Application Note

Single-Phase Energy Metering IC

M90E26

APPLICATION OUTLINE

This document describes system application issues when using the M90E26, single-phase energy metering ICs to design single-phase energy meters.

Generally, a single-phase smart meter consists of a single-phase energy metering IC, an MCU processor and its peripheral equipments. Section 1.1 Schematics provides the schematics of an energy meter using the M90E26. MCU reads and writes data of the metering IC through the SPI/UART interface. Considering low-cost and anti-tampering etc., ground of the single-phase energy metering IC is generally connected to the phase line (L line) of the single phase power supply. MCU can be isolated from the metering IC by optocoupler. While in cases when the end user does not touch the internal components of the energy meter, ground of the MCU can also be connected to the phase line and MCU connects to the metering IC directly.

In a typical application, shunt resistor is generally used for phase line (L line) current sampling. To ensure isolation between phase line (L line) and neutral line (N line), Current Transformer (CT) is generally used for N line current sampling. While resistor divider network can be used for voltage sampling.

The M90E26 uses 3.3V single power supply. In the reference design, the AC voltage output by the transformer is rectified by a diode then passes through the regulator 78L33 and forms 3.3V linear power supply. The 3.3V linear power supply is then directly connected to digital power DVDD of the M90E26 after being decoupled by the capacitors. The analog power AVDD is connected to DVDD via a 0Ω resistor. The M90E26 has a power-on reset circuit and the $\overline{\text{Reset}}$ pin can connect to DVDD directly.

The M90E26 has highly stable on-chip reference power supply. Different from competitor's products, the M90E26 requires only a 1µF SMT capacitor to connect to the Vref pin. Considering the characteristics under high frequency, it is suggested to also add a 1nF capacitor to the Vref.

The M90E26 provides the active energy pulse output pin CF1 and the reactive energy pulse output pin CF2, which can be used for energy calibration. The CF1/CF2 pin can also be connected to the MCU for energy accumulation. The maximum source/sink current for the CF1/CF2 pins is 10mA which can turn on the energy pulse light and drive the optocoupler (even when the energy pulse light and the optocoupler are in parallel with each other).

The M90E26 provides programmable voltage zero-crossing pin ZX which can be used by MCU to complete operations such as power line carrier sending and relay operation.

The M90E26 provides the independent metering parameter error warning output pin WarnOut. When there is any metering parameter error, the WarnOut pin outputs high level to remind MCU to reset the M90E26 and reload the metering parameters. In addition, the M90E26 also has voltage sag warning function. The WarnOut pin outputs high level when there is voltage sag provided the SagWo bit (FuncEn, 02H) enables voltage sag warning output through the WarnOut pin.

The M90E26 provides a dedicated interrupt request output pin IRQ. The IRQ pin outputs high level when there is any metering / measurement parameter error, active/ reactive energy direction change, voltage sag, metering line change in anti-tampering mode, etc.

The maximum source current for the above ZX, WarnOut and IRQ pins is 5mA. In application when MCU is isolated from the M90E26, these pins can directly drive the optocouplers.

