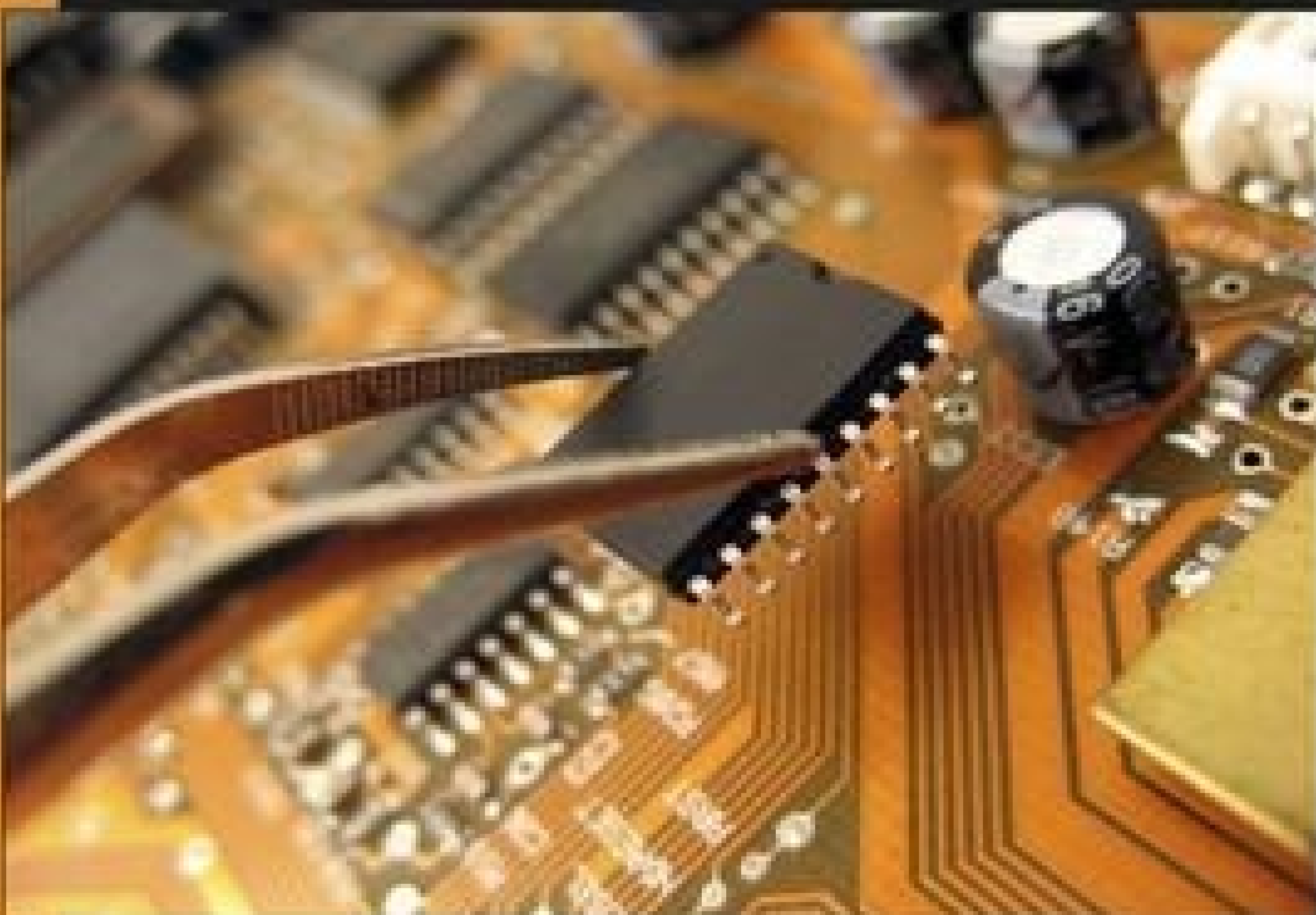
JB Institute of Engineering & Technology

TECHTRONICS



May 2018

Technical Magazine

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2017-2018

Editor: Dr. Towheed Sultana
Dr. Anindya Jana
Mr. Rajkumar D Bhure

Best Complements

from

The Dept. of

ECE

Massage from the Desk of Principal

It gives me immense pleasure and delight to know that the Dept of ECE, JBIET have mooted up a time needed, need based and innovative move, t bring out a domain specific annual magazine, in the name and style of TECHTRONICS while involving all the faculty, staffs, students and the Electronics Engineering fraternity.

The objectives, as spelled out by the Editorial board of the newly emerging magazines are quite sublime, ennobling as well as triggering of and enlightening about the basic concepts and philosophy of knowlwdge Engineering among all the knowledge seekers on all the latest vital, pivotal and critical aspects of the profession in the field of ECE and its technology.

Being the Head of the Institution, I do have all the pleasure and purpose to hai and congratulate the head of the Dept., the faculty, staffs and students of the Dept for their keen and vigorous effort in widening the knowledge base.

