MidWest Time Control, Inc.

Master Clock Systems
Application
Guide

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MASTER CLOCK SYSTEMS

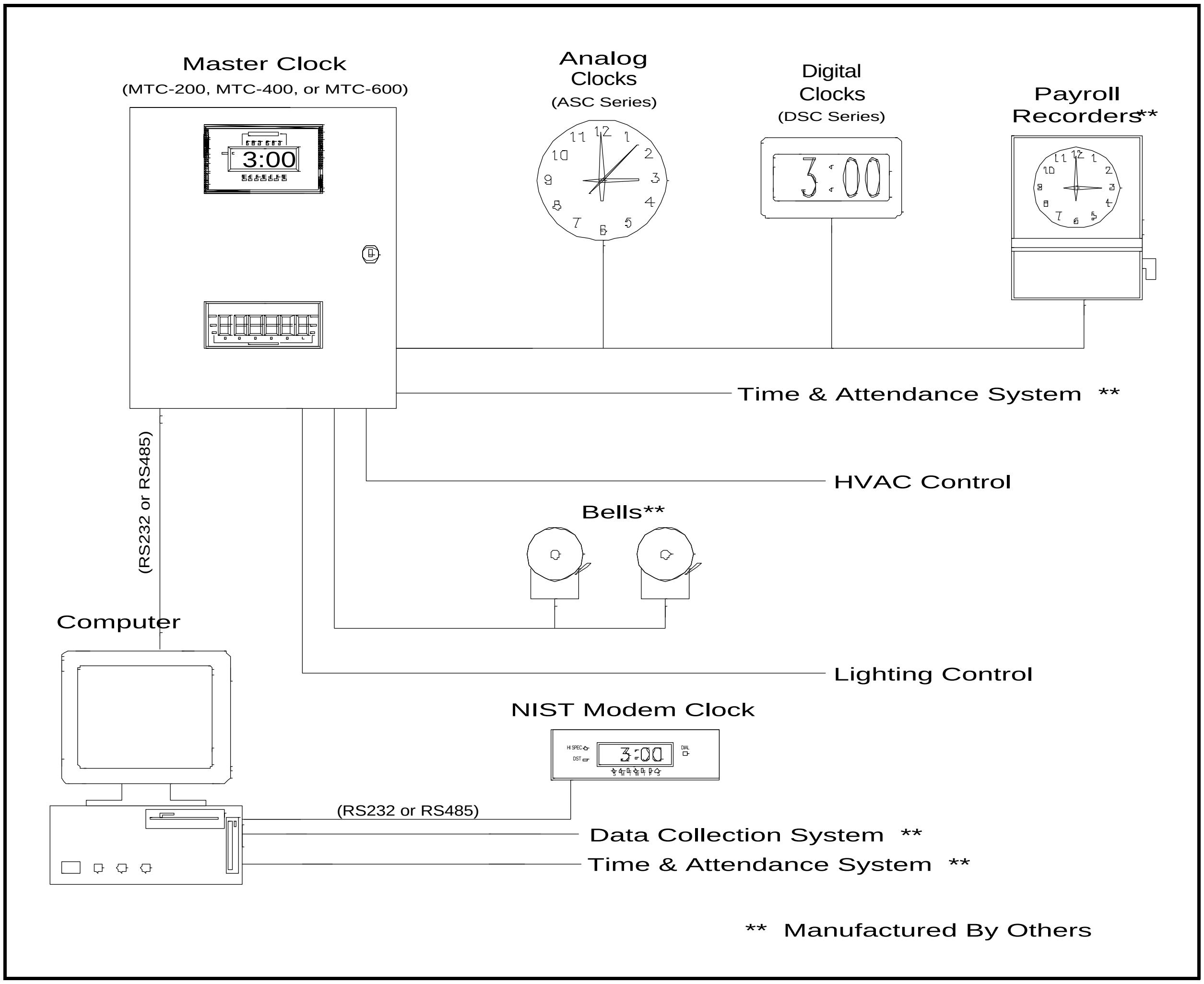
Central to any building time control system is a Master Clock. A Master Clock will provide a time base for synchronizing all of the time related functions in a building or building complex. With a central time base, all time sensitive functions in the building will be in unison. As an example, the Wall Clocks will be synchronized with the bells, the payroll system, the computers, the lighting controls, the security system, Etc. Operations in a building with a central time base are usually much more coordinated even though most people within the building are unaware of its existence.

Wall Clocks are generally the first and most visible indication of a synchronized or master clock system. All wall clocks will indicate the same time of day.

Master Clock Systems can be very simple or as sophisticated as the customer requires. A very simple system could be only synchronized Wall Clocks or only automatic ringing of Bells.

A more sophisticated system may include both Wall Clocks and automatic bell control. It could also include synchronizing Payroll Recorders, Time Stamps, Data Collection Systems, and Computerized Time & Attendance Systems.

A modern Master Clock System can also be used to perform functions which historically were not included in Clock Systems; Turn on lighting, turn on Security Systems, Heating and Air Conditioning systems.



WALL CLOCKS

Through the years, the Master Clock System has evolved through a great number of different schemes for correcting Wall Clocks, and many older systems are still in operation. For purposes of expediency, this discussion will primarily focus on the most common wall clocks used in new installations.

In Analog or Dial type system Wall Clocks, there are basically two types, the Minute Impulse and Synchronous Motor. There is no best type, each has both advantages and disadvantages. The End User's requirement will generally determine the choice for any particular installation.

