ECM-1220 and ECM-1240 Real-Time Packet Format

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BINARY DATA FORMAT

BYTE	ECM-1220 or ECM-1240	ECM-1240	
1	Header Byte 0xFE	Header Byte 0xFE	Unique Header Bytes
2	Header Byte 0xFF	Header Byte 0xFF	
3	Header Byte 0x01	Header Byte 0x03	
4	Volt Hi Byte	Volt Hi Byte	The value of "Volt" must be divided by ten. This provides one decimal place resolution.
5	Volt Low Byte	Volt Low Byte	
6	CH1 W-S Byte1 (LSB)	CH1 W-S Byte1 (LSB)	CH1 Absolute Watt-Second counter. This 5-byte counter increments with energy flowing in either direction (consuming or producing). *1kW = 1,000 Watts and 1 Hour = 3600 Seconds* *1KWh = 3,600,000 Watt Seconds*
7	CH1 W-S Byte2	CH1 W-S Byte2	
8	CH1 W-S Byte3	CH1 W-S Byte3	
9	CH1 W-S Byte4	CH1 W-S Byte4	
10	CH1 W-S Byte5(MSB)	CH1 W-S Byte5(MSB)	
11	CH2 W-S Byte1 (LSB)	CH2 W-S Byte1 (LSB)	CH2 Absolute Watt-Second counter. This 5-byte counter increments with energy flowing in either direction (consuming or producing).
12	CH2 W-S Byte2	CH2 W-S Byte2	
13	CH2 W-S Byte3	CH2 W-S Byte3	
14	CH2 W-S Byte4	CH2 W-S Byte4	
15	CH2 W-S Byte5(MSB)	CH2 W-S Byte5(MSB)	
16	CH1 W-S Byte1 (LSB)	CH1 W-S Byte1 (LSB)	CH1 Polarized Watt-Second counter. This 5-byte counter increments with energy flowing in one direction only. The direction may be selected using software commands. *1kW = 1,000 Watts and 1 Hour = 3600 Seconds* *1KWh = 3,600,000 Watt Seconds*
17	CH1 W-S Byte2	CH1 W-S Byte2	
18	CH1 W-S Byte3	CH1 W-S Byte3	
19	CH1 W-S Byte4	CH1 W-S Byte4	
20	CH1 W-S Byte5(MSB)	CH1 W-S Byte5(MSB)	
21	CH2 W-S Byte1 (LSB)	CH2 W-S Byte1 (LSB)	CH2 Polarized Watt-Second counter. This 5-byte counter increments with energy flowing in one direction only. The direction may be selected using software commands.
22	CH2 W-S Byte2	CH2 W-S Byte2	
23	CH2 W-S Byte3	CH2 W-S Byte3	
24	CH2 W-S Byte4	CH2 W-S Byte4	
25	CH2 W-S Byte5(MSB)	CH2 W-S Byte5(MSB)	
26	Reserved	Reserved	
27	Reserved	Reserved	
28	Reserved	Reserved	
29	Reserved	Reserved	
30	Device Address Byte Hi	SN Byte Hi	Pre-programmed Serial Number
31	Device Addr Byte Low	SN Low	
32	Flag Byte	Flag Byte	Contains Unit information
33	Unit ID	Unit ID	Pre-programmed ID byte
34	CH1 Current Byte Lo	CH1 Current Byte Lo	Two byte value represents 1/100th of an Ampere
35	CH1 Current Byte Hi	CH1 Current Byte Hi	
36	CH2 Current Byte Lo	CH2 Current Byte Lo	Two byte value represents 1/100th of an Ampere
37	CH2 Current Byte Hi	CH2 Current Byte Hi	
38	Seconds Counter (LSB)	Seconds Counter (LSB)	Three byte continuous counter incrementing every second.
39	Seconds Counter	Seconds Counter	
40	Seconds Counter (MSB)	Seconds Counter (MSB)	
41	0xFF	Aux 1 Watt-Sec LSB	Four byte Watt-Second counter for Aux channels 1 to 4. Watt = delta_counter / delta_seconds
42	0xFE	Aux 1 Watt-Sec	
43	Single byte Checksum of bytes 1 to 42.	Aux 1 Watt-Sec	
44		Aux 1 Watt-Sec MSB	
45		Aux 2 Watt-Sec LSB	
46		Aux 2 Watt-Sec	
47		Aux 2 Watt-Sec	
48		Aux 2 Watt-Sec MSB	
49		Aux 3 Watt-Sec LSB	
50		Aux 3 Watt-Sec	
51		Aux 3 Watt-Sec	
52		Aux 3 Watt-Sec MSB	
53		Aux 4 Watt-Sec LSB	
54		Aux 4 Watt-Sec	
55		Aux 4 Watt-Sec	
56		Aux 4 Watt-Sec MSB	
57		Aux 5 Watt-Sec LSB	Aux5 channel may be Watt-Second counter or pulse counter depending on input source Watt = delta_counter / delta_seconds
58		Aux 5 Watt-Sec	
59		Aux 5 Watt-Sec	
60		Aux 5 Watt-Sec MSB	
61		DC input Byte Lo	Two byte value representing DC voltage connected to Aux 5 input
62		DC Input Byte Hi	
63		0xFF	
64		0xFE	
65		Checksum of bytes 1 to 64	

