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ADI - Analog Devices Inc at JPMorgan CES Technology Forum

EVENT DATE/TIME: JANUARY 05, 2017 / 6:30PM GMT

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PRESENTATION

Harlan Sur - *JPMorgan - Analyst*

Okay, why don't we go ahead and get started. Again, my name is Harlan Sur. I'm the semiconductor analyst here at JPMorgan. We are very pleased to have Mark Gill who is the Vice President of Analog Devices' automotive business unit and we also have Mike Lucarelli, Senior Manager of Investor Relations here with us as well. We don't often get business heads to present, so this is a special treat. So what I've done is I have asked Mark to start us off with an overview of himself, his responsibilities at Analog Devices, a brief overview of the automotive business that he runs and then a brief snapshot of what his auto team is showcasing here at CES. And then we can go ahead and kick off the Q&A. So gentlemen, thank you very much for joining us this morning. Let me turn it over to you, Mark.

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Thank you. Can you hear me okay from this distance or you need me to get closer to the microphone? Some nodding heads. We will go with it here. So my name is Mark Gill. I've been involved with Analog Devices for the last 25 years, an engineer from the beginning, but probably cut my teeth in the semiconductor business world around the 1990s with wireless GSM phones. Perhaps we were in similar businesses at that point in time in the early 1990s. And that was a pretty wild ride, I must say. It's my first experience to worldwide customers and also to customers that wanted to take products from first sample to production in six months. And so as that was my first impression, I thought, well, that's how life is.

So at the end of the 1990s, Analog got involved in a joint development with Intel to create our microprocessor platform that was DSP and microcontroller stuck together and at the successful completion of that, I said, well, you know, this is good. We've got audio and speech in this thing and we've got CAN connectivity, so let me take this into the car. I think we can do it and perhaps I was a little naive just coming out of the wireless communications as to what was actually required to be able to put this into the car.

Well, looking at today, the cumulative revenue, so over a long period of time now, the cumulative revenue of what for ADI is the Blackfin franchise that came out of that core in automotive was more than a couple hundred million dollars of revenue. So yes, I was pretty naive, but it actually has worked out for us quite nicely there.

So my background starts off in audio, then I get more involved in the automotive world, get involved with start stop technologies, getting involved with ADAS technologies and eventually now looking after the entire business. It's about a $500 million and change commensurate R&D and people associated with that.

If I look at CES, this is just a fantastic showcase location. It's like some of the most creative technologies are shown here at CES and we have got about a dozen different demos going on in the pavilion in the South Hall where we have a booth there. But perhaps for this discussion, there are three that really spring to mind that I enjoy there. The first is our A2B, our automotive audio bus technology. What we are trying to show there is a complete cockpit, an audio cockpit. There's many different situations where you want voice, you want audio, you want sound, you want various different things, lots of different ECUs and what the A2B technology does is allow you to connect all of them together with just a single twisted pair of wire. So it reduces wiring complexity, reduces cost, reduces weight, which helps out everybody for fuel efficiency. So it's kind of strange; it's like taking audio and moving into fuel efficiencies and stuff like that.

Second one perhaps, I think, I didn't check, but I think this is actually a world premiere discussion today is around our 77 gigahertz radar solution. We are showing that in the booth there and our radar is really about high-performance systems. It's about how we transform radar into life-saving applications. So that's the second thing that we are going to be showing there.

Then the third thing maybe takes a little bit of discussion to start up, autonomous driving is in I think a lot of conversations today and autonomous driving is pretty ambiguous in the middle. We've got levels one through five, a lot of people need to go through Level 3 and Level 3 says the car is sometimes in charge and the human is sometimes in charge and I personally think that's a pretty ambiguous environment.

So one of the things that we are trying to show here is some technology, some sensing technology that would try to inform the AI, the computer part of this, is the driver actually ready, willing and able to be able to take over the vehicle during that period of time. So it's sensing technology to look at the driver and make sure that we are ready for that.

So CES is a fun time. I have to say last year our booth was a few doors down from a place that had some massage chairs. That gave me the R&R that I needed about 2 o'clock in the afternoon. We don't have that anymore this year, so it's going to be a tough one for us, but it's an incredibly enjoyable place. So I enjoy this week here.

