MODERN ELECTRONIC PACKAGE FOR THE WANG 300 SERIES CONSOLES

-or- Honey, I Shrunk My Wang!

The Modern Electronic Package fits inside a Wang 300, 310, 320, or 360 console and brings it to life, without needing the original Wang Electronic Package. It closely emulates the original Wang calculator behavior and optionally provides a clock feature and a Reverse Polish Notation calculator feature.

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INTRODUCTION

The Wang 300 Series calculators were built in the 1960s and '70s. They consisted of a large Electronic Package (EP) connected to multiple keyboard/display consoles. The calculations were all done in the EP. The consoles were merely "dumb terminals" with a keyboard, a nixie tube display, and nothing else.

EPs are rare, expensive, and frequently broken. They use discrete diode-transistor logic, three different voltage levels, and core memory, so they're a challenge to repair.

The Modern Electronic Package (MEP) is a single circuit board that fits inside most Wang 300 series consoles and brings them to life without the need for an original EP. Not only does it closely (but not perfectly) emulate the original Wang calculator's behavior, but it adds features like a self-setting clock and a Reverse Polish Notation calculator that works much like a Hewlett-Packard calculator.

The MEP was developed by me, Bob Alexander. It did not have the benefit of a team of engineers and quality-assurance testers, so it's possible you will discover bugs. If you come across any, please contact me at WangCalculator@LoadAccumulator.com. While I cannot make promises, I take pride in my work and may be able to fix the bugs.

The MEP provides five applications:

- A Wang calculator emulator
- A clock
- A Reverse Polish Notation calculator
- A Settings or Configuration application
- A Keyboard Test application

INSTALLATION

A picture is worth a thousand words and a demo is worth a thousand pictures. To learn how to install the MEP in your Wang 300 series console, please watch the video at https://www.youtube.com/watch?v=cqvbP1HLWEA. You really should watch the whole video, but the installation part starts at 17 minutes and 50 seconds.

Additional information is in another video at https://youtu.be/zqRInya9oIw.

Some features have been added since the video was made, so don't be surprised if a few things look a little different on your calculator.

Here are a few extra notes:

- Be sure to set the red jumper for the clock before installing the board. The reason for enabling the nixie clock feature should be self-evident. The reason not to enable it would be that it uses about 5 watts.

- Before you install the MEP, consider whether you want to replace the key labels. If you're going to use the RPN calculator feature instead of the Wang calculator emulator, you might want to replace some of the key labels. That involves removing the keyboard's circuit board. Since you have the console open already, now would be a good time to do that. See my video at https://youtu.be/zqRInya9oIw for an example.
- Getting the MEP's edge connectors into the slots properly can be tricky. If they're not seated well, you could see a bizarre display on the nixies or no display at all. As you see me do in the video, tip the console onto its back so that you can see what you're doing. Another technique I've found helpful is to tilt the MEP to the left and just put the left side of the edge connectors into the slots. Then, push the MEP to the left so that the edge connectors butt up against the left side of the slots. Then, push the right side down.
- Your goal is to be able to look at the edge connectors, as I do in the video, and not see any of the electrical contacts (except maybe a little on the left side; one of the integrated circuits is sort of in the way and prevents you from pushing the edge card down in that last millimeter. Sorry.)
- When you put the bottom plate back on, it will bulge a bit as it presses down on the power connector. There's a risk that the plate will short the 12V to ground. I have not had any problem with shorts, but if you're worried, you can wrap electrician's tape around the power connector.
- Avoid bending the MEP. When you apply pressure, apply it directly on or near the edge cards.
- If you ever need to remove the MEP, again, avoid bending it. Pull up near the edge cards.
- The board requires a 12V DC power supply that can provide at least 1 amp. The connector is 5.5mm outer diameter, 2.1mm inner diameter, center-positive.

TESTING AND TROUBLESHOOTING

Once the MEP is installed, there's still no guarantee things will work. Keys might not work or nixie tubes might not work.

The aforementioned video at https://www.youtube.com/watch?v=cqvbP1HLWEA shows the built-in keyboard test application starting at 8 minutes, 40 seconds. However, there's a new feature in the Keyboard Test app that is not in the video.

When you press a key, its code will be displayed as an octal (base 8) number. The one exception is the Clear All key which is wired separately from the other keys. The code displayed for Clear All is 99.

