CleverLoad Software

Main Measuring Routine

Menu Items

1. Measurement Menu
    a. Full Range
    b. Auto range
    c. Peaking
        i. Reset zero
        ii. Disable auto range
    d. Attenuator mode – use external pad to reduce power to detector, display indicator notes mode
        i. Set attenuator value using Up Dn on display and a 3 digit value XX.X dB. If zero don't write an A to the display after battery icon.
    e. Datalog
        i. Set Measurement Interval
2. Utilities Menu
    a. Set Backlight
        i. 15 choices plus memory location for current choice. Each choice shows current consumed
    b. Set Temp Alarm
        i. 35 to 75deg in 5 deg increments with fixed hysteresis 5,10 for too hot \
    c. Set Off Interval
        i. 2,5,10,20,30,60,never min
    d. Change Clock Hour –increment or decrement one hour to account for DST
    e. Dump Datalog
        i. Transfer EEPROM –through serial link
        ii. Clear EEPROM

Features Functionality & Operational Behaviour

1. Restore measurement condition on power-up using EEPROM memory allocations
    a. Set display backlight level
    b. Kick the clock to start it
    c. Reload CGRAM display data
    d. Reload antilog table and any other storage variables back in to RAM
    e. Display mode dBm or Watts
    f. Attenuator in use? if so use value
    g. Measurement mode –full range –auto range -peaking
    h. Off time interval
    i. Temperature alarm setting
2. In measurement mode S2 switches readings between dBm and Watts.
3. Servicing background tasks should not alter user perceived unit behaviour.
    a. Only battery check has the potential for altering behaviour. Need to define interval. Fast enough so that if user plugs in or removes external power display is updated within a couple of seconds.

Background Tasks

Need to determine interval and how to break out of measurement loop to service. Probably once every 32 readings. Need to determine time required and impact on display updating.

4. Update off timer
    a. Respond to switch pushes and increment
    b. Disable off timer if line powered – combine with battery check
5. Battery check
    a. Update Icon
    b. Check for power source & disable off timer if line powered

Interrupt Driven Tasks

6. Off timer and temperature alarm
    a. Interrogate devices to determine which one caused interrupt
    b. If off-timer simply turn off unit
    c. If Temperature alarm
        i. Write display warning removing all readings except input power in dBm and flash display. Continue warning mode until below temp hysteresis value then resume normal mode

Software Processes

Power-up tasks

Sequence to be done after power down, either by turn off or time out timer

1. Load backlight value and set level
2. Initialize the display and display splash screen until initialization is complete
3. Kick clock to start it
4. Load measurement mode –full=1 auto range=2 peaking=3 data logging=4
5. Turn on power supply to the detector, supply voltage monitor and if in peaking turn on amplifier
6. Reload CGRAM characters
7. Reload antilog table
8. Load attenuator state and if on also load attenuator value. If the attenuator is on adjust power ranges on full range by 10dB to suit over the range 10 to 40dB.
9. Load temperature alarm value
10. Load off time interval and start counter
11. Measure supply voltage and store value for appropriate battery icon.
12. Start power measurement routine

Power Measurement Routine

1. Do n standard measurements (128?) then do all background tasks repeat
2. Within a 'check SW1 SW2 and SW3' loop do measurements while no switches are pushed
    a. If SW1 is pushed reset off time to selected increment or turn the unit off if held for more than 3 sec
    b. If SW2 is pushed reset off time and toggle measurements readings between dBm and Watts
    c. If SW3 is pushed reset off time and stop measuring & go to Utilities Menu
3. Make a raw power measurement
4. If low power, reading less than 83, then go to the LORF routine
5. If less than 0dBm raw reference count as stored in Housekeeping EEPROM then do the low power decade lookup in EEPROM before proceeding
6. If greater than 0dBM then take reading to display using selected mode. Remember to account for attenuator offsets.
7. Go to step 1.

Peaking Routine

1. Turn on 8x gain block
2. Insure readings stabilized
3. Read relative power in .01dBm increments, (dBm only) to +/-3.5dBm
4. Allow options while in this mode to re-center zero & hold range rather than auto center if reading goes above or below the 3.5dBm pealing range limit.

LORF routine

1. Display LORF screen
    a. Display LO RF as first two characters of each display line
    b. Display battery state icon
    c. Display temperature & time

2. return

Peaking Mode Measurement routine

3. Turn on 8x gain op-amp supply
4. Find half rain and set as zero reference
5. Calculate and display delta reading in the form x.xxdBr
6. Pressing S3 brings up submenu options
    a. Re-center zero
    b. Turn off auto center if on (Auto center automatically re-centers the reading if delta power is greater than 3.5dB
    c. Turn on auto center if off

Interrupt Handling routine

7. Determine which device caused the shared interrupt
    a. Off time time out
    b. Temperature exceeds threshold
8. If Time out timer then turn off unit
9. If temperature too high
    a. Display alarm, flash backlight show temp and high temp warning
    b. Remain in this mode until temperature hysteresis threshold is crossed then return to RF power measurements.

Background Task Routine

10. Check raw battery ADC voltage & store variable
11. If AC powered disable time-out timer

Datalog Routine

1. Details to be determined after Solar Panel monitor Datalog completed

Utilities Menu

While in utilities menu any key push must also reset the turn-off timer if enabled.

