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1  /* ===== Arduino Projects =====
2      TestEval Programm (Wire.h included in LiquidCrystal_I2C)
3      File: Power Box 12_24V
4      Sketch: Keypad_4x4 rev 1
5      Revise: add continuous current trip watch
6  */
7  #include <Wire.h>
8  #include <Adafruit_INA219.h>
9  #include <LiquidCrystal_I2C.h>
10 // SDA pin 20
11 // SCL pin 21
12
13 Adafruit_INA219 ina219;
14 LiquidCrystal_I2C lcd(0x27, 20, 4);
15
16 // Red LED and the four AC pwr relays
17 // Connect 1 red and 4 green LEDs
18 const int red = 8; // Bootup indicator
19 const int K1 = 39; // +12V
20 const int K2 = 41; // +24V
21 const int K3 = 43; // J1-AC
22 const int K4 = 45; // J2-AC
23
24 float trip12 = 0.5;
25 float trip24 = 0.5;
26 float amp12 = 0.00;
27 float amp24 = 0.00;
28 //const int cur12 = 63; //A9 conn voltage divider
29 const int cur24 = 62; //A8 conn voltage divider
30
31 boolean menu_funcSel = true;
32 boolean run_once = false;
33 boolean read_keypad = false;
34 boolean local_loop = false;
35 int dead_switch = 0;
36 String term;
37
38 volatile int dataAvail = 19; // Keypad pressed->INT4 issued
39
40 // keypad 5-bit binary input => pad
41 volatile byte key; // 5-bit binary value created
42 volatile int bit_A = 38; // LSB
43 volatile int bit_B = 40;
44 volatile int bit_C = 42;
45 volatile int bit_D = 44;
46 volatile int bit_E = 46; // MSB
47
48 /* ==== INT4 from pin 19 dataAvail ==== */
49 void readPanel() { // key - global variable
50     key = 0x00;
51     if (digitalRead(bit_A)) key |= 0x01;
52     if (digitalRead(bit_B)) key |= 0x02;
53     if (digitalRead(bit_C)) key |= 0x04;
54     if (digitalRead(bit_D)) key |= 0x08;
55     if (digitalRead(bit_E)) key |= 0x10;
56     menu_funcSel = false; // switches from menu to function selection
57 } // end readPanel int handler

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58 /* ===== */
59
60 void setup() { //*****
61   Serial.begin(9600);
62   uint32_t currentFrequency;
63   ina219.begin();
64   ina219.setCalibration_32V_2A();
65   lcd.init();
66   lcd.clear();
67   lcd.backlight();
68   lcd.noCursor();
69   Serial.println("");
70   Serial.println("  App up and Running");
71   Serial.println("  Version: 4x4 keypad - add trip current monitoring");
72   Serial.println("");
73
74   // 'dataAvail' sig from keypad IC goes HIGH when a key is pressed
75   attachInterrupt(digitalPinToInterrupt(dataAvail), readPanel, RISING);
76
77   pinMode(red, OUTPUT);
78   pinMode(K1, OUTPUT);
79   pinMode(K2, OUTPUT);
80   pinMode(K3, OUTPUT);
81   pinMode(K4, OUTPUT);
82   //pinMode(cur12, INPUT);
83   pinMode(cur24, INPUT);
84
85   // ensure bootup LED and AC relays are off
86   digitalWrite(red, LOW);
87   digitalWrite(K1, LOW);
88   digitalWrite(K2, LOW);
89   digitalWrite(K3, LOW);
90   digitalWrite(K4, LOW);
91
92   // keypad inputs as a byte - uses readPanel interrupt
93   pinMode(bit_A, INPUT);
94   pinMode(bit_B, INPUT);
95   pinMode(bit_C, INPUT);
96   pinMode(bit_D, INPUT);
97   pinMode(bit_E, INPUT);
98
99   // indicates Arduino booted up
100  digitalWrite(red, HIGH);
101  delay(750);
102  digitalWrite(red, LOW);
103
104  // Relay test
105  digitalWrite(K1, HIGH);
106  delay(250);
107  digitalWrite(K1, LOW);
108  delay(250);
109  digitalWrite(K2, HIGH);
110  delay(250);
111  digitalWrite(K2, LOW);
112  delay(250);
113  digitalWrite(K3, HIGH);
114  delay(250);

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115 digitalWrite(K3, LOW);
116 delay(250);
117 digitalWrite(K4, HIGH);
118 delay(250);
119 digitalWrite(K4, LOW);
120 } // end setup
121
122 void loop() { //*****
123   if (menu_funcSel) { // initialized true
124     menu();
125   } else if (!menu_funcSel) {
126     functionSelect();
127   }
128 } // end loop
129
130 ///////////////////////////////////////////////////////////////////
131 ////////////// Sketch ends, functions begin ///////////////
132 ///////////////////////////////////////////////////////////////////
