UM10774

EM783 Software Development Kit (SDK)

Rev. 2.0 — 16 January 2014 **User Manual**

Document information

Info	Content
Keywords	EM783, SDK, User manual, Metrology
Abstract	This document is the user manual for the EM783 software development kit.

Revision history

Rev	Date	Description
2.0	20140116	Updated SDK folder structure in section 2
1.0	20131219	Initial version.

Contact information

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1. Introduction

EM783 is the next generation e-metering chip with a built-in metrology engine. EM783 is built around a low-power, cost-effective and industry standard ARM Cortex-M0 core. The ARM Cortex-M0 runs with a speed up to 48 MHz and offers 4 kB of EEPROM, 32 kB of flash memory, 8 kB of SRAM and various serial peripherals.

For design flexibility, NXP offers multiple variants of EM783 as single-channel (SC), multi-channel (MC), single-phase (SP) and three-phase (TP). The variant chips are:

- EM783-MC3
- EM783-MC6
- EM783-SC
- EM783-SP
- EM783-TP

The EM783 reference design evaluation module (EVM) includes an SDK package consisting of a reference energy meter application and metrology library in binary format. The metrology library provides the interface to the EM783 metrology engine. The SDK package is available for download from the NXP website.

This document describes the EM783 EVM, the software development kit and the steps to evaluate the EVM. This document also details the calibration procedure for the EVM.

This document does not describe the application interface provided by the metrology engine library.

For detailed information on…	Refer to …
EM783 metrology engine API	[1]
EM783 EVM	[2]
EM783 FAQ	[4]

1.1 Key applications

- Smart plugs and plug meters
- Single-phase residential meters
- DALI/DMX and KNX nodes with metering functionality
- Industrial sub-meters
- Power monitors for servers
- Smart appliances

1.2 Block diagram

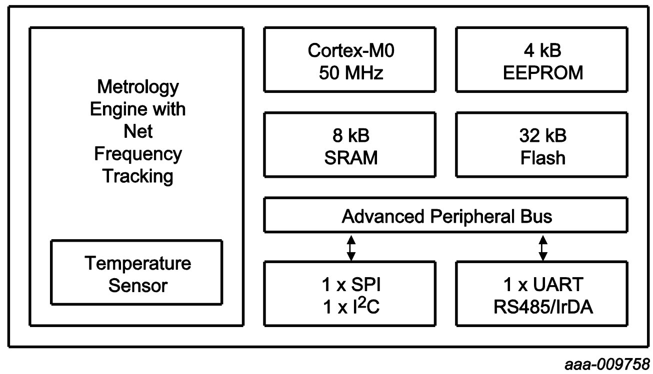

Fig 1. EM783 block diagram

1.3 Disclaimer

This is a prototype for demonstration and evaluation purpose only.

The EVM operates at voltages and currents that can result in electrical shock and fire hazard, if used improperly. This EVM should only be operated by qualified personnel familiar with the risks and hazards associated with handling high voltages and currents. The EVM or its components should not be touched when it is energized.

Fig 2. Caution

1.4 Support information

Use the following link for additional information on EM783.

http://www.nxp.com/products/power_management/energy_measurement_ics/series/EM783.html

For further support on EM783, send an email to em7xx.support@nxp.com.

1.5 References

[1] EM783 Metrology Engine API document

[2] EM783 EVM User Manual

[3] EM783 User Manual

[4] EM783 FAQ

2. EM783 evaluation module overview

This section gives an overview of the EM783 EVM. The EVM includes:

- EM783 EVM hardware
- SDK installer *EM783_SDK_<x.y>.exe*.

The installer contains the following folders under the top level SDK folder as shown in Fig 3. Here <x.y> indicates the release number (Note: All paths shown in this document are relative to the top level SDK folder).

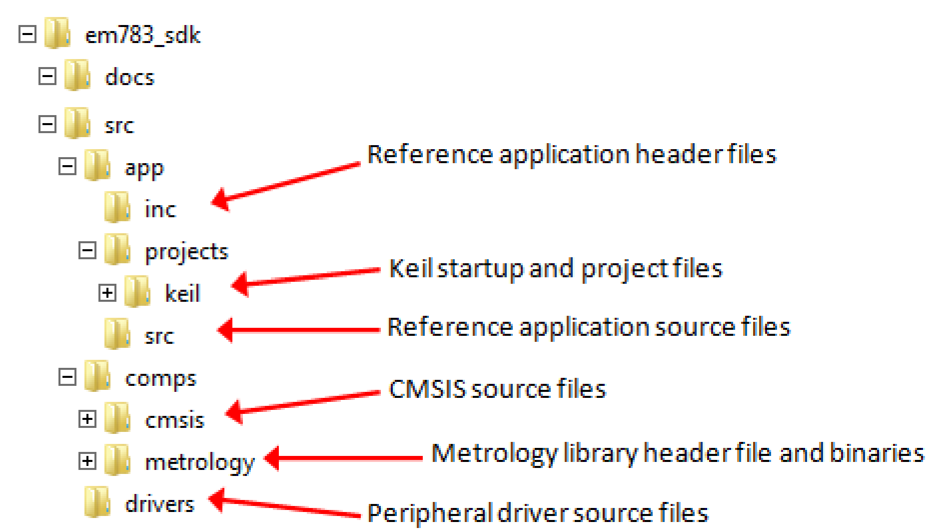

Fig 3. EM783 SDK folder structure

The EVM is equipped with:

