

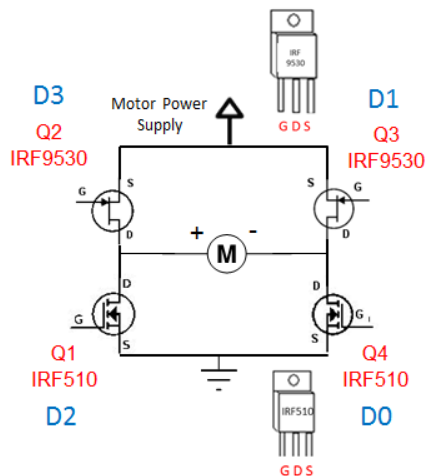
## Project

### H-Bridge and Keypad

An H-Bridge is used to control a motor's rotational direction. An H-bridge can be constructed with 2 N-channel and 2 P-channel transistors. Each transistor can be turned on/off with a digital line. As such, the four digital output lines from the PCF8574 will be used to control the motor's state.

The Lego NXT Brick only has 4 keys. A 12-key keypad can be easily interfaced to a PCF8574. Such keypads use a row/column matrix membrane. The keys 0 to 9, \* and # have a specific row and column position. Thus 4 digital lines can be used to detect the row, and 3 digital lines can be used to detect the column.

### H-Bridge Circuit and the PCF8574



**Fig. 1A:** Classic H-bridge using two N-channel (IRF510) and two P-channel (IRF9530) MOSFETs

From a recent lab, one knows that HI or LO voltages on a MOSFET's gate will switch the transistor on or off. The PCF8574 can provide four digital lines D0, D1, D2, and D4. Connecting these lines to the gates of the four transistors Q1, Q2, Q3, and Q4 will turn the motor clockwise or counter-clockwise, stop the motor, or allow the motor to freely rotate.

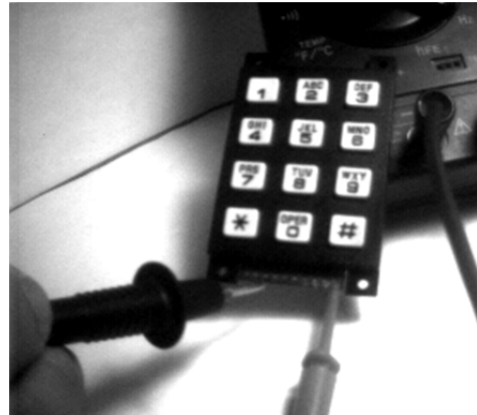
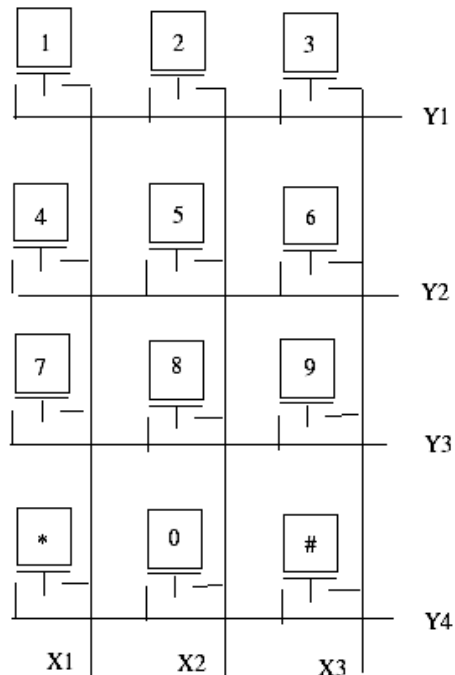
### 12-key Keypad and the PCF8574

Surplus keypads rarely come with pinout specifications. However, they are easy to decode with an ohmmeter **Fig. 2A** (right). The first step is to clip the ohmmeter probes to two different pads<sup>1</sup> on the keypad. The second step is to observe the ohmmeter and press keys until you find the key that returns an almost 0 Ohm resistance. The resistance is almost zero because there is a row and column wire associated with each key (see **Fig. 2A** left). Write down this key's row and column position and continue doing this two-step procedure for all pads on the keypad. You should start seeing a pattern. Once all keys on the keypad have been assigned their row and column position, you can then decipher which pad corresponds to which column, and which pad corresponds to which row. Once you have determined X1-X4 and Y1-Y3 (for a 12-key touch-tone

<sup>1</sup> Some keypads have pads (for soldering wires to) or come with header pins

## Lego Interfacing – H-Bridge and Keypad

phone like keypad), you can then wire them to the PCF8574 digital lines D0-D3 for rows Y1-Y4 and digital lines D4-D6 for columns X1-X3.



**Fig. 2A:** Standard 12-key keypad requires an ohmmeter (right) to determine which row and column are shorted when the specific key is closed (left).

### Sample code:

```
// FILE: keypad1_2.nxc - Works!
// AUTH: P.Oh
// DESC: Detect keys 1, 4, 7, and *

#define I2Cport S1 // Port number
#define I2CAddr8574 0x70 // I2C address x040 8574 or 0x70 for 8574A

// Global variables
// array variables (since NXC's I2C functions take array variables
byte WriteBuf[] = {I2CAddr8574, 0x00}; // sets up PCF8574A for writing
byte ReadBuf[]; // data received from PCF8574A. We won't be reading any data but we need this for I2CBytes
int RdCnt = 1; // number of bytes to read

long GetKey() {
  WriteBuf[1] = 0xEF; // Col 1: 0xEF = 239 decimal = 1110 1111. Sets Col 1 HI
  I2CBytes(I2Cport, WriteBuf, RdCnt, ReadBuf);
  if(ReadBuf[0]==0xEE) return(1); // Row 1: "1" key. 0xEE = 238 decimal = 1110 1110. If HI, then "1" key
  if(ReadBuf[0]==0xED) return(4); // Row 2: "4" key
  if(ReadBuf[0]==0xEB) return(7); // Row 3: "7" key
  if(ReadBuf[0]==0xE7) return(14); // Row 4: "*" key

  return(-1); // return -1 if no key pressed
} // end of GetKey
```

## Lego Interfacing – H-Bridge and Keypad

```
task main() {  
  
    long key;  
    long value = 0;  
  
    SetSensorLowSpeed (I2Cport); // PCF8574A connect to NXT on S1  
  
    NumOut(0,0,value,true); // show initial value  
  
    while(true) { // endless loop  
        while(GetKey() < 0); // do nothing  
        key = GetKey(); // get key value  
        PlayTone(1000,5); // make key pressed sound  
        switch(key) { // case based on key value  
            case -1: // no key, do nothing  
                break;  
            case 15: // #: so negate value  
                value = -value;  
                break;  
            case 14: // *: quit  
                Stop(true);  
                break;  
            default: // 0-9: just build up number  
                if(value >= 0) value = value*10 + key;  
                else value = value*10 - key;  
                break;  
        } // end switch  
  
        NumOut(0,0,value, true); // show current value  
        while(GetKey() >= 0); // wait for key to be unpressed  
    } // end of while  
} // end main
```

**Project:** This project is worth 15% of your final grade. Partner up as pairs. One student shall construct and program the H-bridge, while the other constructs and programs the 12-key keypad.

**Objective:** Using a single Brick (with perhaps 2 NXT breadboard adapters) have the motor perform the following:

Key	Motor Function
4	Rotate CW
6	Rotate CCW
8	Brake
2	Free spinning

Grading rubric will be presented in another document