Statement of Robert J. Rathert, Sr. (Jay) KLA
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Detroit, MI

On behalf of KLA, it is an honor to be here to address this hearing.

Nearly all of us carry a technological miracle with us practically everywhere we go without giving it another thought. More than 7 Billion smartphones are in use today. Each is loaded with a few dozen of the most advanced chips ever designed. Inside those chips are incomprehensibly small transistors that allow it to perform its many functions. The continuous march of chip technology, known as Moore's Law, has shrunk these transistors to the point that 150M of them will fit in the period at the end of a sentence. The chip that is the brains of a smartphone (the application processor) is the size of postage stamp and contains nearly 12B transistors itself. KLA's role, simply put, is to help chip manufacturers ensure that each transistor that powers these chips functions as designed when manufactured - and reliably does so, day after day. The technology KLA brings has enabled the advance of the entire semiconductor industry for more than 45 years. We're the third largest semiconductor equipment company in the US and our equipment is in every chip fab, worldwide.

Chips are now incorporated into many products, including automobiles, enabling innovations like driver assistance features, electrification and autonomy that appeal to today's drivers. Many are surprised to learn that premium cars may contain, not a few dozen chips, but more than 10,000. A growing percentage of these are advanced chips that are central to the operation of the vehicle, serving in either mission critical or safety critical roles. When a chip fails in a phone after a few years, it's a frustrating inconvenience. But when a chip fails in a car, it can be catastrophic: not only bad for business or brand reputation, it can put lives at stake.

KLA believes the growth in importance of chips in automobiles is a significant secular shift, and that our quality role will be crucial to its success. In recognition of this trend, KLA has built a second headquarters campus here in Michigan to be close to the heartbeat of America's automotive industry and to collaborate with the community of local car manufacturers, suppliers and academics that are bringing innovation to this market. As part of the Good Jobs for Michigan program, our move here was conceived in partnership with the Michigan Economic Development Corporation (MEDC) and approved by the Michigan Strategic Fund. We're proud of our plan to bring 600+ high-tech jobs to the region.

The forces that power the semiconductor industry's success are access to a talented and creative workforce, a fair and hospitable business environment and an ongoing commitment to an investment in R&D. As transistors shrink further to 3nm and below, the technical challenges continue grow harder for everyone across the industry. Innovation and collaboration are critical.

While the US currently maintains leadership in many sectors that support semiconductors, sadly, America's share of global chip manufacturing has fallen to just 12%, down from 37% in 1990. Nearly three quarters of chips are now built in Asia, including all of the most advanced ones found in your phone and car – as well as an increasing share that power internet, cellular networks, cloud computing and AI. Many of these chips are designed here at home, but all are built overseas by two major contract manufacturers, known as foundries. Each of these are susceptible to unplanned disruption, either from natural disasters or geopolitical events, creating a significant strategic liability for America.

In the past, America had multiple domestic chip manufacturers vying for technology leadership. Most fell behind on the necessary investment to remain technically competitive and therefore profitable. This caused them to change their strategies away from the cutting edge, leaving only one US-based supplier positioned to potentially serve this market and compete here at home against the entrenched foundry leaders overseas. The importance in R&D investment to stay relevant and

competitive in this rapidly evolving business cannot be overstated. Furthermore, the capital required to build even one 5nm chip fab can exceed $15B. Tax policy and incentives are often key factors in determining where and when these factories are built.

KLA's business is worldwide, but we support efforts to increase competition in the chip industry and to re-shore advanced manufacturing and foundry production in America. Investments, like the CHIPs act, enable America to advance our competitive differentiation and reinforce the strength of the domestic semiconductor business ecosystem. Therefore, we support the $52B public funding of the CHIPS act to supplement the $150B in private capital the industry is already investing this year. But long-term change requires a long-term view. As such we also support concepts like the FABs act to provide ongoing tax credits for R&D investments that will encourage the growth of our domestic manufacturing base and create a positive economic ripple across the economy. Similar programs created the astonishing economic engine that is the Taiwan Science Park. We also support programs that focus on STEM education to develop the best and brightest workers here at home, as well as those that allow us to attract and retain the best in global talent.

At KLA, our motto is "Keep Looking Ahead" reflecting our focus on enabling the advance of semiconductor technology. We're grateful to those in the U.S. Congress and in the state of Michigan who share this view and who support this strategic industry.

Thank you.

Supplementary written testimony

Understanding the chip manufacturing landscape:

- Companies that design and manufacture their own chips are known as Integrated Device Manufacturers, or IDMs. Intel is an example of an US-based IDM.
- Foundries are contract manufacturers. They build chips designed by others. They are selling their manufacturing expertise and factory capacity. The leading foundries that can produce the most advanced chips include TSMC, based in Taiwan, and Samsung, based in Korea. GlobalFoundries and several others also serve this market, but can no longer compete for the most advanced designs. While the bulk of foundry production is overseas, Samsung and GlobalFoundries have existing foundry fabs in the US and TSMC has broken ground for a new fab in Arizona. Intel has announced their intent to re-enter the foundry business in the US.
- Fabless companies, such as Qualcomm, Apple or Nvidia, only design chips. They are 100% reliant on foundries to manufacture for them.
- Some US IDMs with older factories (such as NXP or Texas Instruments), also use foundries for two different reasons.
    1. When demand temporarily exceeds their internal capacity, they can send overflow to be manufactured by the foundry without building an expensive, new factory. When demand returns to normal, they can turn off foundry orders without idling an internal factory and laying off workers.
    2. They also use foundries to produce branded chips whose advanced designs exceed their in-house capability to manufacture. They are 100% reliant on foundries to build these chips.
- Foundries now produce a large percentage of chips worldwide and all of the most advanced designs. If overseas foundry manufacturing capacity were disrupted due to natural disasters or geopolitical events, the economic and strategic impact to the US economy and all of its many chip-reliant sectors would be devastating, dwarfing the current shortages.