Dr. Towheed Sultana
Principal, JBIET

Massage from the Desk of HOD

The INFOQUEST 2018 program conducted by the ECE in this year was a grand success. There was a lot of effort behind this great success. I have a great pleasure in congratulating the INFOQUEST coordinator, Dr. Anindya Jana, Assoc. Prof, Student coordinator and organizers for their laudable effort in this big success. I would like to thank Mrs. K. Snehalatha, Associate Professor, for giving her valuable suggestions and advice to move forward and make the program success.

I would also like to say, special thanks to our Principal madam, for her help and support. I appreciate all the teaching, non teaching and students of the Dept of ECE for their activities in TECHTRONICS to achieve this memorable success.

I am very proud of this moment and I remember this great achievement and sweet memories of this event in my life forever as HOD and I wish all my students for their future career and endeavor.

Dr. Md. Salauddin
HOD, ECE

5G Network

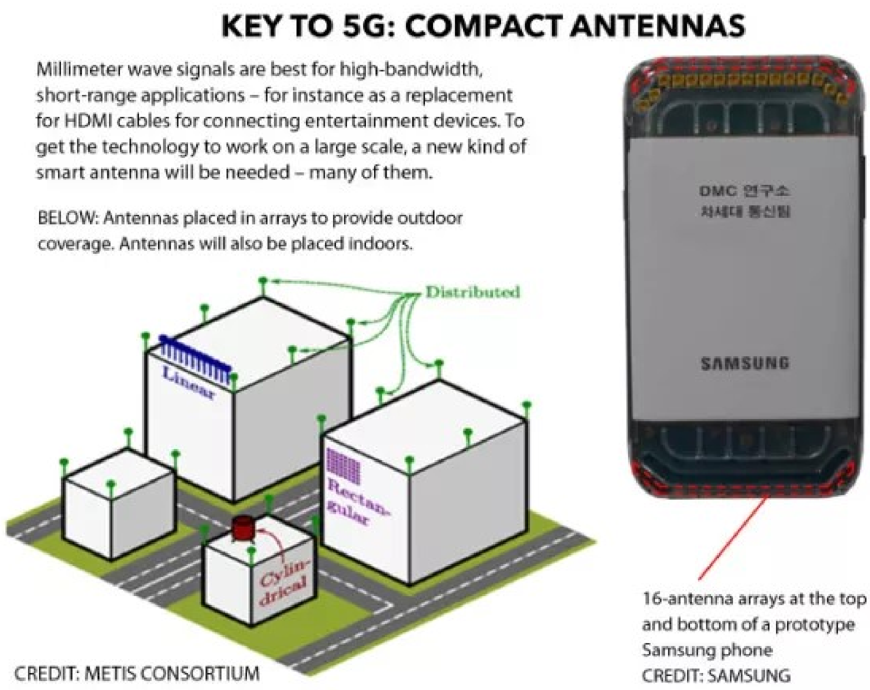
The backbone of the 5G standard is comprised of low-, mid- and high-band spectrum. 5G networks operate on different frequencies with sub-6 GHz and millimeter-wave (20-60 GHz) at the low and high ends of the spectrum.

Carriers were already using sub-6 spectrum for existing LTE networks, and now they need more of it to build out 5G. Millimeter-wave frequency was previously unused, and the advent of 5G has given carriers access to the spectrum that will enable the faster speeds we expect with the new standard.

But mm Wave has a few drawbacks: Because it's so high-frequency, the waves don't travel long distances. In fact, they can't even travel through windows or buildings. That means a device operating on an mmWave-based network, like Verizon, T-Mobile and AT&T's 5G networks, will need to be extremely close to a 5G node to catch a signal.

That's fine in a dense metropolitan area, where you can stick a 5G node every few hundred feet. But in rural areas where there are few buildings or cell towers, mmWave won't work.

That's why both sub-6 and mmWave are necessary to make 5G widespread and high speed. Indeed, at Qualcomm's annual developer get-together this month, Qualcomm president Christian Amon said that real 5G will be a combination of the low, mid, and high-band frequencies.



To that end, Sprint is using its existing midband (2.5 GHz) spectrum to build out its 5G network. At 2.5 GHz, a signal can travel farther but not as fast as with mmWave. We've seen that play out in our testing of Sprint's network, which doesn't deliver the 1 Gbps speeds that mmWave-based networks from its rivals do, but does allow you to catch a signal more reliably.

T-Mobile launched its 5G network using mmWave in a half-dozen cities, but now features a nationwide 5G service using low-bad spectrum that can reach 5,000 cities in addition to some rural areas.

Rollout: When can We expect 5G?

5G is already here, but unless the stars of your location, the wireless carrier you subscribe to and the smartphone you own are perfectly aligned, you probably can't use it yet.

AT&T, Verizon, T-Mobile and Sprint have all launched their 5G networks, but there are caveats. First, there are only a handful of 5G-compatible smartphones on the market. (More on those in a moment.) And with the exception of T-Mobile's newly launched nationwide service, the carriers have launched service only in some parts of certain cities, with little overlap. Even AT&T's newly launched low-band network is available in a limited number of areas at the moment.

What's more, it's evident many smartphone users aren't sure what 5G is. In fact, one in three Americans think they already have 5G, according to a recent study. The results showed that 47% of AT&T subscribers who own iPhones think their device is 5G-capable.

