Quick Reference

By Dave Collins AD7JT
2018-03-11

*This Quick Reference contains brief descriptions of the **Midnight Precision Clock** (MPC) displays, operating procedures, and controls.*

The product and display images shown herein are current at the time of this writing. Future releases may change appearance and content.

Contents

1. FEATURE OVERVIEW

Very Compact Design ... *Attractive 4.5"W x 1.5"H x 3" all black enclosure.*

Bright LED Display ... *Four seven-segment characters with center colon*

Format Options ... *Choose 24-hour or 12-hour time display.*

Two Single LEDs ... *Indicate alarm set and PM for 12-hour display.*

Simple, Intuitive Control ... *Single rotary control with unique displays to guide you using an extended character set and blinking characters and varying brightness.*

Local and UTC time displays ... *Displays time in* **HH:MM** *format.*

Super Accurate Clock ... *GPS time reference, visual indication when GPS receiver unable to track satellites.*

GPS Status Display ... *Shows number of satellites currently being used by the GPS receiver (12 maximum).*

Limited, non-GPS time maintenance ... *When satellite tracking is not possible, uses less-accurate internal time base.*

Programmable Frequency Standard ... *Square wave logic signal, 50-ohm output, 1Hz to 10-MHz in 1 Hz steps, 1% to 99% duty cycle in 1% steps..*

Alarm Function ... *Visual and audio alarm function.*

Location ... *Computes and displays maidenhead coordinates for current location.*

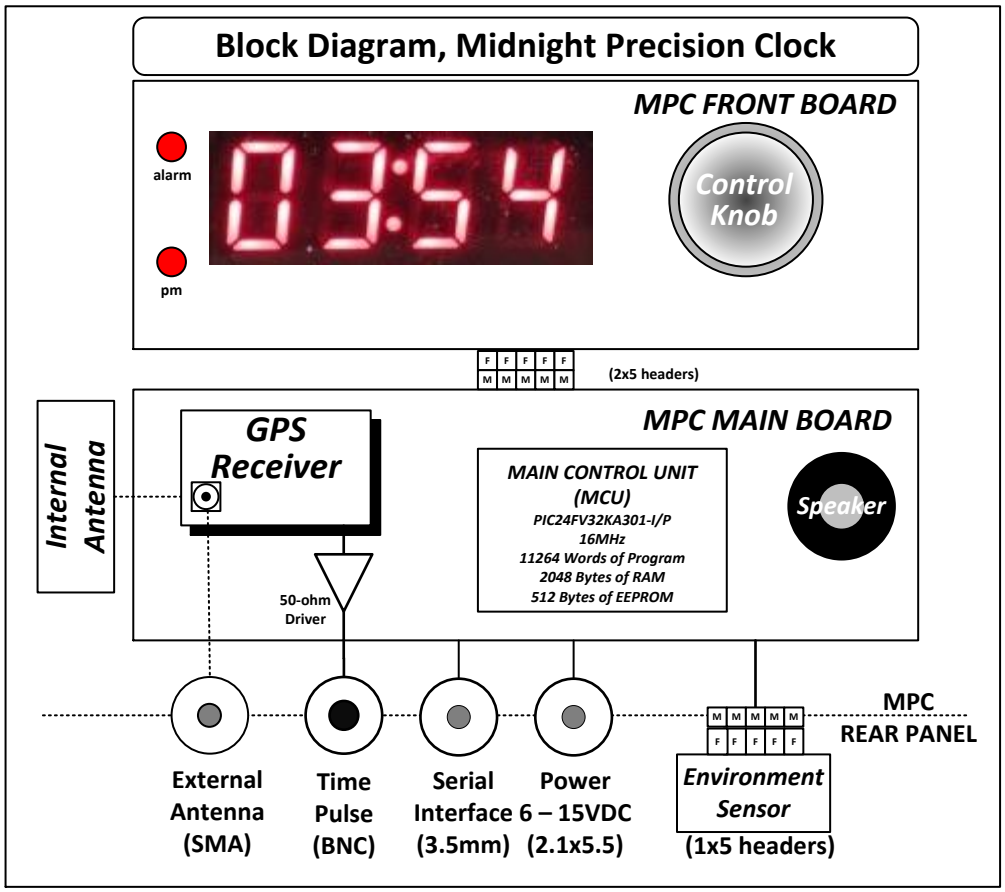
Thermometer Functions ... *Displays current ambient temperature in F (Fahrenheit), C (Celsius), and K (Kelvin).*

