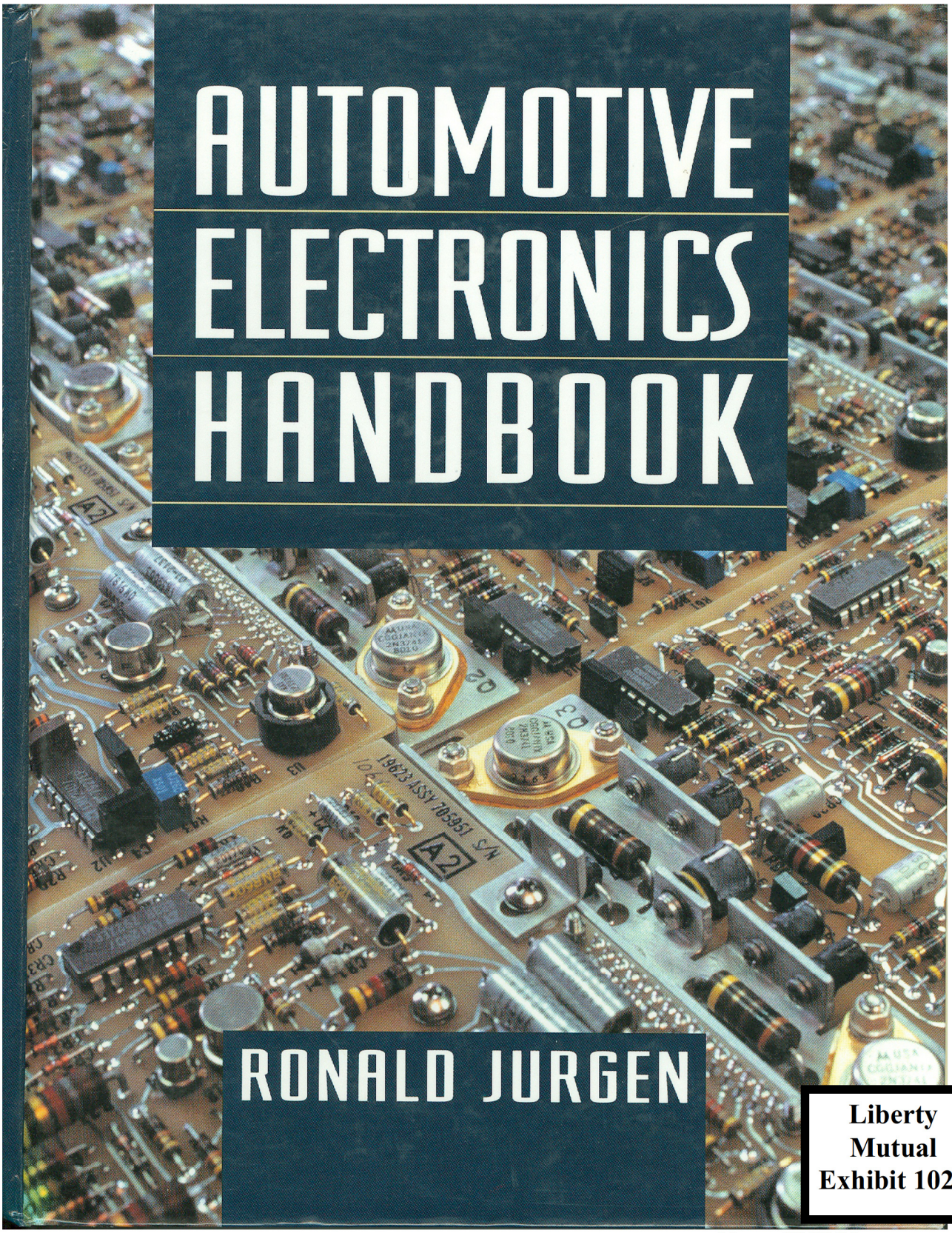
Exhibit 1029



AUTOMOTIVE ELECTRONICS HANDBOOK

Ronald K. Jurgen Editor in Chief

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Ambient temperature under bias (TA) refers to the temperature range that the microcontroller is guaranteed to operate at within a given application. While powered-up or operating, a microcontroller must not be subjected to temperatures that exceed its specified ambient temperature range. The most common ambient temperature ranges in industry are:

Commercial	0 to +70 °C
Extended	–40 to +85 °C
Automotive	–40 to +125 °C

11.2 MEMORY

Microcontrollers execute customized programs that are written by the user. These programs are stored in either on-chip or off-chip memory and are often referred to as the *user's code*. On-chip memory is actually integrated onto the same piece of silicon as the microcontroller and is accessed over the internal data bus. Off-chip memory exists on a separately packaged piece of silicon and is typically accessed by the microcontroller over an external address/data bus.

A memory map shows how memory addresses are arranged in a particular microcontroller. Figure 11.19 shows a typical microcontroller memory map.