Digital Clocks have a growing acceptance in Clock System applications. They are very easily read by a casual observation, they are self illuminating and long lasting. Digital Clocks may be installed and intermixed with most existing analog clock systems.

IMPULSE CLOCKS

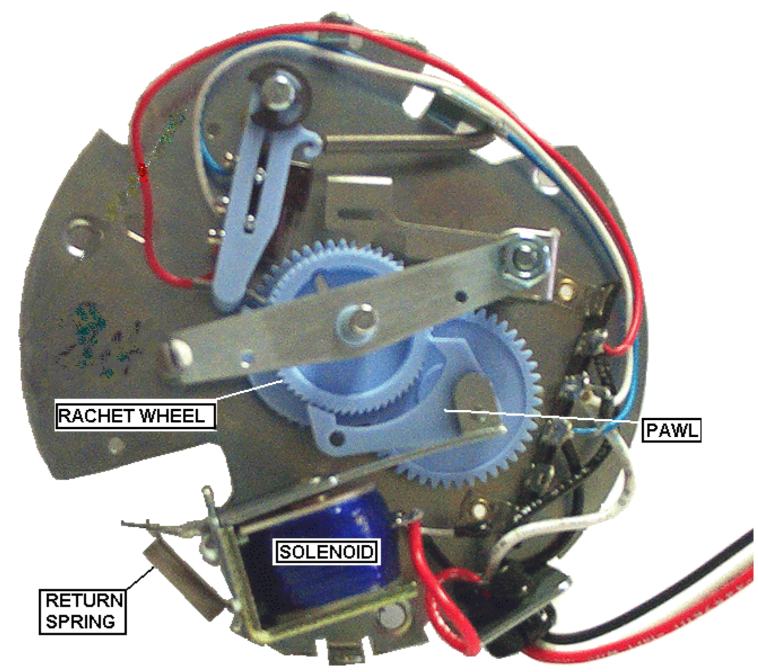


Figure 1
Minute Impulse Clock Movement

Impulse or Minute Impulse Clocks are probably the oldest type used in clock systems. They do not run independently. These clocks will advance in one minute increments. They do not have a Second Hand. These clocks have an advantage of very low wear therefore are long lasting. They generally have the lowest operating cost. They require no power except when stepping.

The most widely used Minute Impulse Wall Clocks are advanced by a 24 Volt DC electrical signal sent from the Master Clock. The 24 Volt DC signal energizes a solenoid which in turn advances a Pawl on a Ratchet Wheel. When the 24 Volt DC signal ends, the Solenoid releases and the Pawl advances the Ratchet Wheel by spring action. In the normal time keeping sequence, the signal is 2 seconds long. The clock minute hand advances at the end of the 2 second period. In keeping with this sequence, the master clock sends out a 24 Volt DC signal 2 seconds long starting at the 58th second of each minute. This signal assures that the minute transition is synchronized with the master. It does not assure that the actual indicated minute is correct.

Figure 2 is a schematic representation of a minute impulse clock movement. Notice that a switch contact is in series with the Ratchet Solenoid. If we cause that switch to open, the 24 Volt DC signal could no longer reach the Solenoid and thus the clock would stop at the point the switch was opened.

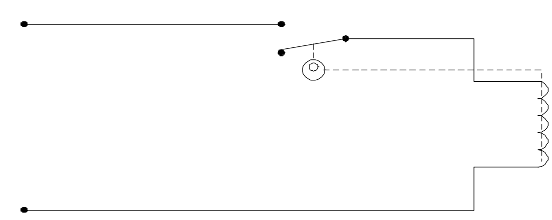


Figure 2 - SIMPLIFIED 2 WIRE IMPULSE MOVEMENT SCHEMATIC

Figure 3 is the same as Figure 2 except a third wire is connected to the Normally Closed (NC) contact of the switch. If we cause a 24 Volt DC signal to be applied to the third wire at the time we are ready for the clock to restart, we can control the precise time to start and thus cause all clocks in the system to be at the same point on the dial and advance in unison.

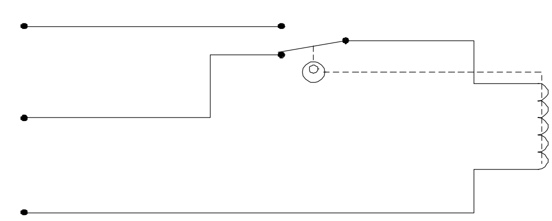


Figure 3 - SIMPLIFIED 3 WIRE IMPULSE MOVEMENT SCHEMATIC

Figure 4 is a schematic representation of an actual minute impulse clock movement. The three wires are identified as "A", "B" & "C". The "C" wire is common. The normal time keeping signal from the Master Clock is applied to the "A" wire each minute. The switch contact is operated by a cam which is part of the ratchet and gear attached to the minute hand. At the 59th minute, the cam causes the switch contact to transfer from the normally open (NO) to the normally closed (NC) contact. If the wall clock is fast, it will stop at the 59th minute. During the 59th minute, the master clock sends 25 rapid 24 Volt DC signals on the "A" wire. If the wall clock is slow, these 25 fast signals will advance the minute hand until the switch contact opens (59th Minute). When the Master Clock time is at 59:58, the 24 Volt DC signal is sent on the "B" wire. This signal will cause the minute hand to advance to the 00 minute. This sequence synchronizes the Minute Hand with Master Clock.