1. LCD Panel: To enable the user to view the metrology results
2. UART Port: The UART port on the reference kits must be connected to the host PC using a UART-to-USB cable. This interface can be used for the following:
    a. Application firmware flashing via EM783 In-System Programming (ISP) interface. Refer to EM783 user manual for more details on ISP interface.
    b. Debug messaging
    c. Metrology engine calibration
3. SWD Port: To attach SWD debugger module (the EVM has been tested with Keil ULINK2 SWD debugger).
4. I2C Port: I2C port is used to connect the LCD to EM783. It is also available at the expansion header.
5. SPI Port: SPI port is used to connect the ZigBee module to EM783. It is also available at the expansion header.
6. USB: A USB port is available for PC connectivity.
7. RS485: RS485 port is available for multi-drop communication. This interface can be used to calibrate and test multiple meters connected in parallel.

The EM783 is pre-flashed with the reference application firmware and includes the metrology library binary for the evaluation.

Warning:

- Do not try to open the box when it is connected to the mains supply.
- Do not to connect USB without isolation, which can result in incorrect measurement and cause potential damage to the PC/Laptop.

3. Evaluating EM783

3.1 Building the project

1. Install the SDK package using the installer *EM783_SDK_<x.y>.exe*.
2. Navigate to the folder *src\app\projects\keil*.
3. Open the project *EM783_<variant>.uvproj* using Keil IDE tool; variant refers to EM783 variants (MC3, MC6, SC, SP and TP).
4. Click **Project** and select **Build target** to build the project. This generates the *EM783_<variant>.hex* and *EM783_<variant>.axf* images in the folder *src\app\projects\keil\objs_<variant>*.

3.2 Flashing the image

1. Download and install the **Flash Magic** tool (ensure the tool version is at least **7.51.3222**).
2. Ensure the EVM is powered off (SW3 in **OFF** position). Connect a UART-to-USB serial cable between the connector **J12** on the EM783 EVM and the PC.
3. Set the switch SW8 to the **ON** position.
4. Power up the EVM (SW3 in **ON** position).
5. Run the **Flash Magic** tool.
6. Set the target to **EM783-<variant>** using the select button.
7. Set the **COM** port to match the port to which the UART serial cable is connected.
8. Set the Baud Rate to **115200** (any baud rate up to 115200 can be used).
9. Set the Interface to **None (ISP)**.
10. In the **Hex File** tab, browse to the project directory *src\app\projects\keil\objs_<variant>* and select the file *EM783_<variant>.hex*.
11. Click on the **Start** button to program the image onto the EVM.
12. Once the image is flashed, set the switch SW8 to the **OFF** position.

3.3 Evaluating the EM783 EVM

3.3.1 EM783 EVM power up

1. Ensure the switch SW8 is set to the **OFF** position.
2. Connect the mains supply to the connectors provided on the front panel of the EVM. Refer to EM783 EVM user manual for the connection details.
3. Power up the EVM (SW3 to **ON** position).
4. EM783 metrology engine initialization messages are displayed on the UART console.
5. The metrology results for all the channels are displayed on the LCD screen.

3.3.2 EM783 EVM display layout

This section describes the format of metrology parameters displayed on the LCD panel for all the EM783 variants.

3.3.2.1 Initialization message

On powering up the EVM, the message is displayed on the LCD panel as shown in Fig 4, while the metrology engine is initializing. The figure shown below is an example for the MC3 variant.

Fig 4. EM783 initialization message

3.3.2.2 Metrology parameter display

Once the initialization is complete the measurement results are displayed on the LCD panel as shown in the figure below. The display consists of four sections:

1. **Total Energy and Total power**: This section displays the total accumulated energy in kWh and the total power in W.
   a. The total energy is the sum of the accumulated energy from all the channels and is displayed in **XXX.YY** format.
   b. The total power is the sum of the instantaneous power from all the channels and is displayed in **XXXXX.YY** format.
   c. The total accumulated energy is displayed for 1 second is as shown in Fig 5.

Fig 5. Total accumulated energy display

   d. This is followed by the display of the total power for the next 1 second as shown in Fig 6.

Fig 6. Total instantaneous power display

   e. Steps ‘c’ and ‘d’ are repeated by the metrology engine as long as the meter is running.
2. **Channel Voltage**: This section displays the instantaneous channel voltage in V. The voltage is displayed in **XXX.Y** format.
3. **Channel Current**: This section displays the instantaneous channel current in A.
   a. The channel number, for which the value of current, voltage and power is being displayed, is identified using the following notation: C<channel id>.
   b. The channel id ranges from 1 to the maximum number of current channels present in the EM783 variant.
   c. The current is displayed in **X.YY** format.
4. **Channel Power**: This section displays the instantaneous channel power in W.
   a. The channel power is displayed in **XXXX.Y** format.
   b. If the channel power is greater than 9999W, the display changes to **XXXXX** format to accommodate the maximum value of the power.

The channel current and channel power sections display the per channel data and is refreshed every 2 seconds in the following order:
Channel-1 → Channel-2 → Channel-3 → Channel-max → Channel-1 and so on.

3.4 SWD pin configuration for EM783

1. EM783 EVM will be pre-flashed with the reference application including the metrology library. The reference application maps the EM783 SWD signals as shown in Table 1.