Basics:

The technique developed by the Brultech for efficient transfer of energy data is based on using a **"Watt-second counter"** to provide a granular value representing "kilowatt-hour" kWh. This along with a **"seconds counter"** value provides up to date energy information each time a packet is sent. Energy (kWh) and power (Watt) information is easily calculated using the two parameter described above.

This method provides an accurate value of energy used, even if packets are lost or the receiving system is down for a period of time.

Real-time Data Start Command

ECM-1220 or ECM-1240	0xFC	"TOG"	"PLR"
ECM-1240 only	0xFC	"TOG"	"XTD"

START-STOP COMMANDS:

Communication with the ECM-1220 is based on the RS-232 format set for: 19,200 baud, 8 bits, No parity, 1 stop bit: 19200 8N1.

Communications with the ECM-1220 is initiated by sending a single FC (hex) byte. The energy monitor then responds with an FC byte (acknowledge) then will pause and listen to the port for the next command. If no command is received, the monitor will timeout and resume normal operation. It will also exit command mode if an improper command has been received.

After a command has been sent, the ECM-1220 will respond with an acknowledge byte, FC (hex).

The procedure for starting the "polarized real-time" format is:

PC sends FC(hex)

ECM-1220 responds with FC(hex)

PC send three ASCII bytes "T" "O" "G" (must be upper case characters)

ECM-1220 responds with FC(hex)

PC send three ASCII bytes "X" "T" "D" (must be upper case characters)

ECM-1220 begins sending packets every second

Real-time data transmission is halted by sending an OFF command. This consists of performing the same procedure above sending "O" "F" "F" instead of "X" "T" "D"

POLARIZED REAL-TIME DATA:

This is the latest packet format which provides additional data. The packet consists of the following:

1. Packet Header (3 bytes)
2. Voltage Data (2 bytes)
3. CH1 Absolute Watt-Second Counter (5 bytes)
4. CH2 Absolute Watt-Second Counter (5 bytes)
5. CH1 Polarized Watt-Second Counter (5 bytes)
6. CH2 Polarized Watt-Second Counter (5 bytes)
7. Reserved (4 bytes)
8. Device Serial Number (2 bytes)
9. Reset and Polarity Information (1 byte)
10. Device Information (1 byte)
11. CH1 Current (2 bytes)
12. CH1 Current (2 bytes)
13. Seconds Counter (3 bytes)
14. End Of Packet Identifier (2 bytes)
15. Checksum (1 byte)

This information forms a 43 byte packet.

Each packet byte is a value of 0 to 255 represented by the ASCII value of the byte received. For example the letter "M" would represent a byte value of decimal 77. A two byte value represented by "M:N" would be:

M = ASCII value of 77
N = ASCII value of 78

Hi byte =	77 x 256	= 19712
Low byte =	78	= 78
Two byte value =	19712 + 78	= 19790

PACKET DATA:

Packet Header (ECM-1240):

The packet header consists of three unique bytes. This indicates the beginning of a packet. These bytes are FE, FF, 03 (hex).

CH1 and CH2 Absolute Watt-Second:

Watt-Second is a granular representation of kilowatt-hour. This is a continuously incrementing counter representing the watt-second value of energy. There is a separate counter for each channel which will increment regardless of whether the power is generated or consumed. This counter will always be used regardless of whether the application is for consumption only (typical) or generation such as power returned to the grid via inverter from wind or solar renewable energy source.