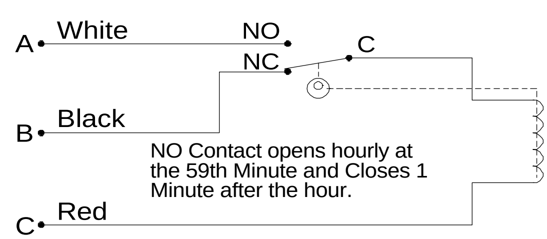


Figure 4 - 3 WIRE IMPULSE MOVEMENT SCHEMATIC

In practical Master Clocks, the 24 Volt DC signal is placed on both the "A" and "B" wire for the 00 Minute until the next 49th minute transition. The signal is applied to the "A" wire only from the 50th to the 59th minute transition. With this sequence, the minute hand can be corrected to the precise minute if it is less than 10 minutes fast or 25 minutes slow.

This clock is usually referred to in the industry as a 3 Wire 59th Minute Impulse Clock.

This clock is MidWest Time Control Model ASC-4-xxx.

Figure 5 is a schematic representation of another version of a Minute Impulse Clock Movement. This movement is referred to as a 2 Wire Reverse Polarity Movement. Notice that the "B" wire has been omitted and a Diode is installed in parallel with the switch contact. With a diode installed as shown, it would not matter if the switch contact were open or closed as long as the 24 Volt DC signal applied at wire "A" was positive in respect to wire "C". If the 24 Volt DC signal applied at wire "A" was negative in respect to wire "C", the voltage to the ratchet solenoid would be blocked if the switch contact was open.

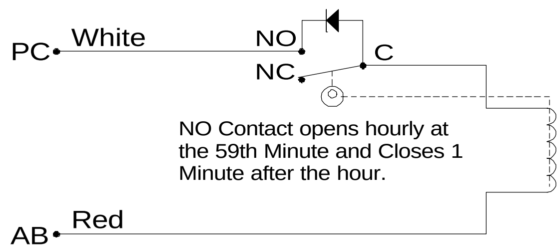


Figure 5 - 2 WIRE, REVERSE POLARITY, MINUTE IMPULSE MOVEMENT SCHEMATIC

In normal operation, the 24 Volt DC signal applied to the "A" wire is positive from the 00 minute until the next 49 minute transition. The polarity of the voltage is then reversed and a negative 24 Volt DC signal is applied to the "A" wire from the 50 to the 59th minute transition.

In a movement of this type, the "A" wire is often referred to as the "AB" wire and the "C" wire "PC".

This clock is MidWest Time Control Model ASC-3-xxx. It is referred to as a 59th minute, 2 wire, reverse polarity clock.

A wall clock of the types shown in Figure 4 and 5 can not be corrected for errors of the hour hand. This is not normally a problem, these clocks are normally very reliable. Modern Master Clocks have an accumulator that remember the total time of a power loss. When power is restored, the accumulator advances the minute impulse clocks to make up for the time of power loss.

A revised version of the 2 Wire Reverse Polarity Movement is made with a 12 Hour update capability. In simpler terms, the hour hand can be corrected. With this movement, between 5:00 and 5:35, the switch contact is held at the NC position by a cam section molded into the gear attached to the hour hand. During this period, the Master Clock sends a series of rapid negative 24 Volt DC signals each minute and the regular minute signal is positive. With this sequence, if the clock time is not correct (NO closed), the clock will advance, if the clock time is correct (NC closed) the rapid negative signals will be ignored. It takes 3 minutes correction for each hour the clock is slow. This movement can correct an hour hand that is eleven hours slow during the 5:00 to 5:35 period. The final correction of the minute hand is made during the 6:59 minute.

This clock is MidWest Time Control model ASC-6-xxx.

A combination of a Master Clock with a power loss accumulator and 12 hour correctable Wall Clocks provides a very reliable system that requires little operator intervention or service.

MidWest Time Control master clocks do accumulate impulses during a power failure.

Page 12 shows wiring for impulse clock systems.

WIRED SYNCHRONOUS CLOCKS

Wired Synchronous Clock Systems are as the name describes. They are connected to the Master Clock by wires and are driven by a Synchronous motor. They generally are easily identified by the presence of a Second Hand. They will always operate on AC Power and under normal operation will be as accurate as the frequency of the AC power. Normally the Synchronous Motor runs at 1 revolution per minute with gear reductions for the Minute and Hour Hands. Correction operations for a Wired Synchronous clock movement is through a series of brakes and slip clutches which allow all clocks in a system to be regulated and indicate the same time.