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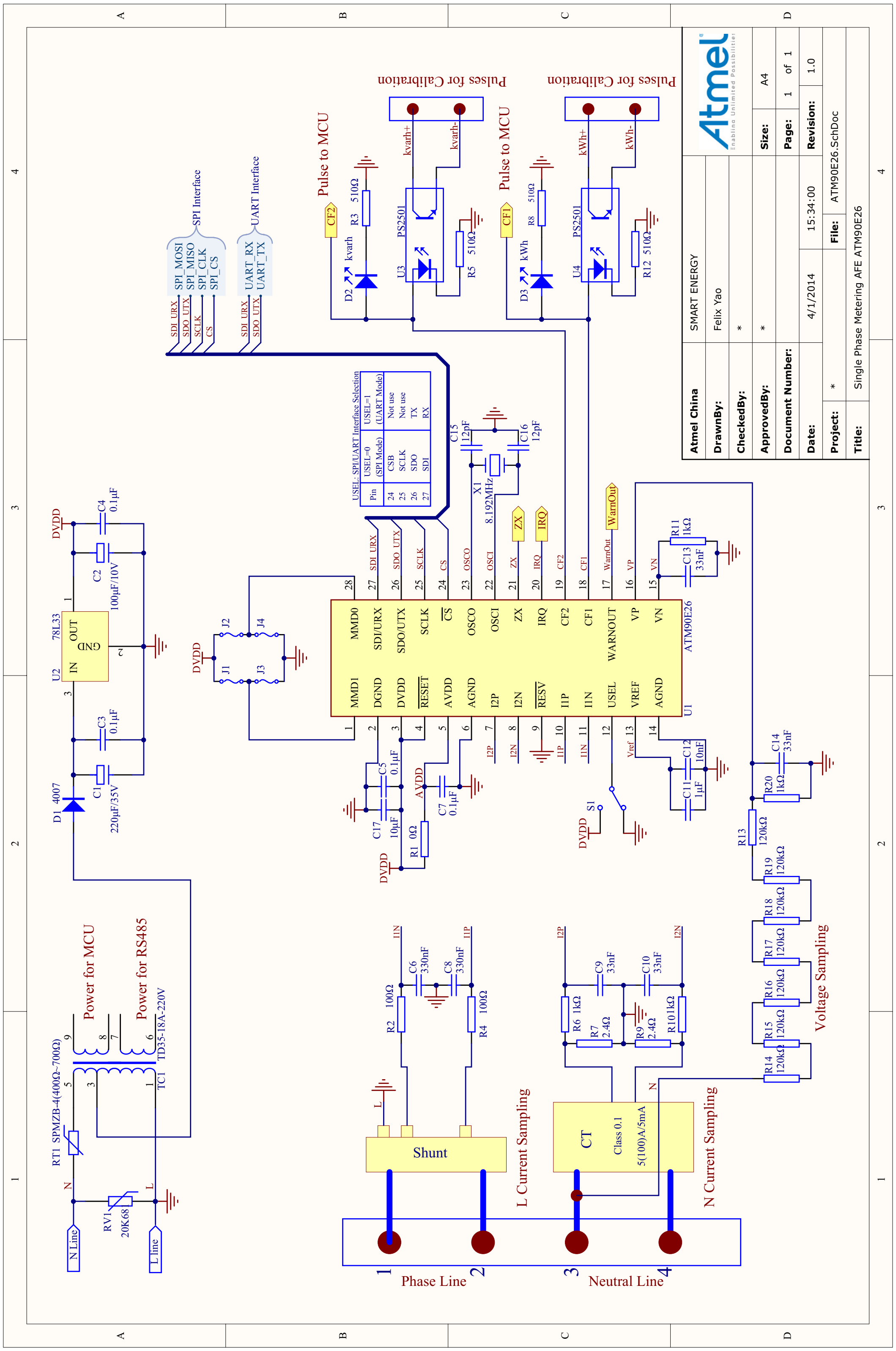
1 HARDWARE REFERENCE DESIGN

1.1 SCHEMATICS



1.2 COMPONENT BOM

Table-1 Component BOM

Component Type	Designator	Quantity	Parameter	Tolerance
SMT Capacitor	C12	1	0603 1nF	±10% X7R
	C9 C10 C13 C14	4	0603 33nF	±10% X7R
	C3 C4 C5 C7	4	0603 0.1µF	±10% X7R
	C6 C8	2	0603 0.33µF	±10% X7R
	C11	1	0603 1µF	±10% X7R
Electrolytic Capacitors	C2	1	100µF/10V	-
	C1	1	220µF/35V	-
SMT Resistor	R7 R9	2	0603 2.4Ω	±5% 1/8W 25ppm
	R1	1	0603 0Ω	±5% 1/8W 100ppm
	R2 R4	2	0603 100Ω	±5% 1/8W 100ppm
	R3 R5 R8 R12	4	0603 510Ω	±5% 1/8W 100ppm
	R6 R10 R11 R20	4	0603 1kΩ	±5% 1/8W 100ppm
	R13 R14 R15 R16 R17 R18 R19	7	0805 120kΩ	±5% 1/8W 100ppm
SMT Diode	D1	1	1N4007	-
Optocoupler	U3 U4	2	PS2501	-
Crystal	X1	1	8.192MHz	100ppm
IC	U1	1	M90E26	-
	U2	1	78L33 TO-92	-
LED	D2 D3	2	Red Φ3	-
Regulator	TC1	1		-
Varistor	RV1	1	20K681	-
Thermal Resistor	RT1	1	SPMZB-4 (400Ω ~ 700Ω)	-