Following the code is a space and then 7 digits showing the state of the 7 wires used to read the keyboard. The wires are read as analog signals, not digital, and the analog signal for each wire is shown on a scale from 0 to 9. Normally, when no key is pressed, all seven wires should be at 0 or 1. When a key is pressed, some of those wires should go high, to 8 or 9. Some of the wires might fluctuate from 1 to 2, but that's still small enough to be read as a logical zero. The pattern of low and high numbers will match the octal code. For example, a

code of 52 would have wire signals like 918282 (a high number, a low number, high, low, high, low, corresponding to logic levels 101010, or octal 52).

If there's not enough difference between a wire's high and low numbers, that will cause a problem with sensing key presses. The trouble would not be in the key switch itself, but in the circuit board.

(Note: the calculator inverts the numbers when it displays them to correspond more intuitively with logic 1s and 0s. In fact, if you measured with a voltmeter, you'd see that a wire's voltage is higher when the calculator shows a low number, like 0 or 1, and the voltage is lower when the calculator shows a high number like 8 or 9.)

If the number keys on your keyboard are working, it's easy to test the nixies. Just fill the display with all 1s, all 2s, etc.

If a specific nixie tube never displays anything, then either the tube is bad or the circuit driving it is bad. I have no experience fixing this, but Brian White has written up his work repairing the display at https://brianwhite94.wixsite.com/electronics/wang-320-calculator-ii.

If a single digit in a nixie tube doesn't work, it's possible that it's suffering from cathode poisoning, Please read about cathode poisoning at http://www.tube-tester.com/sites/nixie/different/cathode%20poisoning/cathode-poisoning.htm.

It is possible to use the MEP to increase the voltage to the nixies. I don't know if this will fix cathode poisoning and I don't know if it will cause other damage. Try it at your own risk. There's an adjustable potentiometer (it's blue with slots for a small Philips screwdriver) on the MEP's high voltage sub-board (https://youtu.be/zqRInya9oIw, 1 minute and 25 seconds). If you increase the voltage to fix cathode poisoning, remember to turn the voltage back down when you're done. Also, you're playing with 250 to 330 volts. Use an insulated screwdriver and keep your other hand away from the board, so that you don't create a circuit across your chest.

THE WANG CALCULATOR APPLICATION

The Wang calculator has a manual of its own that you can download from https://www.galacticstudios.org/wp-content/uploads/2019/08/Wang-300-Series-Instruction-Manual-Vol.-1-1968.pdf. I also have a few nicely printed and bound copies that I would be happy to sell you at cost. Contact me if you're interested. The emulator closely matches the Wang calculator's original behavior (the only deviation I'm aware of is that if you multiply large numbers by zero, the original Wang displays the answer with multiple digits before the decimal, like 000.0000000, whereas my emulation just shows .0000000000).

To use the Wang calculator, turn the console ON. If you see +.0000000000, you are in the Wang calculator app. If you see a digit before the decimal point, like +0.000000000, you are in the RPN calculator app and you need to go into the Configuration app to switch. See the Configuration section.

CONFIGURATION

The MEP has several configuration options. You enter the Configuration application by turning the console ON and holding the ENTER key down for 4 seconds.

You will see either "12   1" or "24   1". The rightmost number indicates the option; the leftmost number indicates the current setting of the option.

For a given option, you can change the current setting by pressing the + (Plus) or – (Minus) keys. To advance to the next option, press the ENTER key. When you're done, hold down the CLEAR ALL key for 4 seconds to go to the Calculator app or turn the console off to go to the Clock app.

The options are:

Option Number	Option	Possible Values	Notes
Clock Options			
1	Hour Mode	12 24	Indicates whether the time is displayed in 12 hour mode, with a PM indicator, or 24 hour mode.
2	Time Format	12.00 12.00.00 12.00 1.31	Indicates whether the time is displayed as hours and minutes; hours, minutes, and seconds; or hours, minutes, month, and date.
3	Time Zone	-12.00 -11.00 : : +14.00	Indicates the time zone offset from Universal Time. Set this to the *Standard Time* (not Daylight Saving Time) offset of your time zone from UT. For example, if you're in the Eastern time zone of the US, set this to -5.00 (even if you're doing this in the summer and DST is in effect).
4	DST	0 1 2	Indicates whether Daylight Saving Time is off (0), on (1), or automatic

			(2). If automatic, options 5 through 8 indicate when DST starts and ends.
5	DST Start Month	1 2 : : 12	Indicates the month that DST starts. Used only when DST is automatic.
6	DST Start Week	1 2 3 4 5	Indicates the Sunday that DST starts (1st, 2nd, 3rd, 4th, or last) when DST is automatic.
7	DST End Month	1 2 : : 12	Indicates the month that DST ends. Used only when DST is automatic.
8	DST End Week	1 2 3 4 5	Indicates the Sunday that DST ends (1st, 2nd, 3rd, 4th, or last) when DST is automatic.
Calculator Options			
9	Calculator Selection	0 1	Indicates the type of calculator to emulate. 0 means Wang 300 series, 1 means RPN.

