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// Code inspired by - Model Railroading with Arduino
//   - NCE Auxiliary Input Unit (AIU) Example - (c) 2019 Alex Shepherd
// Code modified by Terry Chamberlain to run without use of NceCabBus library - March 2021
// Allows setting of Cab Bus Address via USB Serial connection when pin 20 (D21, A3) held LOW
// .. Cab Bus Address value set on Inputs 1-6 and input when pin 18 (D18, A0) set LOW
// .. Set Address is held in EEPROM @ address 256 (requires EEPROM library)
// Also allows Inputs 10-14 to be changed to outputs which reflect the states of either
// .. Inputs 1-5 or Inputs 5-9 - Output Mode is set by inputting a Cab Bus Address with
// .. either Input 8 set LOW to monitor Inputs 1-5, or Input 7 set LOW to monitor Inputs 5-9
// .. Output Mode is held in EEPROM @ address 257, Mode active when EEPROM @ 257 = 0x05 to
// .. monitor Inputs 1-5 or EEPROM @ 257 = 0x0A to monitor Inputs 5-9
// .. Each of Outputs 10-14 are set HIGH when the corresponding Inputs 1-5 or 5-9 are set LOW
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#include <EEPROM.h>
#include <Bounce2.h>

// Change the #define below to match the Serial port you're using for RS485
#define RS485Serial Serial1

// Change the #define below to match the RS485 Chip TX Enable pin
//#define RS485_TX_ENABLE_PIN 2
byte RS485_TX_ENABLE_PIN = 2;

// Set the default AIU Cab Bus Address - altered to value in EEPROM read in void(setup)
byte CAB_BUS_ADDRESS = 5;

#define DebugMonitor Serial
// Uncomment the line below to enable Debug Output
byte DEBUG = 1;

// Set the Number of AIU Inputs to be scanned
byte NUM_AIU_INPUTS = 14;

// The Array below maps Arduino Pins to AUI Inputs, change as required
// .. AIU Input Numbers  1 2 3 4 5 6 7  8  9 10 11 12 13 14
byte aiuInputPins[] =   {3,4,5,6,7,8,9,20,19,18,15,14,16,10};

// Change the #define below to set the Number of Debounce milliseconds for the AIU Inputs
//#define DEBOUNCE_MS        20

Bounce * debAIUins = new Bounce[NUM_AIU_INPUTS];

// EEPROM used to hold current AIU Cab Bus Address and QSDM Mode
int   eepm_addr = 256;     // Use location above first page (0 - 255)
byte  eepm_data = 0;
byte  numswpins = 8;
byte  swpins[] = {3,4,5,6,7,8,9,20};   // Digital pins for Cab Bus Setting switches (D20 = A2)
byte  prog_actv = 0;
byte  prog_redy = 0;
byte  prog_done = 0;
byte  outp_mode = 0;
byte  flash = 0;
const byte adr_prog = 21; // Prepare to set AIU Cab Bus Address when pin D21 (A3) pulled low
const byte prog_led = 19; // D19 (A1) drives LED to show programming AIU Cab Bus Address
const byte prog_set = 18; // Set AIU Cab Bus Address when pin D18 (A0) pulled low
int i;                    // Loop index

const char* splashMsg = "QSDM - Monitor Section - Version 2.5";
// AIU Input Index - used to update one auiInput per loop
byte aiuInputIndex = 0;

byte in_Cmnd = 0;               // Serial command in
byte out_Buf[] = {0x7F, 0x7F};  // Serial data out - state of AIU pins 1-7 and 8-14
const byte typ_AIU = 0x64;      // AIU Cab Type = 'd'
byte pingAIU = 0;               // Flag set if this AIU just pinged -
 reset if ping not for this AIU

void setup() {
  uint32_t startMillis = millis();