Barometer Functions ... *Displays current air pressure in inches of Mercury and millibars compensated for altitude.*

Humidity Functions *Displays current relative and absolute humidity and dew point.*

Current operating parameters preserved in non-volatile memory ... *UTC offset, alarm time, and signal generator frequency.*

2. GENERAL DESCRIPTION



The main components of the MPC shown in the block diagram are divided between three PCBs. The following briefly describe each of the main components.

1. *MCU* Processes input from other components and generates displays.

2. *GPS Receiver* Receives data and time from GPS satellites and computes its location and altitude.

3. 50-Ohm Driver Boosts the power level of the Time Pulse (frequency standard) signal.

4. *Internal Ant.* Depending on your location, a small internal antenna may be used with the clock. The supplied antenna connects to the MMCX connector on the GPS receiver module and resides in the MPC enclosure.

5. *Speaker* Small Piezo speaker for alarm and warnings

6. *Control* Rotary control with detents and push-switch. Used to select displays and set parameters.

7. *Display* Four-character, seven-segment LED display with center colon. A special font set is used to display a full character set (see Appendix B).

8. *Indicators* Indicate **ALARM ON** (upper LED) and **PM** (lower LED)

The connectors on the back panel are as follows:

1. *Time Pulse*. BNC jack for frequency standard output. The output is a square wave with a programmable frequency between 1 Hz and 10 MHz and a programmable duty cycle between 1% and 99%. The output is buffered as shown in the block diagram. There will be some phase jitter if the frequency is not an integer factor of 48 MHz.

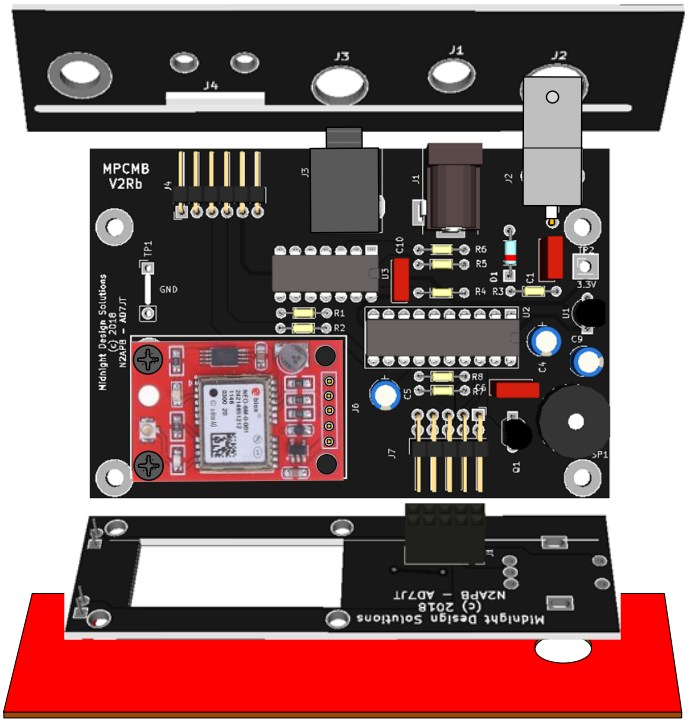
2. *Power* Barrel connector (2.1x5.5mm) for DC power source. Power requirements: 6 to 15VDC @ 125 ma.

3. Serial Interface — Available to reload the MCU firmware. It is shared by the GPS receiver and can be used to interface an external GPS receiver.

4. ***Environment Sensor*** — Plugs into the rear panel and senses ambient temperature, humidity, and atmospheric pressure. The sensor assembly plugs directly into and mounts on the rear panel external to the MPC enclosure.