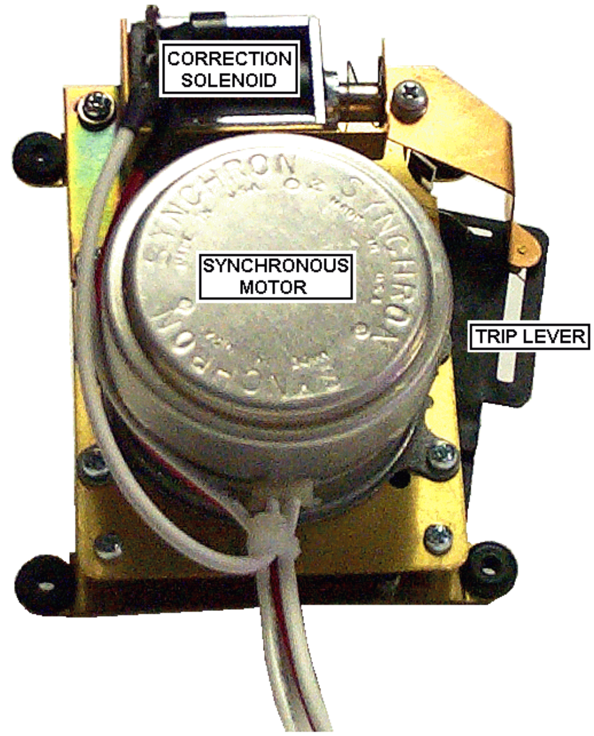


Figure 6 - WIRED SYNCHRONOUS CLOCK MOVEMENT

The most common Synchronous Clock Movement used in clocks systems is called the Hansen Movement. This movement has two levels of correction, hourly and 12 hour. The hourly correction can correct the minute and second hands for errors of approximately 55 seconds fast and 59 minutes slow. The 12 hour correction can correct errors in the hour hand. The hourly correction from the Master Clock is an 8 second signal beginning at 57 minutes and 54 seconds after each hour. A complete hourly correction requires 1 Minute and 6 seconds. The Second and Minute Hands will be synchronized with the Master Clock at the 59th minute. The 12 hour correction signal is a 14 second signal beginning at 5:57:54. If a correction is needed, the movement will advance at 60 times the normal rate to 5:59:00. The time required for this correction depends on the error in the hour hand. The final correction of the Minute and Second Hands will occur at the 6:57:54 hourly correction and will be correct at 6:59:00. Wired Synchronous Clock Systems are available in 115 VAC or 24 VAC.

These clocks are MidWest Time Control Models ASC-10-xxx (120 vac) and ASC-12-xxx (24 vac).

Page 13 shows wiring for wired synchronous clock systems.

An example of an older type System Wall Clock still in operation was manufactured by Cincinnati Time, Faraday and Honeywell. An hourly correction signal for this clock begins at 58:05 and is 55 Seconds long. A 12 hour correction is accomplished by multiple hourly corrections between 5:02 and 5:35 AM and PM. A second clock in wide spread use is a Dual Motor clock manufactured by Standard Electric, Stromberg and Edwards. Many of these older Wall Clocks can be corrected by modern microprocessor based Master Clocks.

Pages 14 & 15 show wiring for these systems.

ELECTRONIC SYNCHRONOUS CLOCKS

Electronic Synchronous Clock Systems are very similar to Wired Synchronous Systems. The primary difference is the technique used to send a correction signal to the movement. In an Electronic System, the Master or synchronizing device correction signal is a high frequency signal impressed on the AC Power Line. Each clock has a receiver that is tuned to that high frequency. When the receiver senses the signal, it will then start a correction cycle in the movement. The correction cycle within the movement is the same as Wired Synchronous systems.

DIGITAL CLOCKS

Digital Clocks provide a new dimension in Synchronized Clock Systems. They are generally electronic in operation with no mechanical moving parts. They can be configured to operate in a Minute Impulse or Wired Synchronous system. In addition, they can be configured to be corrected from a low voltage data signal (RS485). The most common Digital Clocks are constructed with Red Light Emitting Diodes for the display.

Modern Digital Clocks used as system clocks are normally micro-processor based and can be programmed to perform many functions reserved for more conventional Master Clocks. The correction method and time can be factory programmed to interface with many existing clock systems and computerized time and attendance systems.

Wired Synchronous Digital Clocks operate very similar to analog wired-synchronous clocks. The clock is continuously powered by the run voltage. When a correction signal of the proper time duration is received, the clock will set to the proper minute for an hourly correction or set the hours and minutes for a 12 hour correction. Most clocks of this type may be mixed with analog clocks of the same correction type without any problem.

MidWest Time Control manufactures a Digital Wall Clock with a relay output to correct Wired Synchronous clocks. This Clock may be used as a Master for Digital or Analog clocks.

Impulse Digital Clocks are only slightly more complicated to use. A digital clock requires continuous power to light the display. A separate power source is required for these clocks. The impulse digital clocks manufactured by MidWest Time Control will correct to most 2 or 3 wire impulse systems on the market. The clocks run independent of the impulse system except during the correction sequence. These clocks use 2 wires and are not polarity sensitive. From the above discussion on impulse clocks, you will recall that there is a series of rapid impulses during the 59th minute of each hour. The digital clock will sense these rapid pulses and set xx:59. The master clock will stop these rapid pulses at the 50th second. The digital clock will sense this dead period and wait for the next impulse. This next impulse is the 0 minute pulse. The digital clock will set to xx:00. The digital clock also resets the seconds and cycle counters to synchronize with the master clock. The clock will accept impulses at any time except between 5:00 and 5:40. This allows the clock to be used on 12 hour correctable systems.

RS485 Correctable Digital Clocks provide a new dimension to synchronized clock systems. The clocks manufactured by MidWest Time Control run independent until a signal is received. This signal is checked for proper protocol and correct data. The clock is then set to the time received. These clocks may be synchronized by a master clock, computer, or any other device capable of transmitting a RS485 signal.

MidWest Time Control manufactures a Digital Clock that is a master that sends out a RS485 signal to correct other digital clocks. This provides a very economical synchronized digital clock system.