Table 1. EM783 EVM SWD pin mapping

SWD Signal	EM783 Pin Name	Pin Number
SWDIO	P0_3	11
SWCLK	P0_5	19

2. Attach the SWD debugger to the debug connector J1.
3. If the reference application is erased from the flash memory, then on power up, the SWD pins of EM783 reverts to the default mapping as shown in Table 2.

Table 2. Default SWD pin mapping

SWD Signal	EM783 Pin Name	Pin Number
SWDIO	P0_10	25
SWCLK	P0_5	19

4. In this mode, the debugger cannot be used to connect to EM783. Use the procedure listed in Section 3.2 to flash the image into EM783.

3.5 Calibration of the metrology engine

To calibrate the EM783 EVM, define the option SUPPORT_CALIBRATION in the file *src\app\inc\app_config.h*. The calibration is performed through the EM783 UART interface using serial terminal emulator software running on the PC. The steps to perform the calibration are shown in the following sections.

3.5.1 Calibration setup

1. Connect the UART serial cable from the connector **J12** on the EM783 EVM to the PC.
2. Run the serial terminal emulator software.
3. Click Setup and select Serial port. Set Port to match the COM port to which the UART serial cable is connected. Set Baud rate to 57600, Data to 8 bits, Parity to none, Stop bits to 1 and Flow control to none.
4. Enable **Local echo** option in the serial terminal.
5. Connect the EM783 EVM to a reference power supply and a resistive load.

3.5.2 Calibration commands

This section lists the set of commands available for calibrating the EVM. These commands can be entered into the serial terminal any time after the metrology initialization is complete. The number of voltage channels (NR_VOLTAGE_CHANNELS), current channels (NR_CURRENT_CHANNELS) and the number of gain channels (total number of current channels including the high and low gain channels – NR_GAIN_CHANNELS) for the EM783 variants as shown in Table 3.

Table 3. EM783 variant configuration parameters

Variant	NR_VOLTAGE_CHANNELS	NR_CURRENT_CHANNELS	NR_GAIN_CHANNELS
MC3	1	3	6
MC6	1	6	6
SC	1	1	2
SP	1	2	4
TP	3	3	3

The calibration commands are described below.

1. Display Metrology result.

Table 4. Calibration command – display metrology result

Field	Value
Command	CDM
Description	This command displays the metrology results on the serial terminal.
Response	The following metrology parameters are displayed on the serial terminal: • RMS Voltage for NR_VOLTAGE_CHANNELS in Volts • RMS Current for NR_CURRENT_CHANNELS in Amperes • Active Power for NR_CURRENT_CHANNELS in Watts • Fundamental Reactive Power for NR_CURRENT_CHANNELS in VAR • Energy in Ws accumulated during the previous integration period for NR_CURRENT_CHANNELS • Phase angle for NR_CURRENT_CHANNELS in degrees • Mains frequency in Hz • EM783 die temperature in degree Celsius • Duration of the last integration period in seconds • Positive Peak Voltage for NR_VOLTAGE_CHANNELS in volts

Field	Value
	• Negative Peak Voltage for NR_VOLTAGE_CHANNELS in volts • Positive Peak Current for NR_CURRENT_CHANNELS in Amperes • Negative Peak Current for NR_CURRENT_CHANNELS in Amperes

```
Metrology result:

Vrms[1]: 230.000000 V

Channel Irms (A)  P (W)          Q (VAR)        E (Ws)         Phi (Degrees)
1       01.093801 0000114.014709 0000224.252701 0000288.164307 063.050275
2       01.095649 0000111.454643 0000226.010132 0000281.693909 063.750248
3       01.094365 0000111.176659 0000225.817871 0000280.991333 063.787644

Signal peaks:
Channel +ve Peak (V)  -ve Peak (V)
1        324.984589   -324.984589

Channel +ve Peak (A)  -ve Peak (A)
1H      001.280000    -02.725333
1L      001.545605    -01.545605
2H      001.280000    -02.725333
2L      001.548217    -01.548217
3H      001.280000    -02.725333
3L      001.546403    -01.546403

Frequency: 51.437977 Hz; Temperature: 20.840000 C; Integration period: 2.527431 s
```

Fig 7. CDM command output for MC3 variant

2. Display Offsets.

Table 5. Calibration command – display offset corrections

Field	Value
Command	CDO
Description	This command displays the values of the offset corrections for all the current and the voltage channels.
Response	The following offset values are displayed on the serial terminal: • NR_VOLTAGE_CHANNELS offsets for the voltage inputs • NR_GAIN_CHANNELS offsets for the current inputs

```
cdo
Offsets:
Channel   Offset
V1        3

Channel   High Gain   Low Gain
          Offset      Offset
I1        0           -1
I2        0           -1
I3        1            0
```

Fig 8. CDO command output for MC3 variant

3. Display Ranges.

Table 6. Calibration command – display ranges

Field	Value
Command	CDR
Description	This command displays the calibration parameters (peak-to-peak current and voltage ranges) on the serial terminal.
Response	The following ranges are displayed on the serial terminal: • Ranges for NR_VOLTAGE_CHANNELS voltage inputs • Ranges for NR_GAIN_CHANNELS current inputs • Phase correction value for NR_GAIN_CHANNELS current inputs

```
Current ranges:
Channel   High Gain   Low Gain
          Range       Range
1         02.728000   003.314789
2         02.728000   003.320391
3         02.728000   003.316499

Phase corrections:
Channel   High Gain   Low Gain
          Correction  Correction
1         00.001108   -0.053092
2         00.001108   -0.065308
3         00.001108   -0.065961
```

