back through the entire process. The best vendors will be able to take a power solution from the field and trace all the way back to individual component lot/date codes to take the FA in any direction it needs to go in to seek resolution. How traceable is the standard process? How traceable is a deviation?

Remember, EVERY vendor and resource will have issues, but it is how they respond, document, and solve the issues (permanently) that is the true measure of a great power supply manufacturing partner. Take a very simple request, like asking to see the template for an FA process, such as the Eight Disciplines (8D) problem-solving method [2] or requesting a report on last month's quality/yield. If this cannot be quickly produced (and ideally walked through an example use of), then that is a big red flag!

CAN THE MANUFACTURER AFFORD YOUR REQUIREMENTS?

In general, the larger the organization, the larger the list of requirements, standards, certifications, derating guidelines, and qualification testing (amongst many other things) that a power solutions provider must meet to become a qualified vendor and win the business. Even worse, these stipulations may be forced regardless of the volumes being produced or unit price being paid. In fact, the trend of large organizations in the last several years is to try and push more and more of their internal test/qualification needs directly onto vendors, perhaps justified as the "cost of doing business."

Refer back to the earlier conversation on the interdependent and often conflicting partnership between a design engineer and a power solutions provider, which also involves the challenge of dealing with multiple suppliers. This point is quite salient here as well since you are adding major risk to your AOS if you are not enabling that vendor to share in the profits of your system and/or application. Is it financially viable for the vendor to meet all your stipulations and still turn a sustainable profit? If not, then they can decide to walk away from

the business (potentially well into the development cycle or even post-release), grossly underperform (i.e. – quality issues, deprioritize your build over your competitor's for the same line, etc.), take the business at a loss (a.k.a. – "buying the business" with the hope and/or promise of future, more lucrative opportunities), or in the worst-case scenario actually go bankrupt.

Even if someone is willing to buy the business, then future opportunities are often teased and unlikely to be guaranteed. This means supplier and customer get into a very vicious cycle resulting in a fractured relationship in which a supplier will eventually get frustrated with unfulfilled prospects and/or increasing inequitable demands (remember share splits?) and stop working with a customer, likely for one of the reasons mentioned in the previous paragraph. Supply Chain groups from certain organizations may even gain negative reputations for this behavior, which inhibits their ability to source new and/or top vendors. Even if someone is willing to buy the business, you lose if they lose.

The critical takeaway here is the more you treat your vendors like collaborative development partners, the better it will work out for all (or even just you from a more selfish perspective). This is in terms of AOS, stress, cost (in time and money), system performance, and even brand reputation. At the onset of a new project, do your Design Engineering AND Supply Chain Management AND Component Engineering stakeholders have these kinds of discussions together? If not, then it is recommended to take under serious consideration. Ensure your guidelines and requirements are reasonable and justifiable and not overly stringent, particularly for the solution/application/volumes in question. If the discussion yields little more justification than "I don't know who/where it came from, but because that is how we have always done it." or similar, then do not be afraid to challenge these requirements. Surely, they can cost a lot of money/resources and severely impact time-to-market (TTM) so it may not be terribly difficult to make the case to a high-level decision maker. It is much easier to "fight City Hall" when it is in their financial best interests.

One last consideration in this regard is related to cost reduction efforts of the power solution(s) over time, which can sometimes be referred to as "value engineering" a design. The goal may be to reduce the solution's price tag over time by addressing the costliest components and testing (particularly in the case of qualification testing that continues throughout the manufacturing life, such as Burn In, Ongoing Reliability Testing or ORT, and Highly Accelerated Stress Screening or HASS). Multisourcing can be a major factor here for all the reasons described in the dedicated subsection on it above. Just ensure if your roadmap/budget calls for quarter-over-quarter (QoQ) or year-over-year (YoY) cost reductions, then it comes with a strategy that ensures equitable sustainability for all critical stakeholders involved.

SUMMARY/CONCLUSIONS & FOLLOW-ON INFO

Buying a part is one thing, but power solutions tend to be critical components to system viability. It does not matter how cheap and/or technically cool a solution or how high the demand is for the product is if it cannot be built and delivered (when/where it is needed). This is why AOS and proper assessment of the full supply chain involved is integral to the success of your own shipments. See this example of a collection of useful technical resources and reports from RECOM, then compare to what you see from other power solutions providers. Reach out and have some direct discussions about things like the QMS and you will quickly gain a sharp eye for which vendors stand out above the crowd.

Even with the help of many resources and stakeholders (if you are lucky enough to have them on your team or within your organization), it is really important for the design engineer ultimately responsible for delivering the power solution(s) to have a finger on the pulse of all these factors related to supply chain and AOS. Learning how to properly assess a solutions provider will inexorably be tied to your daily professional life at one point or another (likely many) and always yields tons of great experience (positive or negative, all experience is good experience), particularly in the very specialized and multidisciplinary world of power supply development. No matter the actual cause, you will be the first one on the hook when something goes wrong.

Considering power solutions are typically one of the largest chunks of system BOM costs, the buyer/vendor relationship needs to be treated more like a collaborative partnership due to the risk/reward ratios shared by all parties. After all, nothing runs without power!

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