<table>
<tr><th>Address</th><th colspan="3">Memory Function</th></tr>
<tr><td>0FFFFh
0A000h</td><td colspan="3">External Memory</td></tr>
<tr><td>9FFFh
2080h</td><td colspan="3">Internal ROM/EPROM or External Memory</td></tr>
<tr><td>207Fh
2000h</td><td colspan="3">Internal ROM/EPROM or External Memory
(Interrupt vectors, CCB's, Security Key, Reserved locations, etc.)</td></tr>
<tr><td>1FFFh
1F00h</td><td colspan="3">Internal Special Function Registers (SFR's)</td></tr>
<tr><td>1EFFh
0600h</td><td colspan="3">External Memory</td></tr>
<tr><td>05FFh
0400h</td><td colspan="3">INTERNAL RAM (Address with indirect or indexed modes.)
(Also know as Code RAM)</td></tr>
<tr><td>03FFh
0100h</td><td>Register RAM</td><td>Upper Register File (Address with indirect or indexed modes or through windows.)</td><td rowspan="3">Register File</td></tr>
<tr><td>00FFh
0018h</td><td>Register RAM</td><td rowspan="2">Lower Register File (Address with direct, indirect or indexed modes.)</td></tr>
<tr><td>0017h
0000h</td><td>CPU SFRs</td></tr>
</table>

FIGURE 11.19 Microcontroller memory map.

Memory is commonly referred to in terms of Kbytes of memory. One Kbyte is defined as 1024 bytes of data. Memory is most commonly arranged in bytes which consist of 8 bits of data. For instance, a common automotive EPROM is referred to as a "256k × 8 EPROM". This EPROM contains 256-Kbytes 8-bit memory locations or 2,097,152 bits of information.

11.2.1 On-Chip Memory

On-chip microcontroller memory consists of some mix of five basic types: random access memory (RAM), read-only memory (ROM), erasable ROM (EPROM), electrically erasable ROM (EPROM), and flash memory. RAM is typically utilized for run-time variable storage and SFRs. The various types of ROM are generally used for code storage and fixed data tables.

The advantages of on-chip memory are numerous, especially for automotive applications, which are very size and cost conscious. Utilizing on-chip memory eliminates the need for external memory and the "glue" logic necessary to implement an address/data bus system. External memory systems are also notorious generators of switching noise and RFI due to their high clock rates and fast switching times. Providing sufficient on-chip memory helps to greatly reduce these concerns.

RAM. RAM may be defined as memory that has both read and write capabilities so that the stored information can be retrieved (read) and changed by applying new information to the cell (write). RAM found on microcontrollers is that of the static type that uses transistor cells connected as flip-flops. A typical six-transistor CMOS RAM cell is shown in Fig. 11.20. It consists of two cross-coupled CMOS inverters to store the data and two transmission gates, which provide the data path into or out of the cell. The most significant characteristic of static memory is that it loses its memory contents once power is removed. After power is removed, and once it is reapplied, static microcontroller RAM locations will revert to their default state of a logic "0". Because of the number of transistors used to construct a single cell, RAM memory is typically larger per bit than EPROM or ROM memory.

Although code typically cannot be executed from register RAM, a special type of RAM often referred to as *code RAM* is useful for downloading small segments of executable code. The difference between code and register RAM is that code RAM can be accessed via the

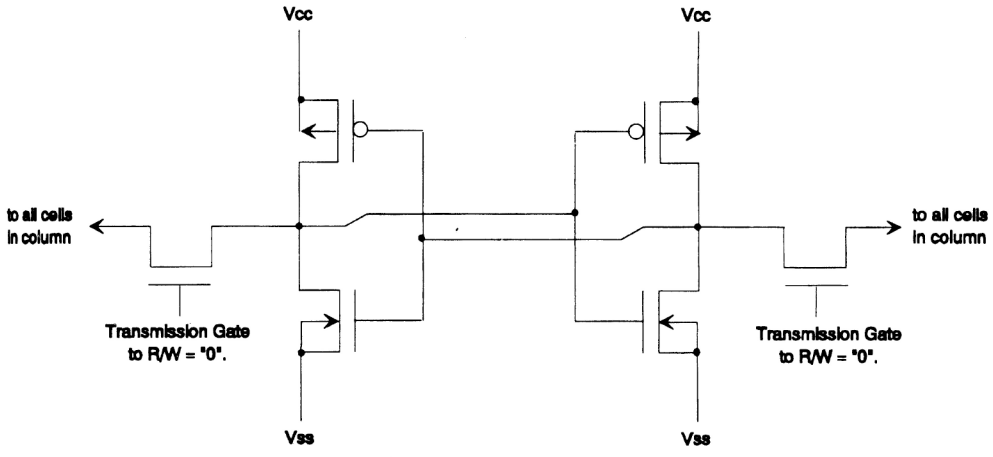

FIGURE 11.20 CMOS RAM memory cell.

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