Keyboards

Networks and Embedded Software

Module 4.3.7

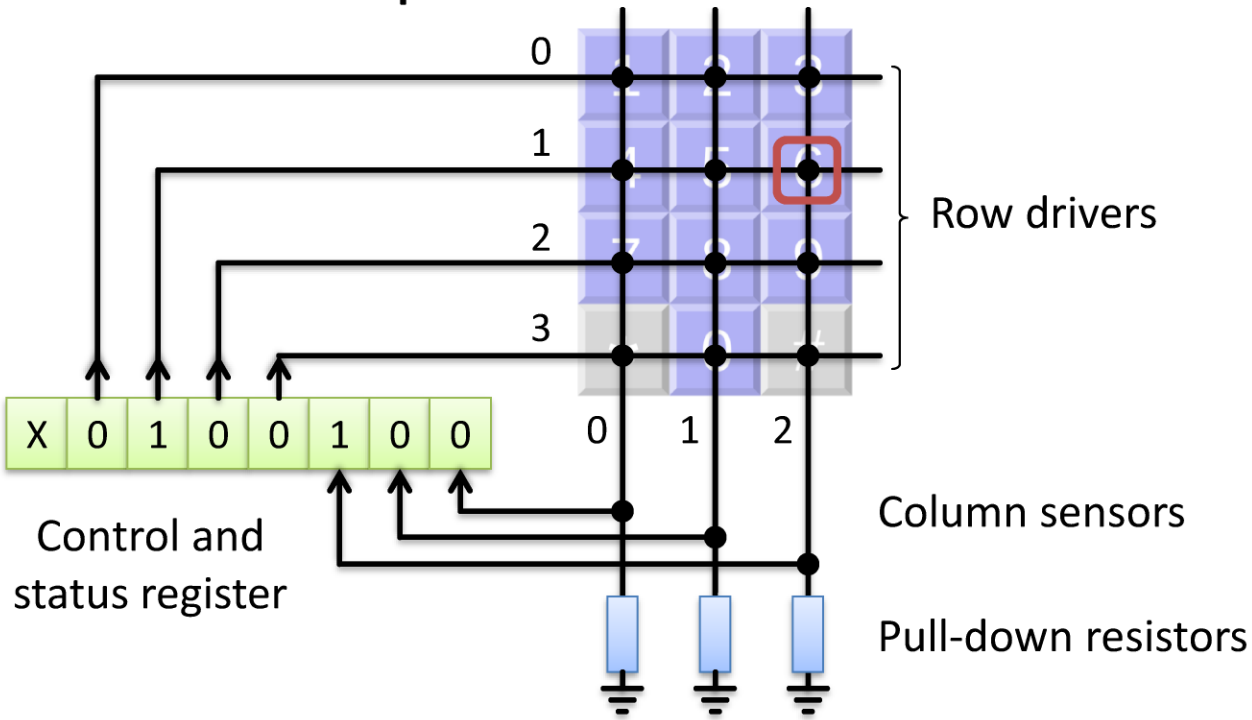
by Wolfgang Neff

Keypads (1)

- Programming Example
  - Functional Description
    - 3×4 matrix keypad
    - Keys are active high
    - No external pull-up resistors
    - Row control and column sensor share a register
    - No key debouncing

Keypads (2)

- Programming Example continued
  - Hardware Setup



Keypads (3)

- Software Setup
  - `#define PAD_COLS 3`
  - `#define PAD_ROWS 4`
  - `#define PAD_COLS_gp 0`
  - `#define PAD_COLS_gm 0x07`
  - `#define PAD_ROWS_gp COLS`
  - `#define PAD_ROWS_gm 0x78`
  - `#define PAD_ROW0_bm PIN6_bm`
  - …

Keypads (4)

- Control Flow

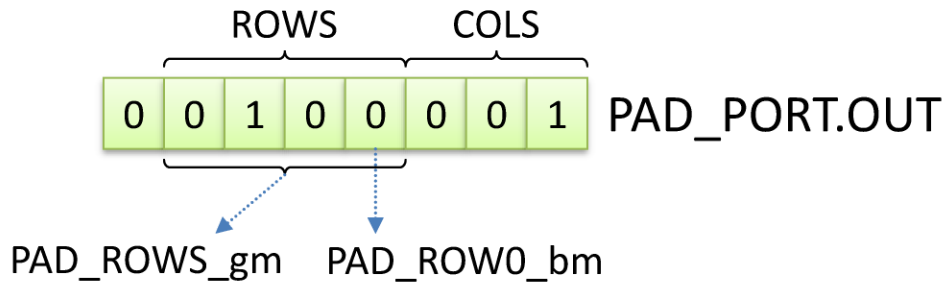
```
uint16_t scanPad(void)
{
  uint16_t keyStates = 0x0000;       // No keys pressed
  for (uint8_t i=0; i<PAD_ROWS; i++) {
    SelectRow(i);
    keyStates |= readCols();         // Add new key states
    keyStates = newRow(keyStates);   // Place for more keys
  }
  return keyStates;
}
```

