# Three-Phase Energy Meter Chipset

ADSST-EM-2030*

FEATURES
3-Phase, 4-Wire Metering IC
High Accuracy Support for 50 Hz/60 Hz, IEC1036
Design Accuracy:
    0.5% over 5% of Ib to 6% of Ib
    0.65% over 2% of Ib to 5% of Ib
Measures:
    kWh
    kW
    rms Voltage of Each Phase
    rms Current of Each Phase
Phase and Nonlinearity Compensation for CTs
Potentiometer-Free Design
SPI Communication for:
    Data to Microcontroller
    Calibration
Programmable E-Pulse
Drive for:
    Electromechanical Counter
    2-Phase Stepper Motor Counter
Low Power (50 mW Typ)

FUNCTIONAL BLOCK DIAGRAM
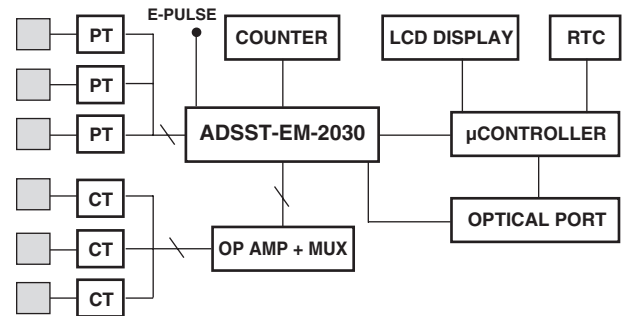
POLY PHASE ENERGY METER USING THE ADSST-EM-2030

GENERAL DESCRIPTION

ADSST-EM-2030 is a highly accurate and low cost phase energy measurement IC intended to be used in 3-phase, 4-wire systems. When used with an op amp and a multiplexer, the ADSST-EM-2030 surpasses the accuracy requirement of the IEC1036 standard.

ADSST-EM-2030 is a MicroConverter® consisting of a microcontroller, 6-channel, 12-bit ADC, SPI port, program memory and Flash for storage of constants. The only analog circuitry used in ADSST-EM-2030 is the ADC. All other signal processing is carried out in digital domain. This provides superior accuracy over extreme environmental conditions and time.

ADSST-EM-2030 can drive an electromechanical counter or a 2-phase stepper motor counter, or can be interfaced to a microcontroller to build a feature-rich meter with LCD, maximum demand, time of use, and communication.

Ratio, phase, and nonlinearity errors of the CTs are compensated for by using software. This reduces the cost of CTs and reduces calibration time caused by unreliable potentiometers.

Because the ADSST-EM-2030 is a low power device, it can be powered by a simple R-C power supply, reducing the cost of operation.

ADSST-EM-2030 supplies average real power information on the low frequency outputs F1 and F2. These logic outputs can be used to drive an electromechanical counter. The CF logic pin gives the instantaneous real power information. This output is intended to be used for calibration.

ADSST-EM-2030 is available in a 28-lead SSOP package.

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ADSST-EM-2030

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADSST-EM-2030	–40°C to +85°C	Tiny Shrink Small Outline Package	RU–28

PIN FUNCTION DESCRIPTION

Pin No.	Mnemonic	Description
1	DGND	Digital Ground
2	DLOAD	Used to Enable Serial Download of Program Memory
3	GAIN 1	Logic Channels Output for Multiplexer to Switch Gain for A-Phase Current
4	GAIN 2	Logic Channels Output for Multiplexer to Switch Gain for B-Phase Current
5	TAMP	Logic Output Indicating that One More Current Is Reversed
6	CF	Calibration Frequency Logic Output. This gives instantaneous real power information and can be used for calibration.
7	GAIN 3	Logic Channels Output for Multiplexer to Switch Gain for C-Phase Current
8, 9	F1, F2	Low Frequency Logic Outputs. F1 and F2 provide average real power information. The logic outputs can be used to drive electromechanical counters and 2-phase stepper motors.
10	RESET	System Reset
11	APHV	A-Phase Voltage Input
12	APHC	A-Phase Current Input
13	AVDD	Analog Positive Supply
14	AGND	Analog Ground
15	AGND	Analog Ground
16	VREF	Input for External Voltage Reference

PIN CONFIGURATION
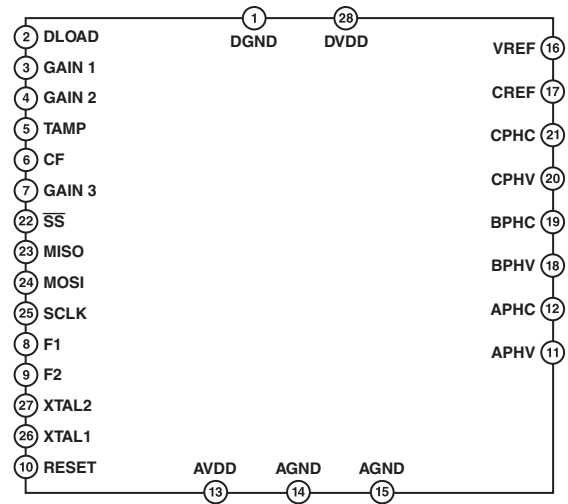
PIN FUNCTION DESCRIPTION (continued)

Pin No.	Mnemonic	Description
17	CREF	Filter Capacitor for Reference
18	BPHV	B-Phase Voltage Input
19	BPHC	B-Phase Current Input
20	CPHV	C-Phase Voltage Input
21	CPHC	C-Phase Current Input
22	$\overline{SS}$	This Logic Signal conveys to ADSST-EM-2030 that data transfer on SPI is requested.
23	MISO	Data Output on SPI from ADSST-EM-2030
24	MOSI	
25	SCLK	Clock for SPI. This clock is generated by an external microcontroller when the data transfer to or from ADSST-EM-2030 takes place.
26	XTAL1	Crystal Oscillator
27	XTAL2	Crystal Oscillator
28	DVDD	Digital Positive Supply

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SERIAL PERIPHERAL INTERFACE (SPI)

The SPI bus available on the ADSST-EM-2030 is useful to communicate to an external microcontroller as shown in Figure 1.
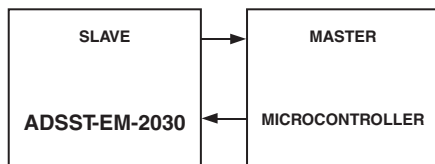

Figure 1. SPI Communication between ADSST-EM-2030 and Microcontroller

Here, the microcontroller functions as master and the ADSST-EM-2030 is a slave for this protocol. Using this communication port, the microcontroller will be able to read and write to the ADSST-EM-2030 to perform the following functions:

- Calibrate the meter
- Configure the ADSST-EM-2030 chipset
- Read measured parameters from the ADSST-EM-2030 chipset

Four pins are used on the ADSST-EM-2030 chipset for the communication, and are shown Table I.