Fig 9. CDR command output for MC3 variant

4. Set offset correction for current and voltage channels.

Table 7. Calibration command – set offset correction parameter

Field	Value
Command	CSO
Description	This command sets the offset calibration parameter for a channel into the metrology engine. The format of the command is: CSO <channel_type> <channel_number> <offset>
Parameters	
channel_type	V – Voltage channel
	I – Current channel
channel_number	The channel number should be input as listed in the table below. The table uses the following notations: H – High Gain Channel L – Low Gain Channel 1 to 6 – Channel number Voltage channel number must be from 1 to NR_VOLTAGE_CHANNELS Current channel number must be as given in the table below:

Field	Value				
	MC3	**MC6**	**SC**	**SP**	**TP**
	1H	1	1H	1H	1
	1L	2	1L	1L	2
	2H	3		2H	3
	2L	4		2L	
	3H	5			
	3L	6			
Offset	New offset value				
Response	OK – Success				
	Bad parameter – Incorrect value of offset correction				

Examples:

- CSO V1 1 — Set the offset of the voltage channel 1 to 1
- CSO I1H -1 — Set the offset of the high gain current channel 1 to -1
- CSO I2L -3 — Set the offset of the low gain current channel 2 to -3

5. Calibrate voltage channel.

Table 8. Calibration command – calibrate voltage range for voltage channel

Field	Value
Command	CSV
Description	This command calibrates the voltage channel. The format of the command is: CSV <channel_number> <reference_rms_voltage>
Parameters	
channel_number	Voltage channel number must be a value from 1 to NR_VOLTAGE_CHANNELS.
reference_rms_voltage	RMS voltage obtained from the reference meter in Volts
Response	OK – Success
	Bad parameter – Incorrect range parameter

Examples:

- CSV 1 230 — Calibrate the voltage channel 1 to reference RMS voltage of 230V

6. Calibrate current channel.

Table 9. Calibration command – calibrate current range for current channel

Field	Value
Command	CSI
Description	This command calibrates the current channel. The format of the command is: CSI <channel_number> <reference_rms_current>
Parameters	
channel_number	The channel number should be specified as listed in the table below. The table uses the following notations:

Field	Value
	H – High Gain Channel L – Low Gain Channel 1 to 6 – Channel number

MC3	MC6	SC	SP	TP
1H	1	1H	1H	1
1L	2	1L	1L	2
2H	3		2H	3
2L	4		2L	
3H	5			
3L	6			

Field	Value
reference_rms_current	RMS current obtained from the reference meter in Ampere
Response	OK – Success
	Bad parameter – Incorrect value of offset correction

Examples:

- CSI 1 24 — Calibrate channel 1 on MC6 variant to reference RMS current of 24A
- CSI 2L 24 — Calibrate low gain channel 2 on MC3 variant to reference RMS current of 24A

7. Calibrate phase correction for current channel.

Table 10. Calibration command – calibrate phase correction for current channel

Field	Value
Command	CSP
Description	This command calibrates the phase correction for a current channel. The format of the command is: CSP <channel_number>
Parameters	
channel_number	The channel number should be specified as listed in the table below. The table uses the following notations: H – High Gain Channel L – Low Gain Channel 1 to 6 – Channel number

MC3	MC6	SC	SP	TP
1H	1	1H	1H	1
1L	2	1L	1L	2
2H	3		2H	3
2L	4		2L	
3H	5			
3L	6			

Field	Value
phase correction	New phase correction value for the current channel in radian
Response	OK – Success

Field	Value
	Bad parameter – Incorrect value of offset correction

Examples:

- CSP 6 — Calibrate phase correction for channel 6 on MC6 variant
- CSP 3H — Calibrate high gain channel 3 on MC3 variant

8. Program Offsets into EEPROM.

Table 11. Calibration command – program Offsets

Field	Value
Command	CPO
Description	This command programs the offset values into the EEPROM.
Response	OK – Success

9. Program Ranges into EEPROM.

Table 12. Calibration command – program Ranges

Field	Value
Command	CPR
Description	This command programs the range values into the EEPROM.
Response	OK – Success

3.5.3 Calibration procedure

The calibration is performed with the following steps in the order listed below:

1. Calibrate offsets of all the voltage channels
2. Calibrate offsets of all the current channels
3. Calibrate voltage ranges of all the voltage channels
4. Calibrate current ranges of all the current channels
5. Calibrate phase correction of all the current channels

3.5.3.1 Calibration of voltage channel offset

1. Power up the EVM.
2. Wait for the metrology engine to complete the initialization and display the metrology parameters in the LCD.
3. Set the offset parameter for the voltage channel being calibrated to 0 using the **CSO** command.

   Example: To set offset of voltage channel 1 to 0 enter the following command in the serial terminal: CSO V 1 0
4. Use the **CDM** command in the serial terminal to display the metrology results. Note down the positive peak voltage and the negative peak voltage values.
5. If the values of the positive peak voltage and the negative peak voltage for the channel are different, then the offset calibration needs to be performed.

6. Adjust the value of the offset for the channel being calibrated using the command **CSO** in the serial terminal until both the positive peak and the negative peak voltage values are almost the same.
7. Program the new offset value into the EEPROM by entering the command **CPO** in the serial terminal.