MidWest Time Control has two series of Digital Clocks with 4" Digits (DSC-300-xxx and DSC-400-xxx).

WIRING CONSIDERATIONS

As with any electrical system, the wiring for a clock system should be installed to meet the local electrical code requirements.

10 Gage = 0.00102 Ohms per Ft.
12 Gage = 0.00162 Ohms per Ft.
14 Gage = 0.00257 Ohms per Ft.
16 Gage = 0.00410 Ohms per Ft.
18 Gage = 0.00651 Ohms per Ft.

Wire Resistance by Wire Size
Figure 7

In the design of the electrical wiring, care should be taken to assure that the Voltage available at the most distant clock does not drop below the level required for reliable operation.

Two very important numbers are needed to begin specifying the electrical wiring

1A. **The total load, in Amps.** This is the number of Clocks times the clock current plus any other loads on the system such as Payroll Recorders or Time Stamps.

2A. **The wire length, in feet**, required to reach the most distant Clock or other load. For Minute Impulse Systems the wire length must be the one way distance times 2. For Wired Synchronous Systems the wire length must be the one way distance times 1.5.

MINUTE IMPULSE SYSTEM WIRING

The typical minute impulse clock movement solenoid electrical specification is 24 Volts DC, approximately 0.050 Amps and 480 Ohms. To assure operation of the most distant clock, the voltage available to operate that clock should be no lower than 22 Volts DC.

1B. Note the capacity of the DC Power Source in the Master Clock in Amps. If the total load, in Amps, exceeds the capacity of the Master Clock it will be necessary to separate the system into more than one branch and install a Power Booster.

2B. Note the Voltage level of the DC Power Source in the Master Clock. Most Master Clocks have the capacity for more than 24 Volts DC.

Example:

1C. Assume the Master Clock DC Voltage out is 28 Volts DC and we want the DC Voltage at the most distant Clock to be no lower than 22 Volts DC. 28 - 22 = 6 Volts (The voltage drop that we can allow in the wiring.

2C. Assume there are 50 wall Clocks. (50 X .050 = 2.5 Amps load)

3C. 6 Volts (Allowable Voltage Drop) / 2.5 (Total load) = 2.4 Ohms (Maximum Wire Resistance)

4C. Using the wire resistance figures in Figure 7. (Refer to wire length calculations in 2A)

With 16 Gage wire, the calculation will be; 2.4 Ohms / 0.00410 Ohms per ft. = 585 feet of wire or 292 feet from the master to the most distant clock.

With 12 Gage wire, the calculation will be; 2.4 Ohms / 0.00162 Ohms per ft. = 1481 feet of wire or 740 feet from the master to the most distant clock.

WIRED SYNCHRONOUS SYSTEM WIRING

The Wired Synchronous Clock run motor has a power requirement of 4 VA (0.035 Amp @ 115 VAC or 0.167 Amp @ 24 VAC). The Correction solenoid also has a power requirement of 3 VA for a total load per Clock of 0.061 Amp @ 115 VAC or 0.292 Amp @ 24 VAC.

The electrical wiring should be sufficient to assure that the voltage drop at the most distant clock is no more than 10 % of the nominal line voltage (11.5 VAC for 115 VAC Systems and 2.4 VAC for 24 VAC Systems).

Example:

1D. Assume there are 50 Wired Synchronous Wall Clocks rated at 115 VAC.
(50 X 0.061 = 3.05 Amps load).

2D. 11.5 VAC (Allowable Voltage Drop) / 3.05 Amps = 3.77 Ohms (Maximum wire Resistance).

3D. Using the wire resistance figures in Figure 7. (Refer to wire length calculations in 2A)

With 18 Gage wire, the calculations will be; 3.77 Ohms / 0.00651 Ohms per ft. = 579 feet of wire or 386 feet from the master to the most distant clock.

With 12 Gage wire the calculations will be; 3.77 Ohms / 0.00162 Ohms per ft. = 2327 feet of wire or 1551 feet from the master to the most distant clock.

NOTE: This is a simplified method of computing wire size, it places the total load at the end of the wire. It is a conservative calculation and should provide a good safety margin.

BOOSTERS

In Clock Systems where there are large numbers of Wall Clocks or long distances, the wire size may sometimes be so large to be impractical or the load capacity of the power source in the Master Clock may be insufficient. In these cases it is desirable to break the system wiring at some point and install a Booster. The Booster will accept signals from the Master Clock and restore the voltage levels to the original signal levels.

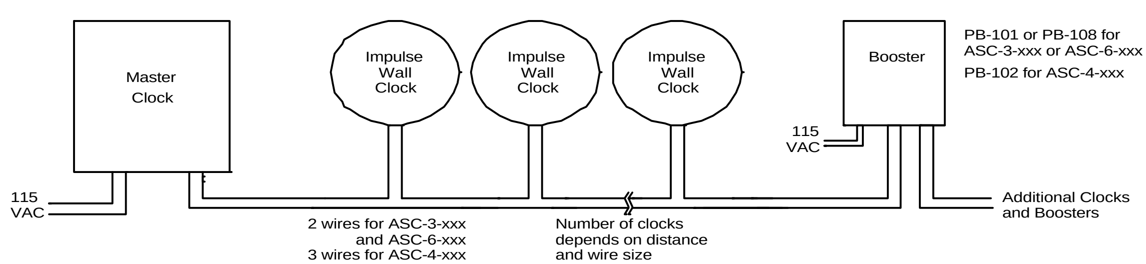


Figure 8 - BOOSTER WIRING DIAGRAM

MASTER CLOCKS

Most modern Master Clocks are micro-processor based, software controlled devices. They are capable of performing functions unheard of in mechanical clocks. Including extended Battery back up for time and memory and automatic daylight savings time correction. (The MidWest Time Control Master contains a 10 year Lithium battery for time and memory retention.) The possibilities for future addition of features and options are very wide. They can be programed to correct most obsolete wall clock systems. They are much more reliable and less expensive to purchase.