133
134 void menu() {
135   lcd.clear();
136   lcd.setCursor(0, 0);
137   lcd.print("A +12V ON B +24V ON");
138   lcd.setCursor(0, 1);
139   lcd.print("C J1-AC D J2-AC ");
140
141   if (dead_switch == 2) {
142     lcd.clear();
143     lcd.setCursor(1, 1);
144     lcd.print("+12V Cur > Trip Cur");
145     lcd.setCursor(4, 2);
146     lcd.print("+12V Power OFF");
147     delay(2000);
148     dead_switch = 1;
149     Serial.println(" Display dead_switch 2");
150   }
151
152   if (dead_switch == 3) {
153     lcd.clear();
154     lcd.setCursor(1, 1);
155     lcd.print("+24V Cur > Trip Cur");
156     lcd.setCursor(4, 2);
157     lcd.print("+24V power OFF");
158     delay(2000);
159     dead_switch = 1;
160     Serial.println(" Display dead_switch 3");
161   }
162
163   if (dead_switch == 1) {
164     lcd.clear();
165     lcd.setCursor(0, 0);
166     lcd.print("A +12V ON B +24V ON");
167     lcd.setCursor(0, 1);
168     lcd.print("C J1-AC D J2-AC ");
169     lcd.setCursor(0, 2);
170     lcd.print("5 Currents 2 ESC ALL");
171     lcd.setCursor(0, 3);

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172     lcd.print("DEL(*) selective OFF");
173     Serial.println("  Display dead_switch 1");
174     tripWatch();
175 }
176
177 // Part of Main Menu - first time only
178 if (dead_switch == 0) {
179     lcd.setCursor(0, 3);
180     lcd.print("  Make Selection ");
181     dead_switch = 1;
182     Serial.println("  Display dead_switch 0");
183 }
184
185 menu_funcSel = false; // switch to func selection
186 read_keypad = true;   // sets up next section
187 } // end menu
188
189 void functionSelect() {
190     Serial.print("  Relay Status: ");
191     Serial.print("K1 ");
192     Serial.print(digitalRead(K1));
193     Serial.print(", K2 ");
194     Serial.print(digitalRead(K2));
195     Serial.print(", K3 ");
196     Serial.print(digitalRead(K3));
197     Serial.print(", K4 ");
198     Serial.println(digitalRead(K4));
199     Serial.print("  12V Cur: ");
200     tripWatch();
201     Serial.print(amp12);
202     Serial.print(" amps");
203     Serial.print("  24V Cur: ");
204     amp24 = currentRead(cur24) / 206.0;
205     Serial.print(amp24);
206     Serial.println(" amps");
207     Serial.print("  12V trip-current: ");
208     Serial.print(trip12);
209     Serial.print("  24V trip-current: ");
210     Serial.println(trip24);
211     Serial.println("");
212     key = 0; // avoid loops
213     while (read_keypad) { // loop until selection made
214         switch (key) {
215             case 0: // Clear          (1 key)
216                 break;
217             case 1: // ESC key        (2 key)
218                 ESC();
219                 read_keypad = false;
220                 Serial.println("  I'm back from ESC function call");
221                 Serial.println("");
222                 break;
223             case 2: // +12V off      (3 key)
224                 digitalWrite(K1, LOW);
225                 break;
226             case 3: // +12V on       (A key)
227                 V12();
228                 read_keypad = false;

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229     Serial.println(" I'm back from +12V function call");
230     Serial.print(" Current trip: ");
231     Serial.print(trip12);
232     Serial.print(" Current read: ");
233     Serial.println(amp12);
234     Serial.println("");
235     break;
236     case 4: // N/U           (4 key)
237         break;
238     case 5: // post current (5 key)
239         postCurrent();
240         read_keypad = false;
241         Serial.println(" I'm back from postCurrent function call");
242         Serial.println("");
243         break;
244     case 6: // +24V off     (6 key)
245         digitalWrite(K2, LOW);
246         break;
247     case 7: // +24V on     (B key)
248         V24();
249         read_keypad = false;
250         Serial.println(" I'm back from +24V function call");
251         Serial.print(" Current trip: ");