THE CLOCK

If the jumper on the MEP is set to enable the clock, then the clock will come on when the console is switched off (if the jumper is not set, then turning the console off will simply turn off the console).

The clock gets its time from GPS. When you first plug the console it, it might take a few minutes for the GPS receiver to get a satellite fix. The time will flash 12.00 until it does. It's possible that the clock will initially get an incorrect time. Give it another few minutes and it should get the correct time.

If, after 10 minutes, the clock has not set the correct time, you might be in a building that blocks GPS signals.

The clock gas several configurable options. See the Configuration section.

If the clock is displaying 12 hour time, the decimal point after the time will indicate PM. If the clock is displaying 24 hour time, there is no PM indicator.

At midnight, the clock will spend one minute cycling through all the digits. You will see it flash all 1s, all 2s, etc. This is to prevent cathode poisoning.

THE REVERSE POLISH NOTATION CALCULATOR

The RPN calculator operates much like a classic Hewlett Packard calculator. It uses a 4 level stack and 64 bit floating point numbers, which provide about 15 decimal digits of precision.

To use the RPN calculator, turn the console ON. If you see +.0000000000, you are in the Wang calculator app and you need to go into the Configuration app to switch. See the Configuration section. If you see a digit before the decimal point, like +0.000000000, you are in the RPN calculator.

Describing an RPN calculator is beyond the scope of this manual. Refer to an HP RPN calculator manual.

Some of the keys behave differently in the RPN calculator than in the Wang calculator:

Wang Key	New RPN Function	Notes
Left Recall Adder	⇧ (function shift)	Some of the keys in the RPN calculator have two functions, one on top and one on bottom. To select the topmost function, press and release the function shift key. All the decimal points on the display will light. Then, press the function key.
Left Clear Adder	Y^X $1/X$	Reciprocal or, when preceded by the function shift key, raise Y to the X power.
e^X	10^X e^X	
LOG_eX	LOG LN	Natural log or, when preceded by the function shift key, base 10 log
Right +	R⬇ X⇆Y	Swap X and Y in the 4 level stack or, when preceded by the function key, roll the stack down.
Right -	SIN^{-1} SIN	Sine or, when preceded by the function key, inverse sine. The PROD ACCUM switch now selects whether trig functions use degrees or radians.
Right Clear Adder	COS^{-1} COS	Cosine or, when preceded by the function key, inverse cosine. The PROD ACCUM switch now selects whether trig functions use degrees or radians.
Right Recall Adder	TAN^{-1} TAN	Tangent or, when preceded by the function key, inverse tangent. The PROD ACCUM switch now selects whether trig functions use degrees or radians.
PROD ACCUM	DEG RAD	Selects whether trigonometric functions are calculated using degrees or radians.
MULT ACCUM	ENG FIX	Selects whether numbers are displayed in engineering notation or fixed notation.

		Engineering notation always shows numbers as a power of ten, where the power of 10 is a multiple of three. This makes it easy to see kilo, milli, giga, micro, etc.
ENTRY ACCUM	Unused	If you have any idea what I can do with this switch, let me know!

There's no way to enter exponents (e.g. the EEX key on an HP calculator) but if you produce large or small numbers in a calculation, they will be displayed with a mantissa, a space, and the exponent (e.g. "1.234567 12" is 1.234567×10^{12}). A negative exponent will be displayed with a decimal in front of it (e.g. "1.234567 .12" is 1.234567×10^{-12}).

You can change the displayed precision of numbers by pressing the function shift key (all the decimal points will light up) followed by a digit. So if you're doing financial calculations, you could press ⇧ 2, and displayed number will be rounded to two decimal places. The calculations will still be done at full precision.

Some other notes:

- The STORE REG n and RECALL REG n keys on the 360 console store values into memory registers and recall them.
- CLEAR DISPLAY clears the number you were entering (the X register in the 4 level stack)
- CLEAR ALL clears the display, the four level stack, and the memory registers.