Accurizing the NXIC Real Time Clock Manual Calibration Routine

REVISION HISTORY			
REV	**DESCRIPTION**	**DATE**	**APPROVED**
-	Initial Revision	4/17/08	TAM

Purpose

This simple procedure is designed to bring the NXIC clock accuracy into specification of < 30 seconds per month. This procedure will optimize the clock's accuracy at the temperature at which it is performed, and therefore it is best if it is performed at the instrument's typical operating temperature. It is a fixed calibration and does not take into account clock changes in ambient temperature during operation. Take the time to read through this procedure completely before performing the calibration.

Equipment Required

- NIST time reference
- Microsoft Excel
- AN2008002PPMATRTimecal.xls http://www.falmouth.com/AppNotes.htm
- Terminal program for communicating with the NXIC

Background

The onboard RTC IC has an internal register that applies small adjustments that affect the clock's fundamental timekeeping frequency. The NXIC command to read and modify the register is available in OPEN mode and is designated ATR. Typing "ATR < ENTER >" will display the current value in hex, and typing "ATR=2A< ENTER >" will set the register to 2A hex, the equivalent of 42 decimal. *Important: The numbers must be entered in hex format and both digits must be present. A '2' hex must be entered as '02' to be correct.*

NIST Time References

The calibration process requires that you have access to an accurate clock reference. The following may be used:
http://www.time.gov/
This is a real-time clock display that you can reference in the process below.
Another is:
http://www.arachnoid.com/abouttime/
This is the website for the program AboutTime. It has been around a long time and is free and considered safe i.e. without viruses etc.. AboutTime must be installed as an application and will synchronize your PC Clock to the NIST standard automatically or on demand. *Note: Many similar 'free' programs are used as vehicles to install adware and malware, so beware!*

The basic steps:

Phase one

1. Set the NXIC to OPEN mode (***O)
2. Read the ATR value and record it
3. If not already 0, set the ATR to 0.
4. Set CLKA=0, CLKB=0 & CLKC=0 and store to EEPROM using ***E)
5. Synchronize the NXIC clock to the NIST time reference and record the sync time in the worksheet. (see detailed instructions below)
6. Allow 12-24 hours to elapse
7. Read the NIST time reference and the NXIC clock and record in the worksheet.
8. Review the ppm error as automatically calculated on the worksheet.

Phase two (if ppm error from above is unacceptable)

1. Set the ATR to the new value (see detailed instructions below) – remember to set it in HEX using two digits.
2. Set CLKA to the decimal representation of the new ATR value and then store to EEPROM using ***E
3. Repeat steps 5-7 above

Detailed instructions:

To Set the clock:

- Display your NIST time reference on the PC.
- Open the terminal program and set the NXIC to OPEN mode.
- Type 'ATR < ENTER >' and record the value that is displayed.
- Type 'TIME<ENTER>' and the prompt Enter time (hh:mm:ss) will come up.
- At this prompt enter a time that is several seconds in the future as referenced to the NIST time - DO NOT HIT 'ENTER' YET!
- Wait until the NIST time is exactly equal to the time you entered and immediately hit ENTER. The clocks should be synchronized to within one second. Enter the date and time as the start time in the Excel spreadsheet for both the UTC and the NXIC. *Note that Date and the Time are separate cells.*

To Read the clock:

- Display your NIST time reference on the PC.
- Open the terminal program and set the NXIC to OPEN mode
- Type 'TIME' but do NOT hit '<ENTER>' yet!
- Wait for the NIST time seconds digits to hit 00, then immediately press '<ENTER>'
- Record the NIST time and the NXIC times in their respective spreadsheet cells.
- *Note that Date and the Time are separate cells.*

At this point the spreadsheet will have calculated the error and give you an approximate measure of the error in minutes/month and ppm. If this value is in an acceptable range, typically +/- 20ppm, you are done. If the NXIC clock error was unacceptable then try a different value for ATR and repeat the test. *Note that the ppm values calculated are relative. If you test at ATR = 25 and you come up with a ppm value of –26, then add it to the ppm of the current ATR (87) to get the new ppm value (61) which is associated with a new ATR value of 2A.* The lookup table on the last page will give you approximate ATR values to substitute based on the ppm calculated.