Harlan Sur - *JPMorgan - Analyst*

Great. Thanks for the opening remarks. Automotive for Analog in the just completed fiscal year 2016, $540 million business, it was up 3% with accelerating growth in the second half. And it accounts for about 16% of the total Company's revenues. This segment has grown at a 15% CAGR since fiscal year 2009, so I guess the first question is, Mark, how do you see the growth of this segment over the next few years, let's say in a SAARs environment that is growing 1% to 3% and maybe within that, if you can also touch upon the profitability profile for the auto business relative to the overall corporate average, maybe both gross and operating margins.

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

So you put three questions in there. You're going to have to remind me because I am certainly not going to remember every one of those as we are going through. So growth at this point in time, so 2016 was an excellent year for us. It did exactly what we had anticipated from the year. The back end of the year, we saw growth emerging in HEV in our start stop technologies and in audio and they were the three things that really came to life there.

Start stop, if you are not familiar with it, that's this technology that stops the car at the traffic lights and turns off the engine to reduce pollution. The key thing there is that every time you start the engine and stop the engine and start the engine and stop the engine, you wear out the battery. So the technology needs to know is the battery able to restart and you have to be absolutely certain about that.

So the technology we've got is something that looks at the state of health of the battery. It measures that to probably about 1 millionth of its original state and really has a very good way of telling the vehicle, yes, you can stop, save all that pollution and [grow] to start again. Our growth there really is because the technology has been deployed to start with in Europe most broadly and what we've seen over the last couple years is the expansion of that around the marketplaces to China and to North America and I think we've seen that during the back end of 2016 and we are going to see that continuing as we go forward at this point.

HEV, we have dozens and dozens of different types of products that fit into that category. They are converters that look at batteries, they are current sense amplifiers. They are a variety of different things that drive motors. If you look anywhere around the world, there's such a momentum these days about people wanting to be able to build out for new energy vehicles and we see a lot of growth. We have seen it in the last six months, 12 months. We are going to continue to see that growth getting better.

Audio was interesting because again my life started in audio and a couple of years ago, I was thinking that audio is going to be -- pretty much run out of steam. What we've seen is noise cancellation, sound enhancement, in-cabin communications, all sorts of new applications where we really

want to have high fidelity audio coming throughout the car. And so we are seeing actually a lot of growth in the marketplace because of those types of things going forward. So I think 2016 was good, good growth for us and those were maybe some of the standout items for me at the back end of the year.

Harlan Sur - *JPMorgan - Analyst*

So as you think about your design win pipeline and some of these newer product successes here and again, in an automotive production environment that's growing, whatever, 1%, 2% per year, how fast do you think you can grow your automotive business longer term?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

So SAAR is one part of the conversation. This is an interesting year actually. I've seen some numbers where we were thinking about between 2% and 3% growth this year. I haven't actually got the latest numbers for China. I don't know if they have been published yet, but my suspicion is we are actually doing better than that through the back end of 2016. I've seen some discussions that say 2017 is going to be a little bit weaker. I've got to tell you, when I talk to the car manufacturers in China, they are not saying that at all. Now we've got the tax policy closed out a little bit in China. I think we may be seeing a little bit more strength there. So I'm not worried too much about the SAAR numbers. For us, it's about content and about this marketshare, global marketshare. If we can move technology that was based in Europe to China to North America, we've got a great piece of growth there. If we can grow the content, HEV, autonomous vehicle, these are things that carry so much more content to it.

So I think we are looking at an overall growth of -- what we like to think about is between 2 and 3 times that SAAR number both based on SAAR and then this content and so depending upon how that comes out, that sort of mid-single to high single digit growth.

Harlan Sur - *JPMorgan - Analyst*

And then the other question that I had was, and the only reason why I ask this question, because I know that in the automotive business, the reliability requirements, the quality requirements are so much more stringent. You guys are doing stuff like maybe 100% burn in or whatever, all this accelerated life testing. And so while it is a good business, there are costs, additional costs associated with it. So I'm just trying to figure out is the profitability profile relatively comparable to Analog's corporate gross margins or slightly below, slightly above?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Well, I think you've actually given me half my answer here already. So that's exactly right. The net is the automotive business is slightly below the Company corporate average and it's really because of all that extra testing and extra validation we put into the product. Many of the products we have are life-saving products. You look at crash sensing, you look at radar systems, you look at these things and you want to be absolutely sure these products will be working in the field.