2 INTERFACE

The M90E26 provide a selectable interface to communicate with microprocessor (MCU). It can be operated as SPI or UART, selected by the USEL pin. Please refer to below table for interface configuration. Note that the USEL pin should not be changed after reset.

Table-2 Interface Configuration

<table>
<tr><th>Interface</th><th>USEL
(pin 12)</th><th>$\overline{CS}$
(pin 24)</th><th>SCLK
(pin 25)</th><th>SDO/UTX
(pin 26)</th><th>SDI/URX
(pin 27)</th></tr>
<tr><td>4-wire SPI</td><td>Low</td><td>Chip Select of SPI</td><td rowspan="2">Serial Clock of SPI</td><td rowspan="2">Master In Slave Out (MISO) of SPI</td><td rowspan="2">Master Out Slave In (MOSI) of SPI</td></tr>
<tr><td>3-wire SPI</td><td>Low</td><td>Always Low</td></tr>
<tr><td>UART</td><td>High</td><td>Connect to VDD</td><td>Connect to GND</td><td>Transmit UART data</td><td>Receive UART data</td></tr>
</table>

2.1 SPI INTERFACE

The 4-wire SPI interface is operated in a standard slave SPI mode. A complete SPI read/write operation is of 24 bits, which contains 8-bit address and 16-bit data. The SPI read/write only supports single address operation, rather than continuous read or write.

In 3-wire SPI mode, $\overline{CS}$ is always at low level. The SCLK keeps at high level when no operation. The start of a read/write operation is triggered if SCLK is consistently low for at least 400μs. The subsequent read or write operation is similar to that in 4-wire SPI mode.

2.2 UART INTERFACE

When the MCU GPIO resources are limited, especially when the metering part is isolated from the MCU (e.g. IC card prepaid meter), UART can reduce the cost of optocoupler. When the M90E26 is isolated from MCU, the realization of the related functions is as follows:

Energy Pulses CFx: CFx does not need to connect to an MCU pin. Instead, energy can be accumulated by reading values in the corresponding energy registers. CFx can also connect to the optocoupler and the energy pulse light can be turned on by CFx. As the energy registers are cleared after read and the SPI reading process could be disturbed, it is suggested to read the LastData register (06H) after reading the energy registers for confirmation.

Fatal Error WarnOut: Fatal error can be acquired by reading the CalErr[1:0] bits (SysStatus, 01H).

IRQ: IRQ interrupt can be acquired by reading the SysStatus register (01H).

Reset: The M90E26 is reset when '789AH' is written to the software reset register (SoftReset, 00H).

2.3 APPLICATION OF WARNOUT AND IRQ

All functions of the WarnOut pin are covered by the IRQ pin. However, the WarnOut pin can locate abnormal events more rapidly.

2.3.1 METERING PARAMETER ERROR ALARM

The M90E26 only checks the correctness of the metering parameters when the CalStart register (20H) is 8765H. If the metering parameters are not correct, the metering function of the M90E26 is disabled, the CalErr[1:0] bits (SysStatus, 01H) are set and the WarnOut/IRQ pins report warning/interrupt at the same time. In this situation, the MCU should first reset the M90E26, then reload the calibration parameters. It is noted that the metering parameter error alarm can not be configured as disabled.

