ATT7022C User Manual

V0.6

CONTENTS

Features

- Fully compatible with ATT7022B.
- ADC sampling data buffer functions with the length of 240.
- Support single-channel, dual-channel or three-channel simultaneous sampling.
- Enhance the accuracy of small current signal RMS value.
- Get high-precision voltage Line-to-Line angle indirectly (better than 0.2 degrees).

Functions

ATT7022C is the upgrade version of ATT7022B. ATT7022C open the ADC sampling data buffer while retaining all the features of ATT7022B , then users do not need to have frequent interruptions to read the real-time data of the ADC. Also, ATT7022C strengthen the small current signal RMS accuracy at the same time.

Sampling data buffer

ATT7022C added a buffer storage area with the length of 240 for the immediate preservation of the raw sample data. After sending the command, ATT7022C save the corresponding ADC data to the buffer in each sampling period until the buffer is expired. The data buffer keep maintaining the last previous data until user send a new command.

Users can read the contents of the buffer at any moment .Change **gWaveAddress** through the C1 command, users can specify the start address of the buffer; the address will be self-plus-one after every read of the buffer ; when the length is greater than the buffer, it will return to 0.

The method of reading available data is: User can wait for more than the corresponding sampling interval to read the contents of the buffer (for example: wait for 240's sampling intervals when single-channel and 120's sampling interval when dual-channel, the sampling rate is 3.2kHz). Or read the contents of the register whose address is less than **ptrWaveFormRd**. (**ptrWaveFormRd** is the pointer of ATT7022C for saving the data, corresponding to the register 0x7E.)

The data format read from SPI: the higher 2-byte is 16bits data of ADC, the

lower 1-byte is the buffer pointer. Take 'UA+UB+UC' mode for example, the data in the buffer are like this: UA0 UB0 UC0 UA1 UB1 UC1 ... UA79 UB79 UC79. To be remember, the initial values of buffer are 0x00 01 00 ~ 0x00 F0 00.

Small current signal RMS accuracy strengthening:

ATT7022C improves the accuracy of small-signal RMS current and the current start threshold 0x1F also needs to be adjusted accordingly. The default value is 0x0001F0.

$$Istartup = INT(G * I_0 * 2\textasciicircum 23)$$

G is a constant and values 0.648.
I0 is the starting point.
INT means getting the integer of the data.
For example: in order to ensure 0.1% Ib start-up, set the start point at 0.08% Ib, suppose the current pin voltage is 0.1v, then I0 = 0.1 * 0.0008 = 0.00008.
Istartup = INT (0.648 * 0.00008 * 2 ^ 23) = 434 = 0x0001B2.

Get high-precision voltage Line-to-Line angle indirectly

The resolution of ATT7022B / C's inner voltage Line-to-Line angle is about 5 degrees, users can use the same principle of the angle between voltage and current to increase the resolution.
The principle of the angle between voltage u and current is

$$\varphi = a\cos(pf) = a\cos(P/S) = a\cos(\frac{\sum_{k=1}^{N} u(k)*i(k)/N}{urms*irms})$$

Here, N is the number of the sampling points in one cycle.
acos means arc cosine.
Corresponds to the voltage angle, such as Ua&Ub, then

$$\varphi U_{ab} = a\cos(\frac{\sum_{k=1}^{N} Ua(k)*Ub(k)/N}{Uarms*Ubrms})$$

Uarms and Ubrms can be read directly from the register, N can be got from

the frequency register indirectly, Ua (k), Ub (k) can be obtained from the synchronous sampling 'Ua+Ub+Uc' mode buffer.

Our simulation shows the error is less than 0.2 degrees when the angle is above 10 degrees.

Note that the original ADC data has no gain compensation, in actual calculation the final sum need to be multiplied by the corresponding gain.