3.5.3.2 Calibration of current channel offset

1. Set the offset parameter for the current channel being calibrated to 0 using the CSO command.

   Example: To set offset of the high gain current path of channel 1 of MC3 variant to 0 enter the following command in the serial terminal: CSO I 1H 0
2. Use the CDM command in the serial terminal to display the metrology results. Note down the positive peak current and the negative peak current values.
3. If the values of the positive peak current and the negative peak current for the channel are different, then the offset calibration needs to be performed.
4. Adjust the value of the offset using the command CSO in the serial terminal until both the positive peak and the negative peak current values are almost the same.
5. Program the new offset value into the EEPROM by entering the command **CPO** in the serial terminal.

3.5.3.3 Calibration of voltage range

1. Use the CDM command in the serial terminal to display the metrology results and note down the measured RMS voltage for the channel being calibrated.
2. If the error in the measured RMS voltage with respect to the reference meter reported RMS voltage is more than the allowed range, then the voltage range calibration needs to be done.
3. Use the CSV command to calibrate the voltage channel for the reference RMS voltage.
4. Program the new voltage calibration parameter into the EEPROM by entering the command **CPR** in the serial terminal.

3.5.3.4 Calibration of current range

1. Enter the command **CDM** in the serial terminal to display the metrology results and note down the measured RMS current for the channel being calibrated.
2. If the error in the measured RMS current with respect to the reference meter reported RMS current is more than the allowed range, then the current range calibration needs to be done.
3. Use the **CSI** command to calibrate the current channel for the reference RMS current.
4. Program the new current calibration parameter into the EEPROM by entering the command **CPR** in the serial terminal.

3.5.3.5 Calibration of phase correction

1. Use the **CSP** command to calibrate the phase correction for a current channel.
2. Verify that the value of the fundamental reactive power Q1 is as close to 0 as possible using the **CDM** command in the serial terminal.
3. Program the new phase correction factor into the EEPROM by entering the command **CPR** in the serial terminal.

4. EM783 SDK configuration

The EM783 EVM provides the following interfaces to the external world to communicate with the EM783:

1. **UART**: This interface is available at connector J12 and is used for debug messages, ISP flashing and calibration of the metrology engine by the reference application.
2. **USB**: This interface is available at connector J7. The USB controller MAX3420EETG+ is connected to EM783 via the SPI interface. The reference application provides a SPI driver and a CDC class driver for MAX3420E controller.
3. **Wireless**: EM783 EVM also provides wireless connectivity using the NXP JN5148 ZigBee module. The ZigBee module is interfaced to the EM783 via the I2C/SPI-to-UART Bridge chip SC16IS752IBS. The SDK provides both SPI and I2C drivers to communicate with the ZigBee module.
4. **RS485**: EM783 UART data can be routed to the RS485 transceiver on the EVM. The RS485 signals are available at connector J8.
5. **I2C**: EM783 I2C interface is available at the expansion connector J4.
6. **SPI**: EM783 SPI interface is available at the expansion connector J4.

The EM783 SDK provides the following configuration options to enable or disable the required communication interfaces.

Table 13. EM783 SDK configuration parameters

Defined in app\inc\app_config.h

Sl. No.	Configuration option	Default value	Valid values	Purpose
1	EM78X_CORE_CLOCK SPEED_HZ	36000000	12000000, 24000000, 36000000, 48000000,	Sets the EM783_CORE_FREQUENCY_HZ. EM783_CORE_FREQUENCY_HZ Is defined in comps\cmsis\CMSIS_3_01\CM0\DeviceSupport\EM78X\system_EM78x.c
2	EM78X_TICK_RATE_HZ	1000	Application defined	Configures the tick rate of the Cortex M0 Systick timer.
3	LED_BLINK_RATE_IN_MS	250	Application defined	Rate at which LED D5 is blinked in ms.
4	LCD_REFRESH_RATE_IN_MS	1000	Application defined	Rate at which the metrology parameters are refreshed in the LCD in ms.
5	EM783_CONSOLE_BAUDRATE	57600	Application defined	Baud rate of the EM783 console interface
6	I2C_INTERRUPT_PRIORITY	3	2 or 3	I2C driver interrupt priority
7	UART_INTERRUPT_PRIORITY	3	2 or 3	UART driver interrupt priority
8	TMR16B0_INTERRUPT_PRIORITY	3	2 or 3	16-bit Timer B0 interrupt priority (used by the Kilo-Watt-Hour (KWH) pulser module
9	SSP_INTERRUPT_PRIORITY	3	2 or 3	SSP driver interrupt priority
10	SYSTICK_INTERRUPT_PRIORITY	3	2 or 3	Systick timer interrupt priority
11	GPIO_INTERRUPT_PRI	3	2 or 3	GPIO interrupt priority