5. ***Antenna*** — SMA connector for external GPS active antenna(such as GlobalSat AT65SMA). The antenna is powered through the coax interface. Note that the internal antenna must be disconnected when using an external antenna.

The three PCBs and the front lens are positioned in the enclosure like this:



Not all components are shown. See Appendix A for schematics.

3. QUICK START

1. External Connections

a. If used, connect external antenna to the SMA connector on the back panel. Locate the antenna with an unobstructed "view" of the sky.

b. Connect power to the USB connector. Limit voltage range to 6 to 15 VDC.

2. Power On Sequence

a. Observe the countdown during the initialization sequence. During this period the GPS receiver's serial interface is analyzed to determine the appropriate baud rate (auto-baud rate detect).

b. Observe **go** displayed and sounded in Morse code (— — • — — —).

c. Observe the local time display. The display will oscillate between full-intensity and half-intensity until the GPS receiver is tracking satellites and can supply GPS time information. In this case, the time will start at **00:00**. When the clock is used without access to GPS satellites, the time can be manually set and will be maintained using a less accurate, internal time base. The procedure to manually set the time is described in **STATUS AND SET LOCAL TIME**.

d. When the GPS receiver has locked on to one or more satellites (see **STATUS AND SET LOCAL TIME**), UTC

time will be set to the GPS time and local time will be displayed at full brightness.

Note that the GPS receiver module contains a battery that will maintain the time base and may provide time data for the MPC. In this case, the time may lose considerable accuracy and the display will toggle between full- and half-intensity.

3. Set the UTC offset

The GPS receiver provides UTC time and you must enter the offset from UTC for your local time zone.

a. Rotate the control knob one detent clockwise.

b. Observe the current UTC time displayed with the colon flashing.

c. Press the control knob once and observe the current UTC offset hours displayed with the colon flashing.

d. Turn the control knob to adjust the displacement hours. The range is from -12 to +12 in one hour steps. Use a negative offset for locations west of the prime meridian (0) and east of the international date line.

e. Press the control knob once and observe the current UTC offset minutes displayed with the colon flashing.

f. Turn the control knob to adjust the displacement minutes. The range is from zero to 45 minutes in 15 minute steps.

g. Press the control knob twice to return to the UTC time display.

h. Turn the control knob one detent CCW to display local time. Verify that the displayed local time is the correct local time to confirm the UTC offset is correct.

4. CONTROL FUNCTIONS

The single control knob is used to change displays and enter or select operating parameters such as UTC offset and alarm time. Appendix B is a map of the functions and displays. This map is navigated using the control knob.

On the map's top row (0), rotating the control knob will traverse the row left (CCW) and right (CW). Pressing and releasing the knob will sequentially cycle through the lower rows in the same column. Leaving the last (lowest) function in a column will switch to the first (top) function in the same column.

Many functions below the map's top row are used to enter time settings or make selections. In these cases, rotate the control knob to set time values or make selections. The selection will be entered the next time the control knob is pressed.

The control function map in Appendix B provides basic information about each function and the associated display. The following sections describe the functions in more detail and outline the procedures to activate and use these functions. Actual pictures of MPC displays are shown in the right column, the left column contain descriptive text. In many instances the text includes references to the associated display shown in parentheses and very bold text such as (**20:09**). These are intended to only be examples, your displays will depend on your local time and conditions.

Each description assumes that the starting display is the local time display displayed in 24-hour format.

5. ALARM

A. Start at the local time display (**13:09**)and press the control knob once.

A: 

B. Rotate the control knob to set the alarm time hours(**14:**) and press control knob once.

B: 

C. Rotate the control knob to set the alarm time minutes (**:11**) and press the control knob once.

C: 

D. Observe the local time display(**13:09**) and rotate the control knob one detent CCW.

D: 

E. Observe display is dimmed and the ALARM LED is on to indicate that the alarm is armed.

E: 

F. When the alarm is triggered, the local time is displayed at full intensity (**14:11**) flashing once per second. There will also be an audible, warbling sound.

F1: 

F2: 

G. Either rotating the control knob or pressing it will turn the alarm off and return to the local time display.

G: 

6. LOCAL TIME

The default display is the local time display (column 0 and row 0 in Appendix A). Local time is displayed when power is first applied and after a reset and restart. It is also displayed when the alarm is turned off.

When the GPS receiver is tracking one or more satellites, the GPS time will be used to continuously update the UTC time and the local time will be displayed at full intensity. When the GPS receiver is not able to track a satellite, an internal time base will be used to update the UTC time and the local time will be displayed alternating between bright and dim each second.

When the clock is first initialized, UTC time is set to the negative value of the UTC offset. This sets the local time to **00:00**. If satellite tracking cannot be achieved due to, for example, location and/or weather conditions, the local time can be entered manually (see **STATUS AND SET LOCAL TIME**). When the GPS receiver is able to track a satellite, UTC time will be updated to GPS time.

The displayed local time is calculated from UTC time received from the GPS receiver by subtracting the UTC offset value (see **UTC TIME**). When the local time is entered manually, UTC time is set by adding the UTC offset to the local time entered.

7. UTC TIME

A. Starting at the local time display (**08:09**), rotate the control knob one detent CW to the UTC display.

B. Observe the UTC time display with the colon blinking on (**20:09**) and off (**20 09**).

C. Press the control knob once to display the UTC offset hour (**-12**).

D. Rotate the control knob to set the appropriate UTC offset hours (**- 7:**).

E. Press the control knob once to display the UTC offset minutes. Rotate the control knob to set the appropriate UTC offset minutes (increments of 15 minutes).

F. Press the control knob twice to return to the UTC time display.

G. Rotate the control knob one detent CCW to return to the local time display (now **13:09**).

A: 

B1: 

B2: 

C: 

D: 

E: 

F: 

G: 

8. STATUS AND SET LOCAL TIME

A. Rotate the control knob to the status display and observe the number of satellites being used (**SU:12**) to determine current time and location, including altitude.

B. Press the control knob once. The current time display format is displayed (**24hr** or **12hr**).

C. Rotate the control knob to change the format.

D. Press the control knob once. The displayed time format will change between 12 (**08:09** PM) and 24 (**20:09**) hour formats when the control knob is turned.

E. Press the control knob to display the local time hour (**14:**).

F. Rotate the control knob to set the local time hour (**13:**).

G. Repeat steps **C** and **D** to set the local time minute (**:09**).

A: 

B1: 

B2: 

D1: 

D2: 

E: 

F: 

G: 

H. Press the control knob to return to the status display.

I. Rotate the control knob CCW to return to the local time display.

H: 

I: 

Note: The local time can only be set manually when GPS data is not available. Once set, the MPC will maintain time only until it can be updated from GPS data.

9. BAROMETER

Note: If the environment sensor is not installed, the barometer, temperature, and humidity functions cannot be activated and the display will skip over the corresponding displays.

A. Rotate the control knob to the barometer display and observe the current barometer reading in inches of mercury (**29.9"**). Barometer readings are corrected to sea level using the altitude provided by the GPS receiver.

A: 

B. Press the control knob once to display the barometer reading in millibars (**1013** mb).

B: 

C. Press the control knob again to display the current altitude in feet above sea level (**1272**).

C: 

D. Press the control knob again to return to the inches of mercury display.

D: 

E. Rotate the control knob to return to the local time display.

E: 

10.TEMPERATURE

Note: If the environment sensor is not installed, the barometer, temperature, and humidity functions cannot be activated and the display will skip over the corresponding displays. The temperature sensor is mounted on the MPC enclosure and may sense a little higher than the ambient room temperature. . Pressing and rotating the control knob with any temperature display (A, B, C) will set an offset to compensate for the temperature rise.

A. Rotate the control knob to the temperature display and observe the current ambient temperature in degrees Fahrenheit (**79°F**).

A: 

B. Press the control knob once to display the current ambient temperature in degrees Celsius (**26°C**)

B: 

C. Press the control knob again to display the current ambient temperature in degrees Kelvin (**299°**).

C: 

D. Press the control knob again to return to the Fahrenheit display.

D: 

E. Rotate the control knob to return to the local time display.

E: 

11.HUMIDITY

Note: If the environment sensor is not installed, the barometer, temperature, and humidity functions cannot be activated and the display will skip over the corresponding displays.

A. Rotate the control knob to select the relative humidity display (**36%**).

A: 

B. Press the control knob once and observe the current dew point (**12.0°C**).

B: 

C. Rotating the control knob will toggle the display between Fahrenheit and Celsius displays (**54°F**).

C: 

D. Press the control knob once and observe the absolute humidity in grams per cubic meter (**10.4A** grams per cubic meter).

D: 

E. Press the control knob once and return to the relative humidity display.

E: 

F. Rotate the control knob to return to the local time display.

F: 

12. FREQUENCY STANDARD

A. Rotate the control knob to one of the frequency standard displays:

UNITS	DISPLAY	RANGE
MHz	A1: **6M**	0-10
KHz	A2: **543K**	000-999
Hz	A3: **210H**	000-999

A1: 

A2: 

A3: 

B. Press the control knob once and observe the least-significant digit blink. A different digit will blink each time the control knob is pressed and released.

B1: 

B2: 

B3: 

C. Rotating the control knob will increment (CW) or decrement (CCW) the blinking digit. Overflows and under-flows will propagate. When all digits are set, press the control knob until there are no digits blinking to return to the top display.

C1: 

C2: 

D. Rotate the control knob CCW to return to the local time display.

D: 

13.FREQUENCY STANDARD DUTY CYCLE

The frequency standard signal is a square wave with programmable duty cycle of 1% to 99% of the time between pulses. The duty cycle refers to the percent of the signal period that the signal is high.

The duty cycle display (**dC:50**) is reached by navigating to the frequency standard megahertz display (**0m**)and pressing the control knob twice (control state 6,2). Each detent on the control knob adds or subtracts one percent to or from the duty cycle. The following are pictures and screen shots of various duty cycle settings and the resulting scope traces.

Here the frequency standard was set to 100 Hz to a 5-ohm load. The signal amplitude is about 1.5 volts. The default duty cycle is 50%.

14.BAUD RATE

Display and set the baud rate for the GPS receiver interface.

A. Go to the baud rate display (**b 96** = 9,600 bps) and observe the current baud rate (÷100). Press the control knob once and observe the value blinking.

A: 

B. Rotate the control knob to select the desired baud rate (**b384** = 38,400 bps).

B: 

C. Press the control knob once to update the baud rate. After a short time-out, the MPC will briefly display **BRTO** (**B**aud **R**ate **T**ime-**O**ut).

C: 

D. The MPC controller will then reset and restart. The controller then displays a countdown (**00:09** to **00:00**) during which the GPS receiver's baud rate is verified.

D9: 

⋮

D0: 

E. The clock will display **go** and sound it in Morse code. The local time will then be displayed (**13:09**).

E1: 

E2: 

15.LOCATION

(MAIDENHEAD COORDINATES)

A. Rotate the control knob nine to the location display (**LoC**).

A: 

B. Press the control knob once and observe the first four characters of the local maidenhead coordinates (**DN33** = Field and Square).

B: 

C. Press the control knob again and observe the last four characters of the maidenhead coordinates (**33TQ** = Square and Sub Square). Here the location is DN33TQ.

C: 