The Master Clock, as the name implies, is the central time base for a clock system. It has two basic functions. First, it provides the synchronizing signals for indicating clocks and time keeping devices, Second, it has programmable circuits for controlling signaling devices such as bells and whistles or the beginning and ending time for user devices can be programed.

A Master Clock, with the appropriate RS232 communications port, can be programed from a Computer Terminal. With this feature, the Programmable Circuit schedules can be easily modified at the terminal then sent to the Master Clock. This also allows the computer terminal and the master clock time to be synchronized.

RS232 has a limitation of 75 feet between devices. If this is a problem, the signals can be converted to RS422. Page 15 shows wiring for this type of system.

Master Clocks equipped with a RS232 Communications Port and connected to a Modem can be programmed from a remote computer terminal via telephone or dedicated line. Multiple systems can be programmed from a single remote terminal.

With a RS485 communications port, the Master Clock places the correct time on the data buss. This time can be accessed by any device capable of reading an RS485 line. It has very successfully been used to update the time for banks of computers, Digital clock Systems, etc.

OTHER MASTER CLOCK OPTIONS AND CLOCK SYSTEMS

A modern Master Clock, with modified software, can function as a World Clock. Each Output Circuit can be used as a correction circuit for a different Time Zone. Thus a 6 circuit Master Clock can accurately reflect the time in 6 Time Zones in addition to the local time. This includes allowances for varying Daylight savings time changes. The MTC-600 by MidWest Time Control may have this option installed. Page 17 shows this type of system.

Modern Master Clocks can also be connected in a Master-Slave arrangement for additional Output Circuits, multiple building controls, etc.

In most Master Clock Systems, the customer is primarily interested in all of the functions within that business operating with a single time base. There are some critical businesses where it is desirable for a synchronized time base at remote locations. There are several methods of accomplishing this function. The method used depends on the need of the customer and his budget.

1. **Nationwide Power System.** (See Figure 8, Page 11)
   As described in the referenced Figure, the frequency of the electrical power distribution systems in the United States and Canada are monitored and compared to the UTC, then controlled to assure that the long term frequency is 60 cycles per second. At any point in time there may be as much as 240 cycles (4 Seconds) difference but the system frequency is increased or decreased to make up for the difference. There are no synchronizing signals in this system other than the basic frequency of the AC Voltage. Once isolated Clock Systems are coordinated, they can vary by the plus or minus 4 seconds tolerance allowed between different power grids.

   This is the time base used by MidWest Time Control Master Clocks. This allows the Master Clock to be within 4 seconds of UTC (Universal Coordinated Time) at any time. These master clocks are so accurate that when set up beside a UTC clock, you can actually see the 4 second variations.

2. **Universal Coordinated Time (UTC).**
   In the continental United States, the National Bureau of Standards broadcast standard time signals from Fort Collins, Colorado (WWV) which can be used to synchronize clock systems. This is an inexpensive means of obtaining a very accurate time standard. The accuracy of the Clock System depends upon the frequency of sampling the time standard, the availability of the time

standard and the inherent accuracy of the Clock System. The main problem with this signal and similar systems in other countries is the broadcast signals are low power and are subject to fading due to weather disturbances. As distance from the broadcast station increases, the antenna required to receive the signal becomes more elaborate.

3. **National Bureau of Standards Telephone.**
   In the United States, the National Bureau of Standards has a telephone access for Universal Coordinated Time. There is no charge for accessing this service other than normal telephone charges. This signal is also very accurate and the accuracy of the clock system depends on the frequency of call and the inherent accuracy of the Clock System. There is a continuing expense involved in the cost of telephone service. The cost will vary with the frequency of use.

4. **Naval Observatory Telephone.**
   This is a Time Standard Service very similar to the National Bureau of Standards service. It is maintained by the U.S. Naval Observatory. The advantages and disadvantages are the same as those above.

5. **Global positions satellite system.**
   This is a system of 18 Satellites designed for Global Positioning. There are time signals broadcast from these satellites that can be used for synchronizing Clock Systems. A the present time this is an expensive approach to accurate time, but it has the potential for wide spread use.

Power Firms Give Clocks A Big Hand

Chicago Tribune

CHICAGO — You say your kitchen clock seems to be running a little slow or fast these days. Well, it actually is.

The reason: what amounts to time-tampering by electric companies.

Like anything with a synchronous motor in the United States and Canada, clocks with a sweeping second hand or a mechanical digital display are designed to run on alternating current that has 60 cycles, or hertz, a second.

