ITR / IBM Slave Clock: Secondary
Using either a 12 volt or a 24 volt, or a mix of each.

by Joe Fox

It really doesn't matter if you buy a 12 volt or 24 volt secondary for your International Time Recording (ITR) or International Business Machine (IBM) master clock system. This PDF will show you how to wire and use any combination of master or secondary clocks.

You can have a 12 volt master clock system or a 24 volt master clock system and mix and match secondaries any way you want. I have already discussed a way to convert a 12 volt secondary to work on a 24 volt system; I now offer a way you can use that 24 volt ITR or IBM secondary on a 12 volt master clock system. So if you just happened to make an affordable and an adorable Impulse Secondary find, it does not matter that it has the wrong voltage for your master clock system.

Wiring an ITR or IBM, 12 volt secondary to a 24 volt master clock system:
Wiring a 12 volt DC secondary to work on a 24 volt DC master clock system is as easy as adding a single resistor in series with the C connection and the coil's C terminal. The current limiting resistor consumes the extra 12 volts, leaving the remaining 12 volts for the Impulse Secondary's coil. The system sees a total load of 24 volts and will be happy. (12 + 12 = 24 volts) See the resistor conversion table below.

Type	Description	12 Volt	24 volt	12V to 24 V Conversion Resistor
25	Master's Winding Magnet	.273 amps	.132 amps	43 ohm 5 watt (actual 3.36 watts)
25	Impulse Accumulator	.280 amps	.140 amps	43 ohm 5 watt (actual 3.36 watts)
805-2	Program Magnet	.545 amps	.279 amps	22 ohm 10 watt (actual 6.54 watts)
561	Indicating Clock Movement	(20V)	*.028 amps.	Use R1, 150 ohm 1 watt resistor to convert coil from 20 to 24 volts.
	(**20 volt coil measured with 20V applied: I=28 mA)*			
561-2	Indicating Clock Movement	.050 amps	.024 amps	240 ohm 1 watt (actual .6 watts)
563-2	Indicating Clock Movement	.333 amps	.171 amps	36 ohm 5 watt (actual 3.9 watts)
565-2	Indicating Clock Movement	.170 amps	.085 amps	68 ohm 2 watt (actual 2.1 watts)
569-2	Tower Clock Movement	.050 amps	.024 amps	240 ohm 1 watt (actual .6 watts)

Table 2: *Table of resistors (R1) required to convert from 12 volt (and 20 volt) coils to 24 volt operation.*

Photo 1: 12 volt to 24 volt conversion, showing the resistor and splice to the resistor and the green wire. Splice (screw and nut) covered with heat shrink tubing.

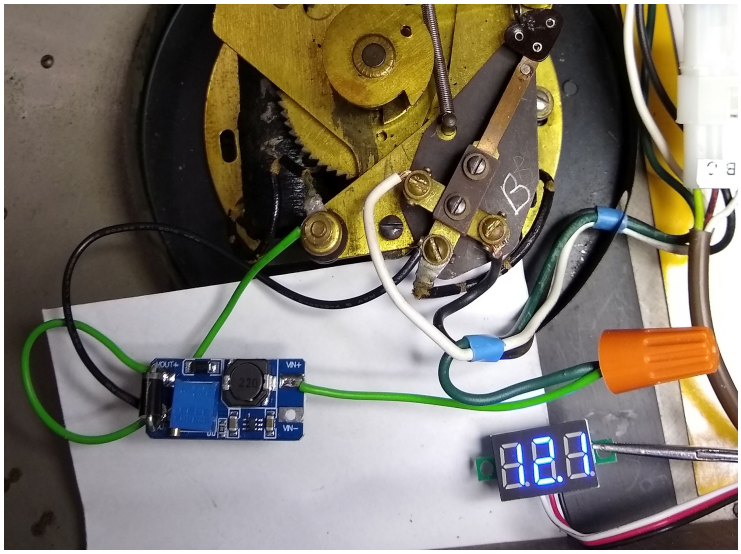


Photo 2: The MT3608 DC to DC converter (the smaller one of the two converters featured here) connected and adjusted to 24 volts. Dark green removed from coil and spliced with a wire nut to the wire connected to converter's input. Black wire (added) connected to contact operating strap. Diode added to output holes on the board. Cathode to (+) output, Anode to (-)output.

