Advanced Pulse WattNode - Option 2N1 (Two Per-Phase Outputs + One Sum of Phases Output)

Option 2N1 specifies two per-phase outputs and one sum-of-phases output. Specifically, the pulse output channels P1, P2, and P3 report the following:

- **P1** - Phase A positive real energy
- **P2** - Phase B positive real energy
- **P3** - Positive real energy (sum of all phases: A, B, and C)

The primary application for this model is in cases where you might be monitoring two single-phase branch circuits or one multi-phase (two or three) circuit, but you aren't sure of the mixture of single-phase to multi-phase circuits and don't want to have to pre-order some regular Pulse WattNodes and some with ***Option P3***. With ***Option 2N1***, one model of WattNode can be used for monitoring either two single-phase circuits or one multi-phase circuit, simplifying ordering, stocking, and installation.

Details

As with other Pulse WattNode models and options, each monitoring phase can be connected to the same or different mains phases. For example, you might connect phase A to L1 and phase B to L2. Or, you might connect phase A, B, and C to L1 to monitor three different branches all powered from L1. The only requirement is that all three phases have the same nominal line-to-neutral voltage and that you make sure to match the current transformer (CT) monitored phases to the mains phases (i.e. don't connect phase A to L1, but then put the CT around an L2 conductor or vice versa).

Limitations

This option is only intended for use with wye models of the WattNode.

If you connect a load to phase C, you can only monitor the phase C energy and power with the P3 output (sum of all phases), which will also include phases A and B.

Installation

The installation is the same as documented in the normal **Installation and Operation Manual**.

Power and Energy Computation

Every pulse from the WattNode corresponds to a fixed amount of energy. Power (watts) is energy divided by time, which can be measured as pulses per second (or pulses per hour). The following scale factor tables convert from pulses to energy (watt-hours or kilowatt-hours). This conversion can be more complex with ***Option 2N1***, because the scale factors are different for the sum-of-phases channel (P3 output).

DO NOT use the scale factor tables from the **Installation and Operation Manual**, they will not be correct.

Scale Factors - P1 and P2 Outputs (Per-Phase)

The following table provides scale factors for the P1 and P2 output channels as a function of current transformer rated amps. This table assumes the WattNode was ordered with the standard full-scale pulse output frequency of 4.00 Hz. The last row contains equations for custom pulse frequencies (***Option Hz***). Also see **Custom Pulse Frequencies** below.

CT Size (amps)	Pulses Per kilowatt-hour (PpKWH)				Watt-hours per pulse (*WHpP*)			
	3Y-208 3D-240	**3Y-400 3D-400**	**3Y-480 3D-480**	**3Y-600**	**3Y-208 3D-240**	**3Y-400 3D-400**	**3Y-480 3D-480**	**3Y-600**
5	24000.0	12521.7	10397.1	8299.71	0.04167	0.07986	0.09618	0.12049
15	8000.00	4173.91	3465.70	2766.57	0.1250	0.2396	0.2885	0.3615
20	6000.00	3130.43	2599.28	2074.93	0.1667	0.3194	0.3847	0.4819
30	4000.00	2086.96	1732.85	1383.29	0.2500	0.4792	0.5771	0.7229
50	2400.00	1252.17	1039.71	829.971	0.4167	0.7986	0.9618	1.2049
60	2000.00	1043.48	866.426	691.643	0.5000	0.9583	1.1542	1.4458
70	1714.29	894.410	742.651	592.837	0.5833	1.1181	1.3465	1.6868
100	1200.00	626.087	519.856	414.986	0.8333	1.5972	1.9236	2.4097
150	800.000	417.391	346.570	276.657	1.2500	2.3958	2.8854	3.6146
200	600.000	313.043	259.928	207.493	1.6667	3.1944	3.8472	4.8194
250	480.000	250.435	207.942	165.994	2.0833	3.9931	4.8090	6.0243
300	400.000	208.696	173.285	138.329	2.5000	4.7917	5.7708	7.2292
400	300.000	156.522	129.964	103.746	3.3333	6.3889	7.6944	9.6389
600	200.000	104.348	86.643	69.164	5.0000	9.5833	11.542	14.458
800	150.000	78.261	64.982	51.873	6.6667	12.778	15.389	19.278
1000	120.000	62.609	51.986	41.499	8.3333	15.972	19.236	24.097
1200	100.000	52.174	43.321	34.582	10.000	19.167	23.083	28.917
1500	80.000	41.739	34.657	27.666	12.500	23.958	28.854	36.146
2000	60.000	31.304	25.993	20.749	16.667	31.944	38.472	48.194
3000	40.000	20.870	17.329	13.833	25.000	47.917	57.708	72.292
any	$\frac{120000}{CtAmps}$	$\frac{62609}{CtAmps}$	$\frac{51986}{CtAmps}$	$\frac{41499}{CtAmps}$	$\frac{CtAmps}{120.00}$	$\frac{CtAmps}{62.609}$	$\frac{CtAmps}{51.986}$	$\frac{CtAmps}{41.499}$
any Hz	$\frac{30000*Hz}{CtAmps}$	$\frac{15652*Hz}{CtAmps}$	$\frac{12996*Hz}{CtAmps}$	$\frac{10375*Hz}{CtAmps}$	$\frac{CtAmps}{30.00*Hz}$	$\frac{CtAmps}{15.652*Hz}$	$\frac{CtAmps}{12.996*Hz}$	$\frac{CtAmps}{10.375*Hz}$

Table 1: Scale Factors - P1 and P2 Outputs (Per-Phase)

Scale Factors - P3 Output (Sum of Phases)

The following table provides scale factors for the P3 output channel (the sum of phases A, B, and C), assuming the WattNode was ordered with the standard full-scale pulse output frequency of 4.00 Hz. The last row contains equations for custom pulse frequencies (***Option Hz***). Also see **Custom Pulse Frequencies** below.