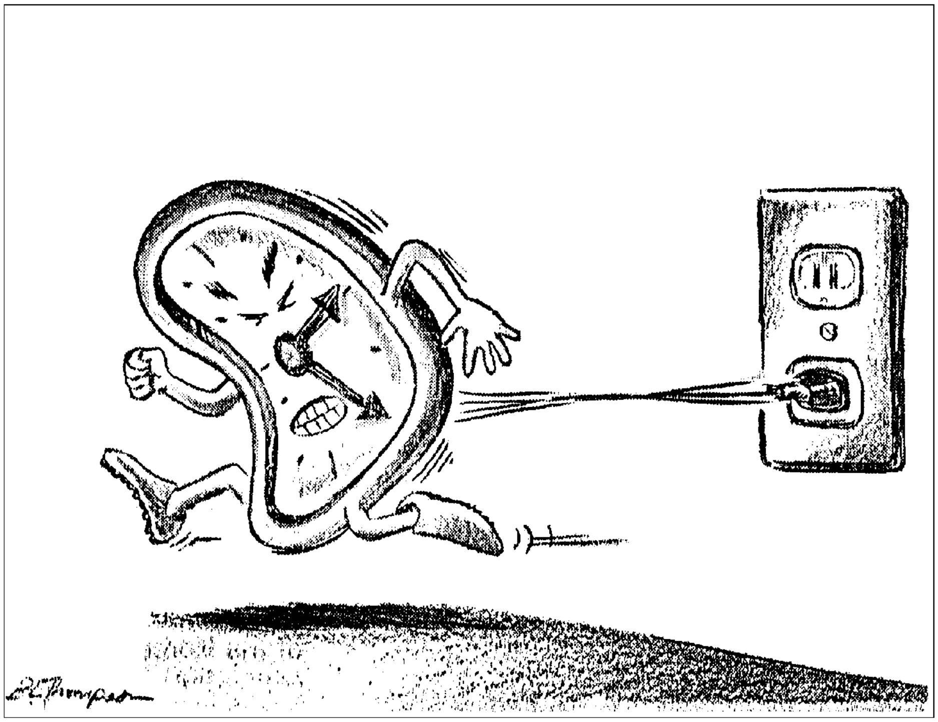
Likewise, U.S. and Canadian power generators are synchronized to spin at a frequency that produces electricity that alternates 60 times a second.

Problem is, the electricity that comes into your home is almost never exactly 60 hertz.

Whenever power consumption and output slip out of balance — an imbalance that typically occurs often in extreme weather when demand is high and rising and a generator or transmission line goes down — the power system responds by slowing down its generators, effectively stretching its output.

This means that the electricity leaving the power plant will be, say, 59.987 hertz or 59.913 hertz or some other number slightly below 60 hertz.

In turn, this means that your clock's second hand turns just a little slower, advancing not 60 seconds a minute, but 59.987 seconds or 59.913 seconds or whatever the hertz is.



Furthermore, because utilities are interconnected, an imbalance at any utility will cause an instant slowdown at all electric companies tied to the power grid.

This happened on a recent hot day, when Braidwood I tripped off-line. By mid-afternoon, clocks from Manitoba to Mississippi to Maine were more than 4 seconds slow.

The slippage is registered by computers at all the utilities' control centers and is monitored by American Electric Power Co., which acts as the official timekeeper for the United States and Canada east of the Rockies.

The Columbus, Ohio-based utility holding company assumed its timekeeper role back in the 1920s, when it used a grandfather clock with a huge pendulum as the standard against which an electric clock was measured.

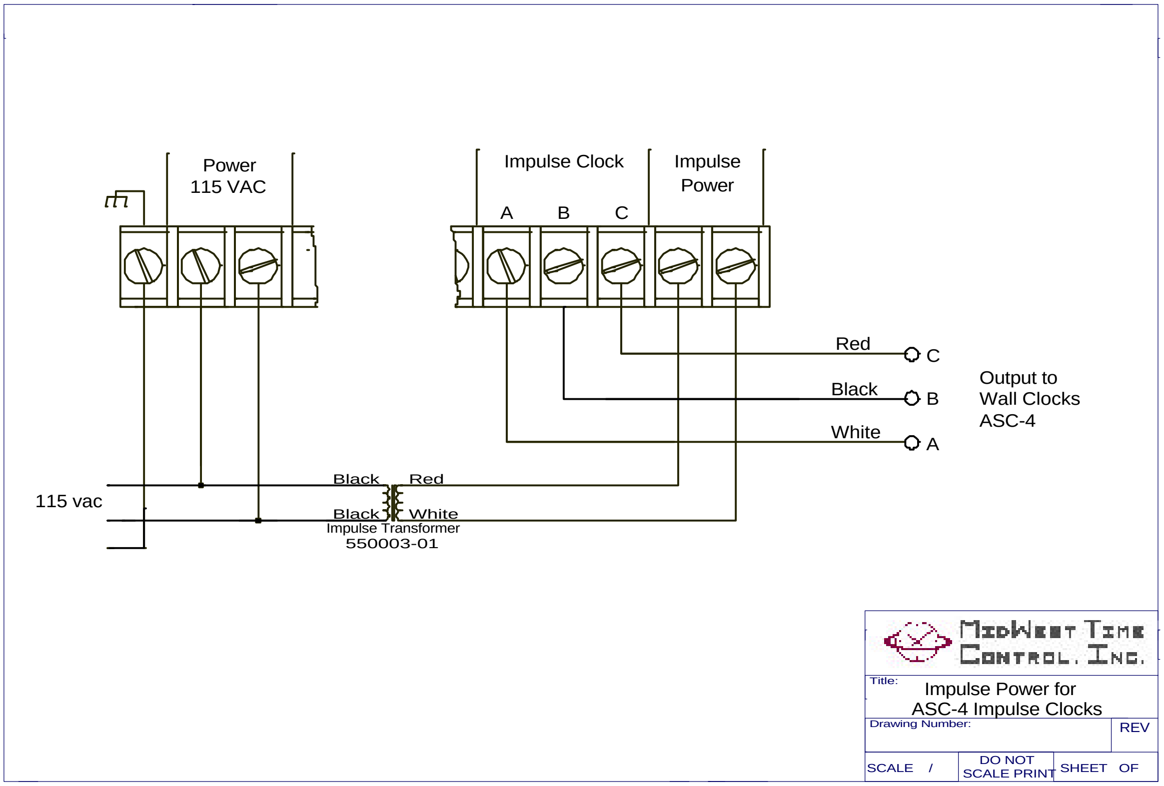
Today's set-up is more sophisticated. Like Southern California Edison Co., which is the West Coast's official timekeeper, American Electric constantly receives a radio signal from the National Bureau of Standards in Denver, telling the precise time of its atomic clock.