The worksheets have values showing results of the real testing. The topmost worksheet shows the values with the original ATR. The next worksheet shows the values with ATR set to 0. The third shows ATR set to 0x25H based on the nearest value from the lookup table at the end of this document based on the previous test's offset of 86ppm.

	UNIT ID:	
	ATR=0x96 (0x16)	
	NIST	**NXIC**
start time	4/4/2008 15:42:18	4/4/2008 15:42:18
end time	4/7/2008 17:14:00	4/7/2008 17:12:59

elapsed secs	elapsed secs
264702	264641

total error 61 (secs)	230 ppm
	9.96 minutes/month

	UNIT ID:	
	ATR=0	
	NIST	**NXIC**
start time	4/7/2008 15:46:05	4/7/2008 15:46:05
end time	4/8/2008 7:53:00	4/8/2008 7:52:55

elapsed secs	elapsed secs
58015	58010

total error 5 (secs)	86 ppm
	3.72 minutes/month

	UNIT ID:	
	ATR=0x25	
	NIST	**NXIC**
start time	4/8/2008 13:02:00	4/8/2008 13:02:00
end time	4/8/2008 17:18:30	4/8/2008 17:18:30

elapsed secs	elapsed secs
15390	15390

total error 0 (secs)	0 ppm
	0.00 minutes/month

Clock Adjustment Values Table

This table relates ppm to ATR value and to final CLKA value which must be written to the EEPROM to make these changes permanent. The ATR value is in hex, and the CLKA value is the decimal equivalent of the ATR value. Before committing these values to the EEPROM check the CLKB and CLKC values. If they are not already 0 make sure they are set to 0.

ppm	ATR (HEX)	CLKA (DEC)	ppm	ATR (HEX)	CLKA (DEC)
116	20	32	0	0	0
110	21	33	-2	1	1
104	22	34	-4	2	2
98	23	35	-6	3	3
93	24	36	-7	4	4
87	25	37	-9	5	5
82	26	38	-11	6	6
77	27	39	-12	7	7
72	28	40	-14	8	8
67	29	41	-15	9	9
63	2A	42	-17	A	10
58	2B	43	-18	B	11
54	2C	44	-19	C	12
50	2D	45	-21	D	13
46	30	48	-22	10	16
42	31	49	-23	11	17
39	32	50	-25	12	18
35	33	51	-26	13	19
32	34	52	-27	14	20
29	35	53	-28	15	21
25	36	54	-29	16	22
22	37	55	-30	17	23
19	38	56	-31	18	24
17	39	57	-32	19	25
14	3A	58	-33	1A	26
11	3B	59	-34	1B	27
9	3C	60	-35	1C	28
6	3D	61	-36	1D	29
4	3E	62	-36	1E	30
2	3F	63	-37	1F	31

Notes:

Due to Internet congestion the NIST time references can have errors up to 3 seconds, though the error is typically less than one second. Therefore the longer the time interval you measure over the better your accuracy.

Set and read the time in OPEN mode only. This gives direct read from the time chip with no other processing overhead.

There are two crystals used with the time chip, one with a 12.5 pf load capacitance and another with 6.0pf. The 12.5 will wants to have an ATR value of 0 to start, the 6.0 wants an ATR value of 25 (Hex) to start. There is no way to tell which crystal is installed, but a short timing test of 4-5 hours with an ATR of 0 should give a clear indication which is installed. The ppms should be low (< 40) for the 12.5 and high (70-90) for the 6.0pf. If low you can continue the test assuming a 12.5pf crystal is installed. If ppms are high, restart the test with and ATR of 25 (hex). Don't forget to set CLKA to the decimal value of the ATR and CLKB and CLKC = 0. If they are not properly set and you remove and reapply power or run in interval mode the ATR may be reset to an incorrect value.

In reading and interpreting the results of the interval time test in the spreadsheet ignore the time difference and focus on the ppm value. This gives a representation of the actual error over the time interval. If the ppm value is within the range +/-20 then the clock should be accurate within spec.

This time adjustment does not include compensation over temperature. If there are to be long deployments at low temperatures and time accuracy is critical, then before deployment perform the interval timing test at the deployment temperature. For best results set the clock immediately before deployment. Alternately, you can take values from the following graph to adjust the ATR from its value at the original test temperature to the deployment temperature. Just take the difference in the ppm from the original test temperature to the deployment temperature and add it to the value of the ppm at the current ATR setting to get the new ATR value. Again, be sure to reset CLKA value as well as the ATR value.