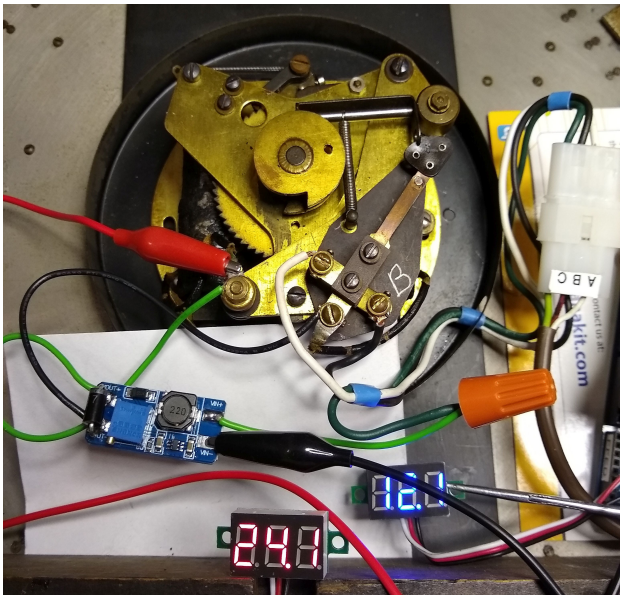


Photo 3: Device setup. Black clip lead connected to negative input and negative power supply to power while adjusting to 24 volts. Blue voltmeter is 12.1 volt power, Red voltmeter is output reading. Red clip lead is measuring converter's output.

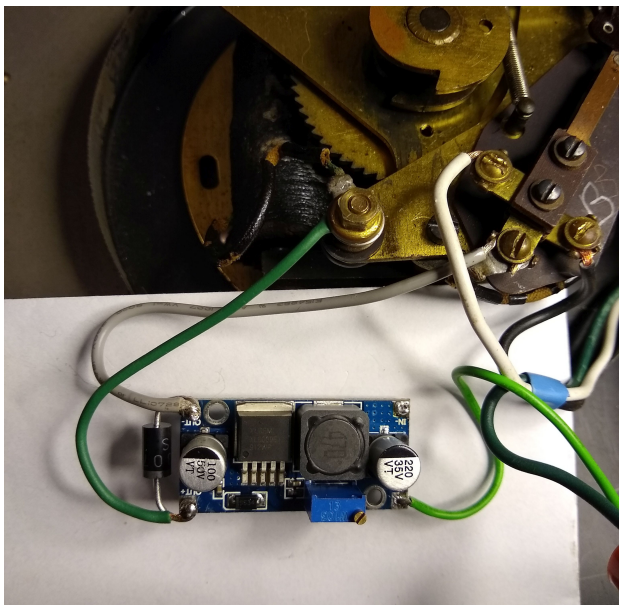


Photo 4: The larger XL6009 connected and adjusted to 24 volts. Diode is attached to the output, Cathode (white band on the diode) to the plus output terminal, Anode to the negative output terminal of the device.

The voltmeters are mini digital voltmeters, small and inexpensive, and can measure from 3 to 30 volts and 3 to 100 volts. Very cool. https://www.amazon.com/s?k=mini+digital+dc+voltmeter&crid=50YRDLHIDCGX&sprefix=DC+mini+digital+voltmeters%2Caps%2C213&ref=nb_sb_ss_i_1_26

Wiring an ITR or IBM 24 volt Secondary to work with a "12 volt" master clock system:
For those who have a 12 volt master clock system and want to install and operate a 24 volt secondary, you only need to purchase a small device called a DC to DC Boost converter and a diode. Making a 24 volt coil work with a 12 volt system is a little more involved than the resistor conversion described above, but not by much. We need to convert the 12 volts that is available (the C line) into the 24 volts that the secondary is designed to operate with. Through the marvel of electronics there is now available a very small and economical voltage converter called an MT3608, DC to DC Boost converter that will work just fine. Economical means from around $1.50 to $5.00 each, and up, depending on where you buy. I have chosen the MT3608, DC to DC Boost converter for several reasons.