Table I. Pin Description for SPI Communication Port

Pin No.	Mnemonic	Description
22	$\overline{SS}$	Select
23	MISO	Output
24	MOSI	Input
25	SCLK	SPI Clock

TIMING SPECIFICATIONS

This section contains timing information for the ADSST-EM-2030 chipset.

General Notes

Use the exact timing information given. Do not attempt to derive parameters from the addition or subtraction of others. While addition or subtraction would yield meaningful results for an individual device, the values given in this data sheet reflect statistical variations and worst cases. Consequently, parameters cannot be added up meaningfully to derive longer times.

Timing Notes

Switching characteristics specify how the processor changes its signals. Designers have no control on this timing—circuitry external to the processor must be designed for compatibility with these signal characteristics. These characteristics can be used to ensure that any timing requirement of a microcontroller connected to the chipset is satisfied.

Timing requirements apply to signals that are controlled by circuitry external to the chipset, such as the data input for a read operation. Timing requirements guarantee that the chipset operates correctly with the external microcontroller.

Data Access

Data can be written or read to the ADSST-EM-2030 chipset only when the $\overline{SS}$ pin is low. Since the chipset is a slave, the external controller must bring the $\overline{SS}$ pin low, the SCLK clock should be sent to clock in or clock out the data. For sending the data to the chipset, data should be sent on MOSI pin; for receiving the data from the chipset, data should be collected on MISO pin.

With the external microcontroller as the master for the SPI communication, the microcontroller should send eight successive clocks to the ADSST-EM-2030 every 5 ms. At this instant, the microcontroller may either send a command or data or may receive an acknowledgment followed by data from the chipset. The ADSST-EM-2030 maintains a time gap of 5 ms between transmission of two successive bytes to or from the microcontroller. This helps in avoiding clashing of interrupts while the chipset and the microcontroller are executing their respective tasks.

Table II. SPI Pin Timings

| Timing	Parameter	Min	Typ	Max	Unit
t_{SS}	$\overline{SS}$ to SCLOCK Edge	0			ns
t_{SC}	SCLOCK Low Pulsewidth		300		ns
t_{SH}	SCLOCK High Pulsewidth		300		ns
t_{DAV}	Data Output Valid after SCLOCK Edge			50	ns
t_{DSU}	Data Input Setup Time before SCLOCK Edge	100			ns
t_{DHD}	Data Input Hold Time before SCLOCK Edge	100			ns
t_{DF}	Data Output Fall Time		10	25	ns
t_{DR}	Data Output Rise Time		10	25	ns
t_{SR}	SCLOCK Rise Time		10	25	ns
t_{SF}	SCLOCK Fall Time		10	25	ns
t_{SFS}	$\overline{SS}$ High after SCLOCK Edge	0			ns

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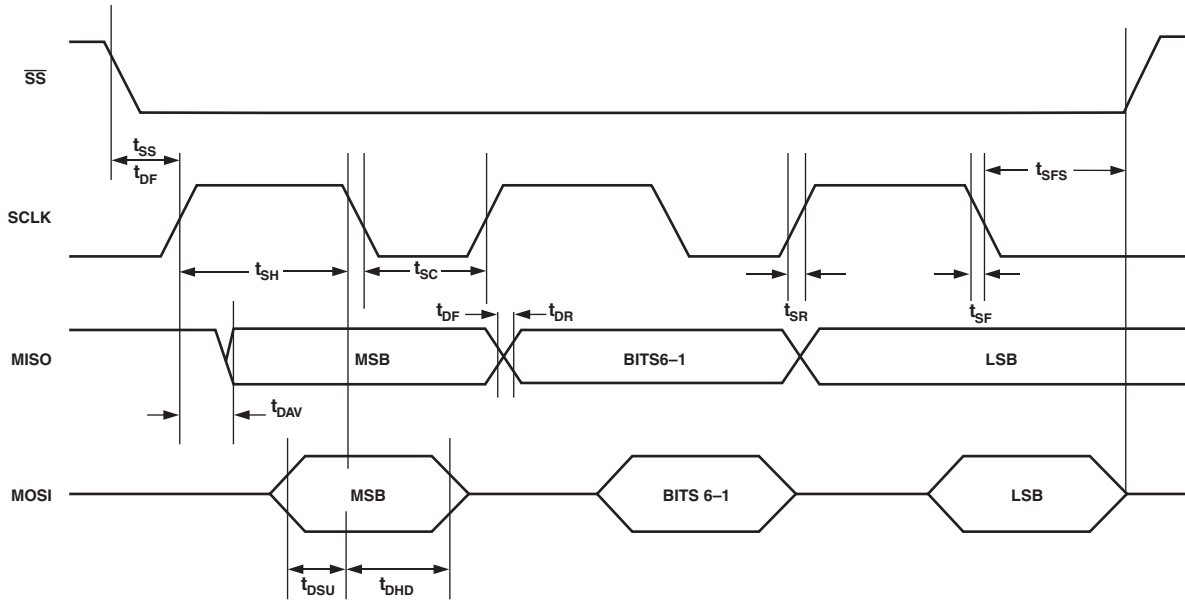
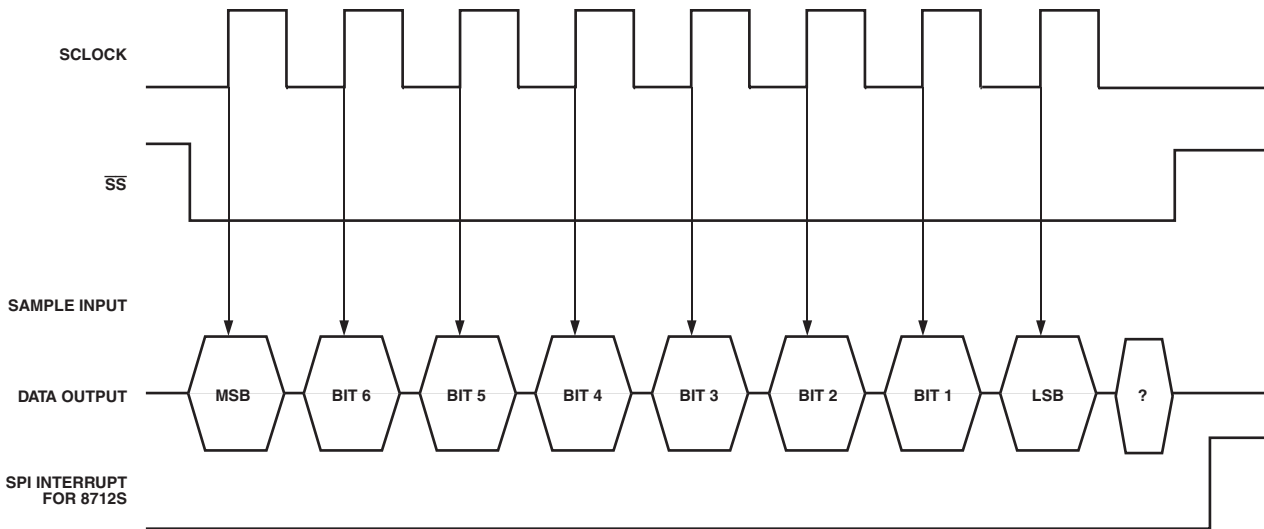Figure 2. SPI Communication Port Timing

Figure 3. SPI Timing for Data Transmission Byte

SPI FUNCTIONS

Three specific functions can be performed on the SPI communication port on the ADSST-EM-2030 chipset:

Data Read—The external microcontroller can read the data from the ADSST-EM-2030 by sending specific commands; this includes metering data, constants, and so on.

Data Write—The external microcontroller can send data to the ADSST-EM-2030 to be stored in its internal nonvolatile memory; this includes calibration and configuration constants, and so on.

Special Commands—The external microcontroller can send special commands to the ADSST-EM-2030 for performing specific functions. These commands do not have any data.

Data Read

The microcontroller being the master for the SPI communication, has to send the desired commands for getting data from ADSST-EM-2030. For the data transfer to take place, the following sequence of operations must take place:

1. The microcontroller should send the specific command to the ADSST-EM-2030 chipset to read the desired data.

2. The ADSST-EM-2030 will first respond with an acknowledgment to the microcontroller within 5 ms that it has received the command. To send the acknowledgment, the ADSST-EM-2030 adds 0x30 to the received command, and which is then sent back to the microcontroller.

3. If the microcontroller does not get this acknowledgment from the ADSST-EM-2030 within 5 ms then the microcontroller may transmit this command to read the same data again.

4. After being sensed by the microcontroller, the ADSST-EM-2030 sends an acknowledgment to the microcontroller, the chipset then prepares a packet of 10 bytes of requested data and starts transmitting the bytes one by one at intervals of 5 ms. This packet of 10 bytes also includes a header as the first byte of the packet and checksum as the last byte.

5. The microcontroller can strip the data from this packet, compute the checksum, and compare it with the last byte in the packet. If the checksum does not match, the microcontroller should then send the command again to ADSST-EM-2030 chipset.

The complete process of reading a packet of data should take 60 ms. The next command from the microcontroller to the ADSST-EM-2030 can be sent immediately after receipt of data or wait for the desired amount of time. The amount of time the microcontroller should wait for the next command to be sent to the ADSST-EM-2030 is purely dependent on the execution of other functions on the microcontroller. It may be sufficient for the microcontroller to collect data from the chipset after

every second. The remaining time may be used by the micro-controller to perform other housekeeping functions.

For example, if the command sent by the microcontroller is 0x01, the ADSST-EM-2030 adds 0x30 to it, making it 0x31, and sends this to the microcontroller as an acknowledgment.

The data packet structure created by the ADSST-EM-2030 has 10 bytes. The first byte is a packet start byte (0xEE) and the last byte is a checksum byte.

< START of Packet (0xEE) >< 8 Bytes of Data>
< CHECKSUM >

The checksum is calculated by adding the first nine bytes, including the packet start byte.

CHECKSUM = 1st + 2nd + ... + 9th Byte

Table III shows various commands that can be sent to the ADSST-EM-2030 chipset by the microcontroller on the SPI communication port. The chipset returns a specific number of bytes for each data parameter specified, in the data column of the table. The data that can be read from the chipset could be calibration constants or instantaneous data.

Table III. Read Commands to ADSST-EM-2030 on SPI

Function	Command to ADSST-EM-2030 from µC	Number of Data Bytes from ADSST-EM-2030
CONSTANTS		
GAIN CALIBRATION CONSTANTS		
Read Voltage Gain Constants	0x01	6
Read Low Gain Current Constants	0x02	6
Read High Gain Current Constants	0x03	6
POWER CALIBRATION CONSTANTS AT HIGH CURRENT RANGE		
A-Phase Power Constant at High Current (Including E-Pulse and Counter Pulse Constant)	0x07	4
B-Phase Power Constant at High Current	0x09	2
C-Phase Power Constant at High Current	0x0B	2
POWER CALIBRATION CONSTANTS AT LOW CURRENT RANGE		
A-Phase Power Constant at Low Current	0x06	2
B-Phase Power Constant at Low Current	0x08	2
C-Phase Power Constant at Low Current	0x0A	2
PHASE COMPENSATION COEFFICIENTS		
Read A-, B-, and C-Phase Coefficients	0x15	6
DC OFFSET CONSTANTS		
Read DC Offset Constants	0x0E	6
INSTANTANEOUS PARAMETERS		
Read Voltages for Phase A, B, and C	0x0F	6
Read Currents for Phase A, B, and C	0x10	6
Read Energy and Power for Phase A, B, and C	0x11	8

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Data Structure in the Packet

The ADSST-EM-2030 sends out eight bytes of data for every command. The last bytes of a parameter with a 6-byte structure are kept at zero and should be neglected.

Table IV. Byte Wise Packet Data Structure for Voltage Gain Constants

Command to ADSST-EM-2030: 0x01
Acknowledgment from ADSST-EM-2030: 0x31

1	2	3	4	5	6	7	8	9	10
SPB	AVMS	AVLS	BVMS	BVLS	CVMS	CVLS	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	AVMS	Voltage Constant for A-Phase – MSB
3	AVLS	Voltage Constant for A-Phase – LSB
4	BVMS	Voltage Constant for B-Phase – MSB
5	BVLS	Voltage Constant for B-Phase – LSB
6	CVMS	Voltage Constant for C-Phase – MSB
7	CVLS	Voltage Constant for C-Phase – LSB
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table V. Byte Wise Packet Data Structure for Low Gain Current Constants

Command to ADSST-EM-2030: 0x02
Acknowledgment from ADSST-EM-2030: 0x32

1	2	3	4	5	6	7	8	9	10
SPB	AILM	AILL	BILM	BILL	CILM	CILL	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	AILM	Current Constant for A-Phase – Low Gain – MSB
3	AILL	Current Constant for A-Phase – Low Gain – LSB
4	BILM	Current Constant for B-Phase – Low Gain – MSB
5	BILL	Current Constant for B-Phase – Low Gain – LSB
6	CILM	Current Constant for C-Phase – Low Gain – MSB
7	CILL	Current Constant for C-Phase – Low Gain – LSB
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table VI. Byte Wise Packet Data Structure for High Gain Current Constants

Command to ADSST-EM-2030: 0x03
Acknowledgment from ADSST-EM-2030: 0x33

1	2	3	4	5	6	7	8	9	10
SPB	AIHM	AIHL	BIHM	BIHL	CIHM	CIHL	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	AIHM	Current Constant for A-Phase – High Gain – MSB
3	AIHL	Current Constant for A-Phase – High Gain – LSB
4	BIHM	Current Constant for B-Phase – High Gain – MSB
5	BIHL	Current Constant for B-Phase – High Gain – LSB
6	CIHM	Current Constant for C-Phase – High Gain – MSB
7	CIHL	Current Constant for C-Phase – High Gain – LSB
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table VII. Byte Wise Packet Data Structure for Power Constants at High Current for Phase A

Command to ADSST-EM-2030: 0x07
Acknowledgment from ADSST-EM-2030: 0x37

1	2	3	4	5	6	7	8	9	10
SPB	PAHM	PAHL	EPC	CPC	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	PAHM	Power Constant for A-Phase, High Current – MSB
3	PAHL	Power Constant for A-Phase, High Current – LSB
4	EPC	E-Pulse Constant in Pulses per kWh (1 = 1600, 2 = 800, 3 = 400, and 4 = 200), Default Value = 1
5	CPC	Counter Pulse Constant in Pulses per kWh (1 = 200 and 2 = 400), Default Value = 1
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table VIII. Byte Wise Packet Data Structure for Power Constants at High Current for Phase B

Command to ADSST-EM-2030: 0x09
Acknowledgment from ADSST-EM-2030: 0x39

1	2	3	4	5	6	7	8	9	10
SPB	PBHM	PBHL	NLV	NLV	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	PBHM	Power Constant for B-Phase, High Current – MSB
3	PBHL	Power Constant for B-Phase, High Current – LSB
4	NLV	No Legal Value (0x00)
5	NLV	No Legal Value (0x00)
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table IX. Byte Wise Packet Data Structure for Power Constants at High Current for Phase C

Command to ADSST-EM-2030: 0x0B
Acknowledgment from ADSST-EM-2030: 0x3B

1	2	3	4	5	6	7	8	9	10
SPB	PCHM	PCHL	NLV	NLV	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	PCHM	Power Constant for C-Phase, High Current – MSB
3	PCHL	Power Constant for C-Phase, High Current – LSB
4	NLV	No Legal Value (0x00)
5	NLV	No Legal Value (0x00)
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table X. Byte Wise Packet Data Structure for Power Constants at Low Current for Phase A
Command to ADSST-EM-2030: 0x06
Acknowledgment from ADSST-EM-2030: 0x36

1	2	3	4	5	6	7	8	9	10
SPB	PALM	PALL	NLV	NLV	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	PALM	Power Constant for A-Phase, Low Current – MSB
3	PALL	Power Constant for A-Phase, Low Current – LSB
4	NLV	No Legal Value (0x00)
5	NLV	No Legal Value (0x00)
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XI. Byte Wise Packet Data Structure for Power Constants at Low Current for Phase B
Command to ADSST-EM-2030: 0x08
Acknowledgment from ADSST-EM-2030: 0x38

1	2	3	4	5	6	7	8	9	10
SPB	PBLM	PBLL	NLV	NLV	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	PBLM	Power Constant for B-Phase, Low Current – MSB
3	PBLL	Power Constant for B-Phase, Low Current – LSB
4	NLV	No Legal Value (0x00)
5	NLV	No Legal Value (0x00)
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XII. Byte Wise Packet Data Structure for Power Constants at Low Current for Phase C
Command to ADSST-EM-2030: 0x0A
Acknowledgment from ADSST-EM-2030: 0x3A

1	2	3	4	5	6	7	8	9	10
SPB	PCLM	PCLL	NLV	NLV	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	PCLM	Power Constant for C-Phase, Low Current – MSB
3	PCLL	Power Constant for C-Phase, Low Current – LSB
4	NLV	No Legal Value (0x00)
5	NLV	No Legal Value (0x00)
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

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Table XIII. Byte Wise Packet Data Structure for Phase Compensation Coefficients

Command to ADSST-EM-2030: 0x15
Acknowledgment from ADSST-EM-2030: 0x45

1	2	3	4	5	6	7	8	9	10
SPB	PGA	PSA	PGB	PSB	PGC	PSC	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	PGA	Phase Constant for Low Current – Phase A
3	PSA	Phase Constant for High Current – Phase A
4	PGB	Phase Constant for Low Current – Phase B
5	PSB	Phase Constant for High Current – Phase B
6	PGC	Phase Constant for Low Current – Phase C
7	PSC	Phase Constant for High Current – Phase C
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XIV. Byte Wise Packet Data Structure for DC Offset Constants

Command to ADSST-EM-2030: 0x0E
Acknowledgment from ADSST-EM-2030: 0x3E

1	2	3	4	5	6	7	8	9	10
SPB	DAM	DAL	DBM	DBL	DCM	DCL	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	DAM	DC Offset for Phase A - MSB
3	DAL	DC Offset for Phase A – LSB
4	DBM	DC Offset for Phase B – MSB
5	DBL	DC Offset for Phase B – LSB
6	DCM	DC Offset for Phase C – MSB
7	DCL	DC Offset for Phase C – LSB
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XV. Byte Wise Packet Data Structure while Reading Instantaneous Voltages in Volts

Command to ADSST-EM-2030: 0x0F
Acknowledgment from ADSST-EM-2030: 0x3F
Voltage Value Resolution: Two Decimal Points

1	2	3	4	5	6	7	8	9	10
SPB	VAM	VAL	VBM	VBL	VCM	VCL	Tamper Info	Not used	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	VAM	Voltage for Phase A – MSB
3	VAL	Voltage for Phase A – LSB
4	VBM	Voltage for Phase B – MSB
5	VBL	Voltage for Phase B – LSB
6	VCM	Voltage for Phase C – MSB
7	VCL	Voltage for Phase C – LSB
8	Tamper Info	0 bit: A – CT Reversal
		First Bit: B – CT Reversal
		Second Bit: C – CT Reversal
		Third Bit: Phase Sequence Error
9	Not used	
10	CSUM	Checksum

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Table XVI. Byte Wise Packet Data Structure While Reading Instantaneous Current in Amperes

Command to ADSST-EM-2030: 0x10
Acknowledgment from ADSST-EM-2030: 0x40
Current value resolution: Three Decimal Points

1	2	3	4	5	6	7	8	9	10
SPB	IAM	IAL	IBM	IBL	ICM	ICL	ACTR	ACTR	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	IAM	Current for Phase A – MSB
3	IAL	Current for Phase A – LSB
4	IBM	Current for Phase B – MSB
5	IBL	Current for Phase B – LSB
6	ICM	Current for Phase C – MSB
7	ICL	Current for Phase C – LSB
8	ACTR	Freq (MSB)
9	ACTR	Freq (LSB)
10	CSUM	Checksum

Table XVII. Byte Wise Packet Data Structure While Reading Instantaneous Power and Energy

Command to ADSST-EM-2030: 0x11
Acknowledgment from ADSST-EM-2030: 0x41
Power Value (in kW) Resolution: Five Decimal Points
Energy Value (in kWh) Resolution: Four Decimal Points

1	2	3	4	5	6	7	8	9	10
SPB	PT1	PT2	PT3	PT4	ET1	ET2	ET3	ET4	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	PT1	Total Power First Byte – MSB
3	PT2	Total Power Second Byte
4	PT3	Total Power Third Byte
5	PT4	Total Power Fourth Byte – LSB
6	ET1	Total Energy First Byte – MSB
7	ET2	Total Energy Second Byte
8	ET3	Total Energy Third Byte
9	ET4	Total Energy Fourth Byte – LSB
10	CSUM	Checksum

Data Interpretation

The data sent by ADSST-EM-2030 is in Hex, and the microcontroller has to convert this and place the decimal point at the correct place for display.

Table XVIII. Interpretation of the Voltage Data
The data sent for Voltage has a resolution up to two decimal places.

Each Phase Voltage Data		
Hex Value (2 Byte)	**Decimal Value**	**Voltage**
5A10h	23056	230.56 V

Table XIX. Interpretation of the Current Data
The data sent for Current has a resolution up to three decimal places.

Each Phase Current Data		
Hex Value (2 Byte)	**Decimal Value**	**Current**
278Bh	10123	10.123 A

Table XX. Interpretation of the Power Data
The data sent for Power has a resolution up to five decimal places.

Each Phase Power Data		
Hex Value (4 Byte)	**Decimal Value**	**Power**
0D1C4Ah	859210	8.59210 kW

Table XXI. Interpretation of the Energy Data
The data sent for Energy has a resolution up to four decimal places.

Each Phase Energy Data		
Hex Value (4 Byte)	**Decimal Value**	**Energy**
0D1C4Ah	859210	85.9210 kWh

Data Write

Because microcontroller is the master for the SPI communication, it has to send the desired commands for sending the data to the ADSST-EM-2030. For the data transfer to take place, the following sequence of operation has to occur:

1. The microcontroller should send the packet of 10 bytes including the specific command to the ADSST-EM-2030 chipset to write the desired data. Thus, the packet of 10 bytes includes a header as the first byte of the packet, a specific command for write data, and checksum as the last byte.

2. The ADSST-EM-2030 will receive the bytes one by one in intervals of 5 ms.

3. The ADSST-EM-2030 strips the data from this packet, computes the checksum and compares it with the last byte in the packet. If the checksum does not match, the microcontroller should send the command to the ADSST-EM-2030 chipset again, else the ADSST-EM-2030 sends the acknowledgment of receipt of all the bytes to be written.

4. To send the acknowledgment, the ADSST-EM-2030 adds 0x30 to the received command, which is then sent back to the microcontroller.

5. If the microcontroller does not get this acknowledgment from the ADSST-EM-2030 by 5 ms, then the microcontroller may transmit this command to write the same data again.

The complete process of writing a packet of data should take 60 ms. The next command from the microcontroller to the ADSST-EM-2030 can be sent immediately after receipt of data or wait for the desired amount of time. The amount of time the microcontroller waits for the next command to be sent to ADSST-EM-2030 is purely dependent on the execution of other functions on the microcontroller. It may be sufficient for the microcontroller to collect data from the chipset after every one second. The remaining time may be used by the microcontroller to perform other housekeeping functions.

For example, if the command sent by the microcontroller is 0x01; the ADSST-EM-2030 adds 0x30 to it, making it 0x31, and sends this to the microcontroller as an acknowledgment.

The data packet structure created by the ADSST-EM-2030 has 10 bytes. The first byte is a packet start byte (0xEE), and the last byte is a checksum byte.

< START of Packet (0xEE) ><Command of 1 Byte>
< 7 Bytes of Data><CHECKSUM >

The checksum is calculated by adding the first nine bytes including the Packet start byte.

CHECKSUM = 1st + 2nd + ... + 9th Byte

ADSST-EM-2030

Table XXII shows various commands that can be sent to the ADSST-EM-2030 chipset by the microcontroller on the SPI communication port. The chipset writes the specific number of bytes for each data parameter specified in the data column of the table. The data that can be written to the chipset could be calibration constants.

Table XXII. Interpretation of the Energy Data

Data	Command to ADSST-EM-2030	Data Bytes
GAIN CALIBRATION		
Voltage Coefficient	0x81	6
Current Low Gain Coefficient	0x82	6
Current High Gain Coefficient	0x83	6
POWER CALIBRATION CONSTANTS AT HIGH CURRENT RANGE		
A-Phase Power Constant at High Current (with E-Pulse and Counter Pulse)	0x87	4
B-Phase Power Constant at High Current	0x89	2
C-Phase Power Constant at High Current	0x8B	2
POWER CALIBRATION CONSTANTS AT LOW CURRENT RANGE		
A-Phase Power Constant at Low Current	0x86	2
B-Phase Power Constant at Low Current	0x88	2
C-Phase Power Constant at Low Current	0x8A	2
PHASE COMPENSATION COEFFICIENTS		
A-, B-, C-Phase Coefficient	0x95	6

Data Structure in the Packet

The ADSST-EM-2030 sends out seven bytes of data for every command. The last bytes of a 6-byte structure are kept at zero and should be neglected.

Table XXIII. Byte Wise Packet Data Structure for Voltage Gain Constants

Command to ADSST-EM-2030: 0x81
Acknowledgment from ADSST-EM-2030: 0xB1

1	2	3	4	5	6	7	8	9	10
SPB	CWV	WAVM	WAVL	WBVM	WBVL	WCVM	WCVL	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWV	Command to Write Voltage Constant
3	WAVM	Voltage Constant for A-Phase – MSB
4	WAVL	Voltage Constant for A-Phase – LSB
5	WBVM	Voltage Constant for B-Phase – MSB
6	WBVL	Voltage Constant for B-Phase – LSB
7	WCVM	Voltage Constant for C-Phase – MSB
8	WCVL	Voltage Constant for C-Phase – LSB
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXIV. Byte Wise Packet Data Structure for Low Gain Current Constants

Command to ADSST-EM-2030: 0x82
Acknowledgment from ADSST-EM-2030: 0xB2

1	2	3	4	5	6	7	8	9	10
SPB	CWI	WAIM	WAIL	WBIM	WBIL	WCIM	WCIL	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWI	Command to Write Low Gain Current Constant
3	WAIM	Current Constant for A-Phase – Low Gain – MSB
4	WAIL	Current Constant for A-Phase – Low Gain – LSB
5	WBIM	Current Constant for B-Phase – Low Gain – MSB
6	WBIL	Current Constant for B-Phase – Low Gain – LSB
7	WCIM	Current Constant for C-Phase – Low Gain – MSB
8	WCIL	Current Constant for C-Phase – Low Gain – LSB
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXV. Byte Wise Packet Data Structure for High Gain Current Constants

Command to ADSST-EM-2030: 0x83
Acknowledgment from ADSST-EM-2030: 0xB3

1	2	3	4	5	6	7	8	9	10
SPB	CWHI	WAHIM	WAHIL	WBHIM	WBHIL	WCHIM	WCHIL	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWHI	Command to Write High Gain Current Constant
3	WAHIM	Current Constant for A-Phase – High Gain – MSB
4	WAHIL	Current Constant for A-Phase – High Gain – LSB
5	WBHIM	Current Constant for B-Phase – High Gain – MSB
6	WBHIL	Current Constant for A-Phase – High Gain – LSB
7	WCHIM	Current Constant for A-Phase – High Gain – MSB
8	WCHIL	Current Constant for A-Phase – High Gain – LSB
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXVI. Byte Wise Packet Data Structure for Power Constants at High Current for Phase A

Command to ADSST-EM-2030: 0x87
Acknowledgment from ADSST-EM-2030: 0xB7

1	2	3	4	5	6	7	8	9	10
SPB	CWAPH	WPAHN	WPAHL	EPC	CPC	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWAPH	Command to Write Power Constant for A-Phase at High Current
3	WPAHM	Power Constant for A-Phase, High Current – MSB
4	WPAHL	Power Constant for A-Phase, High Current – LSB
5	EPC	E-Pulse Constant in Pulses per kWh (1 = 1600, 2 = 800, 3 = 400, and 4 = 200), Default Value = 1
6	CPC	Counter Pulse Constant in Pulses per kWh (1 = 200 and 2 = 400), Default Value = 1
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Lalue (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXVII. Byte Wise Packet Data Structure for Power Constants at High Current for Phase B

Command to ADSST-EM-2030: 0x89
Acknowledgment from ADSST-EM-2030: 0xB9

1	2	3	4	5	6	7	8	9	10
SPB	CWBPH	WPBHM	WPBHL	EPC	CPC	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWBPH	Command to Write Power Constant for B-Phase at High Current
3	WPBHM	Power Constant for B-Phase, High Current – MSB
4	WPBHL	Power Constant for B-Phase, High Current – LSB
5	EPC	No Legal Value (0x00)
6	CPC	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXVIII. Byte Wise Packet Data Structure for Power Constants at High Current Phase C

Command to ADSST-EM-2030: 0x8B
Acknowledgment from ADSST-EM-2030: 0xBB

1	2	3	4	5	6	7	8	9	10
SPB	CWCPH	WPCHM	WPCHL	EPC	CPC	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWCPH	Command to Write Power Constant for C Phase at High Current
3	WPCHM	Power Constant for C-Phase, High Current – MSB
4	WPCHL	Power Constant for C-Phase, High Current – LSB
5	EPC	No Legal Value (0x00)
6	CPC	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXIX. Byte Wise Packet Data Structure for Power Constants at Low Current for Phase A

Command to ADSST-EM-2030: 0x86
Acknowledgment from ADSST-EM-2030: 0xB6

1	2	3	4	5	6	7	8	9	10
SPB	CWAPL	WPALM	WPALL	NLV	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWAPL	Command to Write Power Constant for A-Phase at Low Current
3	WPALM	Power Constant for A-Phase, Low Current – MSB
4	WPALL	Power Constant for A-Phase, Low Current – LSB
5	NLV	No Legal Value (0x00)
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXX. Byte Wise Packet Data Structure for Power Constants at Low Current for Phase B

Command to ADSST-EM-2030: 0x88
Acknowledgment from ADSST-EM-2030: 0xB8

1	2	3	4	5	6	7	8	9	10
SPB	CWBPL	WPBLM	WPBLL	NLV	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWBPL	Command to Write Power Constant for B-Phase at Low Current
3	WPBLM	Power Constant for B-Phase, Low Current – MSB
4	WPBLL	Power Constant for B-Phase, Low Current – LSB
5	NLV	No Legal Value (0x00)
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXXI. Byte Wise Packet Data Structure for Power Constants at Low Current for Phase C

Command to ADSST-EM-2030: 0x8A
Acknowledgment from ADSST-EM-2030: 0xBA

1	2	3	4	5	6	7	8	9	10
SPB	CWCPL	WPCLM	WPCLL	NLV	NLV	NLV	NLV	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWCPL	Command to Write Power Constant for C-Phase at Low Current
3	WPCLM	Power Constant for C-Phase, Low Current – MSB
4	WPCLL	Power Constant for C-Phase, Low Current – LSB
5	NLV	No Legal Value (0x00)
6	NLV	No Legal Value (0x00)
7	NLV	No Legal Value (0x00)
8	NLV	No Legal Value (0x00)
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

Table XXXII. Byte Wise Packet Data Structure for Phase Compensation Coefficients

Command to ADSST-EM-2030: 0x95
Acknowledgment from ADSST-EM-2030: 0xC5

1	2	3	4	5	6	7	8	9	10
SPB	CWPC	WPGA	WPSA	WPGB	WPSB	WPGC	WPSC	NLV	CSUM

Byte No.	Name	Description
1	SPB	Start Packet Byte (0xEE)
2	CWPC	Command to Write Phase Compensation Coefficients
3	WPGA	Phase Constant for Low Current – Phase A
4	WPSA	Phase Constant for High Current – Phase A
5	WPGB	Phase Constant for Low Current – Phase B
6	WPSB	Phase Constant for High Current – Phase B
7	WPGC	Phase Constant for Low Current – Phase C
8	WPSC	Phase Constant for High Current – Phase C
9	NLV	No Legal Value (0x00)
10	CSUM	Checksum

ADSST-EM-2030

Special Data

The microcontroller sends some special commands to ADSST-EM-2030 for the special functions like dc offset calculation, initializing the energies, and resetting the calibration constants. The packet sent by the microcontroller to the ADSST-EM-2030 contains only the command byte and no data bytes. On receiving the packet of command, the ADSST-EM-2030 sends back the acknowledgment to the microcontroller by adding 0x30 to the command value. If the microcontroller does not get this acknowledgment from the ADSST-EM-2030 by 5 ms, then the microcontroller may transmit this command to write the same data again.

Table XXXIII shows special commands that can be sent to the ADSST-EM-2030 chipset by the microcontroller on the SPI communication port. The chipset sends back the acknowledgment for each command to the microcontroller. The functions that are done by the chipset are dc offset calibration, initialization of energies, and resetting the calibration constants.

Table XXXIII. Special Commands to the ADSST-EM-2030 on SPI

Function	Command to ADSST-EM-2030	Acknowledgment to the Microcontroller	Comment
DC OFFSET			
Calculate DC Offset	0x0D	0x3D	Calculates DC Offset Constants
INITIALIZATION			
Energy Initialize	0x16	0x46	Initializes the Energy Values to Zero
RESET			
Reset Calibration	0x18	0x48	Reset the Calibration Constants to the Default Values

Reset Calibration

To calibrate the meter using the ADSST-EM-2030, first reset the calibration. By sending a command 0x18 on the SPI to the ADSST-EM-2030, the chipset automatically resets the calibration.

Procedure

1. Power up the meter with standard voltage without any current on the current channels.
2. Send 0x18 on the SPI.

DC Offset Calibration for Voltage and Current

The dc offset calibration takes care of the dc offset that may be there in the signal path introduced by any of the front-end elements. By sending 0x0D command on the SPI communication port to the ADSST-EM-2030, the chipset performs calculation of dc offsets on the voltage and current channels and stores the coefficients in its flash memory. While the calibration is in progress, communication on SPI will not be accepted by the chipset.

Procedure

1. Power up the meter with standard voltage of all phases without any current on the current channels.
2. Send 0x0D on the SPI to perform DC offset calibration.
3. Read back the coefficients on SPI by sending 0x0E to the chipset.

Voltage Gain Calibration

The ADSST-EM-2030 enables software calibration of the voltage channels to take care of tolerances for the passive components used in the signal path.

Procedure

1. Power up the meter by setting the voltage source at 230 V on all the three phases (say V_R).

2. Send 0x01 command on the SPI to the chipset for reading the voltage constants as C_{VA}, C_{VB}, and C_{VC}.
3. The ADSST-EM-2030 will return back six bytes of voltage values for the three phases (V_A, V_B, and V_C).
4. Compute the new constants on a PC or a calculator in Hex as:

$$C'_{VA} = \frac{V_R}{V_A} \times C_{VA}$$

$$C'_{VB} = \frac{V_R}{V_B} \times C_{VB}$$

$$C'_{VC} = \frac{V_R}{V_C} \times C_{VC}$$

5. These coefficients can then be written by sending the 0x81 command to the chipset on the SPI. Refer to Table XXIII for the Write Data sequence. The coefficients are sent in the same sequence as in the Table XXIII. This automatically stores the voltage constants in the chipset's internal nonvolatile memory.
6. To verify the coefficients, send 0x01 to the chipset to receive the six bytes of data as voltage coefficients.
7. The default constants in the chipset for all the voltage channels is 0x709C.

Current Calibration

The ADSST-EM-2030 enables software calibration of the current channels to take care of tolerances for the passive components used in the signal path.

Low Gain Current Calibration

1. Power up the meter by setting the current source at 60 amps on all three phases (I_R).
2. Send 0x02 command on the SPI to the chipset for reading the current constants as: C_{IA}, C_{IB}, and C_{IC}.

3. The ADSST-EM-2030 will return back six bytes of current values for the three phases: I_A, I_B, and I_C.

4. Compute the new constants on a PC or a calculator in Hex as:

$$C'_{IA} = \frac{I_R}{I_A} \times C_{IA}$$

$$C'_{IB} = \frac{I_R}{I_B} \times C_{IB}$$

$$C'_{IC} = \frac{I_R}{I_C} \times C_{IC}$$

5. These coefficients can then be written by sending the 0x82 command to the chipset on the SPI. Refer to Table XXIV for the Write Data sequence. The coefficients are sent in the same sequence as in the Table XXIV. This automatically stores the current constants in the chipsets' internal nonvolatile memory.

6. To verify the coefficients, send 0x02 to the chipset to receive the six bytes of data as current coefficients.

7. The default constants in the chipset for all the low gain current channels is 0x7000.

High Gain Current Calibration

1. Power up the meter by setting the current source at 5 amps on all three phases (i_R).

2. Send 0x03 command on the SPI to the chipset for reading the current constants as: C_{iA}, C_{iB}, and C_{iC}.

3. The ADSST-EM-2030 will return back six bytes of current values for the three phases (i_A, i_B, i_C).

4. Compute the new constants on a PC or a calculator in Hex as:

$$C'_{iA} = \frac{i_R}{i_A} \times C_{iA}$$

$$C'_{iB} = \frac{i_R}{i_B} \times C_{iB}$$

$$C'_{iC} = \frac{i_R}{i_C} \times C_{iC}$$

5. These coefficients can then be written by sending the 0x83 command to the chipset on the SPI. Refer to Table XXV for the Write Data sequence. The coefficients are sent in the same sequence as in Table XXV. This automatically stores the current constants in the chipset's internal nonvolatile memory.

6. To verify the coefficients, send 0x03 to the chipset to receive the six bytes of data as current coefficients.

7. The default constants in the chipset for all the high gain current channels is 0x2300.

Power Calibration

The meter can now be calibrated for power for each phase. The calculation requires the default constants that are stored in the internal nonvolatile memory. Due to the chipset's in-built feature of performing automatic gain switching for the current channels, the power needs to be calibrated at low gain (i.e., high currents) and high gain (i.e., low currents). It is recommended that low gain calibration is performed at I_{MAX} and high gain calibration is performed at $I_{NOMINAL}/2$. In the present example, the meter is specified for 230 V operation with I_{MAX} at 60 amps.

Low Gain Power Calibration

The default power constant for all three phases at low gain is 0x3EE4. By sending commands such as 0x07, 0x09, and 0x0B on the SPI, the chipset will send six bytes each, corresponding to Phases A, B, and C.

Procedure

1. Power up the meter after setting the voltage at 230 V, current at 60 amps and power factor at unity.

2. Read the default power constants for Phase A by sending 0x07 command on the SPI. The chipset will return six bytes, giving the default constants P_{CA} for power constants for Phase A.

3. Read the default constants for Phase B by sending 0x09 command on the SPI. The chipset will return six bytes, giving the default constants P_{CB} for power constants for Phase B.

4. Read the default power constants for Phase C by sending 0x0B command on the SPI. The chipset will return six bytes, giving the default constants P_{CC} for power constants for Phase C.

5. Read the value of power as shown by the reference meter for the three phases, say P_A, P_B, and P_C.

6. If the voltage and current on the source have been set at 230 V and high current (60 amps), then the reference meter should display for each phase a value of P_{REF}. Using this, calculate new constants as:

$$P'_{CA} = P_{CA} \times \frac{P_{REF}}{P_A}$$

$$P'_{CB} = P_{CB} \times \frac{P_{REF}}{P_B}$$

$$P'_{CC} = P_{CC} \times \frac{P_{REF}}{P_C}$$

7. Send command 0x87 followed by P'_{CA} value on the SPI. The chipset will accept the values and store these as power constants for Phase A. Send command 0x89 followed by P'_{CB} value and then command 0xB9 followed by P'_{CC} value. The chipset will store these power constants for Phase B and Phase C respectively.

High Gain Power Calibration

The default power constants for all three phases at high gain is 0xAA0. By sending commands such as 0x06, 0x08 and 0x0A on SPI, the chipset will send six bytes each, corresponding to Phase A, B, and C.

Procedure

1. Power up the meter after setting the voltage at 230 V, current at 5 amps and power factor at unity.

2. Read the default power constants for Phase A by sending 0x06 command on the SPI. The chipset will return six bytes, giving the default constants P_{CA} for Power constants for Phase A.

3. Read the default constants for Phase B by sending 0x08 command on the SPI. The chipset will return six bytes, giving the default constants P_{CB} for Power constants for Phase B.

4. Read the default power constants for Phase C by sending 0x0A command on the SPI. The chipset will return six bytes, giving the default constants P_{CC} for Power constants for Phase C.

5. Read the value of power as shown by the reference meter for the three phases, say P_A, P_B, and P_C.

6. If the voltage and current on the source have been set at 230 V and low current (5 amps), then the reference meter should display for each phase a value, say P_{REF}. Calculate new constants as:

$$P'_{CA} = P_{CA} \times \frac{P_{REF}}{P_A}$$

$$P'_{CB} = P_{CB} \times \frac{P_{REF}}{P_B}$$

$$P'_{CC} = P_{CC} \times \frac{P_{REF}}{P_C}$$

7. Send command 0x86 followed by P'_{CA} value on the SPI. Send command 0x88 followed by P'_{CB} value and then command 0x8A followed by P'_{CC} to save the power constants for high gain.

Phase Compensation

The ADSST-EM-2030 uses a phase compensation technique to take care of the nonlinearities in current transformers. These are two constants, Start value (S) and Guard value (G). The start value corresponds to the phase shift that is exhibited at high current, and the guard value corresponds to the phase shift at lower currents. The default value for S is 0x08 and for G is 0x20. These constants can be read by sending command 0x15 to the chipset on the SPI. The six bytes of data from the chipset will correspond to G_A, S_A, G_B, S_B, G_C, and S_C, in the same sequence as shown in the Table XIII.

Set the current source at I_{MAX}, voltage source at $V_{NOMINAL}$, and the Phase Lag for the current (cosΔ) at 0.5. Energize the meter using the ADSST-EM-2030 chipset (MUT) and measure the error from the reference meter. Round off the error from the reference meter to the first decimal place and multiply by 10. The value thus attained may be added to start value read from the ADSST-EM-2030 chipset. So if the error is negative, then the start value will get subtracted, and if it is positive, then the start value will get added. For example:

1. Let the measured start value for Phase A be S_A

2. Percentage Error noted in the S Value be 0.22%

3. Error rounded off to the first decimal place = 0.2

4. Correction Value: $E_P = 0.2 \times 10 = 2$

Hence the correction start value will be: $S'_A = S_A + E_P$

Or set the current source at $I_{NOMINAL}/2$, voltage source at $V_{NOMINAL}$, and the Phase Lag for the current (cosΔ) at 0.5. Energize the meter using the ADSST-EM-2030 chipset (MUT) and measure the error from the reference meter. Round off the error from the reference meter to the first decimal place and multiply by 10. The value thus attained may be added to guard value read from the ADSST-EM-2030 chipset. So if the error is negative, then the guard value will get subtracted and if it is positive, then the guard value will get added. For example:

1. Let the measured start value for Phase A be G_A

2. Percentage Error noted in the G Value be –0.27%

3. Error rounded off to the first decimal place = –0.3

4. Correction Value: $E_P = –0.3 \times 10 = –3$

Hence the correction start value will be: $G'_A = G_A + E_P$

Procedure

1. Power up the meter after setting the source at 230 V and 60 amps, and power factor at 0.5.

2. Read the error shown by the reference meter. Round off the error value to the first decimal place and multiply by 10. If the error is negative, then decrease the S value (S_A, S_B, and S_C for Phase A, B, and C respectively). If the error is positive, then increase the S value.

3. Set the power source at 230 V and 5 amp. Read the error shown by the reference meter. Round off the error value to the first decimal place and multiply by 10. If the error is negative then decrease the G value (G_A, G_B, and G_C for phase A, B, and C respectively). If the error is positive, then increase the G value.

4. Send command 0x95 to the ADSST-EM-2030 chipset followed by the new sequence G'_A, S'_A, G'_B, S'_B, G'_C, and S'_C.

OUTLINE DIMENSIONS

28-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-28)
Dimensions shown in millimeters
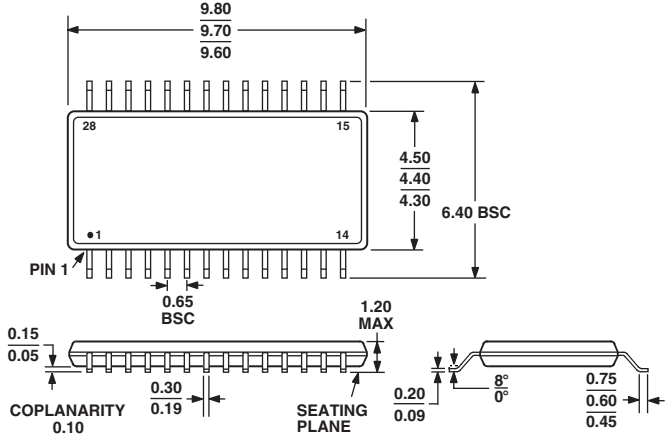
COMPLIANT TO JEDEC STANDARDS MO-153AE