1. Turn Unit Off
2. Choose Measurement Mode
    a. Full Scale mode 0
    b. Auto Range mode 1
    c. Peaking mode 2
    d. Datalog mode 3
3. Set Temperature Alarm value in 1 degree increments from 30 to 75 deg. C
4. Select off interval in 1 minute intervals from 2min to 59min.
5. Change clock hour – inc or dec clock 1 hour to adjust for daylight savings time change
6. Dump Datalog

Calibration Load

Main Menu

1. Display and set clock
2. Calibrate clock
    a. Set clock frequency output to 32,768Hz
    b. Adjust and save analog trim register
    c. Adjust and save digital trim register
3. Calibrate Power readings Raw ADC to record 0dBM and 40dBM reference values
    a. Set generator output for 0dBm and save raw reading in ISL12026 EEPROM
    b. Record reading in default EEPROM section
    c. Set generator output for between +30.0 and 43.0dBm and save raw reading. User enters actual power and scaling factor is calculated then stored in EEPROM
4. Calibrate 8x peaking gain factor

    a. Allow time for gain block to stabilize after turn on
    b. Read raw A-D
    c. Change level from +6dBM to +3dBm and calculate scaling factor
    d. Store peaking gain scaling factor in ISL12026 EEPROM
5. Display EEPROM Cal updates register contents
    a. Displays contents of Clock ATR, Clock DTR, RFPower Cal 0dBm, scaling factor, and 8x scaling factor. User must manually change contents for these registers in the 'Load default EEPROM contents section of the program or 'factory' defaults will be written if the 'Load default EEPROM contents' script is run.
6. Load default EEPROM contents –
    a. details of contents in 'CleverLoadMemoryMap.xls'
    b. Enable easy user updates for 0dbm and +40dBm values

Battery Icons & Threshold voltage

There are four battery icons generated for the Newhaven 16*2 line character display, three in the special characters load, $00 empty, $06 half battery capacity, $07 full battery, and the standard character $1b for mains power. The 'BatteryVoltageThresholds.xls' spread sheet details the calculations behind the selected thresholds. The input to the LDO voltage regulator U4 is measured though a voltage divider consisting of R16 and R17. N channel MOSFET Q10 is used to remove the divider current when in low power mode (supply is turned off through Q3 and Picaxe C.1 so note the unit can't measure battery voltage when in low power mode). The output of the voltage divider is taken to A-D C.7. Originally thresholds for two types of batteries, Alkaline and NiMh were considered but it turned out that the thresholds were close enough that only one set was needed. The alkaline battery has a higher initial voltage and can operate to lower voltages near exhaustion than the NIMH pack, but the lower operating threshold voltage needed for the circuitry prevents use a very low voltages. The LDO is set for 4.4 to 4.45V and the regulator needs 50mV headroom at 30mA load current, the typical fully active current required by the power meter, so the lower voltage limit for guaranteed function is 4.5V or 1.125V per cell. Alkaline cells can operate down to about 1.1V but that exceeds the lower operational threshold of the unit. The empty battery threshold was set at 1.175V per cell, 4.7V for the battery, 73 counts on the 8 bit A-D. This provides a 200mV supply margin when the empty battery symbol is displayed. This represents about 10% remaining capacity on NIMH packs and 30% capacity on alkaline packs. The 1.125 V the minimum needed to insure proper circuit operation takes NiMh batteries to exhaustion and leaves about 10% capacity unused in the alkaline cells. Half battery is set to 1.25V per cell, 5V for the pack, with raw 8 bit A-D count of 78. This represents about a 70% remaining capacity, 30% used on the NiMh pack and 50% on the alkaline pack. There is no full battery threshold. Any A-D count over the half capacity threshold is shown as full. There is no need to store the threshold values in EEPROM as they are hard coded into the program.

Find Half Rail

A MCP4018 10k 128bit pot is used as a D-A converter to set the input voltage to an 8x gain stage using an LM7101 such that for a given RF input the amplifier output is set to half rail as a starting point for dBr measurements. This algorithm that does this sets the pot to 1, so that in the routine there is opportunity to decrement, then in a routine increments the pot tap if the output is above the center threshold or decrements it if below. Initially with the pot set to 1, the op-amp output will be at the positive rail, and incrementing the pot will act to increase the voltage at the non-inverting input of U10 and as the output of U10 feeds the negative input of U5 will act to decrease the output voltage.

Each pot bit moves the output voltage by about 110mV when in the linear range. The supply voltage is set to between 4.4 and 4.45, a voltage divider formed by the 2.4k resistor R10 and the pot itself limits the positive voltage at the pot to .8064xsupply voltage or 13.86mv per step. Accounting for the 8x gain in U5 the output will change about 111mV for each pot bit. This represents about a 28bit step size for the 10 bit A-D sensing the op-amp output (4.096V reference / 1024 steps =.004V/step x 27.7 =111mV.

With a 4.4V rail, half rail is 2.2V or 550 counts on a 10 bit A/D. But the converter reference limits the dynamic range to 4.096V, half rail being 512 counts, so this is chosen as the target half rail end point.. Linearity is needed for about 4dBr, or 400 steps either side of center . In order to insure there is always a sample with the target range given the D-A pot resolution of 28 bits a window of +/-20 bits is used was tried but there was a convergence problem at around -4dBm until the window was increased to +/- 25 bits. This resulted in an upper limit of 537 and a lower limit of 492. Algorithm convergence time is under a second.