252         Serial.print(trip24);
253         Serial.print(" Current read: ");
254         Serial.println(amp24);
255         Serial.println("");
256         break;
257     case 8: // + cur       (7 key)
258         break;
259     case 9: // - cur       (8 key)
260         break;
261     case 10: // J1 off     (9 key)
262         digitalWrite(K3, LOW);
263         break;
264     case 11: // J1 on      (C key)
265         J1();
266         read_keypad = false;
267         Serial.println(" I'm back from J1 function call");
268         Serial.println("");
269         break;
270     case 12: // DEL        (* key)
271         DEL();
272         read_keypad = false;
273         Serial.println(" I'm back from DEL function call");
274         Serial.println("");
275         break;
276     case 13: // ENT        (0 key)
277         break;
278     case 14: // J2 off     (# key)
279         digitalWrite(K4, LOW);
280         break;
281     case 15: // J2 on      (D key)
282         J2();
283         read_keypad = false;
284         Serial.println(" I'm back from J2 function call");
285         Serial.println("");

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286     break;
287     default:
288         break;
289     } // end switch statement
290 } // end while loop
291 menu_funcSel = true; // return to menu
292 } // end function selection
293
294 // ==== Operational Functions ===== //
295
296 float currentRead(int cur) { // independent func routine
297     int val = 0;
298     float ave = 0.0;
299     for (int i = 0; i < 100; i++) {
300         val += analogRead(cur);
301         delay(1);
302     }
303     ave = float(val) / 100.0;
304     return ave;
305 } // end currentRead function
306
307 void tripWatch() {
308     amp12 = ina219.getCurrent_mA() / 1000;
309     if (amp12 > trip12) {
310         digitalWrite(K1, LOW);
311         trip12 = 0.5;
312         dead_switch = 2;
313         delay(2000);
314     }
315     amp24 = currentRead(cur24);
316     amp24 = amp24 / 206; // scale factor
317     if (amp24 > trip24) {
318         digitalWrite(K2, LOW);
319         trip24 = 0.5;
320         dead_switch = 3;
321         delay(2000);
322     }
323 } // end tripWatch function
324
325 void V12() { // Keypad A code 3
326     Serial.println(" I'm inside +12V function");
327     Serial.print(" Key converts to: ");
328     Serial.println(glossary(key));
329     Serial.println("");
330     local_loop = true;
331     read_keypad = true;
332     while (local_loop) {
333         lcd.clear();
334         lcd.setCursor(3, 0);
335         lcd.print("Set cur trip");
336         lcd.setCursor(1, 1);
337         lcd.print("Up/Dwn - half amp");
338         lcd.setCursor(1, 3);
339         lcd.print("ENT to save value");
340         while (read_keypad) {
341             if (key == 8) { // up
342                 Serial.println(" + current");

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343     Serial.print("  Key converts to: ");
344     Serial.println(glossary(key));
345     Serial.println("");
346     trip12 += 0.5;
347     lcd.clear();
348     lcd.setCursor(0, 1);
349     lcd.print("Trip is: ");
350     lcd.setCursor(9, 1);
351     lcd.print(trip12);
352     lcd.setCursor(16, 1);
353     lcd.print("amps");
354     delay(1000);
355 }
356 if (key == 9) { // dwn
357     Serial.println("  - current");
358     Serial.print("  Key converts to: ");
359     Serial.println(glossary(key));
360     Serial.println("");
361     trip12 -= 0.5;
362     lcd.clear();
363     lcd.setCursor(0, 1);
364     lcd.print("Trip is: ");
365     lcd.setCursor(9, 1);
366     lcd.print(trip12);
367     lcd.setCursor(16, 1);
368     lcd.print("amps");
369     delay(1000);
370 }
371 if (key == 13) { // ENT key to freeze current value
372     Serial.println("  ENT");
373     Serial.print("  Key converts to: ");
374     Serial.println(glossary(key));
375     Serial.println("");
376     lcd.clear();
377     lcd.setCursor(0, 1);