D. Press the control knob again to return to the location display (**LoC**).

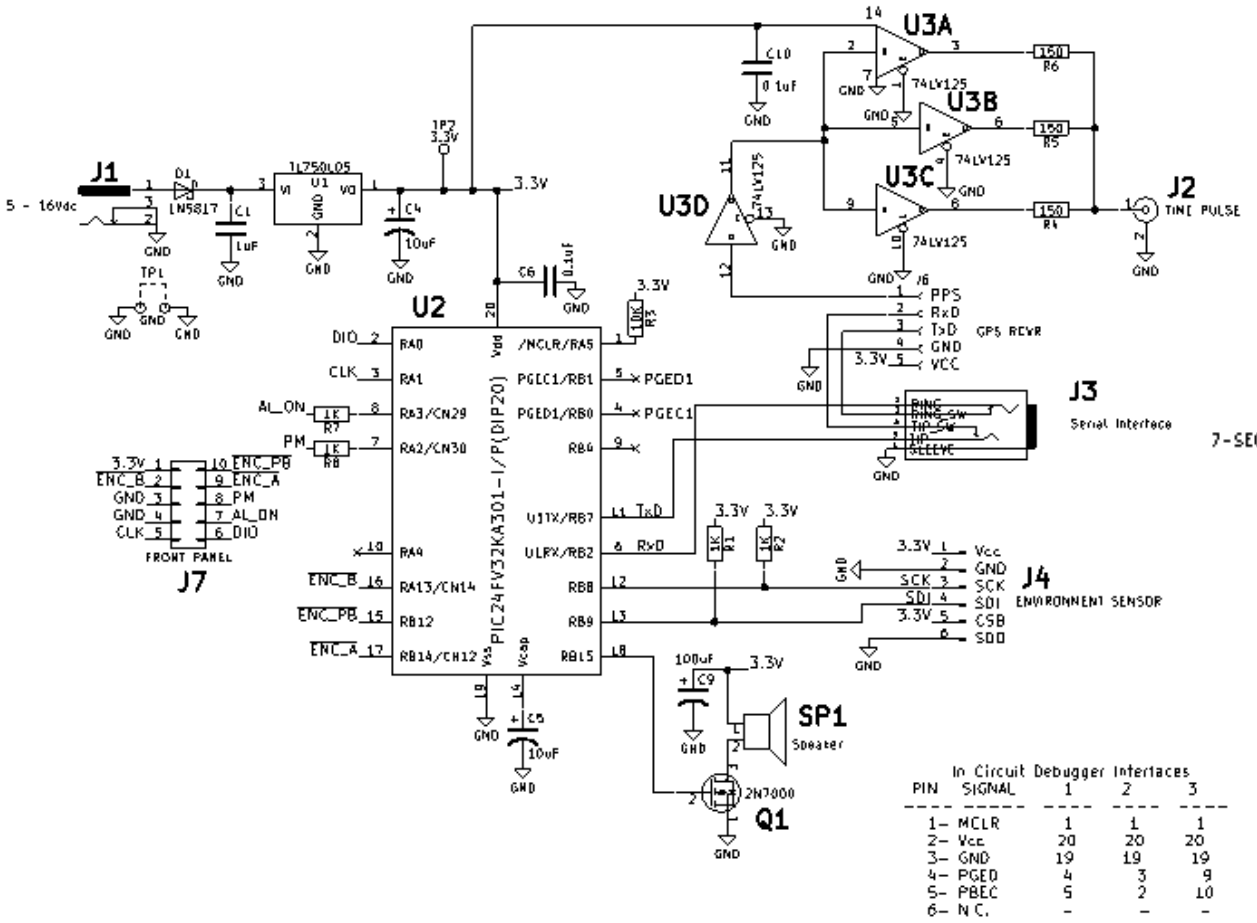
D: 

E. Rotate the control knob CCW to return to the local time display (**13:09**).

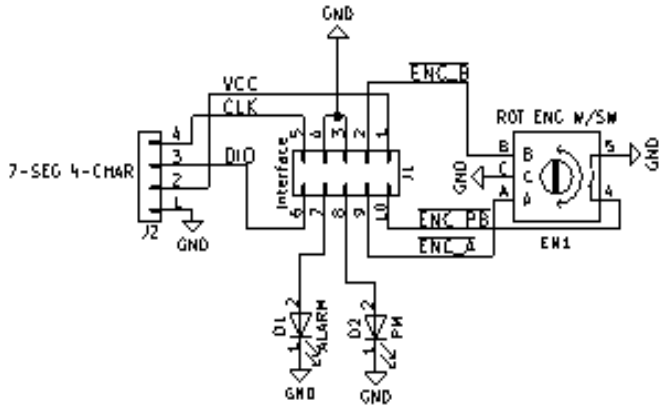
E: 