When I started, our customers would talk to us about PPM, that's parts per million failure rate. They've stopped talking about that now. They moved for a short period of time to parts per billion failure rate. They've stopped talking about that now. They now talk about zero incidents. How do you design a product and then test the product so there is zero incident of that product in the field. And absolutely that creates a little bit more cost associated with that. So it's really just trying to make sure we can deliver the very best product, the very best quality to the automotive industry.

You know as well as I, you buy a car, your brand-new car, within six months, you've got three different problems with it. How frustrated do you feel about that vehicle? The car manufacturers are really trying to work out how we get zero incidents in the new with a huge amount of semiconductor content that's now going into the vehicle and we live with that as part of the business.

Harlan Sur - *JPMorgan - Analyst*

How should we think about your profile as it relates to leadership by your automotive OEM customers from a geographical perspective? Are you more strong with the European automotive OEMs or North America or Asia? How do we think about that?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Yes, I'd say historically it was European-based. Some of the car companies there have had programs where they wanted to get close to semiconductor companies. One of the public ones there was announced by Audi. Honestly, I forget, three years ago or so, their PCSP program, which put Analog and Audi in a position where we could talk much more freely about the types of problems that they are considering and we can talk about the semiconductor types of things that we can do and it's really -- generates a lot of excitement, a lot of insight as to really what the technology can do to try to solve the types of problems that they have.

Last year, you saw us make an announcement about A2B technology with Ford. So you are seeing a transition of our European focus moving, expanding a little bit more broadly into North America. I'd say we've still got some work to do to do the same sort -- or gain the same sort of collaborative positions in Japan and in China. But it's a way that we've changed as a company.

When we started, when I started in this, I was thrilled when we got an RFQ. A request for quotation came in from somebody and we were thrilled. We could respond to someone who wants to talk to us and what you find out really that's not what you want to do. What you really want to be doing is to talk to the car manufacturers to find out really what the problems are they are trying to solve and if we look at that A2B technology, for example, that came out of conversations with car manufacturers. They were trying to deploy noise cancellation in vehicles and noise cancellation mean lots of microphones, lots of vibration sensors, which means lots of wiring and lots of connectors and that's a problem they were struggling with.

I think if we talked to all the Tier 1s then they probably would have described that in a very, very different way and we wouldn't have come up with the solution we have today versus now we've got something where you can deploy noise cancellation, one set of wiring throughout the entire vehicle, connect up all those microphones, connect up all those vibration sensors and it's really picking up very, very nicely. So to me, the collaboration with the car manufacturers just gives us much more insights as to what the problems are they really want to solve.

Harlan Sur - *JPMorgan - Analyst*

With the headwinds from the passive safety overhang behind the team, how do we think about seasonality trends in the automotive business? If I look back historically, it looks like Q1 is weak.

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Q3 is weak.

Harlan Sur - *JPMorgan - Analyst*

Q2 is your strongest quarter, Q3 weak, Q4 again is up. Is that how we tend to think about it?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

It's how -- we have Christmas vacations, New Year vacations, all sorts of things that comes into our first quarter, so that's always a little bit of a lull for us there. Second quarter is strong, third quarter carries into the summertime. So third quarter, depending upon the industry, some car companies

shut down a little bit during that period or run slowly. Some of them actually keep going, but generally speaking for us one weak, two strong, three weak, four strong. It is a picture that happens and the seasonality continues that way.

Harlan Sur - *JPMorgan - Analyst*

Got it. Great. And I mean, like I said, we really started to see the year-over-year growth really start to accelerate and again, I think that's because of the passive safety overhang abating. So are you -- is that fully behind the team now and what we are seeing is the true growth rate for the Company on a go-forward basis or is there still overhang left from that?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

So let me give a little bit of background on that passive safety. This is a business around crash sensors. It's MEMS technology, our (inaudible) crash sensors that are used to provide signals to five airbags. You might not know this, but actually ADI pioneered that technology in 1993, our first deployments in SAARed vehicles in 1993 and that's 25 years ago. If you just think about the rate of change in technology, that was 25 years ago. I look at S-curves that say this is innovation, this is growth, this is maturing. We are way into the maturing phase of this business at this point in time around those sort of crash sensors and what maturing means there is that the package is defined, the interface is defined, the performance and specifications defined and there is really no value in doing anything that is outside of that box.