1. The device is available online from many sources.
2. The 1.2 MHz operating frequency of the device allows for a very small footprint and can be hidden inside the secondary's movement cover and will be out of sight.
3. The device operates at around 91 percent efficiency so it saves energy.
4. It's 2 amp maximum output current (more like 1 amp in reality) is more than enough to drive any impulse device, such as a secondary, a master's winding coil or program unit's impulse coil.
5. This device does not modify the movement, except for an additional wire, and the original movement's wiring is not altered permanently.
6. It is inexpensive.

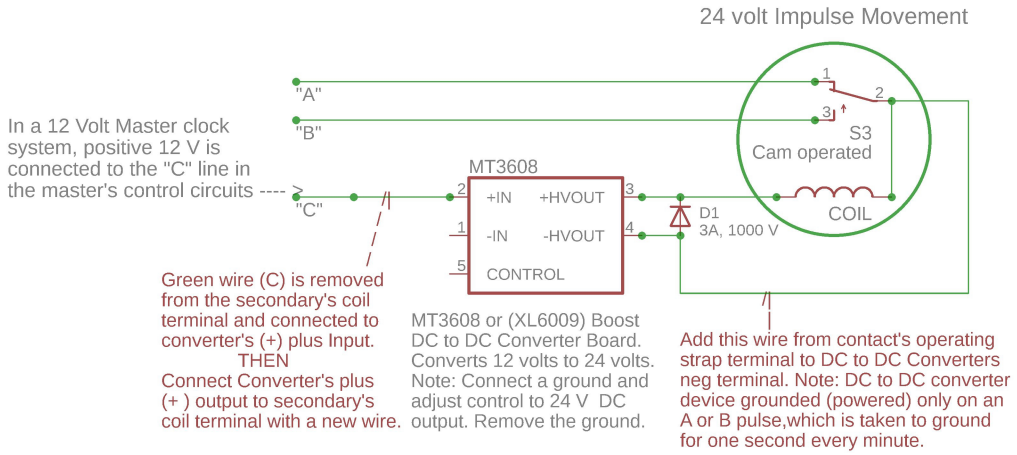
A second option is the XL6009 DC to DC converter (also found on Amazon.com) will work but is slightly larger in size.

I had a failure with the first MT3608 test. It died after two weeks of testing. I believe the problem occurred and the converter was finally damaged from the inherent inductive kickbacks the coil generates when the magnetic field suddenly collapses; at the instant the A or B line is opened. A protection diode (I chose a cheap 3 amp @ 1000 Volt rated diode) is added across the converters output, cathode to the positive output, anode to the negative output, to short circuit this induced counter EMF across the coil as noted in the schematic. The new test with the boost converter and connected protection diode, has been running for more than three months, with no failure.

Referring to my schematic, the C wire is removed from the 24 volt secondary's coil terminal and is rerouted to the positive input of the DC to DC converter. Then the converter's output (adjusted to +24 Volts) is connected back to the secondary's coil terminal. Since the device's negative Input is internally connected to the negative Output, only one connection is necessary. A new wire, connected to the operating strap of the secondary's A/B cam operated contact set, is connected to the negative output of the converter and the anode of the protection diode. This connection is not grounded until an A or B line is grounded by the master relay in the master clock's control circuits, so the DC to DC Converter device needs to be isolated. Once every minute (except maybe the 59th minute), when the A or B line is grounded, one of these pulses will ground the converter and make it active, converting the 12 volts to 24 volts and causing the 24 volt coil to energize for the duration of the pulse. Most of the time (59 seconds of every minute) the converter will not be grounded because the A or B line will not be grounded, and therefore the converter will **not** be powered ON.

You will need a converter and protection diode for each 24 volt secondary you wish to add to a 12 volt master clock system and this converter is installed inside the secondary's cover. The system only sees a 12 volt secondary connected to the A, B, and C lines and will be happy. The secondary only sees the 24 volts at it's C connection and it will be happy.