  DebugMonitor.begin(115200);
  while (!DebugMonitor && ((millis() -
 startMillis) < 3000)); // wait for serial port to connect. Needed for native USB
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  DebugMonitor.println();
  DebugMonitor.println(splashMsg);

  pinMode(adr_prog, INPUT_PULLUP); // Set AIU Cab Bus Address when pin D21 pulled low
  eepm_data = EEPROM.read(256);
  if (eepm_data > 63 || eepm_data < 2){
    eepm_data = 5; // Set default AIU Cab Address = 5
  }
  CAB_BUS_ADDRESS = eepm_data;
  eepm_data = EEPROM.read(257);
  if (eepm_data == 0x05){
    outp_mode = 0x05; // Set Output Mode active for Inputs 1-5
    NUM_AIU_INPUTS = 9;
  }
  else if (eepm_data == 0x0A) {
    outp_mode = 0x0A; // Set Output Mode active for Inputs 5-9
    NUM_AIU_INPUTS = 9;
  }
  else {
    outp_mode = 0; // Set Output Mode inactive
    NUM_AIU_INPUTS = 14;
  }

  pinMode(RS485_TX_ENABLE_PIN, OUTPUT);
  digitalWrite(RS485_TX_ENABLE_PIN, LOW);
  RS485Serial.begin(9600, SERIAL_8N2);

  for(uint8_t i = 0; i < NUM_AIU_INPUTS; i++) {
    debAIUins[i].attach(aiuInputPins
[i], INPUT_PULLUP); // Setup the bounce instance and mode for each AIU Input pin
    debAIUins[i].interval(20);                          // .. with a debounce period of 20msec
    if (i < 7) {
      if (digitalRead(aiuInputPins[i]) == HIGH) {
        bitSet(out_Buf[0], i);      // Initialise output status to reflect state of AIU Input pins
      }
      else {
        bitClear(out_Buf[0], i);
      }
    }
    else {
      if (digitalRead(aiuInputPins[i]) == HIGH) {
        bitSet(out_Buf[1], i - 7);
      }
      else {
        bitClear(out_Buf[1], i - 7);
      }
    }
  }
  if (outp_mode == 0x05 || outp_mode == 0x0A) {
    for(uint8_t i = 9; i < 14; i++) {
      pinMode(aiuInputPins[i], OUTPUT);   // Change Input Pins 10-14 to Output
      digitalWrite(aiuInputPins[i], LOW); // Switch any attached LED off
      bitSet(out_Buf[1], i - 7);  // Report state of these Input Pins as HIGH (not active)
    }
  }
}