Register Description

1. The command register 0xC0 0xC1 and the parameter registers 0x7E 0x7F relate to sampling data function.
2. Strengthening the accuracy of small-signal current modified the default value of register 0x1F , and lead to the default value of parameters register 0x3E and 0x5F changed at the same time .

operation	address	name	reset value	function description
SPI Send command	0xC0	gWaveCommand	0x000000	If 0xCCCCCY, then start the waveform data buffer; or the format is invalid. The Y means the channel number of the data need to be preserved, 0 ~ 0x0B is effective, followed by: Ua \ Ia \ Ub \ Ib \ Uc \ Ic \ In, \ Ua + Ia \ Ub + Ib \ Uc + Ic, \ Ua + Ub + Uc \ Ia + Ib + Ic
	0xC1	gWaveAddress	0x000000	User specify the read location, its value is valid ranging from 0 to 239, and is auto-zero when over the border .
	0x1F	W_Istartup	0x0001F0	Setting the starting current threshold . User can overwrite the default value.
SPI Get data	0x7E	ptrWaveFormRd	0x000000	The next location for writing data, the effective range is 0 ~ 240.Its value stops at 240 after all the data

				update
	0x7F	mWaveDatatmp	0x000000	Users read this data reg repeatedly and the internal pointer automatic increment by 1.When boundary encounters, the pointer gWaveAddress return to 0.
	0x3E or 0x5F	R_checksum	0x043C73	3-phase 4-wire
			0x16BC73	3-phase 3-wire

Recommendation

The recommendation is a flow of executing FFT from sampling data,
1. Start the sampling function (0xC0 command: channel select + start).
2. Wait for the completion of sampling data.
3. Set the starting address of user read pointer (through the command 0xC1), then read the sampling data .
4. Pre-processing about the data.
5. FFT transform.
6. Implement step1 ~ 5 if the next operation is needed.

Notes:
1. The sampling data is the raw ADC data that has no offset correction and gain correction. When gain correction is needed, the coefficient is the same as the RMS correction coefficient.
2. The wordlength of the data read through SPI is 3 bytes. The higher 2 bytes is the ADC data and the msb is in high byte; and the third byte is the internal pointer .
3. Sampling data has a fixed sampling rate, if the frequency deviate from 50Hz when doing 64-point FFT, spectral leakage will occur; when high accuracy is needed, the according data pre-processing is required(A simple method: Since the sampling points are far more than that of one cycle, 1-order(also linear) interpolation can be used to ensure that first 7th harmonic with respect to standard of GB) .
4. Wait for the completion of sampling data, method I: wait for the enough time; method II: Read 0x7E to determine whether the internal write pointer is over the desired value, When equivalent to 240, it represent that one time operation is completed.

Actions

炬力集成

Poly Phase Multifunction Energy Metering IC with Per Phase Infomation ATT7022C

Attachment

FFT simulation results of 1-order interpolation:

The simulation results of adding 50% for both the 3rd harmonic(0 degree) and the 5th harmonic(minus 60 degree) when **50Hz**.
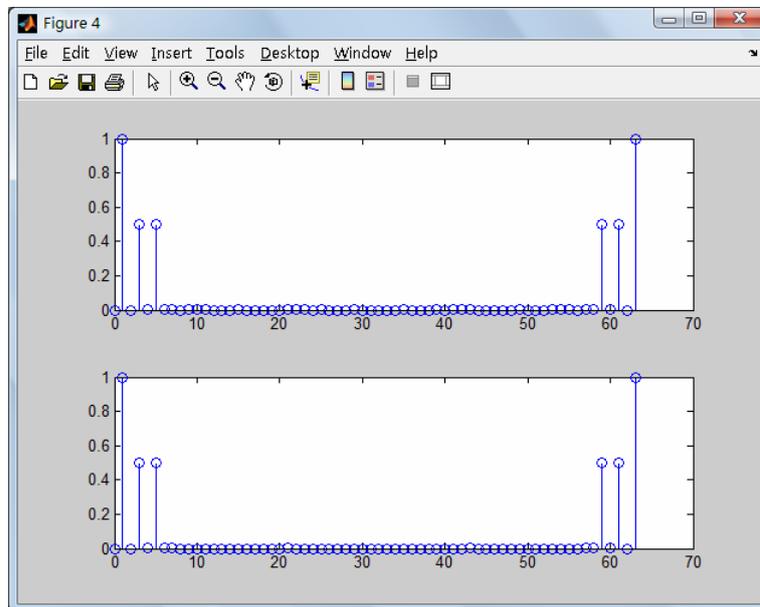
Upper Fig: 1-order interpolation FFT's result
3rd harmonic / fundamental: 0.5000
5th harmonic / fundamental: 0.5000
Under Fig: without interpolation FFT's result
3rd harmonic / fundamental: 0.5000
5th harmonic / fundamental: 0.5000