378     lcd.print("Trip cur: ");
379     lcd.setCursor(10, 1);
380     lcd.print(trip12);
381     lcd.setCursor(16, 1);
382     lcd.print("amps");
383     delay(2000);
384     read_keypad = false; // ends
385     local_loop = false;
386 }
387 } // end keypad reads
388 } // end of trip current setup
389 lcd.clear();
390 lcd.setCursor(4, 0);
391 lcd.print("+12V Pwr-On");
392 lcd.setCursor(2, 1);
393 lcd.print("Cur: ");
394 lcd.setCursor(7, 1);
395 amp12 = ina219.getCurrent_mA() / 1000;
396 lcd.print(amp12);
397 lcd.setCursor(14, 1);
398 lcd.print("amps");
399 lcd.setCursor(0, 3);

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400 lcd.print("DEL/ESC to turn OFF");
401 digitalWrite(K1, HIGH); // turn on +12V supply
402 delay(2000);
403 tripWatch();
404 } // end +12V
405
406 void V24() { // Keypad B code 7
407   Serial.println(" Im inside +24 function");
408   Serial.print(" Key converts to: ");
409   Serial.println(glossary(key));
410   Serial.println("");
411   local_loop = true;
412   read_keypad = true;
413   while (local_loop) {
414     lcd.clear();
415     lcd.setCursor(3, 0);
416     lcd.print("Set cur trip");
417     lcd.setCursor(1, 1);
418     lcd.print("Up/Dwn - half amp");
419     lcd.setCursor(1, 3);
420     lcd.print("ENT to save value");
421     while (read_keypad) {
422       if (key == 8) { // up
423         trip24 += 0.5;
424         lcd.clear();
425         lcd.setCursor(0, 1);
426         lcd.print("Trip is: ");
427         lcd.setCursor(9, 1);
428         lcd.print(trip24);
429         lcd.setCursor(16, 1);
430         lcd.print("amps");
431         delay(1000);
432       }
433       if (key == 9) { // dwn
434         trip24 -= 0.5;
435         lcd.clear();
436         lcd.setCursor(0, 1);
437         lcd.print("Trip is: ");
438         lcd.setCursor(9, 1);
439         lcd.print(trip24);
440         lcd.setCursor(16, 1);
441         lcd.print("amps");
442         delay(1000);
443       }
444       if (key == 13) { // ENT key to freeze current value
445         lcd.clear();
446         lcd.setCursor(0, 1);
447         lcd.print("Trip cur: ");
448         lcd.setCursor(10, 1);
449         lcd.print(trip24);
450         lcd.setCursor(16, 1);
451         lcd.print("amps");
452         delay(2000);
453         read_keypad = false; // ends
454         local_loop = false;
455       }
456     } // end keypad reads

```



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457 } // ends trip current setup
458 lcd.clear();
459 lcd.setCursor(4, 0);
460 lcd.print("+24V Pwr-On");
461 lcd.setCursor(2, 1);
462 lcd.print("Cur: ");
463 lcd.setCursor(7, 1);
464 lcd.print(amp24);
465 lcd.setCursor(14, 1);
466 lcd.print("amps");
467 lcd.setCursor(0, 3);
468 lcd.print("DEL/ESC to turn OFF");
469 digitalWrite(K2, HIGH); // turn on +24V supply
470 delay(2000);
471 tripWatch();
472 } // end +24V
473
474 void J1() { // Keypad C code 11
475   Serial.println(" Inside J1");
476   Serial.print(" Key converts to: ");
477   Serial.println(glossary(key));
478   Serial.println("");
479   digitalWrite(K3, HIGH);
480   lcd.clear();
481   lcd.setCursor(4, 1);
482   lcd.print("J1-AC Pwr ON");
483   delay(2000);
484 } // end J1
485
486 void J2() { // Keypad D code 15
487   Serial.println(" Inside J2");
488   Serial.print(" Key converts to: ");
489   Serial.println(glossary(key));
490   Serial.println("");
491   digitalWrite(K4, HIGH);
492   lcd.clear();
493   lcd.setCursor(4, 1);
494   lcd.print("J2-AC Pwr ON");
495   delay(2000);
496 } // end J2
497
498 void ESC() { // Keypad 2 code 1
499   Serial.println(" Inside ESC");
500   Serial.print(" Key converts to: ");
501   Serial.println(glossary(key));
502   Serial.println("");
503   digitalWrite(K1, LOW);
504   digitalWrite(K2, LOW);
505   digitalWrite(K3, LOW);
506   digitalWrite(K4, LOW);
507   lcd.clear();
508   lcd.setCursor(4, 1);
509   lcd.print("All Rlys OFF");
510   lcd.setCursor(3, 2);
511   lcd.print("12/24 Pwr OFF");
512   delay(2000);