void loop() {
  //  ==========  Check for Address Programming Link fitted  ============
  if (digitalRead(adr_prog) == LOW && prog_actv == 0) {
    delay(200);
    if (digitalRead(adr_prog) == LOW) {
      // Address Programming Link fitted - start data entry
      //*******************************
      DebugMonitor.println(splashMsg);
      DebugMonitor.println("Address Programming Start");
      DebugMonitor.print("Current Address : ");
      DebugMonitor.println(CAB_BUS_ADDRESS, DEC) ;
      if (outp_mode == 0x05) {
        DebugMonitor.println("Output Mode     : Monitoring Inputs 1-5");
      }
      else if (outp_mode == 0x0A) {
        DebugMonitor.println("Output Mode     : Monitoring Inputs 5-9");
      }
      else {
        DebugMonitor.println("Output Mode     : Inactive");
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      }
      //*****************************
      prog_actv = 1;                // Set programming active flag
      prog_redy = 1;                // Set ready for input flag
      pinMode(prog_led, OUTPUT);    // Change pin D19 to Output
      digitalWrite(prog_led, HIGH); // Switch programming LED on
      pinMode(prog_set, INPUT_PULLUP);    // Ensure pin D18 (Programming pushbutton) is Input
      // Ready to set AIU Cab Bus Address
      while (prog_actv == 1) {
        eepm_data = 0;
        for(i = 7; i > -1; i--) {
          // Read address switches 8 > 1 in sequence
          eepm_data = eepm_data << 1; // Shift programming switch data left (x2)
          if (digitalRead(swpins[i]) == LOW) {
            eepm_data = eepm_data + 1; // Add 1 to Address if switch[i] is On
          }
        }
        if (digitalRead(prog_set) == LOW && prog_done == 0) {
          delay(200);
          if (digitalRead(prog_set) == LOW) {
            // Pushbutton pressed - address programming done
            //*****************************
            DebugMonitor.println("Address Entered");
            //*****************************
            prog_done = 1; // Set data accepted flag
            prog_redy = 0; // Clear ready for input flag
            digitalWrite(prog_led, LOW); // Switch programming LED off
            pinMode(prog_led, INPUT_PULLUP);    // Change pin D19 back to Input
            if (digitalRead(adr_prog) == LOW) {
              // Address Programming Link still fitted
              if ((eepm_data & 0x3F) > 2) {
                EEPROM.write(256,
(eepm_data & 0x3F));  // Save entered Cab Bus Address if valid (>02)
                CAB_BUS_ADDRESS = EEPROM.read(256);
                //*****************************
                DebugMonitor.print("Address Stored  : ");
                DebugMonitor.println(CAB_BUS_ADDRESS, DEC) ;
                //*****************************
              }
              if ((eepm_data & 0x80) != 0) {
                EEPROM.write(257,0x05);  // Set Output Mode = Monitor Inputs 1-5
                outp_mode = EEPROM.read(257);
                //*****************************
                DebugMonitor.println("Output Mode     : Monitoring Inputs 1-5");
                //*****************************
              }
              else if ((eepm_data & 0x40) != 0) {
                EEPROM.write(257,0x0A);  // Set Output Mode = Monitor Inputs 5-9
                outp_mode = EEPROM.read(257);
                //*****************************
                DebugMonitor.println("Output Mode     : Monitoring Inputs 5-9");
                //*****************************
              }
              else if ((eepm_data & 0xC0) == 0) {
                EEPROM.write(257,0);  // Set Output Mode = Inactive
                outp_mode = EEPROM.read(257);
                //*****************************
                DebugMonitor.println("Output Mode     : Inactive");
                //*****************************
              }
            }
          }
        }
        if (digitalRead(adr_prog) == HIGH && prog_done == 1) {
          delay(200);
          if (digitalRead(adr_prog) == HIGH) {
            // Programming Link removed after successful programming
            prog_done = 0;  // Clear programmed flag
            prog_redy = 0;  // Clear ready for input flag
            prog_actv = 0;  // Disable Address Programming
            //*****************************
            DebugMonitor.println("Address Programming Completed") ;
            //*****************************
          }
        }
        if (digitalRead(adr_prog) == HIGH && prog_redy == 1) {
          delay(200);
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        if (digitalRead(adr_prog) == HIGH) {
          // Programming Link removed without programming
          //*****************************
          DebugMonitor.println("Address Programming Abandoned") ;
          //*****************************
          digitalWrite(prog_led, LOW); // Switch programming LED off
          pinMode(prog_led, INPUT_PULLUP);    // Change pin D19 back to Input
          prog_done = 0;  // Clear programmed flag
          prog_redy = 0;  // Clear ready for input flag
          prog_actv = 0;  // Disable Address Programming
        }
      }
    } // End while(prog_actv)
  } // End Confirm(adr_prog)
} // End Read(adr_prog)

//  ==========  Otherwise proceed with normal AIU operation  ============
else if (prog_actv == 0)
{
  // Check first if a command has been received
  if (RS485Serial.available())
  {
    // Read incoming command stream from Command Station
    in_Cmnd = RS485Serial.read();

    if((in_Cmnd & 0xC0) == 0x80)
    {
      if (DEBUG == 1)
      {
        DebugMonitor.println();
      }
      else
      {
        delayMicroseconds(100);
      }
    }
    if (DEBUG == 1)
    {
      DebugMonitor.print("R:");
      DebugMonitor.print(in_Cmnd, HEX);
      DebugMonitor.print(' ');
    }
    else
    {
      delayMicroseconds(400);
    }