2.3.2 VOLTAGE SAG

The M90E26 detects voltage sag based on instantaneous value of the voltage. Comparing with the traditional means of evaluating the DC voltage after rectification, the M90E26 can detect voltage sag earlier as there is no lag effect by the Electrolytic Capacitor to maintain the voltage. Voltage sag is detected when there are no 3 sampling points whose voltage is above the voltage sag threshold within one cycle. Voltage sag is detected when voltage is continuously below the voltage sag threshold for one cycle which starts from any zero-crossing point.

Voltage sag detection is disabled by default after power-on reset. Voltage sag detection can be enabled by configuring the FuncEn (02H) and SagTh (03H) registers. When there is voltage sag, the SagWarn bit (SysStatus, 01H) is set and the IRQ pin outputs high level. Voltage sag can be reported by the WarnOut pin at the same time in order to locate abnormal events more rapidly.

Configuration of voltage sag:

The power-on value of SagTh is:

$$\frac{22000 \times \sqrt{2} \times 0.78}{4 \times U_{gain} / 32768}$$

it corresponds to 1D6AH.

Users can calculate voltage sag threshold based on the percentage (x%) of the voltage sag threshold with regards to the reference voltage Un in application. The equation is:

$$SagTh = \frac{100 \times U_n \times \sqrt{2} \times x\%}{4 \times U_{gain} / 32768}$$

2.3.3 MEASUREMENT PARAMETER ERROR ALARM

The M90E26 only checks the correctness of the measurement parameters when the AdjStart register (30H) is 8765H. If the measurement parameters are not correct, the measurement registers (48H-4FH and 68H-6FH) do not update, the AdjErr[1:0] bits (SysStatus, 01H) are set and the IRQ pin reports interrupt. It is noted that the measurement parameter error alarm can not be configured as disabled.

2.3.4 ACTIVE/REACTIVE ENERGY DIRECTION CHANGE

There is no dedicated pin to indicate the change of the direction of active/reactive energy. However, MCU can acquire the change in a timely manner by the following means:

1. MCU reads the SysStatus register (01H) to check if there is any change of the direction when the IRQ pin reports high level. As the SysStatus register (01H) is cleared after read, it is suggested to read the LastData register (06H) for confirmation. This active/reactive energy direction change interrupt can be enabled/disabled by the RevQEn/RevPEn bit (FuncEn, 02H).
2. MCU reads the RevP/RevQ bit (EnStatus, 46H) to acquire the current direction of the active/reactive energy. The RevP bit is updated after each CF1 pulse outputs and the RevQ bit is updated after each CF2 pulse outputs.

In application it is suggested to read the RevP/RevQ bit (EnStatus, 46H) to acquire the current direction of the active/reactive energy as there are cases when the SPI/UART process is disturbed and the direction change is missed. Detailed operation is as follows: MCU reads the EnStatus register (46H) for a fixed interval such as 1s. If there is no change with the RevP/RevQ bit, only read the value of the energy register of the current direction. If there is any change with the RevP/RevQ bit, read both the forward and reverse energy registers.

In addition, the M90E26 provides absolute active/reactive energy registers to meet the needs of absolute value of active/reactive energy in some cases. CFx can be configured correspondingly to realize consistency between CFx output and the absolute active energy register (ATenergy,42H)/ absolute reactive energy register (RTenergy, 45H).

2.3.5 TOGGLE OF L LINE AND N LINE

In anti-tampering mode, when the metering line changes from L line to N line, or changes from N line to L line, MCU can acquire the change in a timely manner by the following means:

1 When L line and N line toggles, the LNchange bit (SysStatus,01H) is set and the IRQ pin outputs high level. MCU can then read the SysStatus register (01H) after receipt of the interrupt reported by the IRQ pin. As the SysStatus register (01H) is cleared after read, it is suggested to read the LastData register (06H) for confirmation.
2. MCU can also read the LLine bit (EnStatus, 46H) to acquire the current metering line.