This counter begins at "zero" when the ECM-1220 is reset. It will continue to count up with energy consumption and will be zeroed should the ECM-1220 be reset. If the energy monitor is never reset, this 5 byte counter will increment to a value equivalent to 305,419.896 KWh (years for a typical home). At this time the counter will roll-over to zero and start again.

There is another byte in the packet which will indicate if the ECM-1220 data has been reset. This prevents software data from being fooled should the ECM-1220 be manually reset.

The method of using this counter is described later in this document.

CH1 and CH2 Polarized Watt-Second:

These two counters (one for CH1 one for CH2) are the same size as the absolute counters just described. The only difference is that the count will increment only if the energy is flowing in one direction. It therefore may be used to record generated only or consumed only energy.

The polarized counter is only required for applications such as solar or wind renewable energy systems connected to an inverter, producing power which is put back on the electrical power grid.

The energy direction which will cause this counter to increment may be set using one of the following methods:

- Send a "polarity" command to the ECM-1220 to change direction. The ECM-1220 then saves this information to its non-volatile memory. There is a separate command for CH1 & CH2.
- Remove the CT for the channel in question and re-install so that the arrow on the CT points in the opposite direction.
- Unplug the wall transformer, rotate it 180 degrees and plug back in so the prong connection is now reverse. This will affect both channels, therefore if only one channel polarity is improper this is not the method to use.

If you do use these counters, care must be taken so that the wall transformer's prong polarity in the 120V outlet is always the same. Unplugging the wall transformer and accidentally re-plugging it in the wrong direction will reverse the polarized counter function.

Reserved:

Four bytes reserved. Bytes 26 to 20

Device Serial Number:

These two bytes form the lower five characters of the device serial number.

Byte 30 = SN low byte
Byte 31 = SN high byte

Ex: byte 30 = 23h and byte 31 = 01h
Combined byte value = 0123h or 291 decimal
The lower five characters of the serial number = 00291

To complete the full device serial number, the Device ID is required …..

Device ID:

Byte #33 now forms the sixth digit character of the device serial number. For example if the Device ID byte was 04h and using the "device serial number" from the example above, the concatenated device serial number would be 4|00291 or simply 400291.

The concatenated number is used to determine the origin of the packet when reading data from multiple ECM-1240 devices.

Reset and Polarity Information Byte (byte # 32):

This single byte is broken down into sections.

Bits 0, 1 & 2:
These bits form a 3-bit counter. This counter is incremented whenever the ECM-1220 is reset either manually or using a software command. Resetting the ECM-1220 causes all KWh, elapsed time, and data-logger memory to be zeroed. When this occurs, the 3-bit counter described here will increment by one. The counter counts from 0 to 7 then rolls over back to zero. The purpose of this counter is explained later in this document.

Bit 3:
This bit is a "1" if the CH1 energy is positive and "0" if negative. This polarity is an indication of which direction the energy is flowing. This bit was previously used before the polarized watt-second counter was available to determine if the energy was being generated or consumed.

Bit 4:
This bit is the CH2 polarity bit as described for bit 3.

Bit 5 & 6:
Not used

Bit 7:
This bit is always a "1".

CH1 and CH2 Current:

The current is represented by a two byte value for each channel representing 1/100th of an ampere. Once assembled this value must be multiplied by 0.01 to provide the value for current.

Seconds Counter:

This three-byte counter increments every second and is synchronized with the ECM-1220. This is a continuous counter which rolls over after 16777216 seconds. The software needs to be aware that the counter rolls over past this value and make provisions for proper adjustment when this occurs.

This is one of the add-ons to this newest packet version.

The power is calculated by Δ Watt-Seconds ÷ Δ Seconds

The source for delta seconds was previously based on the computer clock for older packet versions and could cause an error due to the fact that the ECM clock and PC clock are not synchronized. This new format resolves this issue.

End of Packet Marker:

These are two distinct bytes to mark the end of the packet.

