

# Exhibit 2008

# Fundamentals of Automatic Control

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To my mother

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Figure 1-8 Takeoff-point representation

as being combined at a summing point must be in the same plane, two voltages may be combined but a voltage and current cannot be brought together. Any number of variables may be combined at a summing point.

A takeoff point is simply represented by a dot as shown in Fig. 1-8. In this system is shown in block-diagram form in Fig. 1-9. In this diagram the various blocks may be identified with elements of a system as compared to simplifying the system equations. The combining of cascaded blocks into a single block, as described in Sec. 1-5, is obviously one step toward simplification. As another possibility, it is sometimes useful to move a summing point around a block as indicated in Fig. 1-10. Note that the inputs A and B are introduced through blocks incorporating the function G around which the summing point was moved. Applying the distributive property of algebra, we see that  $C = (A + B)G = AG + BG$ . Thus the two diagrams are equivalent.

Table 1-1 gives a number of transformations useful in simplifying block diagrams. These transformations can be verified by showing that the outputs from the two equivalent diagrams are the same. Note that the original and equivalent identities can be used interchangeably.

### 1-6 SIMPLIFICATION OF BLOCK DIAGRAMS

Since certain functions and types of variables are commonly associated with feedback control systems, a generalized block diagram may be formulated and the associated closed-loop transfer function derived. Some standardization of the symbols and terminology relating to feedback control systems has been achieved and is used in this case.

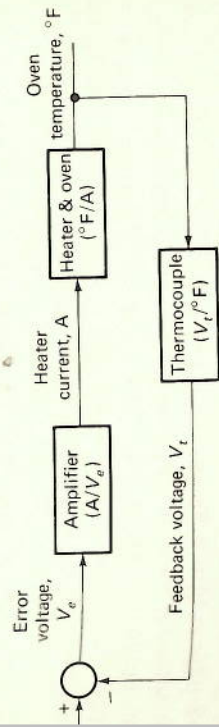


Figure 1-9 Block diagram of oven-temperature control

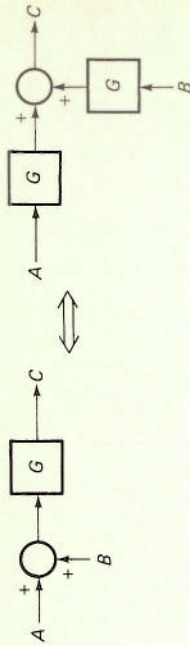


Figure 1-10 Moving summing point around a block

a system diagram to effect simplification is termed block-diagram algebra since it is analogous to simplifying algebraic equations. However, reducing a block diagram has the advantage of providing a better understanding of the interrelationships of the various elements in the system as compared to simplifying the system equations.

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Figure 1-11 is a general block diagram of a closed-loop control system. It is important that the terms used in this diagram be clearly understood.

### 1-7 CLOSED-LOOP TRANSFER FUNCTION

Since certain functions and types of variables are commonly associated with feedback control systems, a generalized block diagram may be formulated and the associated closed-loop transfer function derived. Some standardization of the symbols and terminology relating to feedback control systems has been achieved and is used in this case.

Figure 1-11 is a general block diagram of a closed-loop control system. It is important that the terms used in this diagram be clearly understood.

### System Variables

The desired value V is an external signal applied to the system to command a specific output from the process. The desired value is sometimes called the system command or set point.

TABLE 1-1 BLOCK-DIAGRAM IDENTITIES

Original	Equivalent