3 CALIBRATION

3.1 CALIBRATION METHOD

Calibration includes metering and measurement calibration.

Metering Calibration

The M90E26 design methodology guarantees the accuracy over the entire dynamic range, after metering calibration at one specific current, i.e. the basic current of I_b.

The calibration procedure includes the following steps:

1. Calibrate gain at unity power factor;
2. Calibrate phase angle compensation at 0.5 inductive power factor.

Generally, line current sampling is susceptible to the circuits around the sensor when shunt resistor is employed as the current sensor in L line. For example, the transformer in the energy meter's power supply may conduct interference to the shunt resistor. Such interference will cause perceptible metering error, especially at low current conditions. The total interfere is at a statistically constant level. In this case, the M90E26 provides the power offset compensation feature to improve metering performance.

L line and N line need to be calibrated sequentially. Reactive energy does not need to be calibrated after active energy calibration completed.

Measurement Calibration

Measurement calibration includes gain calibration for voltage rms and current rms.

Considering the possible nonlinearity around zero caused by external components, the M90E26 also provides offset compensation for voltage rms, current rms, mean active power and mean reactive power.

The M90E26 design methodology guarantees automatic calibration for frequency, phase angle and power factor measurement.

3.2 CALIBRATION EXAMPLE

3.2.1 CONFIGURE CALIBRATION START COMMAND REGISTER AND CHECKSUM 1 REGISTER

All metering registers are in 20H-2CH. Among them, the calibration start command register (CalStart,20H) and the Checksum 1 Register (CS1,2CH) are specially designed registers.

3.2.1.1 Calibration Start Command Register (CalStart, 20H)

The default value for the CalStart register (20H) is '6886H' after power-on reset. It should be set to '5678H' when calibration is needed. Then the 21H-2BH registers resume to their power-on values and the M90E26 starts to meter.

Generally after calibration, the CalStart register (20H) should be set to '8765H'. The M90E26 checks the correctness of the 21H-2BH registers. If correct, normal metering. If not correct, metering function is disabled, the CalErr[1:0] bits (SysStatus, 01H) are set and the WarnOut/IRQ pins report warning/interrupt.

3.2.1.2 Checksum 1 Register (CS1, 2CH)

The CS1 register (2CH) can be read through the SPI/UART interface. The readout value is the calculation by the M90E26 based on data in the 21H-2BH registers. The calculation is independent of data in the CalStart register (20H). Note that the readout value of the CS1 register (2CH) might not be the same as the one that is written.

Normally the CS1 register (2CH) should be written during calibration. It is fine to read the CS1 register (2CH) first then write the readout value to the CS1 register (2CH).

3.2.2 PL_CONSTANT CALCULATION AND CONFIGURATION

PL_Constant is determined by L line hardware parameters. PL_Constant is calculated as follows:

$$\text{PL\_Constant} = \text{int}(838860800 \times \frac{G_L \times V_L \times V_U}{MC \times U_n \times I_b})$$

MC: pulse constant of the energy meter, unit is imp/kWh or imp/kvarh;

U_n: reference voltage, unit is V;

I_b: basic current, unit is A;

G_L: L line current circuit gain;

V_L: sampling voltage of the L line circuit at I_b, unit is mV;

V_U: sampling voltage of the voltage circuit at U_n, unit is mV;

838860800: constant.

Before configuring PL_Constant, 5678H should be written to the CalStart register (20H) to start up calibration. Registers 21H-2BH then resume to their power-on values.

Example:

Assume MC=3200 imp/kWh

U_n = 220V

I_b = 5A

G_L=24

L line shunt resistor=200 μΩ, so V_L=1mV

Voltage divider coefficient=880, so V_U=250mV

$$\text{PL\_Constant} = 838860800 \times \frac{G_L \times V_L \times V_U}{MC \times U_n \times I_b} = 1429876.36 = 15D174H$$

'0015H' should be written to the PLconstH register (21H), and 'D174H' should be written to the PLconstL register (22H) .