Checksum:

This is the 43rd byte which is the sum of the 42 previous bytes. This is represented by a single byte only which is the LSB of the sum. For example, if the value for the sum of all byte came to 513 (dec), the checksum value would be:

513 – 256 – 256 = 1

ECM-1220 PACKET STRUCTURE:

Packet length is 43 bytes:

Byte number	
1 to 3	Three distinct header bytes FE, FF, 01
4 to 5	Volt, two bytes Byte 4 = MSB Byte 5 = LSB
6 to 10	CH1 Watt-Second Absolute Counter. Byte 6 = LSB, Byte 10 = MSB
11 to 15	CH2 Watt-Second Absolute Counter. Byte 11 = LSB, Byte 15 = MSB
16 to 20	CH1 Watt-Second Polarized Counter. Byte 16 = LSB, Byte 20 = MSB
21 to 25	CH2 Watt-Second Polarized Counter. Byte 21 = LSB, Byte 25 = MSB
26 to 29	Reserved
30 to 31	Device Serial Number (two bytes)
32	Reset and Polarity Information
33	Device Information
34 to 35	CH1 Current in 100^{th} of a Amp LSB = 34 MSB = 35
36 to 37	CH2 Current in 100^{th} of a Amp LSB = 36 MSB = 37
38 to 40	Seconds Counter LSB = 38 MSB = 40 One second resolution
41 to 42	End of Packet Marker 41 = FF (hex) 42 = FE (hex)
43	Checksum

ECM-1240 PACKET STRUCTURE:

See packet chart "BINARY PACKET FORMAT" table near the beginning of this document.

ACQUIRING DATA VALUES:

Power:

You may have noticed that the power (watt or kilowatt) is not included in the packet. This value is easily and accurately calculated from the received data.

The energy information sent is in the form of watt-second. This is the amount of power used during one second. The power may then be calculated by:

Watt-Second from last packet *minus* Watt-Second from the previous packet

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Elapsed seconds between both packets (this value is included in this packet format)

OR SIMPLY: **Power (watts) = Δ Watt-Seconds ÷ Δ Seconds**

Kilowatt-Hour (KWh):

This is the most important data measured by the ECM-1220. In order to provide a fine resolution of KWh, the packet provides Watt-Second information:

Since there are 3600 seconds in one hour, one watt-hour = Watt-Second ÷ 3600

Since 1000 Watt = 1 Kilowatt then 1 Kilowatt-Hour = (Watt-Seconds ÷ 3600) ÷ 1000

OR SIMPLY: **Kilowatt-Hour (KWh) = Watt-Second / 3600000**

Cost of Energy ($):

The cost of energy consumed is a matter of multiplying the KWh time the rate charged by the power company. Many of the power companies now have a varying rate based on many factors which is beyond the scope of this document. This is best obtained from the power company's web site.