APPENDIX A. MPC SCHEMATICS

Main Board



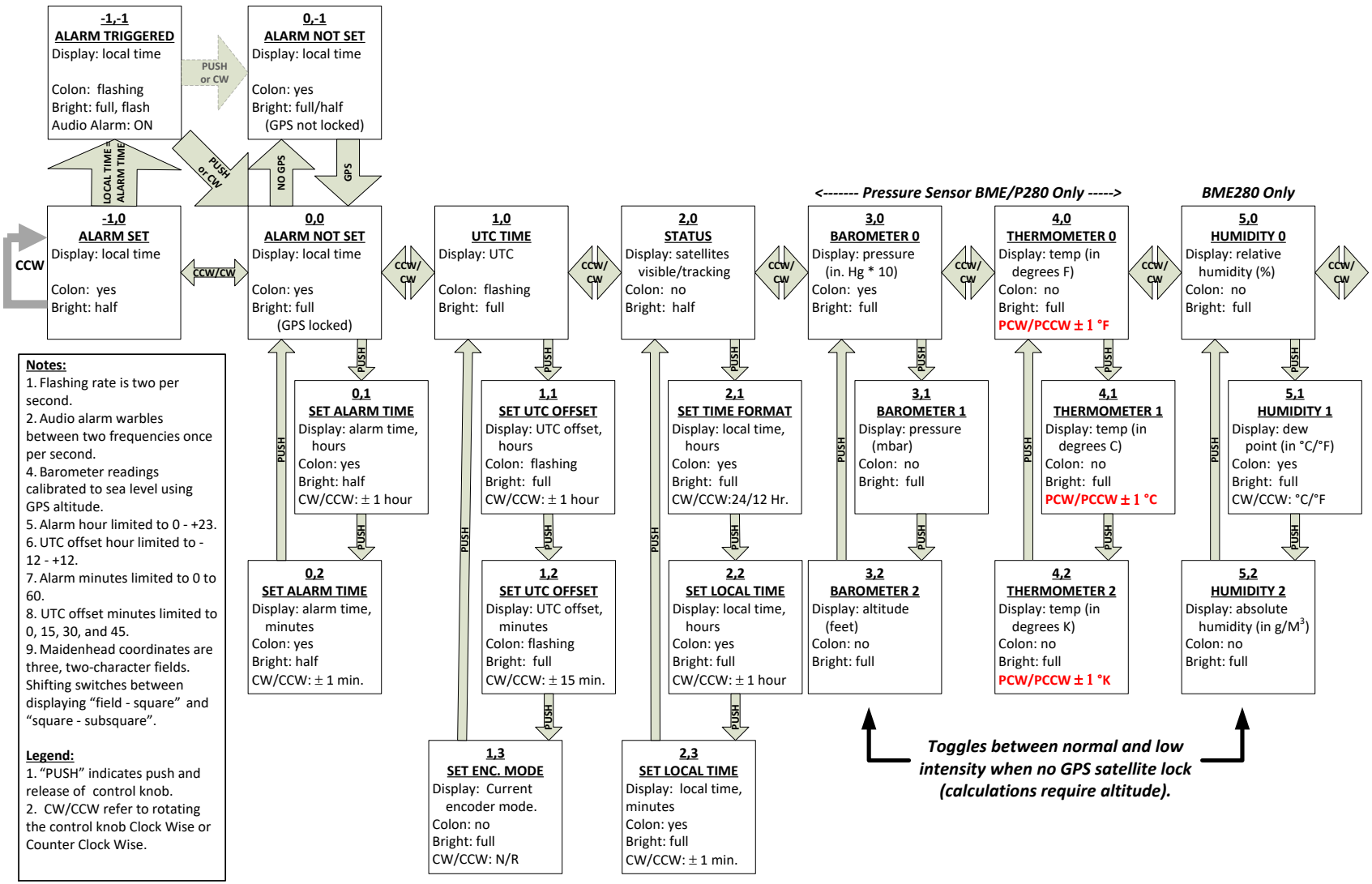
Front Board



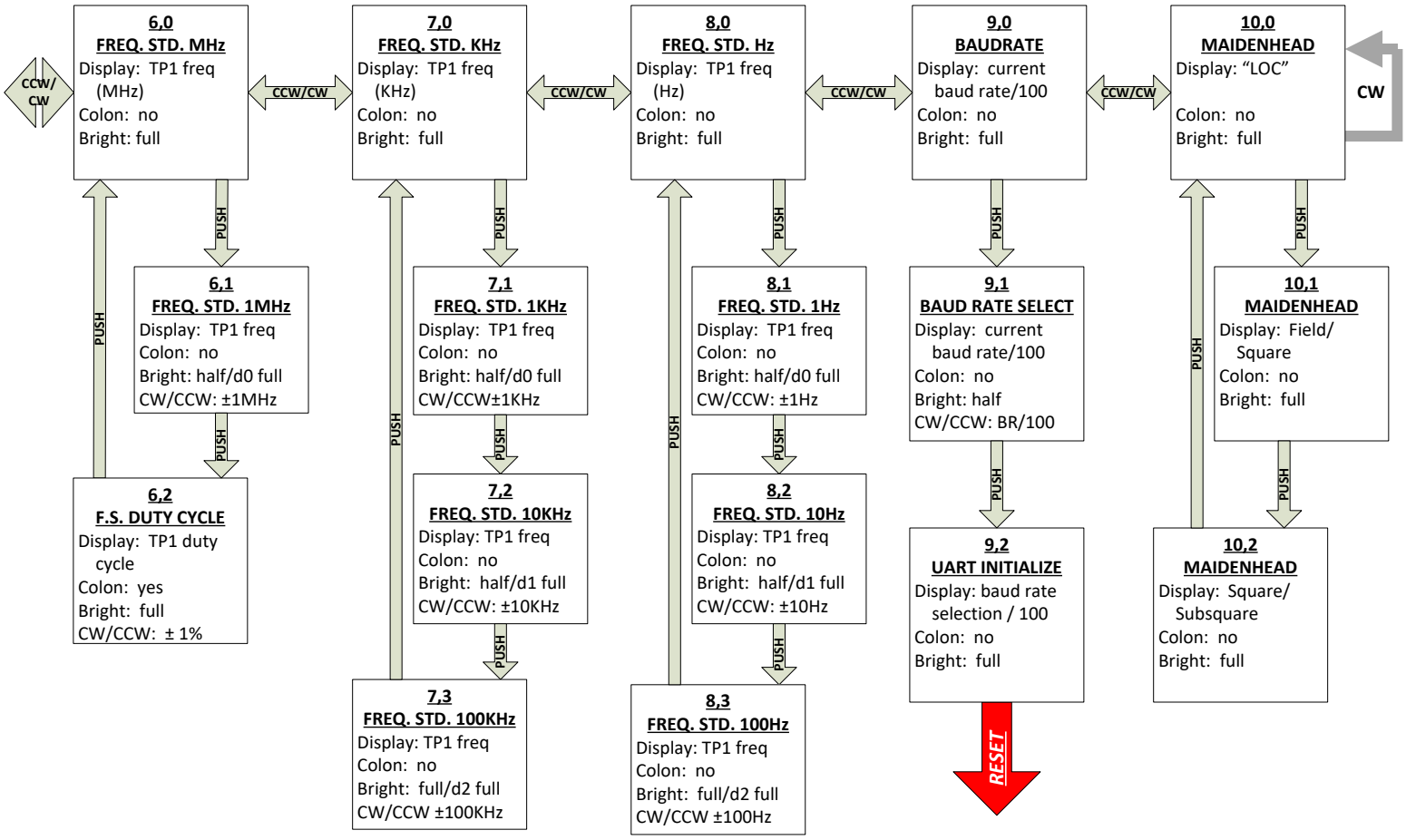
In Circuit Debugger Interfaces

PIN	SIGNAL	1	2	3
1-	MCLR	1	1	1
2-	Vcc	20	20	20
3-	GND	19	19	19
4-	PGED	4	3	9
5-	PGEC	5	2	10
6-	N.C.	-	-	-

APPENDIX B. CONTROL FUNCTION MAP



APPENDIX B. CONTROL FUNCTION MAP (cont.)



APPENDIX C. CHARACER FONTS

ABCD	
EFGH	
IJKL	
MNOP	
QRST	
UVWX	
YZ