Understanding the chip reliability problem

- Semiconductors require very precise manufacturing. The transistors and the connecting circuitry in today's advanced chips measure just a few tens of nanometers (millionths of a millimeter) in size. Minute manufacturing deviations of even a few nanometers can prevent the chip from functioning properly and must be carefully controlled. These processing flaws are known as defects.
- Semiconductor chips have a long manufacturing cycle, lasting 3 months or more. The most advanced chips may require 800 or more individual processing steps. Specialized processing equipment from leading US companies like Applied Materials and Lam Research as well as ASML

(Netherlands) and others perform these many steps. Nanoscale manufacturing defects in the chip are possible at any step due to misprocessing, unpredicted tool failures or a variety of random or systematic causes.

- Complex, automated inspection systems from KLA and others monitor each key process step to ensure the quality of the chips, finding defects and alerting manufacturers to the source of any problem.
- Completed chips are electrically tested on automated test equipment before entering the supply chain so that non-functioning or poorly functioning chips can be identified and removed.
- Some chips may contain small, partial defects that don't yet impact the chip. These can't be detected by the tester, and therefore "escape" into the supply chain. Known as latent defects, they fail only after being in the operating environment.
- These types of defects are a great concern to the automotive industry, especially for autonomous driving and other safety-related applications. Latent defects impact vehicle reliability and brand reputation. Failures can create a liability issue and put customers at risk. The dramatic increase in chip content per car increases the likelihood of these premature failures. The pressure to put the newest chip technologies into cars further exacerbates the issue.
- Collaboration across the supply chain: including vehicle manufacturers, Tier 1 suppliers of electronics, chip manufacturers, process tool and tester suppliers and quality-focused companies like KLA are the best opportunity to identify and remove chips that may contain latent defects and bring undesirable risk to this important emerging capability.

Chips in conventional cars and EVs

- Today's vehicles contain virtually every type of device and design technology to power the driver assistance features, connectivity, navigation, electrification and autonomy capabilities.
- Cars contains dozens of chip-based sensors like CMOS imagers, short and long range radars and ultrasonic ranging systems. Each of these chips feeds data to high power computing systems to make sense of the car's environment and compare it in real time to software models to help it decide on safe actions. These computer chips will be in contact with other chips that actuate lighting, signaling, braking and other safety features. Other chips power the dash and infotainment in the cockpit. Still other chips keep your car in communication with GPS, Bluetooth and emerging connectivity with traffic infrastructure and other vehicles, while others monitor the safe operation of the engine. Chips are critical to performance, innovation and safety in the car.
- While chip content is rapidly growing in all vehicles, it is significantly higher in EV vehicles.
- While most chips are built on silicon wafers, specialized chips made to handle the high power associated with EV electric motors and charging are creating new opportunities for emerging

materials like silicon carbide or gallium nitride that can handle the higher voltages in a smaller chip, along with many other advantageous attributes.

- These new semiconductor types are less mature than silicon-based devices, causing more defects and an increased focus on the type of quality improvement that KLA makes possible.

US competitive interests

- America is rightly concerned about US technology and/or IP being used against our national interests for defense or intelligence use-cases, among others.
- Manufacturing the most advanced chips requires a few very specific technologies from US and allied sources. Limiting these few critical systems alone is sufficient to hobble any advanced chip development.
- The "Big 3" US chip equipment providers (Applied Materials, Lam and KLA) have emerging competitors for the more mature manufacturing technologies made in overseas (China) chip fabs that serve consumer markets. These simpler technologies aren't practically applicable to the national defense interests. Blanket prohibitions, export licensing, etc. on all systems and parts hinder the ability of American companies to serve these non-strategic markets and have the unintended consequence of making overseas competitors stronger. US semiconductor manufacturers can collaboratively work with the US government to better meet the desired policy goals while simultaneously sustaining American competitive business advantages
- In healthy, competitive semiconductor markets, prices for chips at newly released process technologies start very high when demand for them is hot and supply is still somewhat constrained. As the technology (a.k.a. node or design rule) matures, prices fall toward their marginal cost as capacity comes on line, competitors emerge and process economies of scale take hold. Fab personnel and resources then begin to be reallocated to the next technology shrink, powering Moore's Law, as suppliers race to bring the next new, more powerful and economical chips to market and catch the next wave of higher prices. Laggards who fail to bring their technology to market on time, miss the period of high profits, hurting their profitability and ability to invest in new fab capacity and technology. Historically, this initiates a downward spiral of that is difficult to recover from. Remaining competitive requires successful technology development based on both sufficient investment and effective execution.

Chip shortage

- The ongoing chip shortage is the confluence of several short term and long term causes. Long-term, chip demand continues to climb against a historically conservatively growing supply base. Short term, unplanned fab interruptions and misallocation due to COVID and changing inventory models has led to increasing lead times and downstream interruptions for chip customers.
- Existing fabs and foundries are wringing out all inefficiencies and running at very high manufacturing capacity. New capacity comes online very slowly – measured in years – as new fab decisions are made, planned, built, qualified and products ramped to volume. Equipment

lead times exceed 1 year alone. Capacity adds started today won't be felt for a significant period of time.

- KLA's role in improving quality and yield (percentage of working chips vs chips produced) helps chip fabs maximize their productivity, assuring that highest possible percentage of chips that start the manufacturing line are available to serve customers when they finish three months later.