# Application note AN1
# IBM AT and XT Keyboards Operation

The PC AT and XT keyboards are serial keyboards but they use different serial communication protocols and different key-codes. Neither of them is compatible with RS232 signals or ASCII codes. Their common features are:

- They are "make/break" keyboards. When the key is pressed the keyboard sends "make" code, when the key is released - "break" code.
- Every key has its own code. Pressing it will only result in sending this code to a computer.
- Pressing of any key on the keyboard does not affect the key-codes of other keys.
- For both AT and XT make code normally is one byte long (except for extended codes, see below)

But these keyboards also differ in many respects:

- For XT all key-codes have MSB (Most Significant Bit) equal zero,the break code is the same as make code except it has MSB equal one. The "make"-codes for AT are different from those for XT . Additionally, its break codes are two bytes long ("break"-prefix + "make"-code). Break prefix if hex F0.
- The AT keyboard is bi-directional, it can both send and receive data to a computer, while XT keyboard can only send data to the computer; consequently, XT  keyboards in can be wired in parallel but AT - cannot. If two AT keyboards are wired in parallel, then characters sent by one of them are interpreted by the other as information transfer request from the computer. The second keyboard will try to respond.
  This will cause  total confusion of both keyboards and, possibly, of the computer itself.

USE encoders allow for operation in parallel with keyboard by using a different scheme.

**Extended codes and multibyte codes**
There are some keys on both XT and AT keyboards which have "make"-codes consisting of more then one byte. Extended codes consist of two bytes: prefix code (hex E0) and make codes. Multibyte codes may consist of several bytes (like PrintScreen). The USE150/104 allow you to use both.

Make codes for both XT and AT keyboards are shown on Figure 1 and Figure 2. Please note that they are neither ASCII nor PC BIOS codes.
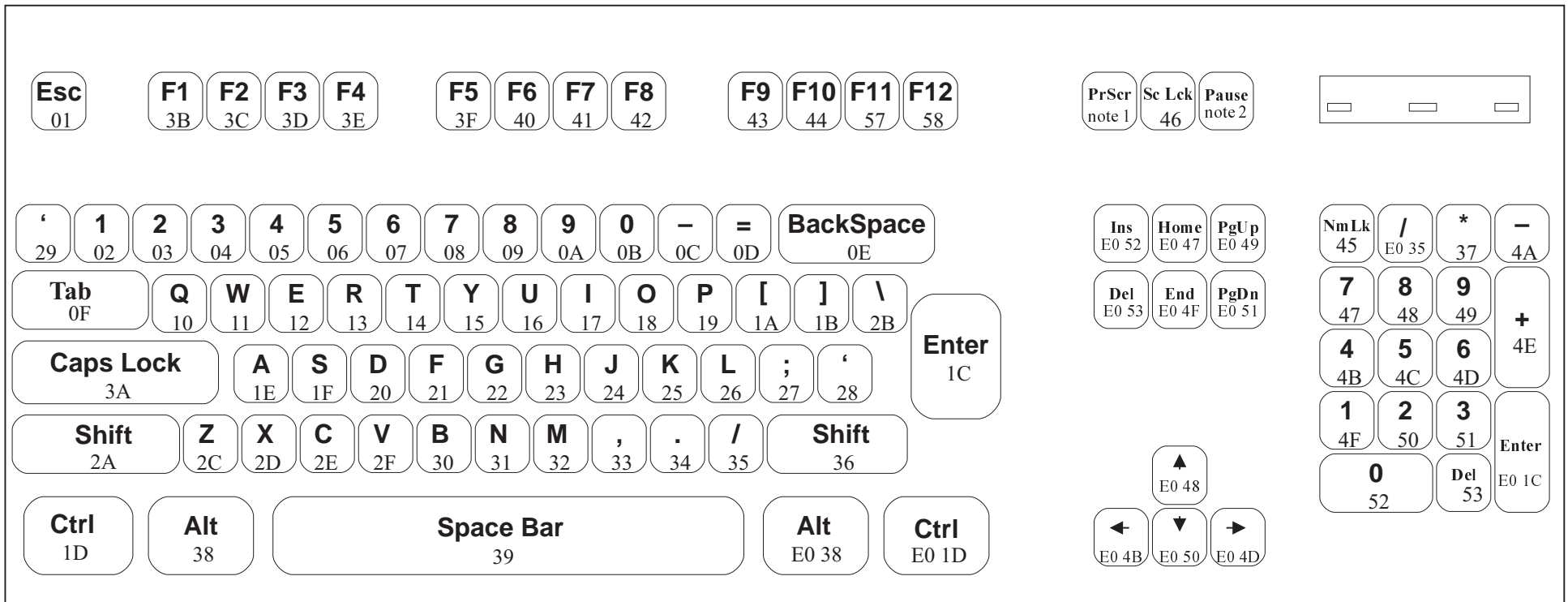
USECON software provides for programming make codes, the USE encoders calculate proper break codes automatically so you don't have to program it.

**SHIFT Keys**
Since each key has its own code and doesn't affect other key-codes, there is no "Shift" function in the literal sense (unlike in RS232 keyboards with ASCII codes) on XT/AT keyboards. After you press a "Shift" key along with any other, the computer BIOS takes the necessary action upon receiving the "Shift"-code. For example, if the keyboard sends code "Hex 16", PC AT compatible computer will interpret it like character "1" (see Figure 2). However, upon receiving it along with the "Shift"-code, (for example "Hex 12" for the left shift) it will translate it into character "!".  The code was the same, "Hex 16", but the interpretation was different.

**Note:**  The USE encoders provide **FUNCTION** keys allow us to have "True Shift" for XT/AT interface modes. This is an enhancement and is not present in standard XT/AT keyboards (except in laptops where similar technique is used for mapping numeric keypad) .