So we made a decision and it's a tough decision to make. If you make a decision to say we are going to take our ball and go play somewhere else for portions of that. So when you change some of your investments and we redirected them for example towards A2B or to radar or some other things there, I think it's really hard to exactly match the growth on the other side with what will be the resulting softness when you reduce a portfolio.

So we've still I think got a nice position with regards to that passive safety. We've got some customers that really value what we have. Again, I come back to this. This is a life-saving application. If I talk to a customer who says I want the lowest price tomorrow and I talk to a customer who says my number one priority is quality. My number two priority is quality, I know where I'd rather have the conversation because someone is valuing life and someone is just trying to squeeze the money.

So we've got some nice customer base. I think it's a nice solid, but reduced portfolio. Our business I think there is going to be fairly stable at this point in time. I don't think there's going to be the big headwind as you describe what we saw there. I also don't think it's going to grow at the mid-single digit rate that the rest of our business is going to grow at. So it's a business that is working out well for us, but I think it's going to be pretty stable rather than that growth rate business.

Harlan Sur - *JPMorgan - Analyst*

If we take a snapshot of your content and penetration, what would it look like today? What is Analog's dollar content, average dollar content per vehicle today and then with some of the things like A2B and we can talk a little bit more about the (inaudible) Gyro accelerator solution that you put out a press release on a couple of days ago, but looking -- fast-forward another three to four five years, where do you see that dollar content going to?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

I honestly think this is a really tricky question because average in this industry is very, very challenging. You go all the way from very entry-level vehicles up to fully loaded vehicles with lots of options in them. I think for us the content ranges from about $50 on the low end to about $250 on the high end in today's vehicles and again, you've got a lot of -- when you bring in radar content, and you bring in audio amplifying content, you bring in a variety of different things, you look at HEV products, that high end, you can really pick up some good, really interesting products from ADI in that.

Harlan Sur - *JPMorgan - Analyst*

So then as you think about, as you mentioned, things like 77 gigahertz and you guys -- we'll talk about it later -- but you guys just did that lidar acquisition and you start loading all that stuff on, so where can your dollar content go in a few years from now?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Yes, so if I allow myself to ignore government policy because government policies may change in North America, we've got Germany, France, Netherlands, they are all changing or potentially changing this year. Who knows what they are going to do for policy for new engine vehicles. But when you look at those vehicles, they carry a lot more content to them. When we are looking at autonomous driving, if we embrace autonomous driving as a methodology for changing the way in which we behave and we bring that technology in rapidly, there's a tremendous amount of sensor content required in that.

Today, we've got eyes and ears. We need to mimic that in radar content, in lidar content and also sorts of things going on around it. So I think it probably doubles the content from $250 to like $500 in that time period. Again caveats there, we need to have HEV happening, we need -- we have got to have some of this autonomous stuff happening. But I think it's a very -- we are very enthusiastic about that actually. There is a lot of momentum behind bringing autonomous vehicles and bringing that sensing content into the car.

Harlan Sur - *JPMorgan - Analyst*

Any questions from the audience? So why don't we stick on the topic because the 77 gigahertz solution is -- there's a nice story around it because I think a lot of that came from the Hittite acquisition. Am I correct?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Well, Analog has had its own experience in millimeter wave RF technologies, but absolutely a couple years back, the intention of bringing the Hittite team in was to really bolster that capability of the Company. So we've now just from base band all the way up to hundreds of megahertz of capability there, absolutely.

Harlan Sur - *JPMorgan - Analyst*

So we've heard other of your competitors like NXP talks about 77 gigahertz. I'm not sure if Infineon or some of these other guys talk about it, but how does Analog differentiate their radar solutions relative to the competition?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

So I think there's two things to think about. The first is we think of this application as a life-saving application. We think of this as a performance-driven application. If I can just imagine for a second, you are driving down the street, you've got lines of cars that are parked on the side of the street around you and generic radar is going to say there are lines of cars parked. There's blobs there on the side of the street. An ADI radar is going to say there is a child standing between those vehicles moving towards the road. The level of precision we want to be able to bring to this is to look at finding small objects, I hate to say it, but a child or whoever it may be and identifying that that is there. To me, that's the difference between sort of the generic radar projects that some people are talking about and really high performance systems.