The simulation results of adding 50% for the 3rd harmonic(0 degree) and the 5th harmonic(minus 60 degree) when **45Hz**.
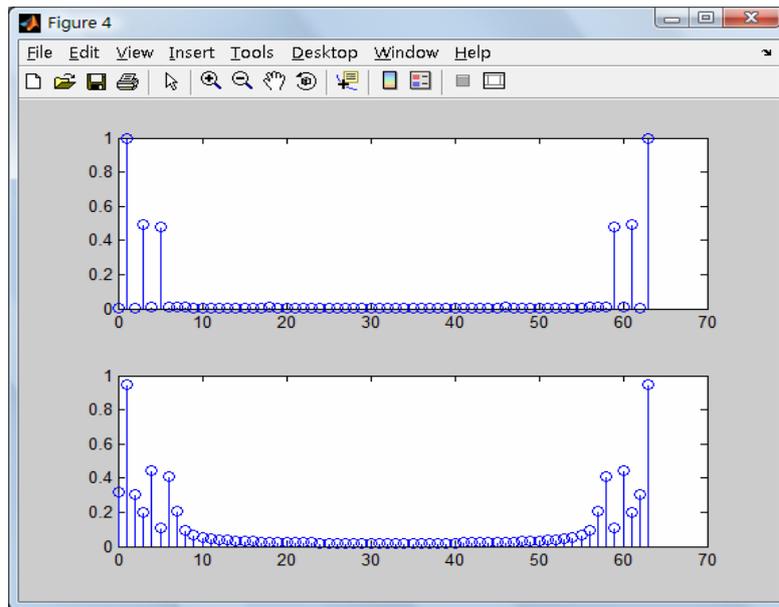
Upper Fig: the 1-order interpolation FFT result
       3rd harmonic / fundamental: 0.4982
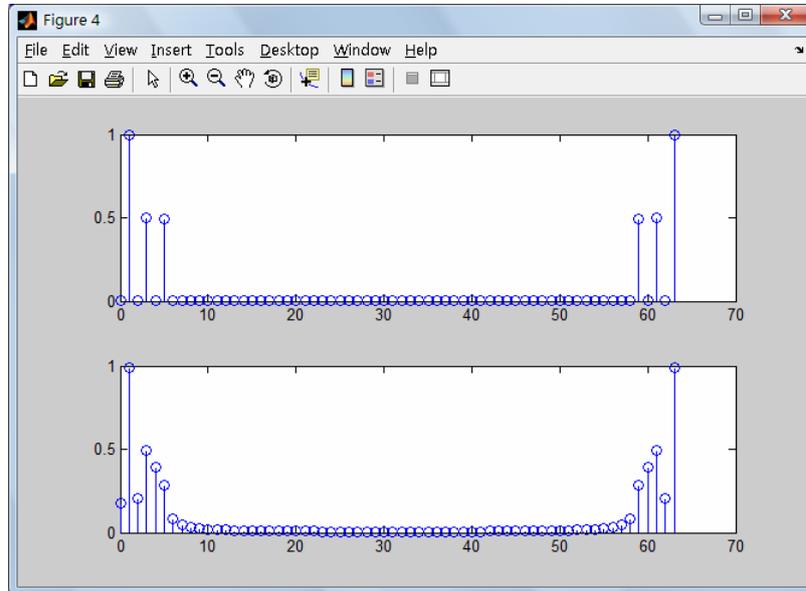   5th harmonic / fundamental: 0.4926
Under Fig: without interpolation FFT result
       3rd harmonic / fundamental: 0.4977
       5th harmonic / fundamental: 0.2849

The simulation results of adding 50% for the 3rd harmonic(0 degree) and the 5th harmonic(minus 60 degree)when **63Hz**.