CT Size (amps)	Pulses Per kilowatt-hour (*PpKWH*)				Watt-hours per pulse (*WHpP*)			
	3Y-208 3D-240	3Y-400 3D-400	3Y-480 3D-480	3Y-600	3Y-208 3D-240	3Y-400 3D-400	3Y-480 3D-480	3Y-600
5	8000.00	4173.91	3465.70	2766.57	0.125	0.2396	0.2885	0.3615
15	2666.67	1391.30	1155.24	922.190	0.375	0.7188	0.8656	1.0844
20	2000.00	1043.48	866.426	691.643	0.500	0.9583	1.1542	1.4458
30	1333.33	695.652	577.617	461.095	0.750	1.4375	1.7313	2.1688
50	800.000	417.391	346.570	276.657	1.250	2.3958	2.8854	3.6146
60	666.667	347.826	288.809	230.548	1.500	2.8750	3.4625	4.3375
70	571.429	298.137	247.550	197.612	1.750	3.3542	4.0396	5.0604
100	400.000	208.696	173.285	138.329	2.500	4.7917	5.7708	7.2292
150	266.667	139.130	115.523	92.219	3.750	7.1875	8.6563	10.844
200	200.000	104.348	86.643	69.164	5.000	9.5833	11.542	14.458
250	160.000	83.478	69.314	55.331	6.250	11.979	14.427	18.073
300	133.333	69.565	57.762	46.110	7.500	14.375	17.313	21.688
400	100.000	52.174	43.321	34.582	10.000	19.167	23.083	28.917
600	66.667	34.783	28.881	23.055	15.000	28.750	34.625	43.375
800	50.000	26.087	21.661	17.291	20.000	38.333	46.167	57.833
1000	40.000	20.870	17.329	13.833	25.000	47.917	57.708	72.292
1200	33.333	17.391	14.440	11.527	30.000	57.500	69.250	86.750
1500	26.667	13.913	11.552	9.2219	37.500	71.875	86.563	108.44
2000	20.000	10.435	8.6643	6.9164	50.000	95.833	115.42	144.58
3000	13.333	6.9565	5.7762	4.6110	75.000	143.75	173.13	216.88
any	$\frac{40000}{CtAmps}$	$\frac{20870}{CtAmps}$	$\frac{17329}{CtAmps}$	$\frac{13833}{CtAmps}$	$\frac{CtAmps}{40.000}$	$\frac{CtAmps}{20.870}$	$\frac{CtAmps}{17.329}$	$\frac{CtAmps}{13.833}$
any Hz	$\frac{10000*Hz}{CtAmps}$	$\frac{5217.4*Hz}{CtAmps}$	$\frac{4332.1*Hz}{CtAmps}$	$\frac{3458.2*Hz}{CtAmps}$	$\frac{CtAmps}{10.00*Hz}$	$\frac{CtAmps}{5.2174*Hz}$	$\frac{CtAmps}{4.3321*Hz}$	$\frac{CtAmps}{3.4582*Hz}$

Table 2: Scale Factors - P3 Output (Sum of Phases)

Scale Factor Equations

The following presents two equivalent methods to compute power and energy from pulses. Be careful to use the correct scale factors, since they will be different for the P1 and P2 output channels than for the P3 channel.

- ***PulseCount*** - This is the count of pulses, which is used to compute energy. You can use the count of pulses over specified periods of time (like a month) to measure the energy for that period of time.
- ***PulseFreq*** - This is the measured pulse frequency (Hertz) out of the WattNode. This can also be computed by counting the number of pulses in a fixed period of time and then dividing by the number of seconds in that time period. For example, if you count 720 pulses in five minutes (300 seconds), then ***PulseFreq*** = 720 / 300 = 2.40 Hz.

Using the “Watt-hours per pulse” ***WHpP*** value from the tables above for your WattNode model and current transformer, you can compute energy and power as follows:

$$Energy\ (watt\text{-}hours) = WHpP \cdot PulseCount$$

$$Power\ (watts) = WHpP \cdot 3600 \cdot PulseFreq$$

To convert these values to kilowatt-hours and kilowatts, divide by 1000.

Using the “Pulses Per kilowatt-hour” ***PpKWH*** value from the tables above for your WattNode model and current transformer, you can compute energy and power as follows (multiply by 1000 to convert kilowatts to watts):

$$Energy\ (kilowatt\text{-}hours) = PulseCount / PpKWH$$

$$Power\ (kilowatts) = 3600 \cdot PulseFreq / PpKWH$$

Custom Pulse Frequencies

Instead of the normal 4.00 Hz, you may order the WattNode with custom pulse frequencies ranging from 0.01 Hz to 150 Hz. Higher frequencies frequently work better with displays like our LCDA-EP Energy & Power Display.

If you do order your Option 2N1 WattNode with custom pulse output frequencies, refer to the **Power and Energy Equations** section of the main manual for equations to use to compute power and energy from the output pulses. The only tricky part is the variable ***PpPO*** - “Phases per Pulse Output”. Unlike regular WattNodes, Option 2N1 WattNodes have two ***PpPO*** values:

- **P1 and P2 Pulse Outputs: *PpPO*** = *1*, because there is one phases (**ØA** or **ØB**) providing energy for each output channel (P1 and P2).
- **P3 Pulse Output: *PpPO*** = *3*, because there are three phases (**ØA**, **ØB**, and **ØC**) providing energy for the P3 output.

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