Note that the PLconstH register (21H) takes effect after the PLconstL register (22H) is configured.

3.2.3 MMODE REGISTER CONFIGURATION

The MMode register (2BH) should be configured according to hardware design.

L line gain Lgain[2:0]: bit 15-13

N line gain Ngain[1:0]: bit 12-11

metering line selection LNSel: bit 10

HPF configuration DisHPF[1:0]: bit 9-8

CFx output for active/reactive power Amod/Rmod: bit 7-6

zero-crossing mode Zxcon[1:0]: bit 5-4

anti-tampering threshold Pthresh[3:0]: bit 3-0

Example:

Hardware design configuration is:
Shunt resistor for sampling current in L line, gain is '24';
CT for sampling current in N line, gain is '1';
L line metering;
HPF is used;
Forward (inductive) or reverse (capacitive) energy pulse output;
All zero-crossing;
Default threshold for anti-tampering mode.
7C22H should be written to the MMode register (2BH).

3.2.4 L LINE CALIBRATION

3.2.4.1 Small-Power Mode and Power Offset Compensation

Power offset compensation can be used to eliminate stationary noise introduced by the external circuits in system design, such as coupling noise on shunt resistor conducted by transformer in meter's power supply.

Power offset compensation is performed in small-power mode. The register value of L line and N line active/reactive power in small-power mode and normal mode are different. Their relationship is:

Power in normal mode

= Power in small-power mode * Ugain * Igain / (100000 * 2^22)

The following steps are recommended:

1. Disconnect the current circuit of the energy meter;
2. Write 'A987H' to the SmallPMod register (04H) to enter small-power mode;
3. Read out L / N line active / reactive power in small-power mode many times to get a mean value;
4. Write the complement of the above mean value to the corresponding L / N line active / reactive power offset registers;
5. Write any non-A987H value to the SmallPMod register (04H) to exit small-power mode.

Example:

Disconnect the current circuit of the energy meter, write 'A987H' to the SmallPMod register (04H) to enter small-power mode. Readout L line active power 5 times consecutively. The values are FFC4H, FFCAH, FFCAH, FFDCH and FFC5H averaged as FFCBH. Then write the complement 35H to the PoffsetL register (37H).

The same procedure goes for reactive power offset compensation. L line reactive power offset register is QoffsetL (38H).

3.2.4.2 L Line Gain Calibration

L line gain calibration is performed when power factor PF=1.0 and the current is I_b.

Assume the error output from the calibration bench is ε, then

$L_{RATIO} = -\varepsilon/(1+\varepsilon)$

L line gain calibration is

LGain= Complementary (L_{RATIO} * 2^15)

which is the complement of L_{RATIO} * 2^15:

if $L_{RATIO} \geqslant 0$, LGain=int(L_{RATIO} * 2^15)

if $L_{RATIO} < 0$, LGain=int(2^16+ L_{RATIO} * 2^15)

Example:

Assume PF=1.0, current=I_b, ε=-13.78%, then
L_{RATIO}= -ε/(1+ε)=0.159823707
LGain= int(LRATIO* 2^15)=5237.10=1475H
That is, '1475H' should be written to the Lgain register (23H).

3.2.4.3 L Line Angle Calibration

L line angle calibration is performed when power factor PF=0.5L, the current is I_b and the frequency is 50Hz.

Assume the error output from the calibration bench is ε_L, then

Angle = $-\varepsilon_L$*180/sqrt(3)/π

L line angle calibration is

LPhi= (ε_L*3763.74)

In this equation, 3763.74 is a constant, and LPhi is signed. LPhi is a negative number when MSB is '1'.

Example:

L line gain is calibrated, PF=0.5L, current=I_b, frequency=50Hz, error of the energy meter ε_L=0.95%
Angle= $-\varepsilon_L$*180/sqrt(3)/π
=-0.0095*180/ sqrt(3)/π=-0.31425747
LPhi=(ε_L*3763.74)
=0.0095*3763.74=35.75553=24H,
That is, '24H' should be written to the LPhi register (24H).

