1 APPLICATION OUTLINE

This document describes system application issues when using the M90E25, 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 2.1 Schematics provides the schematics of a energy meter using the M90E25. MCU reads and writes data of the metering IC through the SPI 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 M90E25 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 M90E25 after being decoupled by the capacitors. The analog power AVDD is connected to DVDD via a 10Ω resistor. The M90E25 has a power-on reset circuit and the Reset pin can connect to DVDD directly.

The M90E25 has highly stable on-chip reference power supply. Different from competitor’s products, the M90E25 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 10nF capacitor to the Vref.

The M90E25 provides the active energy pulse output pin CF1, which can be used for energy calibration. The CF1 pin can also be connected to the MCU for energy accumulation. The maximum source/sink current for the CF1 pin 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 M90E25 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 M90E25 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 M90E25 and reload the metering parameters. In addition, the M90E25 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 M90E25 provides a dedicated interrupt request output pin IRQ. The IRQ pin outputs high level when there is any metering / measurement parameter error, active 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 M90E25, these pins can directly drive the optocouplers.
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2 HARDWARE REFERENCE DESIGN

2.1 SCHEMATICS
### 2.2 COMPONENT BOM

#### Table-1 Component BOM

<table>
<thead>
<tr>
<th>Component Type</th>
<th>Designator</th>
<th>Quantity</th>
<th>Parameter</th>
<th>Tolerance</th>
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<tr>
<td>SMT Capacitor</td>
<td>C12</td>
<td>1</td>
<td>0603 1nF</td>
<td>±10% X7R</td>
</tr>
<tr>
<td></td>
<td>C9 C10 C13 C14</td>
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<td>0603 33nF</td>
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<td>Red Φ3</td>
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<td>1</td>
<td>SPMZB-4 (400Ω ~ 700Ω)</td>
<td>-</td>
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</tbody>
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3 INTERFACE

3.1 SPI INTERFACE

The interface to MCU is a standard 4-wire SPI or simplified 3-wire SPI. The highest rate is 160kbps and the lowest rate is 200bps. MCU can perform read and write operations through low speed optocoupler when the M90E25 is isolated from the MCU.

When the MCU GPIO resources are limited, especially when the metering part is isolated from the MCU (e.g. IC card prepaid meter), 3-wire SPI can reduce the cost of optocoupler, using SCLK, SDI and SDO of the SPI interface. When the M90E25 is isolated from MCU, the realization of the related functions is as follows:

Energy Pulses CF1: CF1 does not need to connect to an MCU pin. Instead, energy can be accumulated by reading values in the corresponding energy registers. CF1 can also connect to the optocoupler and the energy pulse light can be turned on by CF1. As the energy registers are cleared after read and the SPI reading process could be disturbed, it is suggested to read the LastSPIData 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 M90E25 is reset when ‘789AH’ is written to the software reset register (SoftReset, 00H).
3.2 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.

3.2.1 METERING PARAMETER ERROR ALARM

The M90E25 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 M90E25 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 M90E25, then reload the calibration parameters. It is noted that the metering parameter error alarm can not be configured as disabled.

3.2.2 VOLTAGE SAG

The M90E25 detects voltage sag based on instantaneous value of the voltage. Comparing with the traditional means of evaluating the DC voltage after rectification, the M90E25 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:

\[
\frac{22000 \times \sqrt{2} \times 0.78}{4 \times U_{\text{gain}} / 32768}
\]

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:

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

3.2.3 MEASUREMENT PARAMETER ERROR ALARM

The M90E25 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.
3.2.4 ACTIVE ENERGY DIRECTION CHANGE

There is no dedicated pin to indicate the change of the direction of active 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 LastSPIData register (06H) for confirmation. This active energy direction change interrupt can be enabled/disabled by the RevPEn bit (FuncEn, 02H).
2. MCU reads the RevP bit (EnStatus, 46H) to acquire the current direction of the active energy. The RevP bit is updated after each CF1 pulse output.

In application it is suggested to read the RevP bit (EnStatus, 46H) to acquire the current direction of the active energy as there are cases when the SPI 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 bit, only read the value of the energy register of the current direction. If there is any change with the RevP bit, read the forward and reverse energy registers.

In addition, the M90E25 provides absolute active energy registers to meet the needs of absolute value of active energy in some cases. CF1 can be configured correspondingly to realize consistency between CF1 output and the absolute active energy register (ATenergy, 42H).