Don't confuse AT&T's 5G plans with the 5GE logo that appears on AT&T customers' phones. That logo translates to "5G Evolution," AT&T's expanded service with advanced LTE technologies, such as 4X4 MIMO, which doesn't hit the speeds we expect from 5G (or even match Verizon's current 4G service, in our testing).

AT&T is sticking by its decision: "We've been talking about 5G Evolution for a while now. We were pretty public about what we were doing and what we were deploying," Igal Elbaz, senior vice president for wireless technology at AT&T, told us at CES 2019.

Dr. V.V. Rao
CEO, JB Group

OUTCOME-BASED EDUCATION (OBE)

OBE is a student-centric teaching and learning methodology in which the course delivery, assessment are planned to achieve stated objectives and outcomes. It focuses on measuring student performance i.e. outcomes at different levels. Some important aspects of the Outcome Based Education

1. Course is defined as a theory, practical or theory cum practical subject studied in a semester. For Eg. Engineering Mathematics

2. Course Outcome (CO) Course outcomes are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its weightage.

3. Program is defined as the specialization or discipline of a Degree. It is the interconnected arrangement of courses, co-curricular and extracurricular activities to accomplish predetermined objectives leading to the awarding of a degree. For Example: B.E., Marine Engineering

4. Program Outcomes (POs) Program outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.

5. Program Educational Objectives (PEOs) The Program Educational Objectives of a program are the statements that describe the expected achievements of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after graduation.

6. Program Specific Outcomes (PSO) Program Specific Outcomes are what the students should be able to do at the time of graduation with reference to a specific discipline. Usually there are two to four PSOs for a program.

7. Graduate Attributes (GA): The graduate attributes, 12 in numbers are exemplars of the attributes expected of a graduate from an accredited program.

Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

Level	Parameter	Description
K1	Knowledge	It is the ability to remember the previously learned material/information.
K2	Comprehension	It is the ability to grasp the meaning of material.
K3	Application	It is the ability to use learned material in new and concrete situations.
K4	Analysis	It is the ability to break down material/concept into its component parts/subsections so that its organizational structure may be understood.
K5	Synthesis	It is the ability to put parts/subsections together to form a new whole material/idea/concept/information.
K6	Evaluation	It is the ability to judge the value of material/concept/statement/creative material /research report) for a given purpose.

The 12 Graduate Attributes in Outcome Based Education

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:**

The problems:

- that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline.
- that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions.
- that require consideration of appropriate constraints/requirements not explicitly given in the problem statement. (like: cost, power requirement, durability, product life, etc.)
- which need to be defined (modeled) within appropriate mathematical framework.
- that often require use of modern computational concepts and tools.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling to complex engineering activities, with an understanding of the limitations

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11.**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Dr. V.V.Rao
CEO, JBIT

Student Article

How to Boost the Output Current Drive Capability of a Composite Op-Amp

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ABSTRACT

There are applications that could be realized with just a single *ideal* op-amp, but cannot be realized in practice with just one *real-life* device because of certain physical limitations. Mercifully, it is often possible to enlist the help of a second amplifier so that the combination of the two, aptly called a *composite amplifier*, can do what the primary amplifier could not do alone.

STABILITY CONSIDERATIONS IN COMPOSITE AMPLIFIERS

The secondary op-amp is usually placed inside the feedback loop of the primary op-amp, as depicted in Figure 1(a). The phase lag introduced by the secondary device tends to erode the phase margin φm of the composite amplifier, so we may have to take suitable frequency compensation measures.

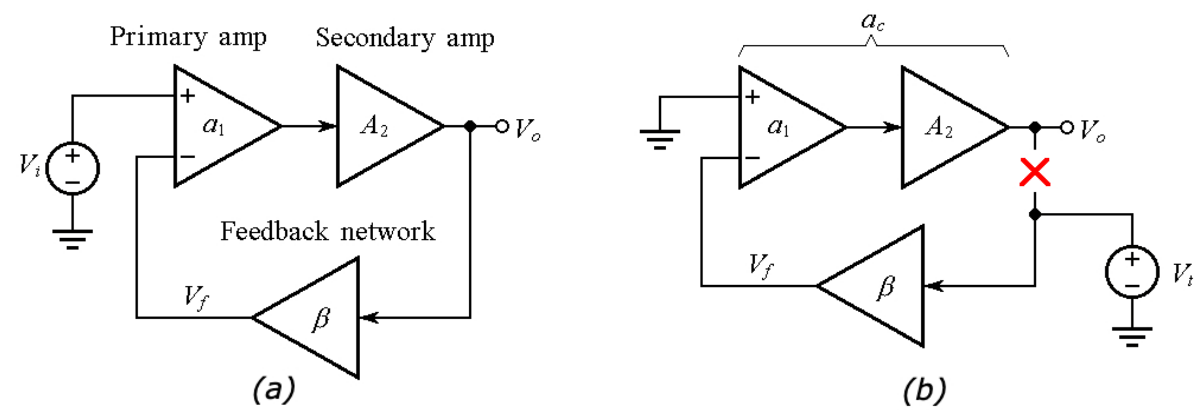

Figure 1. (a) Block diagram of a composite voltage amplifier. (b) Circuit to find the open-loop gain a_c and noise gain 1/β of the composite amplifier.

To assess the stability of the composite amplifier, we shall use the rate-of-closure (ROC) technique. This technique requires that we plot

1. the overall open-loop gain ac (= a1× A2) of the composite amplifier, along with
2. its noise gain 1/β, where β is the feedback factor of the composite amplifier.

Then we refer to Figure 2 to identify the situation at hand and estimate φ_m accordingly.

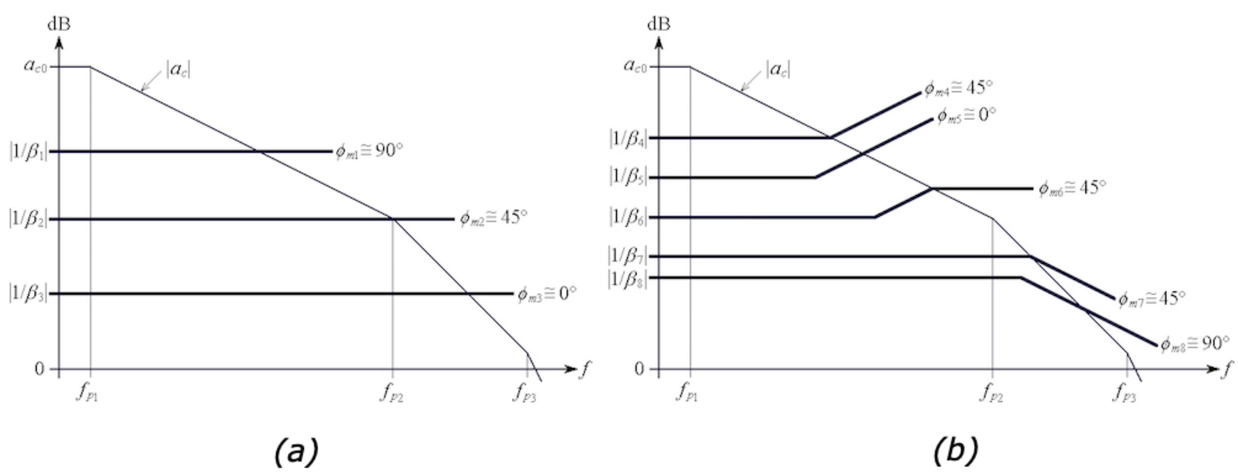

Figure 2. (a) Frequently encountered phase-margin situations with (b) frequency-independent and (b) frequency-dependent noise gain 1/β(jf).

To find ac and 1/β, we break the circuit as in Figure 1(b), where presumably the output impedance of the secondary amplifier is much smaller than the impedance presented by the feedback network. Next, we apply a test voltage Vt , and finally we let

$a_c=V_o-V_f$ac=Vo−Vf **_Equation 1_**

and

$1\beta=V_tV_f$1β=VtVf **_Equation 2_**

BOOSTING THE OUTPUT CURRENT DRIVE CAPABILITY OF AN OP-AMP

Most op-amps are designed to provide output currents of not more than a few tens of milli-Amperes. As an example, the venerable 741 op-amp can handle at most 25 mA of output current. Trying to exceed this value activates some internal watchdog circuitry that prevents the actual current from increasing further.

Under this condition, the op-amp will no longer function properly, but at least it will be protected from possible damage due to excessive power dissipation.

A popular way to boost an op-amp's output current drive capability is by means of a voltage buffer as exemplified in Figure 3(a).

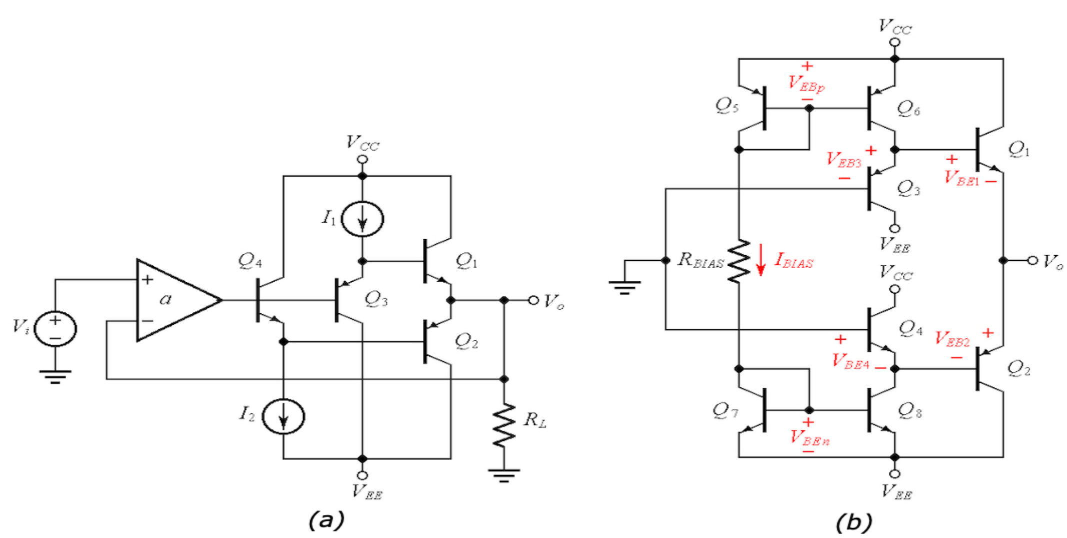

Figure 3. (a) Using a buffer to boost an op-amp's output current drive. (b) Detailed buffer schematic.

The function of Q1 is to source (or push) current to the load RL, whereas that of Q2 is to sink (or pull) current out of RL; hence the reason why the Q1-Q2 pair is said to form a push-pull output stage. Transistors Q3 and Q4 serve a dual purpose:

- They provide a Darlington-type function to raise the current gain from the input to the output node.
- Their base-emitter voltage drops are designed to keep Q1 and Q2 already conductive even in the absence of any output load, this being the reason why Q1 and Q2 are also said to form a class AB output stage. Class AB operation prevents the distortion inherent to Class B operation.

For a more detailed analysis, refer to the full-blown schematic of Figure 3(b), where we note the following:

The Q5-Q6 and the Q7-Q8 pairs form two current mirrors sharing the same bias current IBIAS, where

$$I_{BIAS}=(V_{CC}-V_{EBp})-(V_{EE}+V_{EBn})R_{BIAS}$$ IBIAS=(VCC−VEBp)−(VEE+VEBn)RBIAS ***Equation 3***

- Q6 and Q8 mirror IBIAS and use it to bias Q3 and Q4, respectively. As a consequence, Q3 and Q4 develop the base-emitter voltage drops VEB3 and VBE4.
- In response to VEB3 and VBE4, Q1 and Q2 develop the base-emitter drops VBE1 and VEB2 such that

$$V_{BE1}+V_{EB2}=V_{EB3}+V_{BE4}$$ VBE1+VEB2=VEB3+VBE4 ***Equation 4***

- In the absence of any load, Q1 and Q2 must draw the same current. In view of Equation 4, the common current drawn by Q1 and Q2 must equal that drawn by Q3 and Q4, which is IBIAS. Consequently, with no load, the collector currents satisfy the condition IC1 = IC2 = IC3 = IC4 = IBIAS.

In the next article, we'll expand this conversation by simulating our voltage buffer in PSpice and utilize that analysis to boost our 741 op-amp's current output drive.

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Square Wave-Based Synchronous Demodulator

The block diagram of the square wave-based synchronous demodulator is shown in Figure 1.

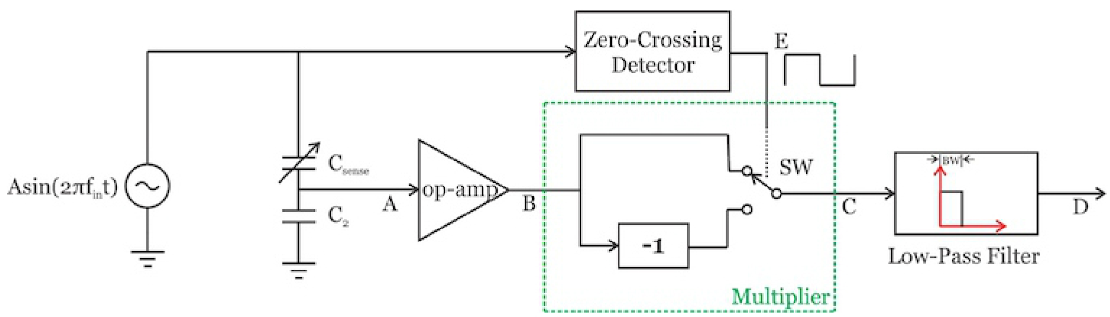

Figure 1. Square wave-based synchronous demodulator

The two blocks that we'll examine are the "zero-crossing detector" and the "multiplier."

Zero-crossing Detector

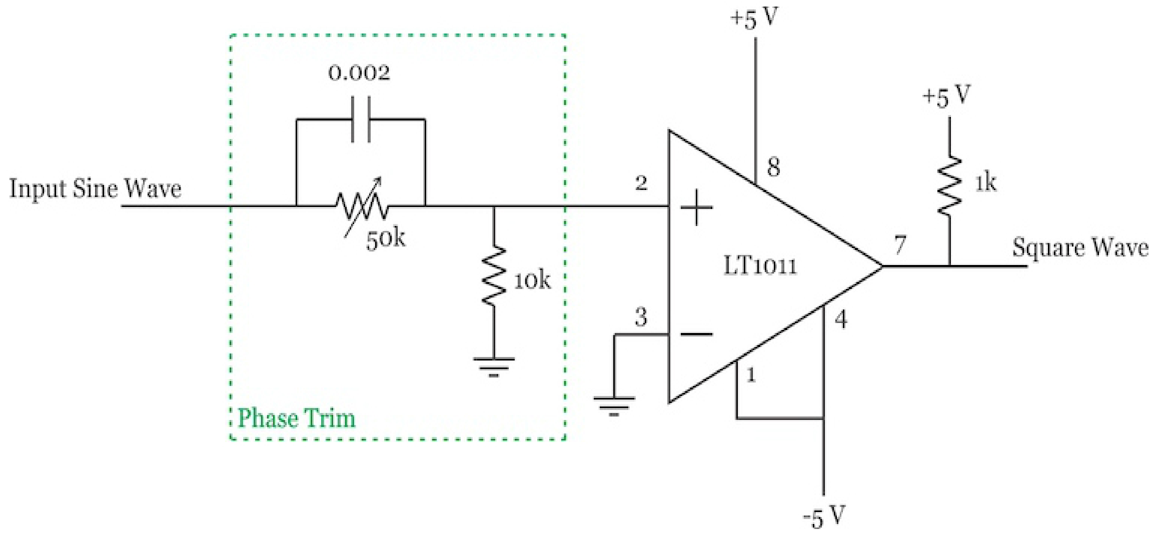

Figure 2. The zero-crossing detector block in a synchronous demodulator. Schematic used courtesy of Linear Technology

The **LT1011** is a voltage comparator that compares the input sine wave with the ground level. The potentiometer is used to adjust the phase of the produced square wave so that it matches the phase of the sine wave at node B in Figure 1.

In this way, we can have a square wave that switches when the sine wave crosses 0 V. Recall that the signal amplitude at the output of the multiplier is a function of the phase difference between the two inputs of the multiplier. When the square wave is in phase with the sine wave, the phase relationship between the two signals is known and we can more easily interpret the voltage that appears at the output of the low-pass filter.

Multiplier

One common implementation for the "Multiplier" block is shown in Figure 3:

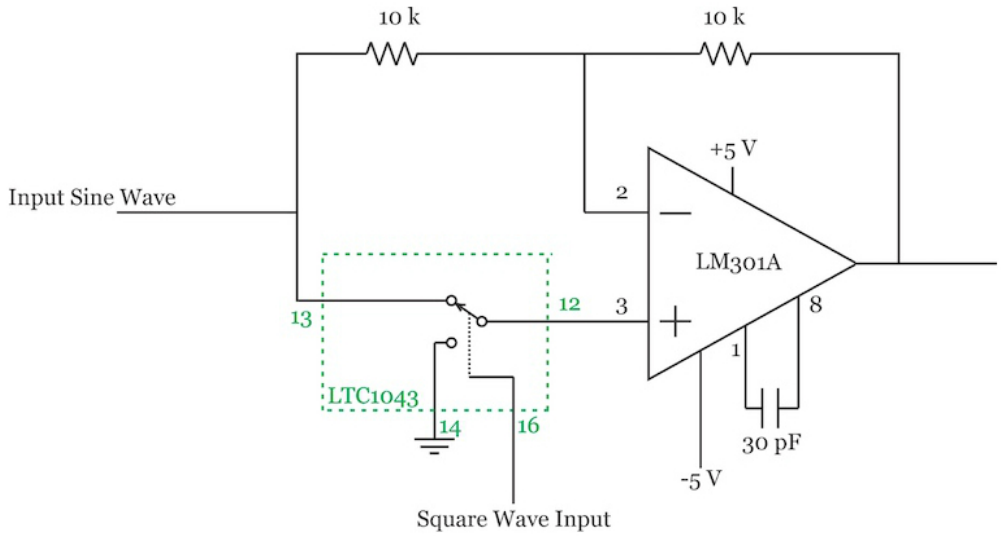

Figure 3. The multiplier block of the example synchronous demodulator. Schematic used courtesy of Linear Technology

In this figure, the LM301A is a general-purpose operational amplifier. The LTC1043 is a building block originally designed for implementing discrete switched-capacitor circuits. Figure 4 shows a simplified block diagram of a portion of the circuitry inside the LTC1043.

As shown in this figure 4, the differential input is connected to an external capacitor during the sampling phase. During the next phase, the charged capacitor is connected to the output port. The clock for the switches can be created either internally or through an external CMOS clock.

This apparently simple functionality allows us to use the LTC1043 in a variety of applications such as precision instrumentation amplifiers and switched-capacitor filters. However, with the schematic shown in Figure 3, the LTC1043 is actually used as a simple switch.

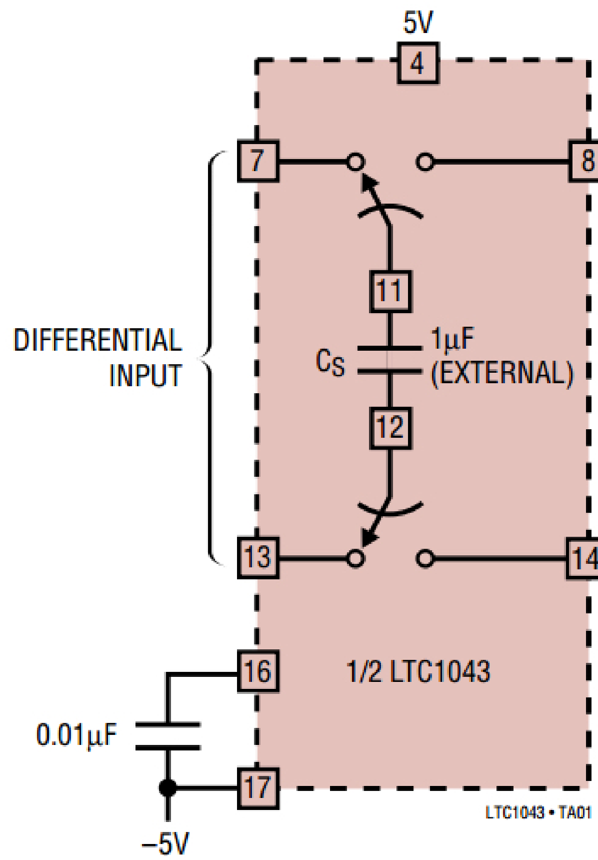

Figure 4. Diagram of the LTC1043. Image courtesy of Linear Technology

Let's see how this circuit can multiply the input by a square wave. When the switch connects terminals 12 and 14 together, we have the following schematic.

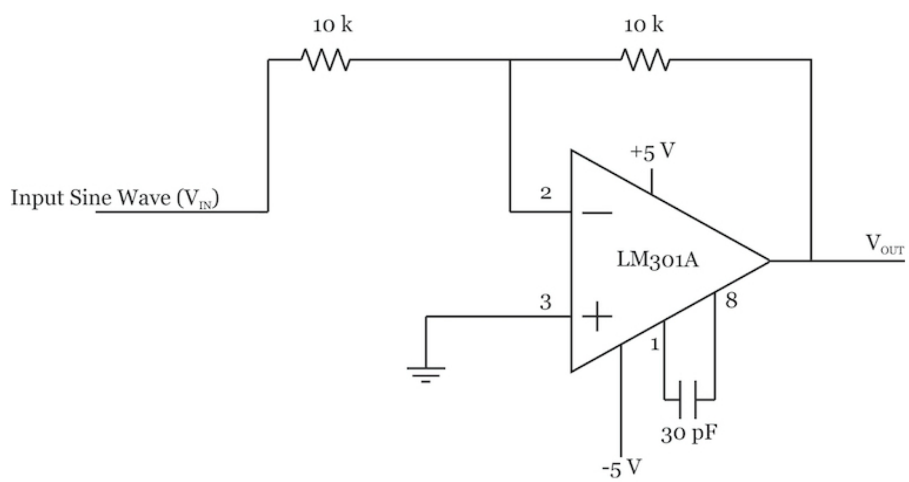

Figure 5

In this phase of operation, we have an inverting amplifier with a gain of VOUTVIN=−1VOUTVIN=−1. However, when terminals 12 and 13 of the LTC1043 are connected together, we obtain the following schematic:

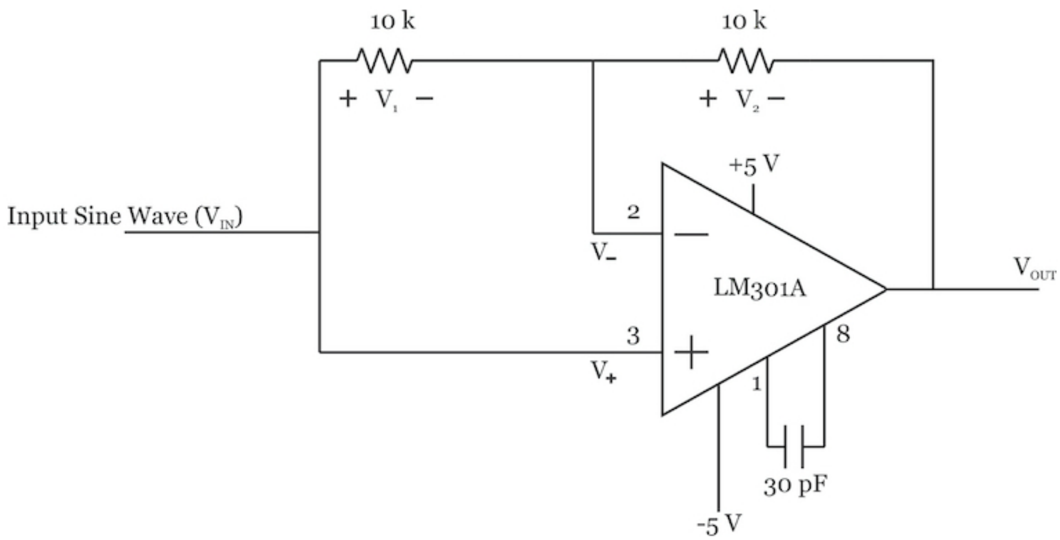

Figure 6. Connecting terminals 12 and 13 of the LTC1043

We know that due to the negative feedback path and the high gain of the op-amp, the two inputs of the op-amp have almost the same voltage: V−=V+V−=V+. Therefore, V1=0VV1=0V and no current flows through the 10 kΩ resistor on the left.

Assuming that the current drawn by the op-amp inputs is negligible, the current through the 10 kΩ resistor in the feedback path will be zero as well and we have V2=0VV2=0V. Therefore, in this phase of operation, we have a gain of VOUTVIN=+1VOUTVIN=+1. In other words, the input is multiplied by a square wave that toggles between ±1.

Digital Implementation of Synchronous Demodulation

Rather than using analog building blocks, we can use digital circuits to implement a synchronous demodulator. The basic idea is shown in Figure 7.