Keypads (5)

- Row Control
  - `void SelectRow(uint8_t row)`
  - `{`
  - `  switch(row) {`
  - `    case 0: PORT.OUT = (PORT.OUT & ROWS_gm) | ROW0_bm;`
  - `    break;`
  - `  // …`
  - `  }`
  - `}`

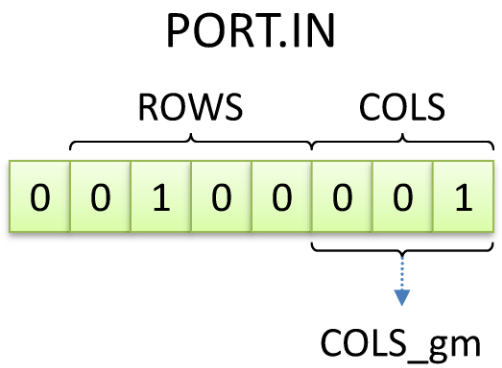
Cf. Bit Manipulation

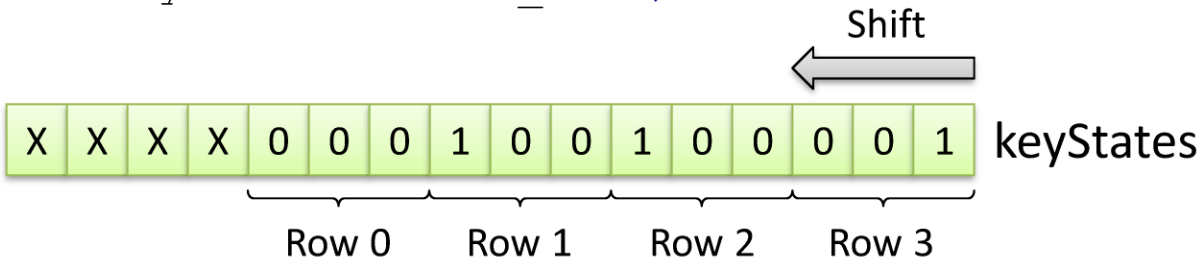
Prefix **PAD_** skipped for brevity



Keypads (6)

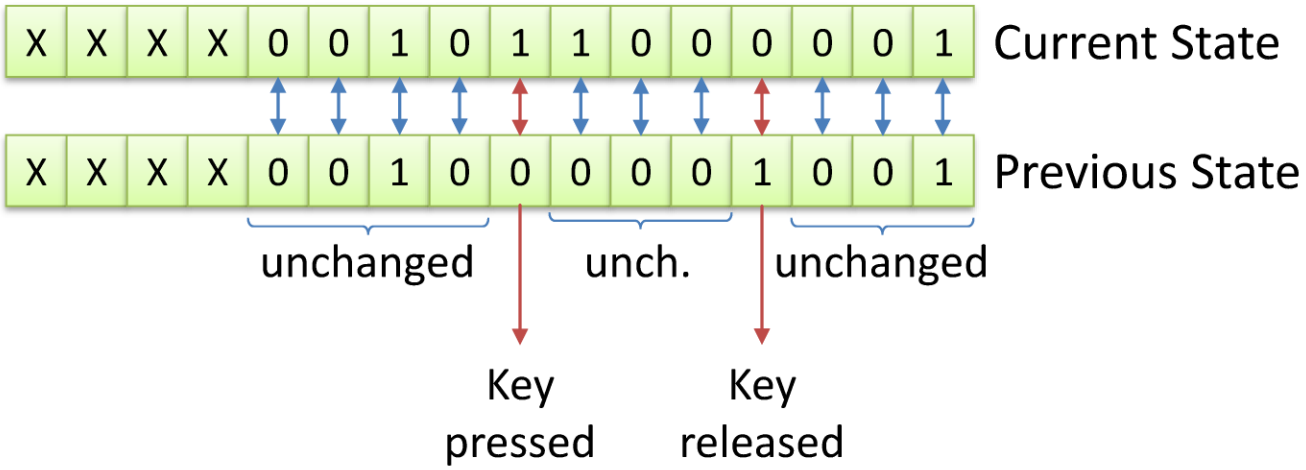
- Column Sensor
  - `uint16_t keyStates;`
  - `uint8_t readCols(void)`
  - `{`
  - `  return PAD_PORT.IN & PAD_COLS_gm;`
  - `}`
  - `uint8_t newRow(uint8_t keyStates)`
  - `{`
  - `  return keyStates << PAD_COLS;`
  - `}`