3.2.4.4 Startup Power/ Current Threshold and No-Load Power/ Current Threshold

The definitions of the Active/Reactive Startup/No-load Power Threshold registers (27H/28H/29H/2AH) are all the same. Below is an example of the active power threshold.

Assume the active startup current is K_S times of I_b (0.004 if 0.4%), then

$$\mathrm{PStartTh} = \mathrm{int}(93.2067556 \times G_L \times V_L \times V_U \times K_S)$$

Assume the active no-load current is K_N times of I_b, then

$$\mathrm{PNolTh} = \mathrm{int}(93.2067556 \times G_L \times V_L \times V_U \times K_N)$$

In the above equations, the unit for V_L and V_U is mV, and 93.2067556 is a constant.

Example:

Assume startup current is 0.4% of I_b

$$\mathrm{PNolTh} = \mathrm{int}(93.2067556 \times G_L \times V_L \times V_U \times K_S) = 2236.962134 = 08BDH$$

The configuration of the no-load power threshold is similar to that of the startup power threshold.

3.2.4.5 Voltage rms Gain and L Line Current rms Gain

Calibration of voltage and current rms is performed at reference voltage and basic current, and has no relationship with power factor PF. So the calibration can be performed at PF=1.0, reference voltage U_n and basic current I_b. To simplify the process, the calibration of voltage and current rms can be after 3.2.4.3 the calibration of angle.

Assume Vol_mea is the readout value of the Urms register (49H) and reference voltage U_n is the actual voltage, voltage rms gain Ugain is calculated as:

$$Ugain = int(\frac{26400 \times U_n}{Vol\_mea})$$

In the above equation, the unit of U_n is V, Vol_mea is the readout value of the Urms register (hex should be changed to decimal and divided by 100, unit is V), and 26400 is the decimal of 6720H which is the power-on value of the voltage rms gain register (Ugain, 31H).

Example:

The actual voltage U_n is 220.024V. The readout value of the Urms register Vol_mea is 6019H, or 246.01V.

$$Ugain = int(\frac{26400 \times U_n}{Vol\_mea}) = int(\frac{26400 \times 220.024}{246.01}) = 23611 = 5C3BH$$

That is, 5C3BH should be written to the Ugain register (31H).

Note that it is not required to calibrate the voltage rms gain when Ugain is the power-on value. The equation is:

$$Ugain_{New} = int(\frac{Ugain_{Old} \times U_n}{Vol\_mea})$$

If the readout of L line current rms (Irms, 48H) is Cur_meaL, the actual current rms is the basic current I_b, then the equation for Igain, the current rms gain is:

$$Igain = int(\frac{31251 \times I_b}{Cur\_meaL})$$

In the above equation, the unit for I_b is A, Cur_meaL is the readout value of the Irms register (hex should be changed to decimal and divided by 1000, unit is A), and 31251, or 7A13H, is the power-on value of L line current rms gain register (IgainL, 32H).

Example:

The actual current rms I_b is 5.008A. Cur_meaL, the readout value of the L line current rms is 1A58H, or 6.744A.

$$Igain = int(\frac{31251 \times I_b}{Cur\_meaL}) = int(\frac{31251 \times 5.008}{6.744}) = 23207 = 5AA7H$$

Note that it is not required to calibrate the current rms gain when Igain is the power-on value. The equation is:

$$Igain_{New} = int(\frac{Igain_{Old} \times I_b}{Cur\_meaL})$$

The current offset calibration should be performed at reference voltage and no current. Calibration is performed by reading the current, multiplying it with the above Igain/2^16 and 2^8, calculating the complement and writing the result to the L line current offset register (IoffsetL, 35H).

Calibration of voltage offset is similar to that of current offset, but voltage offset calibration is not applicable for self-powered meter.

