Specialized English on Telecommunications

电子信息类专业英语

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本书根据电子信息类专业的特点，选编了电路、模拟电子技术、数字电子技术、交直流电机、计算机技术、电子应用技术、通信技术、控制技术、船舶电气和助渔导航设备与系统等领域的原理性和综述性文章，旨在帮助读者掌握和扩大电子信息类专业术语和英语词汇量，提高阅读和理解原版英文文献的能力，掌握英语翻译方法和技巧，为今后了解国内外电子信息技术的新发展和新动态，为从事科学研究、调试安装和维护进口电子仪器设备打下坚实的基础。

本书可作为高等院校电子信息类专业的专业英语教材，也可供从事相关专业的工程技术人员参考使用。

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前　言

随着国内外电子信息产业的飞速发展，熟练阅读和翻译英文文献已成为了解电子信息产业最新动态、进行国际间科学技术交流必不可少的基本技能。本书根据电子信息类专业的特点，选编了电路、模拟电子技术、数字电子技术、船舶电气、探鱼设备与系统、计算机技术、通信技术、电子应用技术与控制技术领域的原理性和综述性文章，帮助读者进一步掌握电子信息类专业术语和英语词汇，提高阅读和理解原版英文文献的能力，掌握英语翻译方法和技巧，为今后了解国内外电子信息技术的新发展和新动态，为从事科学研究、调试安装和维护进口电子仪器设备，打下坚实的基础。

在教材选编过程中，力图将电子信息类专业代表性强的原版章节纳入教材中。各篇课文既相互独立又相互渗透，具有一定的内在联系，按拓宽专业口径、注重学科交叉的原则，由浅入深地将选编内容归纳分类，以便于学习、理解和掌握。

在教学中，为提高学生的自学能力和实践能力，对专业性较强和实践性较强的部分，可组织专题讨论或结合具体设备进行现场教学。

郭连喜教授审阅了原稿，提出许多宝贵的意见和建议，在此表示真诚的感谢！本书在编写过程中得到信息工程学院电工教研室的王世尧老师和丛吉远老师、自动化教研室的崔新忠老师、院办公室的高燕萍老师的热情帮助，在此表示由衷的感谢！

本教材涉及面较广，由于水平和经验有限，难免有欠妥之处，请各位专家读者不吝赐教。

编　者

目 录

前 言

Part I Fundamentals of Electronics

UNIT 1 Circuits

1.1 Circuit Elements

There are five ideal basic circuit elements: voltage sources, current sources, resistors, inductors, and capacitors. In this part we discuss the characteristics of voltage sources, current sources, resistors, inductors and capacitors.

Although this may seem like a small number of elements with which to begin analyzing circuits, many practical systems can be modeled with just sources and resistors. They are also a useful starting point because of their relative simplicity; the mathematical relationships between voltage and current in sources and resistors are algebraic. The basic analytical techniques for solving circuits with inductors and capacitors you must solve integral and differential equations. So, by the time you need to begin manipulating more difficult equations.

Voltage and Current Sources

Before discussing ideal voltage and current sources, we need to consider the general nature of electrical sources. An electrical source is a device that is capable of converting non-electrical energy to electric energy and vice versa. A discharging battery converts chemical energy to electric energy whereas a battery being charged converts electric energy to chemical energy. A dynamo is a machine that converts mechanical energy to electric energy and vice versa. If operating in the mechanical-to-electric mode, it is called a generator. If transforming from electric to mechanical energy it is referred to as a motor. The important thing to remember about these sources is that they can either deliver or absorb electric power, generally maintaining either voltage or current. This behavior is of particular interest for circuit analysis and lead to the creation of the ideal voltage source and the ideal current source as basic circuit elements. The challenge is to model practical sources in terms of the ideal basic circuit elements.

An ideal voltage source is a circuit element that maintains a prescribed voltage across its terminals regardless of the current flowing in those terminals. Similarly, an ideal current source is a circuit element that maintains a prescribed current through its terminals regardless of the voltage across those terminals. These circuit elements do not exist as practical devices-they are idealized models of actual voltage and current sources.

Using an ideal model for current and voltage sources places an important restriction on how we may describe them mathematically. Because an ideal voltage source provides a steady voltage, even if the current in the element changes, it is impossible to specify the current in an ideal voltage source as a function of its voltage. Likewise, if the only information you have about an ideal current source is the value of current supplied, it is impossible to determine the voltage across that current source. We have sacrificed our ability to relate voltage and current in a practical source for the simplicity of using ideal sources in circuit analysis.