    if (in_Cmnd == 0xD2 && pingAIU == 1)
      // AIU must wait at least 100usec and not more than 780usec before responding to make sure
      // the Command Station (RS485 Master) has disabled transmission and is ready for a response
    {
      delayMicroseconds(400);                    // Pause before sending response
      digitalWrite(RS485_TX_ENABLE_PIN, HIGH);  // Enable transmit response on RS485 port
      RS485Serial.write(typ_AIU);                // Output AIU Cab Type 'd'
      RS485Serial.flush();                       // Wait until data sent
      delayMicroseconds(100);                    // Pause after sending response
      digitalWrite(RS485_TX_ENABLE_PIN, LOW);   // .. then disable transmit / enable receive
      if (DEBUG == 1)
      {
        DebugMonitor.println();
        DebugMonitor.print("T:");
        DebugMonitor.print(typ_AIU, HEX);
        DebugMonitor.print(' ');
      }
      else
      {
        delayMicroseconds(400);
      }
      pingAIU = 0;  // Clear ping flag
    }
    if ((in_Cmnd & 0x7F) == CAB_BUS_ADDRESS)
    {
      pingAIU = 1;  // Ping is for this AIU
      delayMicroseconds(400);
      digitalWrite(RS485_TX_ENABLE_PIN, HIGH); // Enable transmit response on RS485 port
      RS485Serial.write(out_Buf[0]);  // Output AIU status - Inputs 1-7
      delayMicroseconds(200);
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    RS485Serial.write(out_Buf[1]);  // Output AIU status - Inputs 8-14
    RS485Serial.flush();                    // Wait until data sent
    delayMicroseconds(100);                   // Pause before sending response
    digitalWrite(RS485_TX_ENABLE_PIN, LOW); // .. then disable transmit / enable receive
    DebugMonitor.println();
    DebugMonitor.print("T:");
    DebugMonitor.print(out_Buf[0], HEX);
    DebugMonitor.print(' ');
    DebugMonitor.print(out_Buf[1], HEX);
    DebugMonitor.print(' ');
  }
  else
  {
    pingAIU = 0;  // Ping is not for this AIU
  }
}
else
{
  // If no command pending, debounce a single AIU Input and update its status
  if(debAIUins[aiuInputIndex].update()) // Check for a change in next AIU Input pin
  {
    DebugMonitor.print("Input Changed: Index: ");
    DebugMonitor.print(aiuInputIndex);
    if (aiuInputIndex < 7)
    {
      if (digitalRead(aiuInputPins[aiuInputIndex]) == HIGH)
      {
        bitSet(out_Buf[0],aiuInputIndex);
        DebugMonitor.print(" - Set Hi");
        DebugMonitor.print(" - Out-0 = ");
        DebugMonitor.println(out_Buf[0], HEX);
      }
      else
      {
        bitClear(out_Buf[0],aiuInputIndex);
        DebugMonitor.print(" - Set Lo");
        DebugMonitor.print(" - Out-0 = ");
        DebugMonitor.println(out_Buf[0], HEX);
      }
    }
    else
    {
      if (digitalRead(aiuInputPins[aiuInputIndex]) == HIGH)
      {
        bitSet(out_Buf[1], (aiuInputIndex - 7));
        DebugMonitor.print(" - Set Hi");
        DebugMonitor.print(" - Out-1 = ");
        DebugMonitor.println(out_Buf[1], HEX);
      }
      else
      {
        bitClear(out_Buf[1], (aiuInputIndex - 7));
        DebugMonitor.print(" - Set Lo");
        DebugMonitor.print(" - Out-1 = ");
        DebugMonitor.println(out_Buf[1], HEX);
      }
    }
  }
  if (outp_mode == 0x05 && aiuInputIndex < 5) {
    if (digitalRead(aiuInputPins[aiuInputIndex]) == HIGH)
    {
      digitalWrite(aiuInputPins[aiuInputIndex + 9], LOW);
    }
    else
    {
      digitalWrite(aiuInputPins[aiuInputIndex + 9], HIGH);
    }
  }
  else if (outp_mode == 0x0A && aiuInputIndex > 3 && aiuInputIndex < 9) {
    if (digitalRead(aiuInputPins[aiuInputIndex]) == HIGH)
    {
      digitalWrite(aiuInputPins[aiuInputIndex + 5], LOW);
    }
    else
    {
      digitalWrite(aiuInputPins[aiuInputIndex + 5], HIGH);
    }
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      }
      aiuInputIndex++;
      if(aiuInputIndex >= NUM_AIU_INPUTS)
        aiuInputIndex = 0;
    }
  }
  delayMicroseconds(500);
}  // End loop
```