The other thing for us is we are not doing this in SiGe or silicon germanium or other things; we are doing this in CMOS. CMOS presents its own challenges, but, at the end of the day, it allows us to integrate to create a smaller, more cost-effective system in the overall system. It allows us to bring mixed signal integration in there. It allows us to bring DSP and microprocessor integration in there. When we look at the whole spectrum of

applications for radar all the way from parking and blind spot, which don't really require a lot of that performance and you go up to 200 meter ACC systems and you go to autonomous driving where the performance is really going to be required, we just need some flexibility with regards to what do you integrate, what vehicle architecture is there and CMOS gives us that level of flexibility to be able to integrate as the applications emerge. So those are two things I think that make us stand out differently than others.

Harlan Sur - *JPMorgan - Analyst*

And on the Vescent Photonics acquisition, lidar. That's a really emerging technology. There's a mechanical way to do it. You guys are bringing in an innovative way to do it. Talk a little bit more about the differentiation for this lidar solution that you guys have under your umbrella now?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Yes, so we've been looking to try to find a way to be different in lidar for quite some time. Others use mechanical MEMS, mirrors and the likes of things and one of the significant challenges there is vibration sensitivity. So what we have done with this company called Vescent Photonics is to create a way where there is no moving parts in that. If you were all at school at some point in time and you put light through a prism and you saw that light bent, what this Company has worked out how to do is to be able to control how we can move and bend the light.

So we're sitting there with a laser and you can scan it. Now just think about this for a second. When we talk to each other, we don't spin our heads around. We don't do those things. We are looking at each other and we have got a peripheral view, but I can focus on you. So electrically I can steer this beam around, I can focus on you, I can focus on targets really well.

So I think it gives us a very significant differentiation overall in this business and you couple radar and the lidar technology that we have together, I think you've got a first-class system of how to identify objects that are out there for us that we need to have for autonomous and safe driving.

Harlan Sur - *JPMorgan - Analyst*

Got it. You guys are in the midst of closing the Linear acquisition.

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

We are.

Harlan Sur - *JPMorgan - Analyst*

They had a great portfolio, great exposure. I think automotive/transportation was 25% of their business with specific strengths in EV, HEV, power management. And I'm sure you've had a chance to maybe take a glimpse of Linear's portfolio on the automotive front. What's the most exciting part of Linear's automotive portfolio and what are going to be the opportunities that you see for potential cross-selling?

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Yes, so maybe start off the deal has not closed, so I'm honestly not intimate with everything they do. Maybe I can back up for second. About two years ago, I was putting together my wish list and I sat there and said what I really would like to have in this business is some cyber security technology. I'd like to be able to have lidar technology, I'd like to be able to have power management technology. So I wrote my letter to Santa and clearly I was good because you never get three out of three and we got three. So I'm kind of like a kid in a candy store right now because there's lots of stuff there that is really exciting that we can use in the industry.

If you look at LTC, two things stand out to me. Firstly, the product portfolio, whether it's battery-attached power, whether it's buck boost regulators, whether it's the lithium-ion portfolio, whether it's the wireless mesh network that sits on top of that, it's power over Ethernet. There are so many different things that we can look at and the business is extraordinarily complementary to ours. It really is going to be adding these two things together.

I think the second thing is the people. It's just such a tremendously dedicated organization and dedicated to performance and precision in very much the same way that ADI is. The LTC team want to create products that are the best in the industry, create the best value in the industry and again, that's very much aligned with what we do. So between the technology and the people, I'm really looking forward to this conversation when, maybe in a year's time, we can talk about now it's closed and now we actually know all these things a bit more.

With regards to -- there is some very simple things that we can do with regards to adding their power devices next to our DSP for example, next to our radar, next to our lidar, those sorts of things. I'm honestly not yet really able to say what the more interesting things would be. They require more collaborative deep discussion, which we are not ready to go into yet. But I do think there's really a great opportunity to be able to combine these portfolios and then lock a few people in a room and say, okay, now you know what each other's technologies are, be creative about this and come up with something that's really new and I think that's going to be happening.

Harlan Sur - *JPMorgan - Analyst*

Great. Well, we are just about out of time. Mark, I want to thank you very much for joining us here this morning and on a go-forward basis, we will be keeping good track of your automotive performance.

Mark Gill - *Analog Devices, Inc. - VP, Automotive*

Will be a pleasure to come back again.

Harlan Sur - *JPMorgan - Analyst*

Thank you very much. Thanks, Mike.