Sl. No.	Configuration option	Default value	Valid values	Purpose
	ORITY			
12	METROLOGY_DEFAULT_INTEGRATION_PERIOD	130	Refer EM783_FAQ for recommended values	Number of mains periods to be used in the calculation of the metrology parameters
13	METROLOGY_DEFAULT_MVDD	3300	Application defined	EM783 VDD voltage in mV.
14	SUPPORT_CALIBRATION	Defined	Defined or undefined	Define this macro to enable the metrology engine calibration interface. Undefined this macro to disable metrology engine the calibration interface.
15	SUPPORT_LOGGER	Disabled	Defined or undefined	Define this macro to enable logging metrology data into a circular buffer in the EEPROM. Undefined this macro to disable the logger module.
16	LOG_RATE_S	(10 * 60)	Application defined	Defines the rate in seconds at which the metrology data are logged into the EEPROM.
17	SUPPORT_UART_DEBUG	Enabled	Enabled or disabled	Define this macro to enable debug messaging on the UART interface Undefine this macro to disable debug messaging on the UART interface
18	SUPPORT_KWH_PULSER	Disabled	Enabled or disabled	Define this macro to enable the KWH pulse module Undefine this macro to disable the KWH pulse module
19	KWH_PULSE_RATE_DEFAULT	2000	1000, 2000, 3000,	Sets the pulse rate of the KWH pulse output in number of pulses per kWH of energy
20	SUPPORT_LCD	Enabled	Enabled or disabled	Define this macro to enable the LCD driver Undefine this macro to disable the LCD driver
21	SUPPORT_MAX3420E	Disabled	Enabled or disabled	Define this macro to enable the MAX3420E driver Undefine this macro to disable the MAX3420E driver
22	MAX3420E_INTERRUPT_PIN	4	GPIO pin number	Defines the GPIO pin number to which the MAX3420E interrupt pin is connected.
23	SUPPORT_SC16IS752	Disabled	Enabled or disabled	Define this macro to enable the SC16IS752 driver
24	SC16IS752_BAUDRATE	38400	Application defined	Baud rate for the SC16IS752 UART interface
25	SC16IS752_I2C_INTERFACE	1	1 or 0	Select I2C interface for communication between EM783 and SC16IS752
26	SC16IS752_SSP_INTERFACE	0	1 or 0	Select SSP interface for communication between EM783 and SC16IS752
27	SUPPORT_UART	Enabled	Enabled or disabled	Define this macro to enable the EM783 UART driver Undefine this macro to disable the EM783 UART driver
28	UART_BAUDRATE	EM783_CONSOLE_BAUDRATE	Standard baud rates up to 115200	Defines the baud rate for the EM783 UART interface
29	SUPPORT_I2C	Enabled	Enabled or disabled	Define this macro to enable the I2C driver Undefine this macro to disable the I2C driver

Sl. No.	Configuration option	Default value	Valid values	Purpose
30	SUPPORT_SSP	Disabled	Enabled or disabled	Define this macro to enable the SSP driver Undefine this macro to disable the SSP driver
31	SSP_CLOCKSPEED_HZ	1000000	Application defined	SSP interface clock speed.
32	SSP_USE_CS	0	Application defined	Set this to 1 to use the SSP slave select signal from the controller Set this to 0 to use P0_18 (in GPIO mode) for slave select
33	SSP_CS_GPIO	18	Application defined	GPIO used as chip select for the EM783 SSP interface
34	SUPPORT_STACK_CHECK	Disabled	Enabled or disabled	Define this macro to enable stack usage check feature. With this option enabled, the stack is filled with known pattern (STACK_MEM_INIT_PATTERN). Exercise the system to ensure the greatest stack depth is achieved. Halt the system using debugger and examine the stack memory to determine how much of the stack is used.
35	STACK_MEM_INIT_PATTERN	0xBAADF00D	Any pattern	Stack memory initialization pattern

[1] KWH pulse module uses P0_4 for KWH pulse output, this is also the pin used as the interrupt pin for MAX3420E USB controller. Hence on the EM783 EVM, SUPPORT_MAX3420E and SUPPORT_KWH_PULSER cannot be enabled simultaneously.

[2] SUPPORT_SSP needs to be defined to enable SUPPORT_MAX3420E.

[3] SUPPORT_I2C needs to be defined to enable SUPPORT_LCD.

[4] SUPPORT_UART_DEBUG needs to be defined to enable SUPPORT_CALIBRATION.

5. EM783 temperature compensation

5.1 Need for temperature compensation

EM783 EVM can be operated over a wide temperature range. The performance characteristics of the EVM vary at different temperatures. This results in the variation of the accuracy of the metrology measurement output, when the EVM is operated at different temperature conditions. Temperature compensation is used to improve the accuracy in the metrology measurement output when the EVM is operated at temperatures other than the ambient temperature at which the unit is calibrated.

5.2 Temperature compensation procedure

The temperature compensation procedure involves measuring a fixed reference current with the EVM at various temperatures and applying the appropriate correction factor. The temperature compensation has to be performed for voltage, current and phase angle of all the channels separately.

5.2.1 Voltage and current compensation

The temperature compensation procedure for the voltage channels and the current channels are the same. The temperature compensation procedure for one current channel is illustrated in the steps below. The setup used for the calibration is reused to derive the correction factor for the temperature compensation; see Section 3.5.3.

1. Enclose the EVM in a temperature chamber

2. Set the reference current to 5A (the effect of variation in the temperature is more towards lower current. Hence set the reference current to about 20% of the range of the current that can be measured with the channel).
3. Set the temperature within the temperature chamber to 80C.
4. Note down the value of the current reported by the metrology engine for the channel being characterized.
5. Repeat steps 2 to 4 by setting the temperature to different values over the entire range in which the EVM is used.
6. An example set of measurement data for a current channel at different temperatures from 0C to 80C is shown in Table 14.
7. Compute the ideal correction factor C_ideal as shown in the table below. Plot a curve of the ideal correction factor against the temperature as shown in Fig 10.