3.2.5 N LINE CALIBRATION

3.2.5.1 Match of N Line and L Line Calibration

N line metering and L line metering share the same PL_Constant, the same voltage and the same gain range (-50%~+50%) of registers (Lgain, 23H) and (Ngain, 25H). Therefore, the L line and N line sampling signals should be about the similar level after amplification of L line gain Lgain [2:0] and N line gain Ngain [1:0]. If the N line current signal is too small, N line gain can be adjusted, for example from '1' to '4'. If, however, the N line current signal is too large even though the gain is only '1', the load resistor of CT can be reduced.

3.2.5.2 Calibration

Calibration of N line is similar to that of L line. Note that the power-on value for the N Line Current rms Gain register (IgainN, 33H) is 7530H, therefore the N line calibration equation is

$$\mathrm{Igain} = \mathrm{int}\left(\frac{30000 \times I_b}{\mathrm{Cur\_meaN}}\right)$$

4 OTHERS

4.1 ACCELERATION OF VERIFICATION AT LOW CURRENT STATE

The acceleration of low current calibration can be achieved by MCU. The M90E26 has good linearity at different PL_constant. It is suggested to set PL_constant as a multiple of 4 because the acceleration is up to 4 times in low current calibration.

4.2 TREATMENT WHEN CURRENT EXCEEDS 65.535A

The current range of the current rms registers is 0 ~ 65.535A. When the current exceeds 65.535A, it is suggested to be handled by MCU as follows:

1. The register value of the Irms/Irms2 registers (48H/68H) can be calibrated to be half of the actual current rms during calibration. For example, when I_b is 20A, the value of the Irms/Irms2 registers (48H/68H) can be calibrated to 10A for a 20(80)A energy meter, that is, IgainL / IgainN is halved. The multiple relationships between the Irms/Irms2 registers (48H/68H) and the actual value should be recorded in memory;
2. MCU automatically multiplies the Irms/Irms2 registers with 2 for applications such as display and communication.

As the current rms uses fiducial error in evaluation, 16-bit registers are sufficient to guarantee measurement accuracy of 0.5%.

Note that if the Irms/Irms2 registers are calibrated to be half of the actual current rms and doubled by MCU, the power measurement parameters such as active / reactive / apparent power have the same multiple relationship with the corresponding actual power.

4.3 APPLICATION OF LASTDATA

The LastData register (06H) stores the latest SPI/UART read/write data. The application of this register can improve the reliability of the SPI/UART read/write operation.

4.3.1 SPI/UART READ

Generally, the SPI/UART read reliability can be improved by reading the target register first, then reading the LastData register (06H), and then comparing the two results. If the results are the same, the read operation is considered to be correct. If the results are inconsistent, the LastData register (06H) should be read again to find out the correct register value.

The M90E26 has some read/clear registers, such as active / reactive energy registers and system status register. When these registers are cleared after read, the LastData register (06H) is updated. This function is very useful in cases such as abnormal timing cycles.

4.3.2 SPI/UART WRITE

Generally, the SPI/UART write reliability can be improved by writing to the target register first, then reading the target register, and then comparing the two results. If the results are the same, the write operation is considered to be correct. An alternative way is to write the target register first, then read the LastData register (06H), and then compare the results.

4.4 APPLICATION OF LSB

The LSB (08H) register is used to extend the precision of RMS and mean power measurement. When read RMS or mean power registers, the additional lower 16 bits of the correlative measurement value will be latched into this LSB (08H) register.

Bit7-0 of the LSB register is always zero. The unit of LSB value is as below,

1. For voltage RMS, the unit of LSB (08H) register value is 0.01 x LSB_Value / 65536 (V)
2. For current RMS, the unit of LSB (08H) register value is 0.001 x LSB_Value / 65536 (A)
3. For mean power, the unit of LSB (08H) register value is 0.001 x LSB_Value / 65536 (kW/ kvar/kVA)

Revision History

Doc. Rev.	Date	Comments
46102A	4/18/2014	Initial release.
46102B	6/19/2014	Updated Table-2 on page 6.

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