Ideal voltage and current source can be further described as either independent source or dependent source. An independent source establishes a voltage or current in a circuit without relying on voltages or currents elsewhere in the circuit. The value of the voltage or current supplied is specified by the value of the independent source alone, In contrast, a dependent source establishes a voltage or current whose value depends on the value of a voltage or current elsewhere in the circuit. You cannot specify the value of a dependent source unless you know the value of the voltage or current on which it depends.

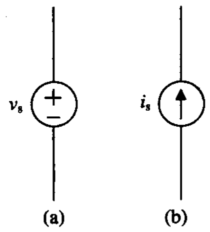


Fig.1.1.1 The circuit symbols for
(a) an ideal independent voltage source and
(b) an ideal independent current source

The circuit symbols for the ideal independent sources are shown in Fig. 1.1.1. Note that a circle is used to represent an independent source. To completely specify an ideal independent voltage source in a circuit, you must include the value of the supplied voltage and the reference polarity, as shown in Fig. 1.1.1 (a). Similarly, to completely specify an ideal independent current source, you must include the value of the supplied current and its reference direction, as shown in Fig. 1.1.1 (b).

The circuit symbols for the ideal dependent sources are shown in Fig. 1.1.2. A diamond is used to represent a dependent source. Both the dependent current source and the dependent voltage source may be controlled by either a voltage or a current elsewhere in the circuit, so there are a total of four variations, as indicated by the symbols in Fig.1.1.2. Dependent sources are sometimes called controlled sources.

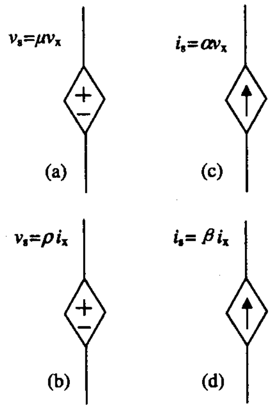


Fig.1.1.2 The circuit symbols for:
(a) an ideal dependent voltage-controlled voltage source
(b) an ideal dependent current-controlled voltage source
(c) an ideal dependent voltage-controlled current source
(d) an ideal dependent current-controlled current source

To completely specify an ideal dependent voltage-controlled voltage source, you must identify the controlling voltage, the equation that permits you to compute the supplied voltage from the controlling voltage, and the reference polarity for the supplied voltage. In Fig. 1.1.2(a), the controlling voltage is named v_x, the equation that determines the supplied voltage v_s is

$$v_s = \mu v_x \tag{1.1.1}$$

and the reference polarity for v_s is as indicated. Note that μ is a multiplying constant that is dimensionless.

Similar requirements exist for completely specifying the other ideal dependent sources. In Fig. 1.1.2(b), the controlling current is i_x, the equation for the supplied voltage v_s is

$$v_s = \rho i_x \tag{1.1.2}$$

the reference polarity is as shown, and the multiplying constant ρ has the dimension volts per ampere. In Fig.1.1.2(c), the controlling voltage is v_x, the equation for the supplied current i_s is

$$i_s = \alpha v_x \tag{1.1.3}$$

the reference direction is as shown, and the multiplying constant α has the dimension amperes per volt. In Fig.1.1.2 (d), the controlling current is i_x, the equation for the supplied current i_s is

$$i_s = \beta i_x \tag{1.1.4}$$

the reference direction is as shown, and the multiplying constant β is dimensionless.

Finally, in our discussion of ideal sources, we note that they are examples of active circuit elements. An active element is one that models a device capable of generating electric energy. Passive elements model physical devices that cannot generate electric energy. Resistors, inductors, and capacitors are examples of passive circuit elements. Examples Fig. 1.1.1 and Fig. 1.1.2 illustrate how the characteristics of ideal independent and dependent sources limit the types of permissible interconnections of the sources.

Electrical Resistance (Ohm's LAW)

Resistance is the capacity of materials to impede the flow of current or more specifically, the flow of electric charge[1]. The circuit element used to model this behavior is the resistor. Fig.1.1.3 shows the circuit symbol for the resistor with R denoting the resistance value of the resistor.

Fig. 1.1.3 The circuit symbols for a resistor having a resistance *R*

Conceptually we can understand resistance if we think about the moving electrons that make up electric current interacting with and being resisted by the atomic structure of the material through which they are moving[2]. *In the course of these interactions, some amount of electric energy is converted to thermal energy and dissipated in the form of heat* [3]. This effect may be undesirable. However, many useful electrical devices take advantage of resistance heating, including stoves, toasters, irons, and space heaters.

Most materials exhibit measurable resistance to current. The amount of resistance depends on the material. Metals such as copper and aluminum have small values of resistance, making them good choices for wiring used to conduct electric current. In fact, when represented in a circuit diagram, copper or aluminum wiring isn't usually modeled as a resistor; the resistance of the wire is so small compared to the resistance of other elements in the circuit that we can neglect the wiring resistance to simplify the diagram.

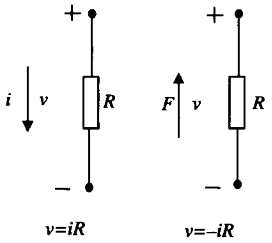


Fig. 1.1.4 Two possible reference choice for the current and voltage at the terminals of a resistor, and the resulting equations

For purposes of circuit analysis, we must reference the current in the resistor to the terminal voltage. We can do so in two ways: either in the direction of the voltage drop across the resistor or in the direction of the voltage rise across the resistor, as shown in Fig. 1.1.4. If we choose the former the relationship between the voltage and current is

$$v = iR \tag{1.1.5}$$

where v——the voltage in volts
i——the current in amperes
R——the resistance in ohms

If we choose the second method, we must write

$$v = -iR \tag{1.1.6}$$

where v, i and R are, as before, measured in volts, amperes, and ohms, respectively[4]. The algebraic signs used in Eqs. (1.1.5) and (1.1.6) are a direct consequence of the passive sign convention, which we introduce in Unit 1.

Equations (1.1.5) and (1.1.6) are known as Ohm's law after Georg Simon Ohm, a German physicist who established its validity early in the nineteenth century. Ohm's law is the algebraic relationship between voltage and current for a resistor. In SI units, resistance is measured in ohms. The Greek letter omega (Ω) is the standard symbol for an ohm.

We may calculate the power at the terminals of a resistor in several ways. The first approach is to use the defining equation and simply calculate the product of the terminal voltage and current. For the reference systems shown in Fig. 1.1.4, we write

$$p = vi \tag{1.1.7}$$

when $v=iR$ and

$$p = -vi \tag{1.1.8}$$

when $v=-iR$.

A second method of expressing the power at the terminals of a resistor expresses power in terms of the current and the resistance. Substituting Eq. (1.1.5) into Eq. (1.1.7), we obtain

$$p = vi = (iR)i = i^2R \tag{1.1.9}$$

Likewise, substituting Eq. (1.1.6) into Eq. (1.1.8), we have

$$p = -vi = -(-iR)i = i^2R \tag{1.1.10}$$

Equations (1.1.9) and (1.1.10) are identical and demonstrate clearly that, regardless of voltage polarity and current direction, the power at the terminals of a resistor is positive. Therefore, a resistor absorbs power from the circuit.

A third method of expressing the power at the terminals of a resistor is in terms of the voltage and resistance. The expression is independent of the polarity references, so

$$p = \frac{v^2}{R} \tag{1.1.11}$$

The Inductor

Inductance is the circuit parameter used to describe an inductor. Inductance is symbolized by the letter *L*, is measured in henrys (H) and is represented graphically as a coiled wire-a reminder that inductance is a consequence of a conductor linking a magnetic. Fig.1.1.5 (a) shows an inductor. Assigning the reference direction of the current in the direction of the voltage drop across the terminals of the inductor as shown in Fig.1.1.5 (b), yields

$$v = L\frac{\mathrm{d}i}{\mathrm{d}t} \tag{1.1.12}$$

where v is measured in volts, L in henrys, i in amperes, t in seconds. Equation (1.1.12) reflects the passive sign convention shown in Figl.1.5 (b); that is, the current reference is in the direction of the voltage drop across the inductor. If the current reference is in the direction of the voltage rise, Eq. (1.1.12) is written with a minus sign.

Note from Eq. (1.1.12) that the voltage across the terminals of an inductor is proportional to the time rate of change of the current in the inductor. We can make two important observations here. First, if the current is constant, the voltage across the ideal inductor is zero. Thus the inductor behaves as a short circuit in the presence of a constant or dc current. Second, current cannot change instantaneously in an inductor that is; the current cannot change by a finite amount in zero time. Equation (1.1.12) tells us that this change would require an infinite voltage, and infinite voltages are not possible. For example, when someone opens the switch on an inductive circuit in an actual system, the current initially continues to flow in the air across the switch, a phenomenon called arcing. The arc across the switch prevents the current dropping to zero instantaneously. Switching inductive circuits is an important engineering problem, because arcing and voltage surges must be controlled to prevent equipment damage. The first step to understand the nature of this problem is to master the inductor material presented in this and the following two parts.

The Capacitor

The circuit parameter of capacitance is represented by the letter C, is measured in farads (F), and is symbolized graphically by two short parallel conductive plates, as shown in Fig. 1.1.5(c). Because the farad is an extremely large quantity of capacitance, practical capacitor values usually lie in the picofarad (pF) to microfarad (μF) range.

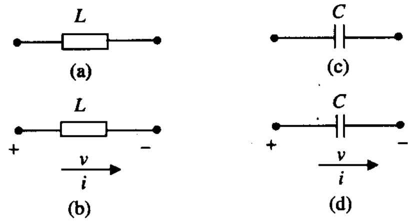


Fig. 1.1.5

(a) The circuit symbol for a inductor

(b) Assigning reference voltage and current to the inductor

(c) The circuit symbol for a capacitor

(d) Assigning reference voltage and current to the capacitor

The graphic symbol for a capacitor is a reminder that capacitance occurs whenever electrical conductors are separated by a dielectric, or insulating material. This condition implies that electric charge is not transported through the capacitor. Although applying a voltage to the terminals of the capacitor cannot move a charge through the dielectric, it can displace a charge within the dielectric. As the voltage varies with time, the displacement of charge also varies with time, causing what is known as the displacement current.

At the terminals, the displacement current is indistinguishable from conduction current. The current is proportional to the rate, at which the voltage across the capacitor varies with time, or mathematically,

$$i = C\frac{\mathrm{d}v}{\mathrm{d}t} \tag{1.1.13}$$

where i is measured in amperes, C in farads, v in volts, and t in seconds.

Equation (1.1.13) reflects the passive sign convention shown in Fig.1.1.5 (d); that is, the current reference is in the direction of the voltage drop across the capacitor. If the current reference is in the direction of the voltage rise, Eq. (1.1.13) is written with a minus sign.

Two important observations follow from Eq. (1.1.13). First, voltage cannot change instantaneously across the terminals of a capacitor Equation (1.1.13) indicates that such a change would produce infinite current a physical impossibility. Second, if the voltage across the terminals is constant, the capacitor current is zero. The reason is that conduction current cannot be established in the dielectric material of the capacitor. Only a time-varying voltage can produce a displacement current. Thus a capacitor behaves as an open circuit in the presence of a constant voltage.

Equation (1.1.13) gives the capacitor current as a function of the capacitor voltage. Expressing the voltage as a function of the current is also useful. To do so, we multiply both sides of Eq. (1.1.13) by a differential time dt and then integrate the resulting differentials:

$$i\mathrm{d}t = C\mathrm{d}v \quad \text{or} \quad \int_{v(t_0)}^{v(t)} \mathrm{d}x = \frac{1}{C}\int_{t_0}^{t} i\,\mathrm{d}\tau$$

Words and Expressions

fundamental	*n.*	基本原理
resistor	*n.*	电阻（器）
inductor	*n.*	电感线圈，电感器
capacitor	*n.*	电容器
characteristic	*n.*	性能，特征，特性
model	*v.*	模仿，模拟
algebraic	*adj.*	代数的，显而易见的
manipulate	*v.*	熟练地使用
device	*n.*	器械，仪表，设备，装置
discharge	*v.*	放电
dynamo	*n.*	直流永磁发电机
transform	*v.*	转换
in terms of		从……方面来说
prescribe	*v.*	规定
across its terminal		通过接线端
restriction	*n.*	限制
sacrifice	*v.*	牺牲，献出，供奉
polarity	*n.*	极性
dimensionless	*adj.*	量纲为 1 的，无因次的
multiply	*v.*	乘，使相乘
ampere	*n.*	安培
impede	*v.*	妨碍，阻碍，阻止
dissipate	*v.*	浪费，消耗
toaster	*n.*	烤面包器
substitute	*v.*	替换
magnetic	*adj.*	磁的
be proportional to		成比例的
arcing	*n.*	电弧放电，产生电弧
dielectric	*adj.*	绝缘的

NOTES

1. Resistance is the capacity of materials to impede the flow of current, or more specifically, the flow of electric charge.

   不定式短语“to impede the flow of current”是“capacity”的后置定语；“the flow of electric charge”是“impede”的宾语。

   电阻是指材料阻碍电流或电荷流动的能力。

2. Conceptually we can understand resistance if we think about the moving electrons that make up electric current interacting with and being resisted by the atomic structure of the material through which they are moving.

   定语从句“that make up electric current”修饰“the moving electrons”；分词“interacting with and being resisted by the atomic structure of the material”做后置定语，也修饰“the moving electrons”；定语从句“through which they are moving”修饰“the atomic structure of the material”。

   从概念上可理解为：移动的电荷相互影响和材料的原子结构阻碍电流电荷的运动产生电阻。

3. In the course of these interactions, some amount of electric energy is converted to thermal energy and dissipated in the form of heat.

   在相互作用过程中，一些电能会转化成热能，并以热的形式散发出去。

4. If we choose the second method, we must write $v=-iR$, where v, i and R are, as before, measured in volts, amperes, and ohms, respectively.

"Where v, i and R are, as before, measured in volts, amperes, and ohms, respectively." 是非限定性定语从句。"respectively" 译为 "一一对应的"。
如果我们选择了第二种方式，公式应写为 $v=-iR$，这里 v、i and R 分别以伏特、安培和欧姆进行计量。

1.2 Signal Sources

The Complete Measurement System

An acquisition instrument — usually an oscilloscope or logic analyzer— is probably the first thing that comes to mind when you think about making electronic measurements. But these tools can only make a measurement when they are able to acquire a signal of some kind. And there are many instances in which no such signal is available unless it is externally provided.

A strain gauge amplifier, for example, does not produce signals; it merely increases the power of the signals it receives from a sensor. Similarly, a multiplexer on a digital address bus does not originate signals; it directs signal traffic from counters, registers, and other elements. But inevitably it becomes necessary to test the amplifier or multiplexer before it is connected to the circuit that feeds it. In order to use an acquisition instrument to measure the behavior of such device, you must provide a stimulus signal at the input.

To cite another example, engineers must characterize their emerging designs to ensure that the new hardware meets design specifications across the full range of operation and beyond[1]. This is known as margin or limit testing. It is a measurement task that requires a complete solution one that can generate signals as well as make measurements.

The toolset for digital design characterization differs from its counterpart in analog/mixed signal design, but both must include stimulus instruments and acquisition instruments. The signal source, or signal generator, is the stimulus source that pairs with an acquisition instrument to create the two elements of a complete measurement solution.

What is a Signal Source

A signal source is nothing less than the cornerstone of almost any instrumentation setup used in hardware design, debug, or evaluation projects. It is a key engineering tool. It is an essential troubleshooting aid for the technician. It is a surrogate for an automotive ignition pulse, a heart pacemaker, or a guided missile's gyro output.

Unless you're working with a purely DC circuit, your circuit is likely to require some kind of AC stimulus signal as you evaluate components, functional blocks, and subsystems. The waveform from the signal source emulates a signal coming in from the outside world, such as a sensor output. Similarly, it can be used as a stand-in for waveforms that will appear in as-yet-unavailable parts of the circuit design.

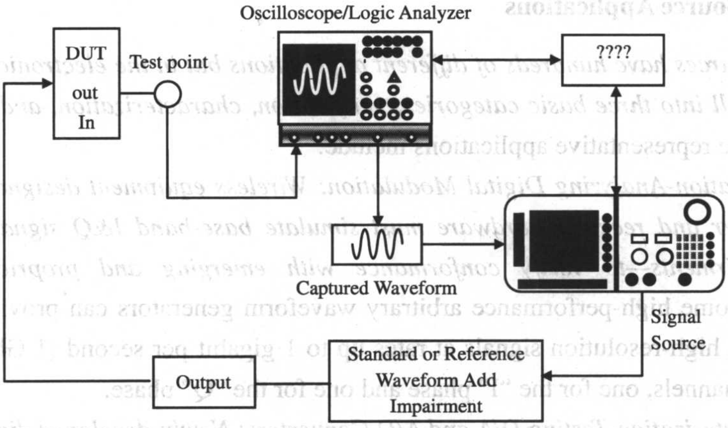
Interestingly, the signal source's job is not simply to provide an "ideal" waveform. Often the instrument must add known, repeatable amounts and types of distortion (or errors) to the signal it delivers. This characteristic is one of the signal source's strongest virtues, since it is often impossible to create predictable distortion exactly when and where it's needed using only the circuit itself. The response of the unit-under-test (UUT) in the presence of these distorted signals reveals its ability to handle stresses that fall outside the normal performance envelope.

A stimulus signal may take the form of a low-distortion sine wave, a stream of logic pulses, a high-frequency radio carrier wave, a mobile telephone transmission, and many other formats. Traditionally, the task of producing these diverse waveforms has been filled by separate, dedicated signal sources, from ultra-pure audio sine-wave generators to multi-GHz RF signal generators. While there are many commercial solutions, the users must often custom-design or modify a signal source for the project at hand. It can be very difficult to design an instrumentation-quality signal generator, and of course, the time spent designing ancillary test equipment is a costly distraction from the project itself.

Fortunately, digital sampling technology and signal processing techniques have brought us a solution that answers almost any kind of signal generation need with just one type of instrument— the arbitrary generator.

Types of Digital Signal Sources

Broadly divided into arbitrary waveform generators (AWG), arbitrary function generators (AFG), and data or pattern generators (DG), digital signal sources span the whole range of signal-producing needs. Each of these types has its unique strengths:



Figl.1.6 Signal source can use standard, user-created, or captured waveforms, adding impairment where necessary for special test applications

AWG: Whether you want a data stream shaped by a precise Lorentzian pulse for disk-drive characterization, or a complex modulated RF signal to test a GSM-or CDMA—based telephone handset, the AWG can produce any waveform you can imagine. You can use a variety of methods— from mathematical formulae to "drawing" the waveform — to create the needed output.

AFG: Typically this instrument offers fewer waveform variations, but with excellent stability and fast response to frequency changes. If the UUT requires the classic "sine and square" waveforms (to name a few) and the ability to switch almost instantly between two frequencies, the AFG is the right tool. An additional virtue is the AFG's low cost, which makes it very attractive for applications that do not require an AWG's versatility.

DG: This third type of signal source meets the special stimulus needs of digital devices that require long, continuous streams of binary data, with specific information content and timing characteristics.

Signal Generation Techniques

There are several ways to create waveforms with a signal source. The choice of methods depends upon the information available about the DUT and its input requirements; whether there is a need to add distortion or error signals, and other variables. Modern high-performance signal sources offer at least three ways to develop waveforms:

Simulation: "Building" an event or sequence of events, based on a specific waveform definition (often from a simulator or a library of waveforms)

Replication: Capturing an existing signal on an oscilloscope and sending it to the signal source for reproduction (Fig. 1.1.6)

Substitution: Creating and/or modifying a defined signal to substitute for a signal from unavailable circuitry (Fig. 1.1.6)

Basic Signal Source Applications

Signal sources have hundreds of different applications but in the electronic measurement context they fall into three basic categories: verification, characterization, and stress/margin testing[2]. Some representative applications include:

1) *Verification-Analyzing Digital Modulation: Wireless equipment designers developing new transmitter and receiver hardware must simulate base-band I&Q signals— with and without impairments—to verify conformance with emerging and proprietary wireless standards*[3]. Some high-performance arbitrary waveform generators can provide the needed low-distortion, high-resolution signals at rates up to 1 gigabit per second (1 Gbps), with two independent channels, one for the "I" phase and one for the "Q" phase.

2) *Characterization-Testing D/A and A/D Converters: Newly-developed digital-to-analog converters (DAC) and analog-to-digital converters (ADC) must be exhaustively tested to determine their limits of linearity, monotonicity, and distortion*[4]. A state-of-the-art AWG can generate simultaneous, in-phase analog and digital signals to drive such devices at speeds up to 1 Gbps.

3) Stress/Margin Testing Stressing Communication Receivers: Engineers working with