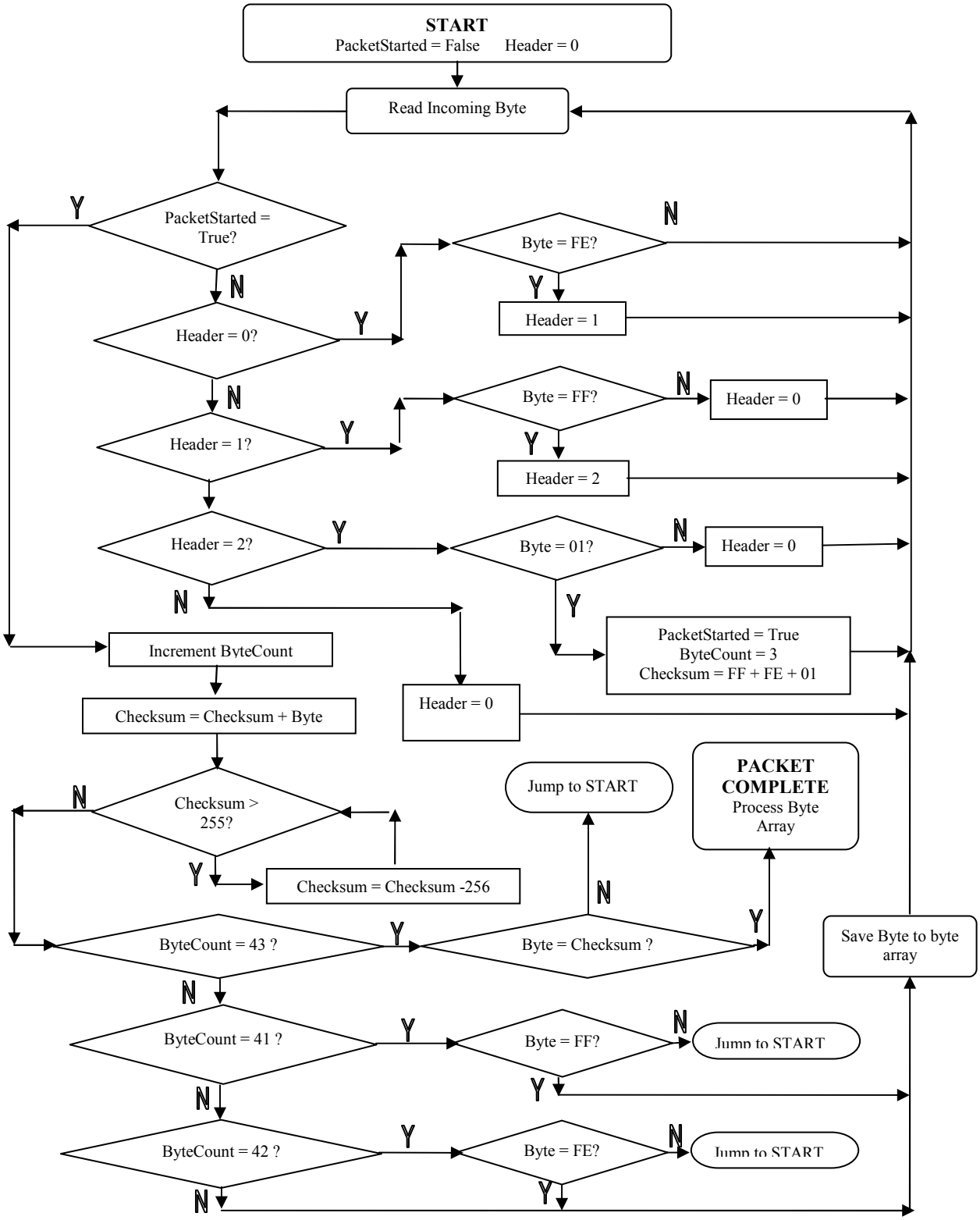
Cost ($) = KWh x Rate Charged ($ per kilowatt-hour)

CO2 Emissions:

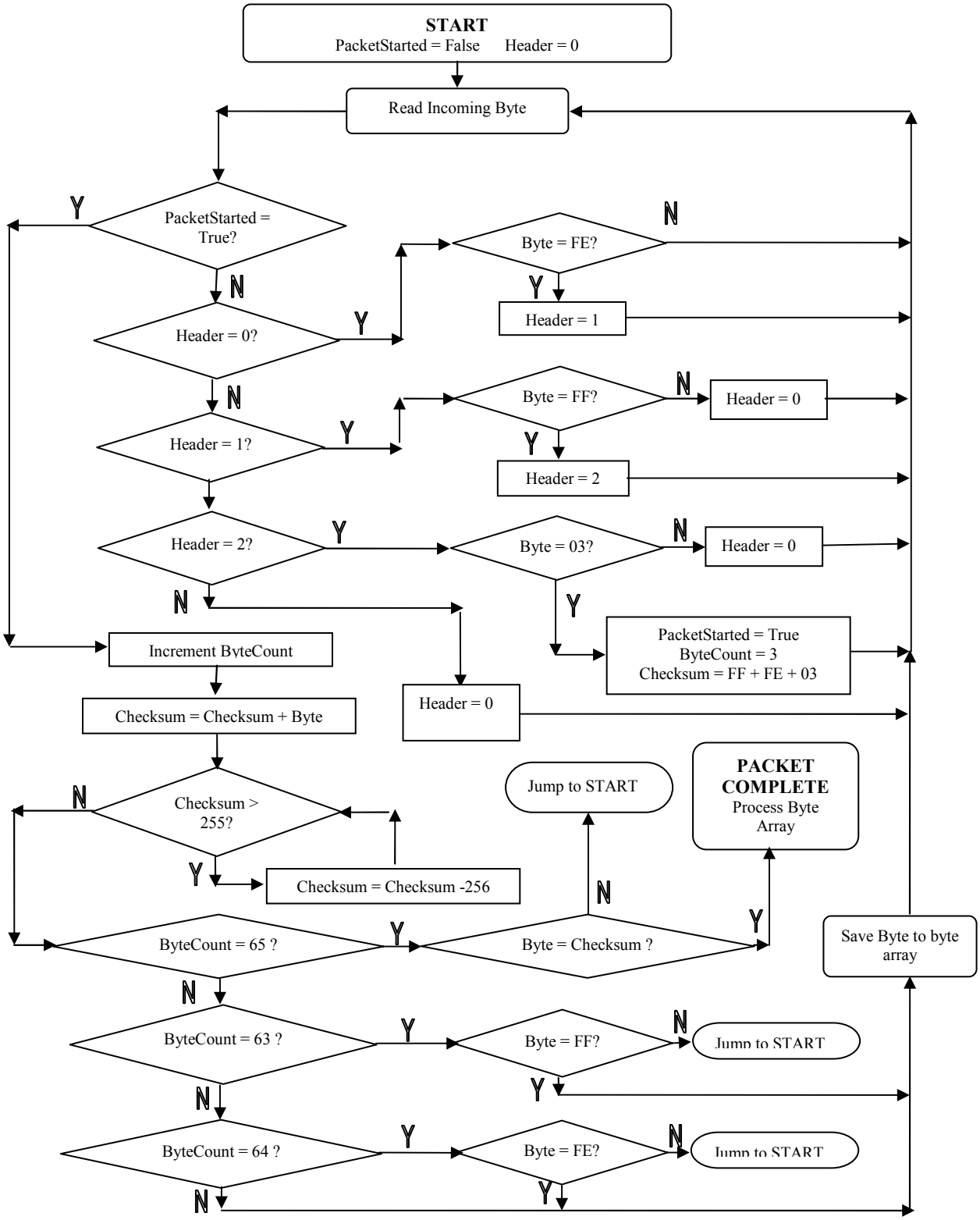
Lately energy use is sometimes represented by the amount of CO2 gases generated to produce the power consumed. This is simply a matter of multiplying the amount of KWh consumed by a CO2 emission per KWh value. This value is dependent on the area the measurements are taken and the method used for the power company to generate the consumed energy.

CO2 Emissions = KWH x CO2 emissions/KWh

Example flowchart for collecting ECM-1220 data



Example flowchart for collecting ECM-1240 data



ASCII DATA FORMAT (ECM-1240 firmware ver 1.24 or greater)

Typical ASCII packet (added Mar 3/2010)**:**

sec=5734556&v=1167&c1w=1561&c2w=1525&wsa1=8981110853&wsa2=3297249514&wsap1=5416008820&wsap2=215139444&A1w=&A1ws=3515735&A2w=&A2ws=3&A3w=27&A3ws=1008982385&A4w=177&A4ws=660420956&A5w=15&A5ws=471514&dev=36929&id=1&CT1=167/4&CT2=167/4&PT1=230/3&PacketIvl=5&TrigPwr=300&FirmVer=1025&Resp=

sec seconds counter
v volt X 10 divide by 10 to get 1 decimal place value
c1w CH1 watt
c2w CH2 watt
wsa1 watt-second absolute CH1
wsa2 watt-second absolute CH2
wsap1 watt-second polarized CH1
wsap2 watt-second polarized CH2
A1w AUX1 power watt
A1ws Aux1 watt-second
A2w AUX2 power watt
A2ws Aux2 watt-second
A3w AUX3 power watt
A3ws Aux3 watt-second
A4w AUX4 power watt
A4ws Aux4 watt-second
A5w AUX5 power watt
A5ws Aux5 watt-second
dev device serial number ... must be converted to 5 digits with leading zeros if required.
id device ID The complete serial number should be the "id" and five digit "dev" concatenated together
CT1 CH1 CT setting (not important or used for measurement)
CT2 CH2 CT setting (not important or used for measurement)
PT1 PT setting (not important or used for measurement)
PacketIvl Packet send interval (not important or used for measurement)
TrigPwr Trigger threshold (watt) for packet send
FirmVer Firmware version 1025 = 1.025
Resp= N/A

NOTE: The total device serial number is a concatenation of "id"|"dev" . For example:
dev=873 (requires leading zeros to form five characters)
id=3
Device serial number = 300873

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