How to Connect a three wire, 24 volt secondary to a 12 volt master clock system.



International Time Recording (ITR) and IBM Master Clock Systems with 12 Volt coils. Wiring a 24 volt Minute Impulse Secondary to work from a 12 volt System.	
May 16, 2020	Schematic by: Joe Fox, KD4MS

Parts (as of 11/2020):
Protection Diode, general purpose,
https://www.amazon.com/20-Pieces-FR307-Rectifier-Electronic/dp/B079KD74V9/ref=sr_1_1_sspa

DC to Dc Boost Converter.
MT3608,
https://www.amazon.com/Organizer-Step-Up-Adjustable-Switching-Converter/dp/B07WRX2LZ7/ref=sr_1_6

DC to Dc Boost Converter.
XL6009
https://www.amazon.com/Converter-Voltage-Adjustable-Step-up-Circuit/dp/B07XG323G8/ref=sr_1_4

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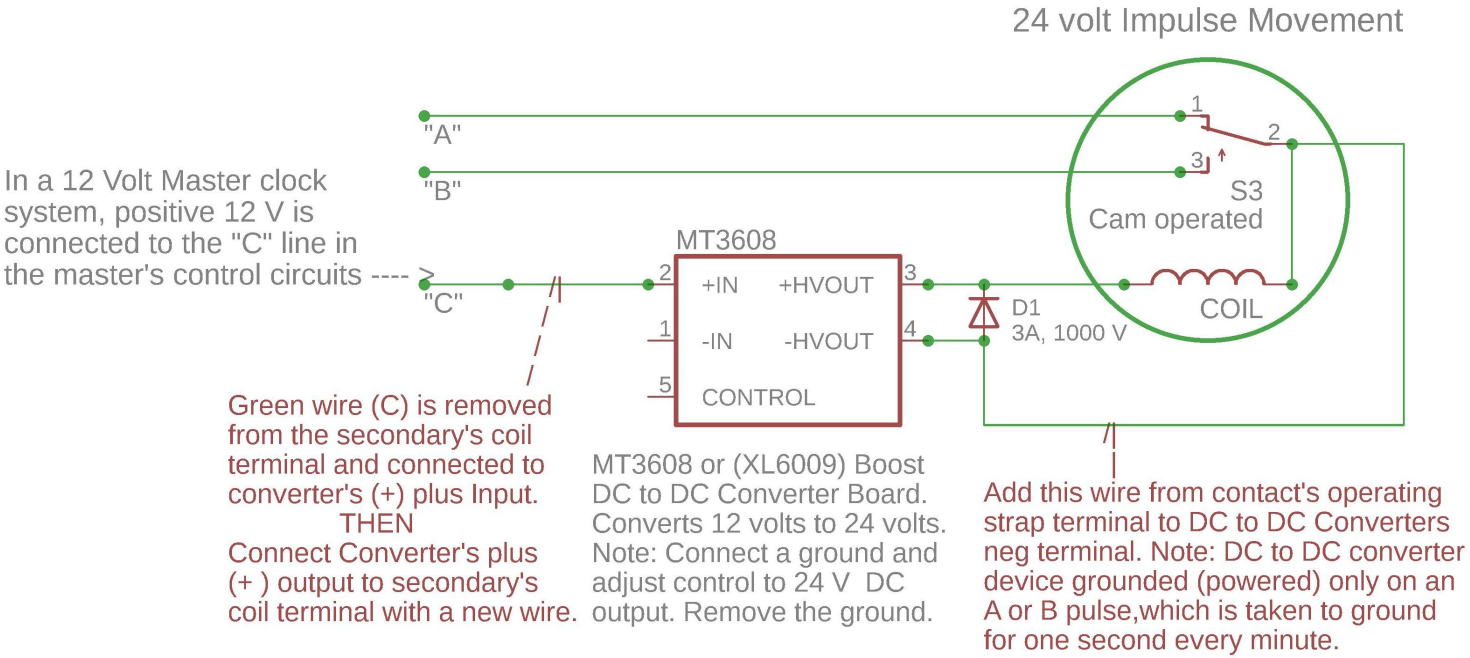

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