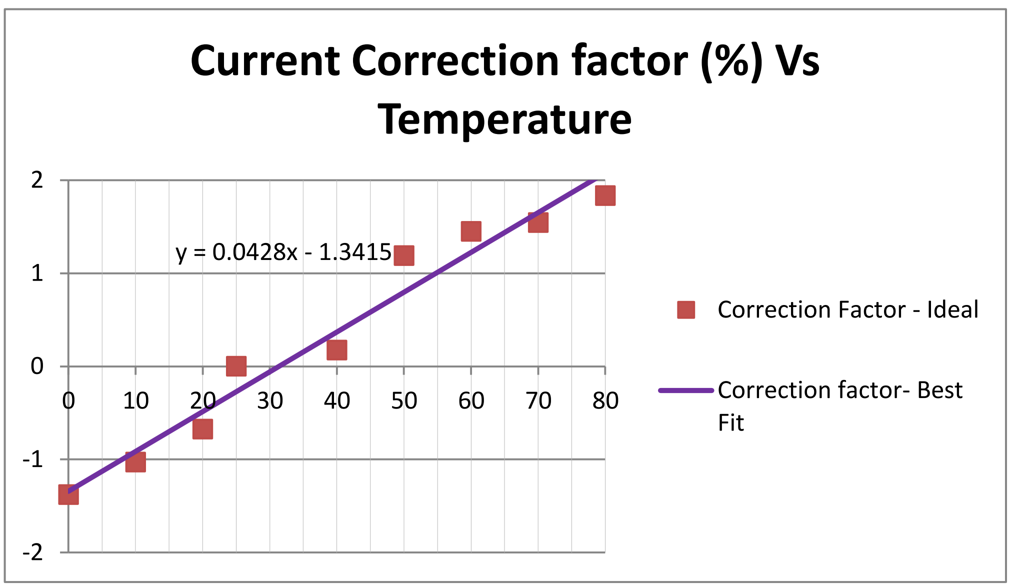

Fig 10. Plot of correction factor for current versus temperature

8. Overlay a best fit curve through the points of the ideal correction factor points. In the above example, the curve is defined by y = 0.0428x – 1.3415.
9. Compute the new calibration factor using the correction factor, as shown Table 14.

Table 14. EM783 temperature compensation example for current

I1L (A) = 5 ; I1Lpp = 3.04876

T (C)	I1Lm (A)	Corr_ideal	Corr_estimated	I1Lpp_comp
80	4.91	1.832994	2.082500	3.112250
70	4.924	1.543461	1.654500	3.099202
60	4.9286	1.448687	1.226500	3.086153
50	4.94128	1.188356	0.798500	3.073104
40	4.99134	0.173501	0.370500	3.060056
25	5	0.000000	-0.271500	3.040483
20	5.034	-0.675407	-0.485500	3.033958
10	5.052	-1.029295	-0.913500	3.020910
0	5.0699	-1.378725	-1.341500	3.007861

Following notations are used in this table

Notation	Formula	Meaning
I1L		Test current applied to channel I1L to derive the temperature compensation formula
I1Lpp		Calibration factor for the channel I1L obtained after calibration
T		Temperature to which the EVM is subjected to in degree Celsius
I1Lm		Measured current in A from channel I1L at the set temperature
Corr_ideal	(I1L – I1Lm) * 100 / I1L	Ideal correction factor
Corr_estimated	(0.0428 * T) - 1.3415	Correction factor estimated using the best fir curve
I1Lpp_comp	I1Lpp * (1 + C)	Corrected calibration parameter

5.2.2 Phase angle correction factor compensation

The temperature compensation procedure for the phase angle correction factor is similar to the procedure for the current and voltage compensation. The example calculation for the phase angle correction factor temperature compensation is shown in Fig 11 and Table 15.