513 } // end ESC

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514
515 void DEL() { // Keypad * code 12
516   Serial.println("  Inside DEL");
517   Serial.print("  Key converts to: ");
518   Serial.println(glossary(key));
519   Serial.println("");
520   local_loop = true;
521   lcd.clear();
522   lcd.setCursor(0, 0);
523   lcd.print("3 12V OFF  6 24V OFF");
524   lcd.setCursor(0, 1);
525   lcd.print("9 J1  OFF  # J2  OFF");
526   lcd.setCursor(4, 2);
527   lcd.print("ESC(2) all-off");
528   lcd.setCursor(3, 3);
529   lcd.print("Make Selection");
530   while (local_loop) {
531     if (key == 2) { // keypad 3
532       digitalWrite(K1, LOW);
533       lcd.clear();
534       lcd.setCursor(4, 1);
535       lcd.print("12V Pwr OFF");
536       delay(2000);
537       local_loop = false;
538     }
539     if (key == 6) { // keypad 6
540       digitalWrite(K2, LOW);
541       lcd.clear();
542       lcd.setCursor(4, 1);
543       lcd.print("24V Pwr OFF");
544       delay(2000);
545       local_loop = false;
546     }
547     if (key == 10) { // keypad 9
548       digitalWrite(K3, LOW);
549       lcd.clear();
550       lcd.setCursor(4, 1);
551       lcd.print("J1-AC Pwr OFF");
552       delay(2000);
553       local_loop = false;
554     }
555     if (key == 14) { // keypad #
556       digitalWrite(K4, LOW);
557       lcd.clear();
558       lcd.setCursor(4, 1);
559       lcd.print("J2-AC Pwr OFF");
560       delay(2000);
561       local_loop = false;
562     }
563     if (key == 1) { // keypad ESC 2
564       local_loop = false;
565     }
566   } // end key read loop
567 } // end DEL
568
569 void postCurrent() { // Keypad 5 code 5
570   Serial.println("  Inside postCurrent");

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571 Serial.print(" Key converts to: ");
572 Serial.println(glossary(key));
573 Serial.println("");
574 lcd.clear();
575 lcd.setCursor(0, 1);
576 lcd.print("+12V cur ");
577 lcd.setCursor(9, 1);
578 amp12 = ina219.getCurrent_mA() /1000;
579 lcd.print(amp12);
580 lcd.setCursor(16, 1);
581 lcd.print("amps");
582 lcd.setCursor(0, 2);
583 lcd.print("+24V cur ");
584 lcd.setCursor(9, 2);
585 amp24 = currentRead(cur24);
586 amp24 = amp24 / 206; // sale factor
587 lcd.print(amp24);
588 lcd.setCursor(16, 2);
589 lcd.print("amps");
590 Serial.print(" +12V Current: ");
591 Serial.print(amp12);
592 Serial.print(" +24V Current: ");
593 Serial.println(amp24);
594 Serial.println("");
595 delay(3000);
596 } // end postCurrent function
597
598 String glossary(int trans) {
599     switch (trans) {
600         case 0 :
601             return term = "Keypad 1 Start Up";
602             break;
603         case 3 :
604             return term = "Keypad A +12V ON";
605             break;
606         case 7 :
607             return term = "Keypad B +24V ON";
608             break;
609         case 11 :
610             return term = "Keypad C J1-AC ON";
611             break;
612         case 15 :
613             return term = "Keypad D J2-AC ON ";
614             break;
615         case 5 :
616             return term = "Keypad 5 Post Currents";
617             break;
618         case 1 :
619             return term = "Keypad 2 ESC";
620             break;
621         case 12 :
622             return term = "Keypad * DEL";
623             break;
624         case 2 :
625             return term = "Keypad 3 +12V OFF";
626             break;
627         case 6 :

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```
628     return term = "Keypad 6 +24V OFF";
629     break;
630 case 10 :
631     return term = "Keypad 9 J1-AC OFF";
632     break;
633 case 14 :
634     return term = "Keypad # J2-AC OFF";
635     break;
636 case 13 :
637     return term = "Keypad 0 ENT";
638     break;
639 case 8 :
640     return term = "Keypad 7 +current";
641     break;
642 case 9 :
643     return term = "Keypad 8 -current";
644     break;
645 default:
646     break;
647 }
648 } // end glossary
649
```