Procedure for adjustment for different operating temperature:

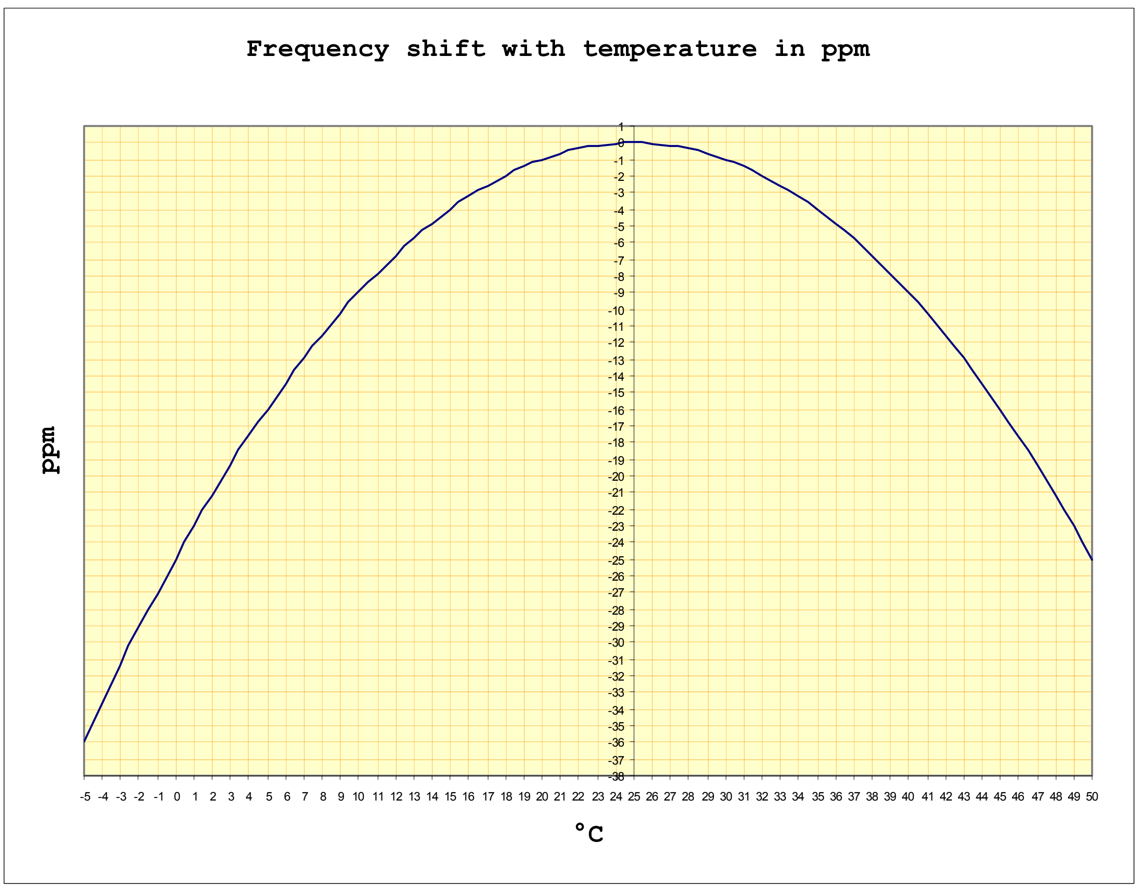
- Get current ATR reading from instrument and note the associated ppm value from the Clock Adjustment Values Table.
- From the following graph get the ppm associated with the temperature the unit was originally tested at.
- From the following graph get the ppm associated with the temperature the unit will be deployed at.

- Note the difference in ppm and add it to the current ppm as read from the Clock Adjustment Values Table – this is the new ATR ppm value
- Lookup the ATR associated with the new ppm value.
- Update ATR and CLKA with the new values.

Numeric example for adjustment for different operating temperature:

- Current ppm = 87 at ATR=25
- Original test temperature = 20°C
- Anticipated deployment temperature = 5°C

- ppm @20°C = -1
- ppm @5°C = -16
- Difference between the two ppm values = -15ppm
- Add –15 ppm to 87 ppm = 72 ppm
- Lookup 72 ppm in Clock Adjustment Values Table to get values to set in instrument: ATR=28, CLKA = 40



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