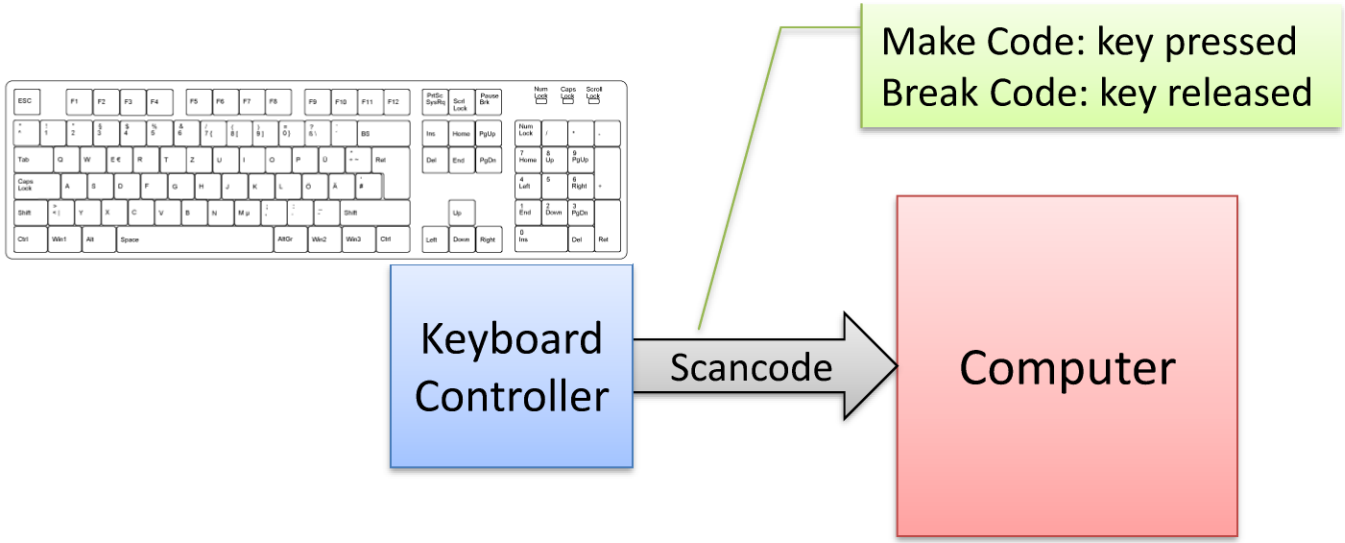
Keypads (7)

- Key Pres and Release
  - Comparison of Current and Previous State
    - Boolean Algebra
      - Example: XOR → Keys which changed their state



Keyboards (1)

- Hardware Setup



Keyboards (2)

- Scancode
  - Example: set 1 (IBM PC XT)
    - Make code (MSB cleared)
      - 02 (1!), 03 (2@), 04 (3#), 05 (4$), 06 (5%), …
      - 1e (A), 1f (S), 20 (D), 21 (F), 22 (G), 23 (H), ...
    - Break code (MSB set)
      - 82 (1!), 83 (2@), 84 (3#), 85 (4$), 86 (5%E), …
      - 9e (A), 9f (S), A0 (D), A1 (F), A2 (G), A3 (H), ...
    - Escape scancodes
      - Enter: 1C (main keyboard), E0 1C (enter numeric keypad)

Keyboards (3)

- Codepages
  - Scancode + Modifier = Character
  - Declaration
    - `char codePage[MODIFIERS][CODES];`
      - `codePage[NONE][0x9E]` → `'a'`
      - `codePage[SHIFT][0x9E]` → `'A'`

…	1	2	3	4	5	6	…	a	s	d	f	g	…	// Section NONE
…	!	@	#	$	%	^	…	A	S	D	F	G	…	// Section SHIFT

Keyboards (4)

- Further Issues
  - Debouncing
  - Character repeat
    - Repeat delay
    - Repeat rate
  - Dead keys
    - Attach diacritics to letters
    - ^ + e → ê