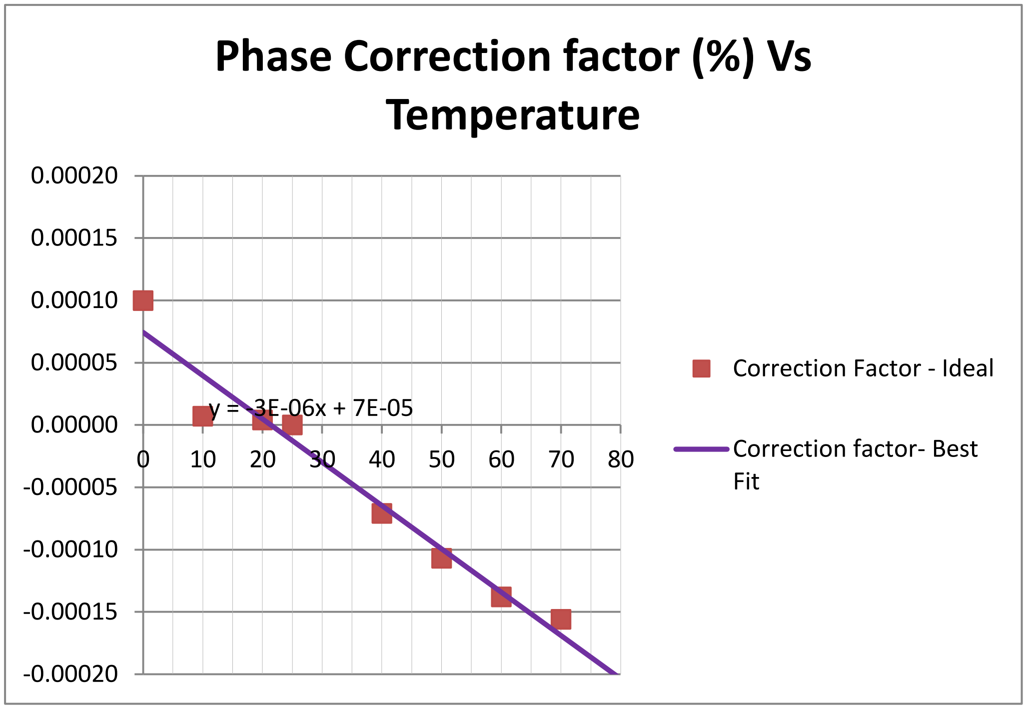

Fig 11. Plot of correction factor for phase angle versus temperature

Table 15. EM783 temperature compensation example for phase angle

Phi1L (rads) = 0.002345; Deltaphi1L (rads) = -0.069813

T (C)	Phi1Lm (rads)	Corr_ideal (rads)	Corr_estimated (rads)	Deltaphi1l_comp (rads)
80	0.002549	-0.000204	-0.000170	-0.069983
70	0.002501	-0.000156	-0.000140	-0.069953
60	0.002483	-0.000138	-0.000110	-0.069923
50	0.002452	-0.000107	-0.000080	-0.069893
40	0.002416	-0.000071	-0.000050	-0.069863
25	0.002345	0.000000	-0.000005	-0.069818
20	0.002341	0.000004	0.000010	-0.069803
10	0.002338	0.000007	0.000040	-0.069773
0	0.0022452	0.000100	0.000070	-0.069743

Following notations are used in this table

Notation	Formula	Meaning
Phi1L		Phase angle value measured for channel 1L for power factor 1
Deltaphi1L		Phase angle correction factor for channel 1L obtained after calibration
T		Temperature to which the EVM is subjected to in degree Celsius
Phi1Lm		Measured phase angle in radians from channel 1L at the set temperature

Corr_ideal	(Pref - Pm)	Ideal correction factor
Corr_estimated	(-3e-6 * T) + 7e-5	Correction factor estimated using the best fir curve
Deltaphi1L_comp	Pcal + C	Corrected calibration parameter

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7. List of figures

Fig 1. EM783 block diagram 4
Fig 2. Caution 4
Fig 3. EM783 SDK folder structure 5
Fig 4. EM783 initialization message............................ 8
Fig 5. Total accumulated energy display..................... 8
Fig 6. Total instantaneous power display.................... 8
Fig 7. CDM command output for MC3 variant........... 11
Fig 8. CDO command output for MC3 variant 11
Fig 9. CDR command output for MC3 variant 12
Fig 10. Plot of correction factor for current versus temperature.. 20
Fig 11. Plot of correction factor for phase angle versus temperature.. 22

8. List of tables

Table 1. EM783 EVM SWD pin mapping 9
Table 2. Default SWD pin mapping 9
Table 3. EM783 variant configuration parameters 10
Table 4. Calibration command – display metrology result 10
Table 5. Calibration command – display offset corrections 11
Table 6. Calibration command – display ranges 12
Table 7. Calibration command – set offset correction parameter... 12
Table 8. Calibration command – calibrate voltage range for voltage channel... 13
Table 9. Calibration command – calibrate current range for current channel 13
Table 10. Calibration command – calibrate phase correction for current channel.......................... 14
Table 11. Calibration command – program Offsets......... 15
Table 12. Calibration command – program Ranges........ 15
Table 13. EM783 SDK configuration parameters 17
Table 14. EM783 temperature compensation example for current 21
Table 15. EM783 temperature compensation example for phase angle.. 22

9. Contents

1. Introduction 3
1.1 Key applications 3
1.2 Block diagram 4
1.3 Disclaimer 4
1.4 Support information 4
1.5 References 4
2. EM783 evaluation module overview 5
3. Evaluating EM783 7
3.1 Building the project 7
3.2 Flashing the image 7
3.3 Evaluating the EM783 EVM 7
3.3.1 EM783 EVM power up 7
3.3.2 EM783 EVM display layout 7
3.3.2.1 Initialization message 8
3.3.2.2 Metrology parameter display 8
3.4 SWD pin configuration for EM783 9
3.5 Calibration of the metrology engine 9
3.5.1 Calibration setup 10
3.5.2 Calibration commands 10
3.5.3 Calibration procedure 15
3.5.3.1 Calibration of voltage channel offset 15
3.5.3.2 Calibration of current channel offset 16
3.5.3.3 Calibration of voltage range 16
3.5.3.4 Calibration of current range 16
3.5.3.5 Calibration of phase correction 16
4. EM783 SDK configuration 17
5. EM783 temperature compensation 19
5.1 Need for temperature compensation 19
5.2 Temperature compensation procedure 19
5.2.1 Voltage and current compensation 19
5.2.2 Phase angle correction factor compensation 21
6. Legal information 24
6.1 Definitions 24
6.2 Disclaimers 24
6.3 Trademarks 24
7. List of figures 25
8. List of tables 26
9. Contents 27

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