Upper Fig: the once interpolation FFT result
        3rd harmonic / fundamental: 0.4926
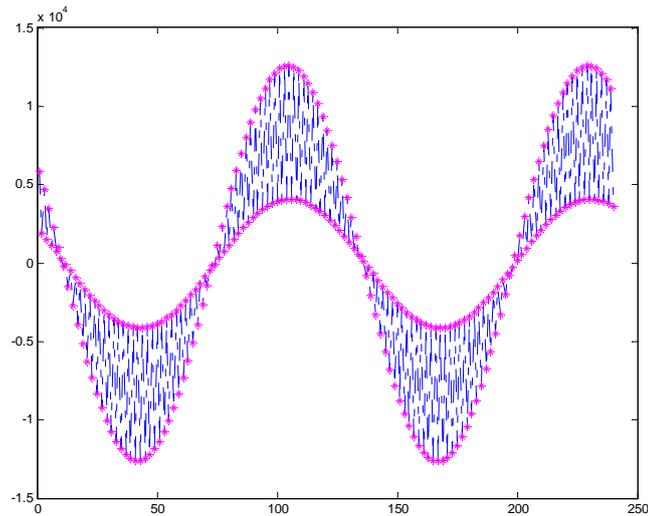   5th harmonic / fundamental: 0.4829
Under Fig: without interpolation FFT result
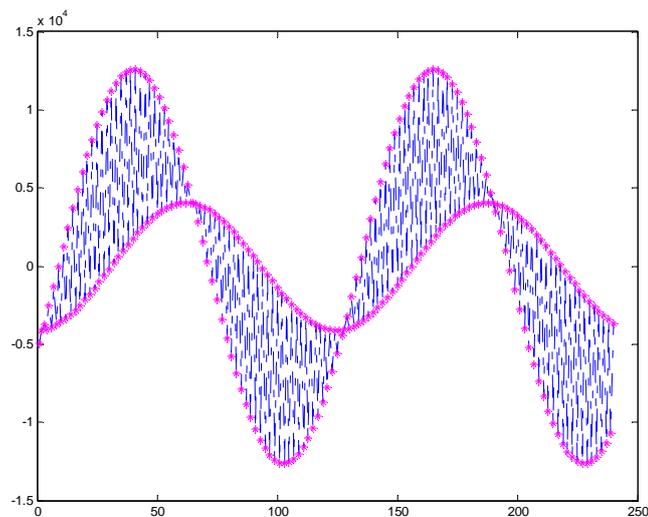   3rd harmonic / fundamental: 0.2091
        5th harmonic / fundamental: 0.1156
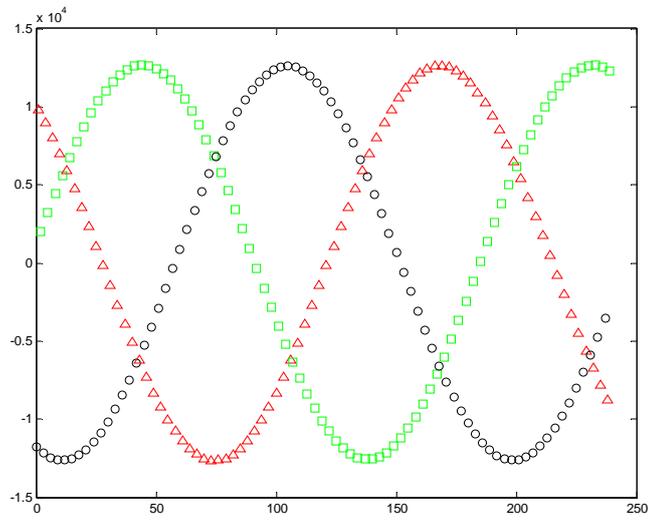
Examples of sampling function:

On the standard platform, 'Ua+Ia' mode, corresponding to Y = 0x07, when PF=1.0:

On the standard platform, 'Ua+Ia' mode, corresponding to Y = 0x07, when PF=0.5L:

On the standard platform, 'Ua+Ub+Uc' mode, corresponding to Y = 0x0A:

On the standard platform, 'Ia+Ib+Ic' mode, corresponding to Y = 0x0B: