www.multimeterwarehouse.com
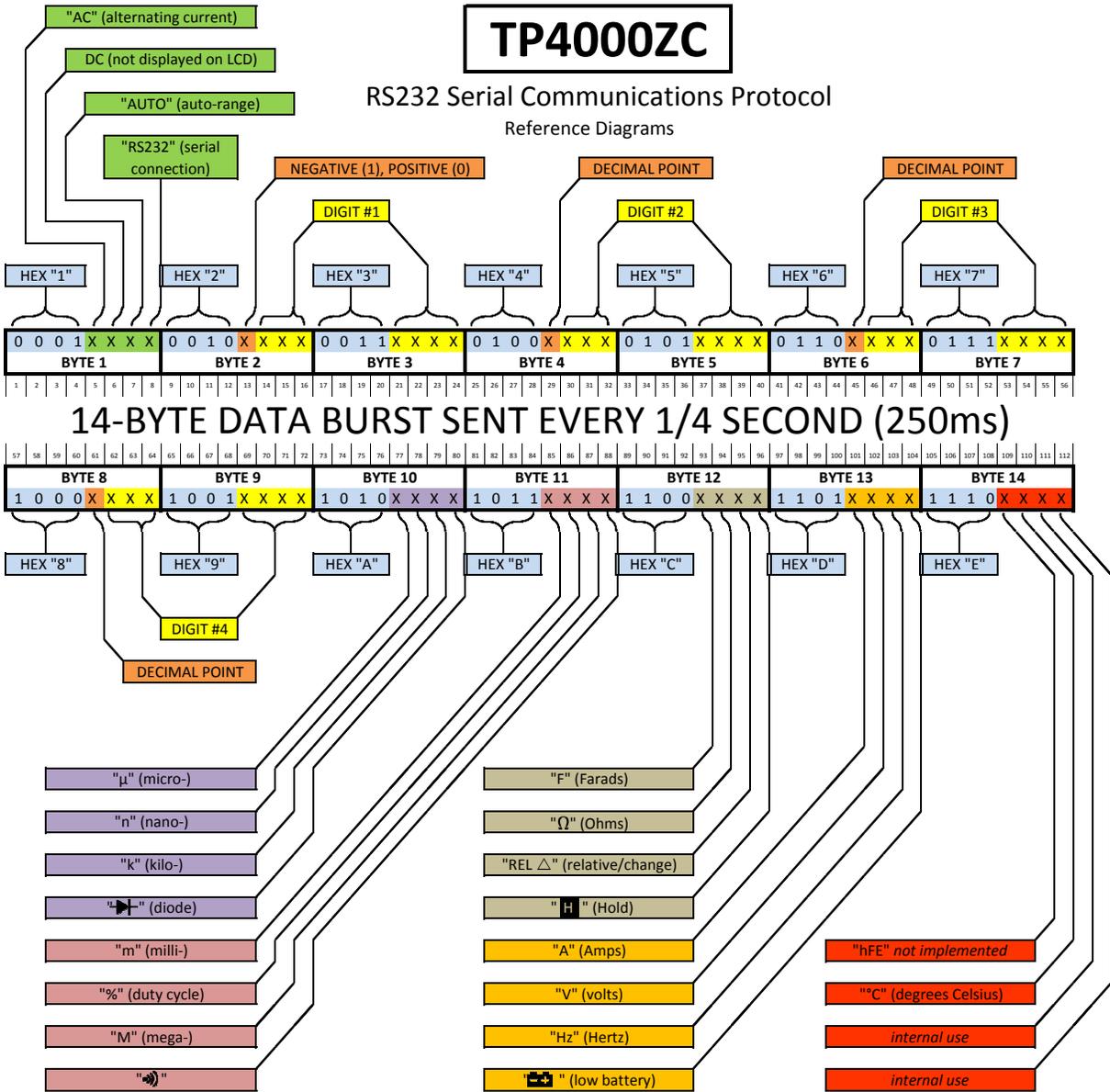
KAITO ELECTRONICS INC.

TEKPOWER

TP4000ZC

RS232 Serial Communications Protocol
Reference Diagrams

"AC" (alternating current)

DC (not displayed on LCD)

"AUTO" (auto-range)

"RS232" (serial connection)

NEGATIVE (1), POSITIVE (0)

DECIMAL POINT

DECIMAL POINT

DIGIT #1

DIGIT #2

DIGIT #3

HEX "1"	HEX "2"	HEX "3"	HEX "4"	HEX "5"	HEX "6"	HEX "7"

0 0 0 1 X X X X	0 0 1 0 X X X X	0 0 1 1 X X X X	0 1 0 0 X X X X	0 1 0 1 X X X X	0 1 1 0 X X X X	0 1 1 1 X X X X
BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56

14-BYTE DATA BURST SENT EVERY 1/4 SECOND (250ms)

57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112

BYTE 8	BYTE 9	BYTE 10	BYTE 11	BYTE 12	BYTE 13	BYTE 14
1 0 0 0 X X X X	1 0 0 1 X X X X	1 0 1 0 X X X X	1 0 1 1 X X X X	1 1 0 0 X X X X	1 1 0 1 X X X X	1 1 1 0 X X X X

HEX "8"	HEX "9"	HEX "A"	HEX "B"	HEX "C"	HEX "D"	HEX "E"

DIGIT #4

DECIMAL POINT

"μ" (micro-)

"n" (nano-)

"k" (kilo-)

"▸⊦" (diode)

"m" (milli-)

"%" (duty cycle)

"M" (mega-)

"🔊"

"F" (Farads)

"Ω" (Ohms)

"REL △" (relative/change)

" H " (Hold)

"A" (Amps)

"V" (volts)

"Hz" (Hertz)

" 🔋 " (low battery)

"hFE" *not implemented*

"°C" (degrees Celsius)

internal use

internal use

7-BIT CODE FOR EACH DISPLAYED DIGIT

BIT POSITIONS

BIT VALUES

INDICATED DIGIT

| A	B	C	D	E	F	G	
X	X	X	X	X	X	X	
0	0	0	0	1	0	1	1
1	0	1	1	0	1	1	2
0	0	1	1	1	1	1	3
0	1	0	0	1	1	1	4
0	1	1	1	1	1	0	5
1	1	1	1	1	1	0	6
0	0	1	0	1	0	1	7
1	1	1	1	1	1	1	8
0	1	1	1	1	1	1	9
1	1	1	1	1	0	1	0
1	1	0	1	0	0	0	L
0	0	0	0	0	0	0	BLANK

(1=ON, 0=OFF)

Note:
The first (upper) half of each byte is a static, non-variable value. They can be used for synchronization.
A valid 14-Byte data burst in hexadecimal would look like:
1X2X3X4X5X6X7X8X9XAXBXCXDXEX
with each "X" representing 4 bits of data describing the current state of part of the LCD (1-ON, 0-OFF).

Serial port settings:
Baud Rate: **2400**
Data Bits: **8**
Parity: **None**
Stop bits: **1**
Flow control: **n/a**
Communication is one-way, from the meter to the PC.
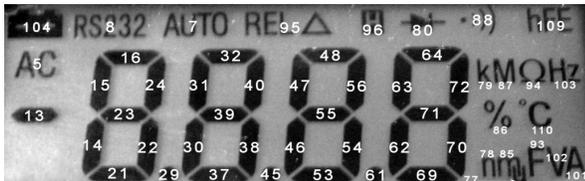
Understanding the TP4000ZC's serial output

The TP4000ZC sends updates to the PC at 4Hz-- that is, 4 times per second or once every 250 milliseconds. At each interval, the meter sends 14 bytes of data. The 14 bytes contain information about what is currently being displayed on the meter's LCD. For example, if the switch is set on "V" (voltage), and the meter is currently reading 13.5 V, then the LCD contains "13.5 V" and the meter outputs data to the PC reflecting that.

The 14 bytes comprise 14 synchronization nibbles (half-bytes) and 14 data nibbles. The first half of each byte (the most significant nibble) is the synchronization nibble. This part of the data never changes. The first half of BYTE 1 is always 0001 (hexadecimal "1"), the first half of BYTE 2 is always 0010 (hexadecimal "2"), and so on. The first half of BYTE 14 is always 1110 (hexadecimal "E"). When writing code to interpret the data stream, you can use these synchronization nibbles to determine where one data burst ends and the next one begins. That way, you can be sure to always begin interpreting a burst at BYTE 1.

In the diagrams above, we've numbered the bits in the stream, 1 through 112. For the purposes of this document, numbering the bits this way makes it easier to refer to individual bit positions within the data burst.

Interpreting the 14-Byte burst

If you set aside the synchronization nibbles (the most significant, first 4 bits of each byte), you are left with the data nibbles. Each binary digit within each data nibble corresponds to one cell of the LCD on the meter. That is, each bit indicates whether its corresponding cell on the LCD is active or not. A value of 1 indicates that the cell is active ("lit"), and a value of 0 indicates that the cell is not active ("blank").

The LCD is divided into 53 cells. One example of a cell is "V" for voltage. When the meter is in the Voltage mode, the "V" for voltage is displayed on the LCD next to the numeric value for the voltage reading. In turn, a "1" is transmitted in the appropriate position of the data burst (to the PC) to indicate that the "V" cell is active.

An LCD cell can consist of one letter ("V"), a symbol ("μ"), a word ("AUTO"), or a part of one of the displayed digits. The digits on the display are each divided into 7 line segments. A "1" is made up of two line segments, while an "8" is made up of all seven. Each of these segments is a separate cell on the LCD, and has a "1" or a "0" transmitted to the PC indicating whether it is active or not active. In order to determine the digit being displayed, these bits must be interpreted on the PC end.

Using the diagram above, "7-BIT CODE FOR EACH DISPLAYED DIGIT," you can derive the digit being displayed from a given 7-bit sequence corresponding to the digit's seven line segments on the LCD of the meter. The first three and last four bits come from two separate bytes in the data burst. When you concatenate the extracted bits, you'll end up with a string of 7 bits.   If they are 0111111, then the digit being displayed in that position is a "9".

The programmer should reassemble all four digits of the display, insert a negative sign if present, and insert a decimal point if it is present to arrive at the total value being displayed on the meter. The appropriate "units" designator can then be appended based on which "units" cell(s) are active on the LCD. For example, if the LCD shows "-123.0 mV", the bit position for "-" will have a value of "1", the 7-bit string for the left-most digit will have a value of "0000101", the 7-bit string for the next digit will be "1011011", the third digit will be "0011111", the bit position for the decimal point between the third and fourth digits will have a value of "1", the 7-bit string for the fourth digit will be "1111101", the bit position for "m" will have a value of "1", and the bit position for "V" will have a value of 1.

Special Notes

The "AC" indicator, represented by bit 5 in the data burst, indicates that the meter is set for alternating current. There is no "DC" cell on the LCD display. When the meter is in "DC" mode, bit 6 will indicate a "1", but the letters "DC" do not actually appear on the meter's LCD.

The "hFE" indicator (bit 109) refers to a function that is not implemented on the TP4000ZC. Thus, the LCD will never show "hFE", and bit 109 will always be "0".

Bits 111 and 112 should be ignored, as they are used by the internal circuitry of the meter in controlling the LCD itself.