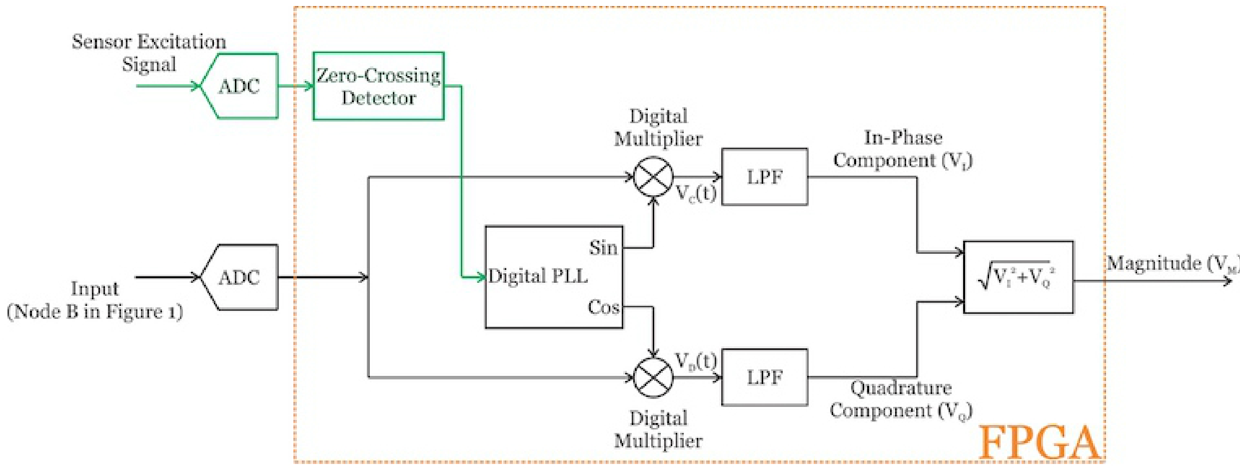

Figure 7. A digital synchronous demodulator circuit

Two A/D converters (ADCs) are used to digitize the input signal (node B in Figure 1) and the sensor excitation sine wave. As shown in the figure, the other blocks are digital and can be implemented by an FPGA.

Digital PLL

It is important to note that the digital PLL in Figure 7 must generate samples of sine and cosine waveforms. We can accomplish this by using a PLL that has a direct digital synthesizer (DDS) as its digitally controlled oscillator (DCO). The basic idea is shown in Figure 8.

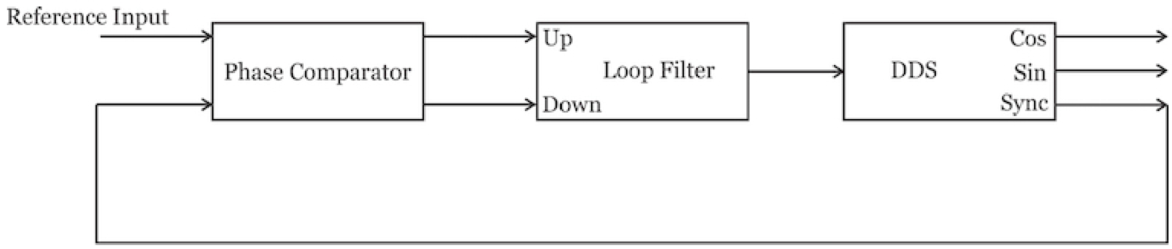

Figure 8. A PLL with a direct digital synthesizer. Image adapted from Cornell University

You can find more information about FPGA implementation of a synchronous demodulator here.

Conclusion

In this article, we examined both the analog and digital implementation of the synchronous demodulation technique:

For the analog implementation, we need a "**zero-crossing detector**" and a "**multiplier**".

For the digital version, we can use two ADCs to digitize the measured signal and the sensor excitation waveform.

The other blocks can be implemented in an FPGA. By implementing both the in-phase and the quadrature paths, we can make the measurement independent of the phase difference between the multiplier inputs. For the digital implementation, we need a PLL that generates samples of sine and cosine waveforms. This can be achieved by a PLL that uses a DDS as a programmable oscillator.

Number Puzzles

1. Find a 10-digit number where the first digit is how many zeros in the number, the second digit is how many 1s in the number etc. until the tenth digit which is how many 9s in the number.

2. Use the numerals 1, 9, 9 and 6 exactly in that order to make the following numbers: 28, 32, 35, 38, 72, 73, 76, 77, 100 and 1000. You can use the mathematical symbols +, -, ×, /, √, ^ (exponent symbol) and brackets.

   Example: $1\times9+9\times6 = 63$

3. Two Fathers and Two Sons Riddle

   Two fathers and two sons sat down to eat eggs for breakfast. They ate exactly three eggs, each person had an egg. The riddle is for you to explain how.

Swami Vivekananda

- When an idea exclusively occupies the mind, it is transformed into an actual physical or mental state.

- All the powers in the universe are already ours. It is we who have put our hands before our eyes and cry that it is dark.

- The more we come out and do good to others, the more our hearts will be purified, and God will be in them.

- Where can we go to find God if we cannot see Him in our own hearts and in every living being.