3.2.5 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 theIRQ 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 LastSPIData register (06H) for confirmation.
2. MCU can also read the LLine bit (EnStatus, 46H) to acquire the current metering line.
4 CALIBRATION

4.1 CALIBRATION METHOD

Calibration includes metering and measurement calibration.

Metering Calibration

The M90E25 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 interference is at a statistically constant level. In this case, the M90E25 provides the power offset compensation feature to improve metering performance.

L line and N line need to be calibrated sequentially.

Measurement Calibration

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

Considering the possible nonlinearity around zero caused by external components, the M90E25 also provides offset compensation for voltage rms, current rms and mean active power.

The M90E25 design methodology guarantees automatic calibration for frequency, phase angle and power factor measurement.

4.2 CALIBRATION EXAMPLE

4.2.1 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.

4.2.1.1 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 M90E25 starts to meter.

Generally after calibration, the CalStart register (20H) should be set to '8765H'. The M90E25 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.

4.2.1.2 Checksum 1 Register (CS1, 2CH)

The CS1 register (2CH) can be read through the SPI interface. The readout value is the calculation by the M90E25 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).

4.2.2 PL_CONSTANT CALCULATION AND CONFIGURATION

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

\[
PL_{\text{Constant}} = \text{int}(838860 \times \frac{G \times V_l \times V_u}{MC \times U_r \times I_b})
\]

MC: pulse constant of the energy meter, unit is imp/kWh;
$U_n$: 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 $\mu$Ω, so $V_L = 1mV$

Voltage divider coefficient=880, so $V_U = 250mV$

\[
PL_{\text{Constant}} = 838860800 \times \frac{G_L \times V_L \times V_U}{MC \times U_n \times I_b} = 1429876.36 = 15D174H
\]

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

Note that the PLconstH register (21H) takes effect after the PLconstL register (22H) is configured.
4.2.3 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
CF1 output for active power Amod: bit 7
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).
4.2.4  L LINE CALIBRATION

4.2.4.1  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 power in small-power mode and normal mode are different. Their relationship is:

Power in normal mode

\[ \text{Power in normal mode} = \text{Power in small-power mode} \times \text{Igain} \times \text{Ugain} / (100000 \times 2^{22}) \]

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 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 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).

4.2.4.2  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 \( \varepsilon \), then

\[ L_{\text{RATIO}} = -\varepsilon / (1 + \varepsilon) \]

L line gain calibration is

\[ \text{LGain} = \text{Complementary } (L_{\text{RATIO}} \times 2^{15}) \]

which is the complement of \( L_{\text{RATIO}} \times 2^{15} \):

- if \( L_{\text{RATIO}} \geq 0 \), then \( \text{LGain} = \text{int}(L_{\text{RATIO}} \times 2^{15}) \)
- if \( L_{\text{RATIO}} < 0 \), then \( \text{LGain} = \text{int}(2^{16} + L_{\text{RATIO}} \times 2^{15}) \)

Example:

Assume PF=1.0, current=I_b, \( \varepsilon = -13.78\% \), then

\[ L_{\text{RATIO}} = -\varepsilon / (1 + \varepsilon) = 0.159823707 \]

\[ \text{LGain} = \text{int}(L_{\text{RATIO}} \times 2^{15}) = 5237.10 = 1475H \]

That is, '1475H' should be written to the Lgain register (23H).
4.2.4.3 L Line Angle Calibration

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

Assume the error output from the calibration bench is $\varepsilon_L$, then

$$\text{Angle} = -\frac{\varepsilon_L \times 180}{\sqrt{3}} \frac{1}{\pi}$$

L line angle calibration is

$$L\Phi_i = (\varepsilon_L \times 3763.74)$$

In this equation, 3763.74 is a constant, and $L\Phi_i$ is signed. $L\Phi_i$ is a negative number when MSB is '1'.

Example:

L line gain is calibrated, PF=0.5L, current=Ib, frequency=50Hz, error of the energy meter $\varepsilon_L=0.95\%$

$$\text{Angle} = -\frac{\varepsilon_L \times 180}{\sqrt{3}} \frac{1}{\pi} = -0.0095 \times \frac{180}{\sqrt{3}} \times \frac{1}{\pi} = -0.31425747$$

$$L\Phi_i = (\varepsilon_L \times 3763.74) = 0.0095 \times 3763.74 = 35.75553 = 24H,$$

That is, '24H' should be written to the $L\Phi_i$ register (24H).