# XT

**Esc** 01

**F1** 3B  **F2** 3C  **F3** 3D  **F4** 3E

**F5** 3F  **F6** 40  **F7** 41  **F8** 42

**F9** 43  **F10** 44  **F11** 57  **F12** 58

**PrScr** note 1  **Sc Lck** 46  **Pause** note 2

`‘` 29  **1** 02  **2** 03  **3** 04  **4** 05  **5** 06  **6** 07  **7** 08  **8** 09  **9** 0A  **0** 0B  **–** 0C  **=** 0D  **BackSpace** 0E

**Tab** 0F  **Q** 10  **W** 11  **E** 12  **R** 13  **T** 14  **Y** 15  **U** 16  **I** 17  **O** 18  **P** 19  **[** 1A  **]** 1B  **\\** 2B

**Caps Lock** 3A  **A** 1E  **S** 1F  **D** 20  **F** 21  **G** 22  **H** 23  **J** 24  **K** 25  **L** 26  **;** 27  **‘** 28  **Enter** 1C

**Shift** 2A  **Z** 2C  **X** 2D  **C** 2E  **V** 2F  **B** 30  **N** 31  **M** 32  **,** 33  **.** 34  **/** 35  **Shift** 36

**Ctrl** 1D  **Alt** 38  **Space Bar** 39  **Alt** E0 38  **Ctrl** E0 1D

**Ins** E0 52  **Home** E0 47  **PgUp** E0 49

**Del** E0 53  **End** E0 4F  **PgDn** E0 51

▲ E0 48

◄ E0 4B  ▼ E0 50  ► E0 4D

**Nm Lk** 45  **/** E0 35  **\*** 37  **–** 4A

**7** 47  **8** 48  **9** 49  **+** 4E

**4** 4B  **5** 4C  **6** 4D

**1** 4F  **2** 50  **3** 51  **Enter** E0 1C

**0** 52  **Del** 53

Notes:
**1.** Print Screen Key has the scan code E0 2A E0 37.
**2.** Pause Key has the scan code E1 1D 45 E1 9D C5.
**3.** All the keys that have upper and lower cases are shown with lower case characters

**Figure 1.   PC XT keyboard hexadecimal make codes**

# AT
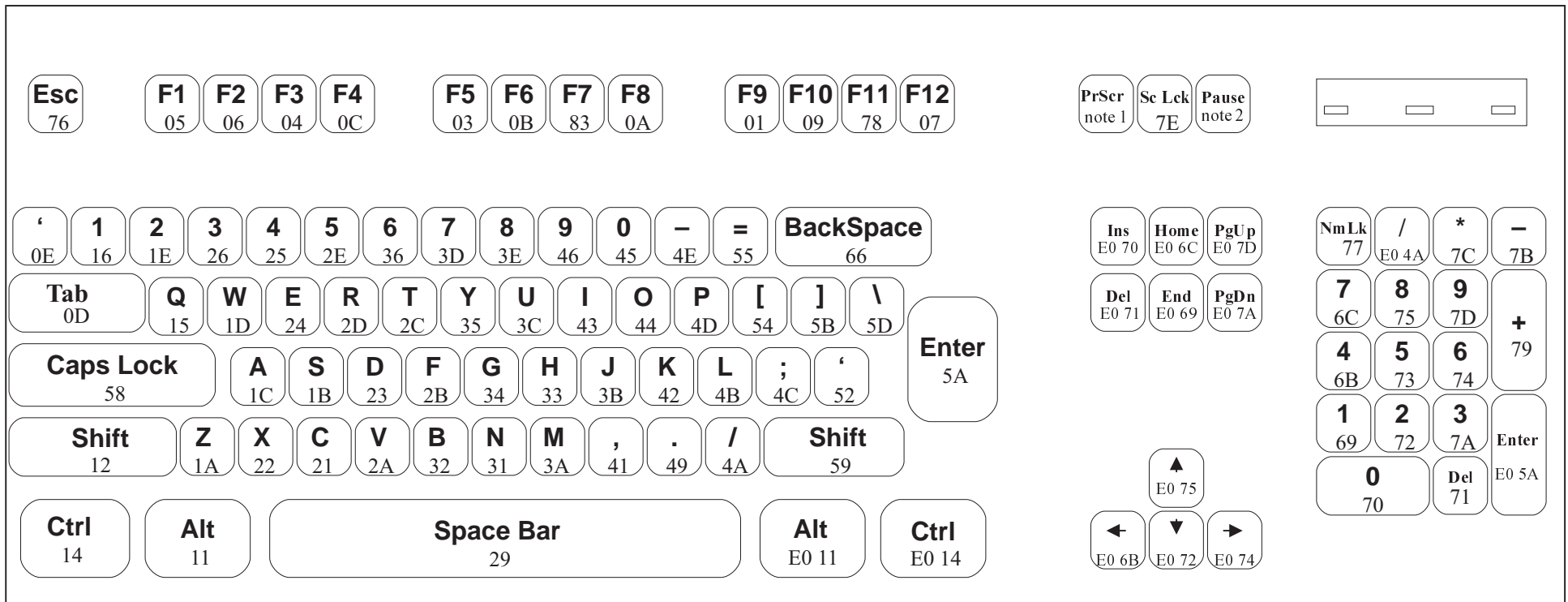


**Notes:**
1. Print Screen Key has the scan code E0 12 E0 7C.
2. Pause Key has the scan code E1 14 77 E1 F0 14 F0 77.
3. All the keys that have upper and lower cases are shown with lower case characters.

**Figure 2.  PC AT keyboard hexadecimal make codes**