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

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

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

$$P_{\text{StartTh}} = \text{int}(93.206 \times 7556 \times G_L \times V_L \times V_U \times K_S)$$

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

$$P_{\text{NolTh}} = \text{int}(93.206 \times 7556 \times G_L \times V_L \times V_U \times K_N)$$

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 Ib

$$P_{\text{NolTh}} = \text{int}(93.206 \times 7556 \times G_L \times V_L \times V_U \times K_S) = 2236.96213 \text{ 4 = 08BDH}$$

The configuration of the no-load power threshold is similar to that of the startup power threshold.
4.2.4.5 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 4.2.4.3 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 \( U_{gain} \) is calculated as:

\[
U_{gain} = \int \left( \frac{26400 \times U_n}{Vol\_mea} \right)
\]

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 (\( U_{gain}, 31H \)).

Example:
The actual voltage \( U_n \) is 220.024V. The readout value of the Urms register Vol\_mea is 6019H, or 246.01V.

\[
U_{gain} = \int \left( \frac{26400 \times 220.024}{246.01} \right) = 23611 = 5C3BH
\]

That is, \( 5C3BH \) should be written to the \( U_{gain} \) register (31H).

Note that it is not required to calibrate the voltage rms gain when \( U_{gain} \) is the power-on value. The equation is:

\[
U_{gain\_new} = \int \left( \frac{U_{gain\_old} \times U_n}{Vol\_mea} \right)
\]

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 \( I_{gain} \), the current rms gain is:

\[
I_{gain} = \int \left( \frac{31251 \times I_b}{Cur\_meaL} \right)
\]

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 (\( I_{gainL}, 32H \)).

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.

\[
I_{gain} = \int \left( \frac{31251 \times 5.008}{6.744} \right) = 23207 = 5AA7H
\]

Note that it is not required to calibrate the current rms gain when \( I_{gain} \) is the power-on value. The equation is:

\[
I_{gain\_new} = \int \left( \frac{I_{gain\_old} \times I_b}{Cur\_meaL} \right)
\]

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 \( I_{gain}/2^{16} \) and \( 2^8 \), calculating the complement and writing the result to the L line current offset register (loffsetL, 35H).

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

4.2.5.1 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.

4.2.5.2 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

\[
I_{gain} = \lfloor \frac{30000 \times I_b}{C_{ur\_meaN}} \rfloor
\]
5 OTHERS

5.1 ACCELERATION OF VERIFICATION AT LOW CURRENT STATE

The acceleration of low current calibration can be achieved by MCU. The M90E25 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.

5.2 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 / apparent power have the same multiple relationship with the corresponding actual power.
5.3 APPLICATION OF LASTSPI DATA

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

5.3.1 SPI READ

Generally, the SPI read reliability can be improved by reading the target register first, then reading the LastSPI Data 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 LastSPI Data register (06H) should be read again to find out the correct register value.

The M90E25 has some read/clear registers, such as active energy registers and system status register. When these registers are cleared after read, the LastSPI Data register (06H) is updated. This function is very useful in cases such as abnormal SCLK cycles.

5.3.2 SPI WRITE

SPI writes to registers only when the number of SCLK cycles is equal to ‘24’. Generally, the SPI 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 LastSPI Data register (06H), and then compare the results.

5.4 CONFIGURATION GUIDE FOR THE REFERENCE VOLTAGE TEMPERATURE COEFFICIENT

An on-chip reference voltage Vref is integrated in the M90E25, which has low temperature coefficient with a typical value of 15 ppm / °C. A special temperature coefficient compensation register is also provided. The address is 16H. In application, the temperature coefficient could be configured according to the actual requirement to obtain better temperature characteristics. It is suggested to set the temperature compensation register to be ‘0x8097’.

The value of the 16H register influences the on-chip reference voltage Vref output. If the 16H register is modified, a deviation will be introduced to the energy metering error for the whole dynamic range. It is suggested to configure the 16H register before calibration in application.

The 16H register is a special register in that direct writing to this register will not generate any operation though reading is normal. Special procedure is needed to write to this register as follows:

1. Write ‘0x9779’ to the 20H register (20H is the Calibration Start Command register-CalStart);
2. Write ‘0x8097’ to the 16H register;
3. Write ‘0x5678’ or ‘0x8765’ to the 20H register.

The following is the recommended configuration flow:
Write '0x9779' to the 20H register

Write '0x8097' to the 16H register

Write '0x5678' or '0x8765' to the 20H register

Configure other registers and calibration parameters

90E2x Reset

Delay 20ms
## Revision History

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<tbody>
<tr>
<td>46101A</td>
<td>4/18/2014</td>
<td>Initial release.</td>
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