The readings are fed into a computer and whenever the time of the atomic clock and a synchronous clock in Columbus deviate by more than 4 seconds, the company orders a time correction.

American Electric calls its utility subsidiaries and they call their neighbors until, like in a pyramid game, every Eastern electric company has been notified.

Then, at a designated time, usually at night when demand is down and more capacity is available, they all change the speed of their generators to produce power at 60.02 hertz if time has lagged or at 59.98 hertz if time has gotten ahead of itself.

Figure 9 - SYNCHRONIZED POWER GRID



Power
115 VAC
Impulse Clock
Impulse
Power
A
B
C
Red
C
Black
B
White
A
Output to
Wall Clocks
ASC-4
115 vac
Black
Red
Black
White
Impulse Transformer
550003-01
MidWest Time Control, Inc.
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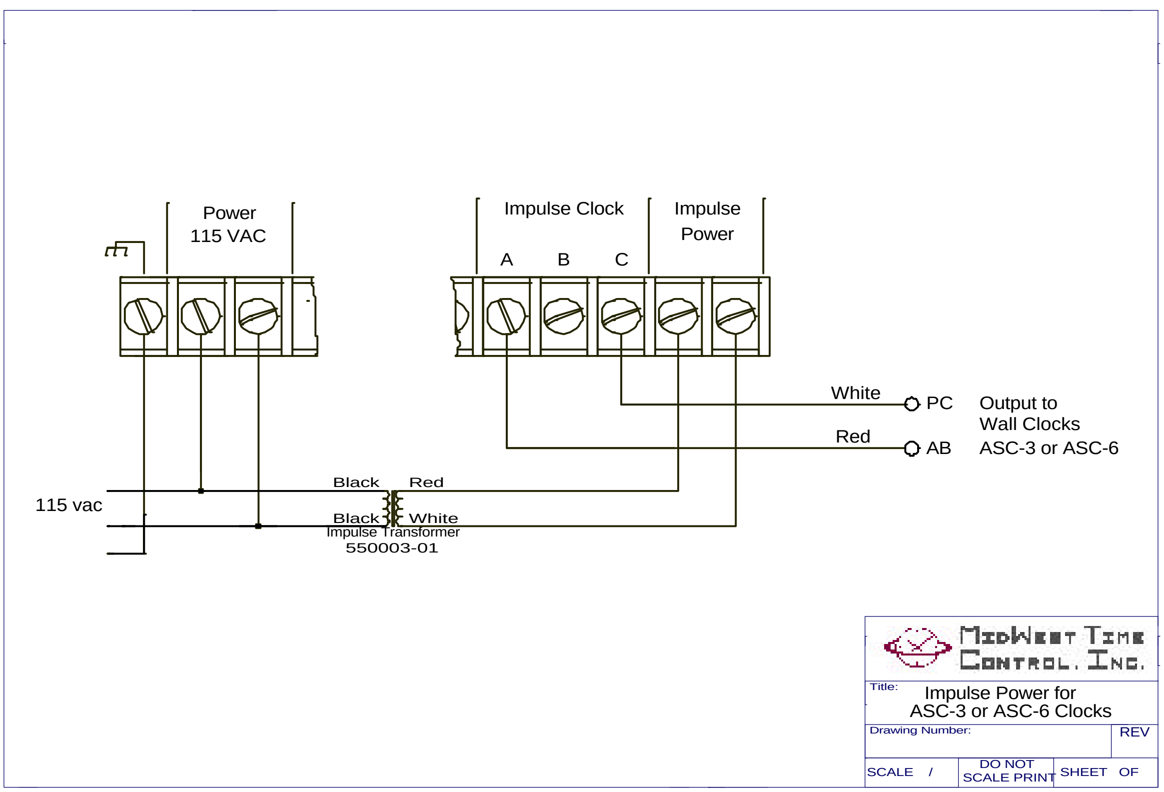
Impulse Power for
ASC-4 Impulse Clocks
Drawing Number:
REV
SCALE /
DO NOT
SCALE PRINT
SHEET OF



Power
115 VAC
Impulse Clock
Impulse
Power
A
B
C
White
PC
Red
AB
Output to
Wall Clocks
ASC-3 or ASC-6
115 vac
Black
Red
Black
White
Impulse Transformer
550003-01
MidWest Time Control, Inc.
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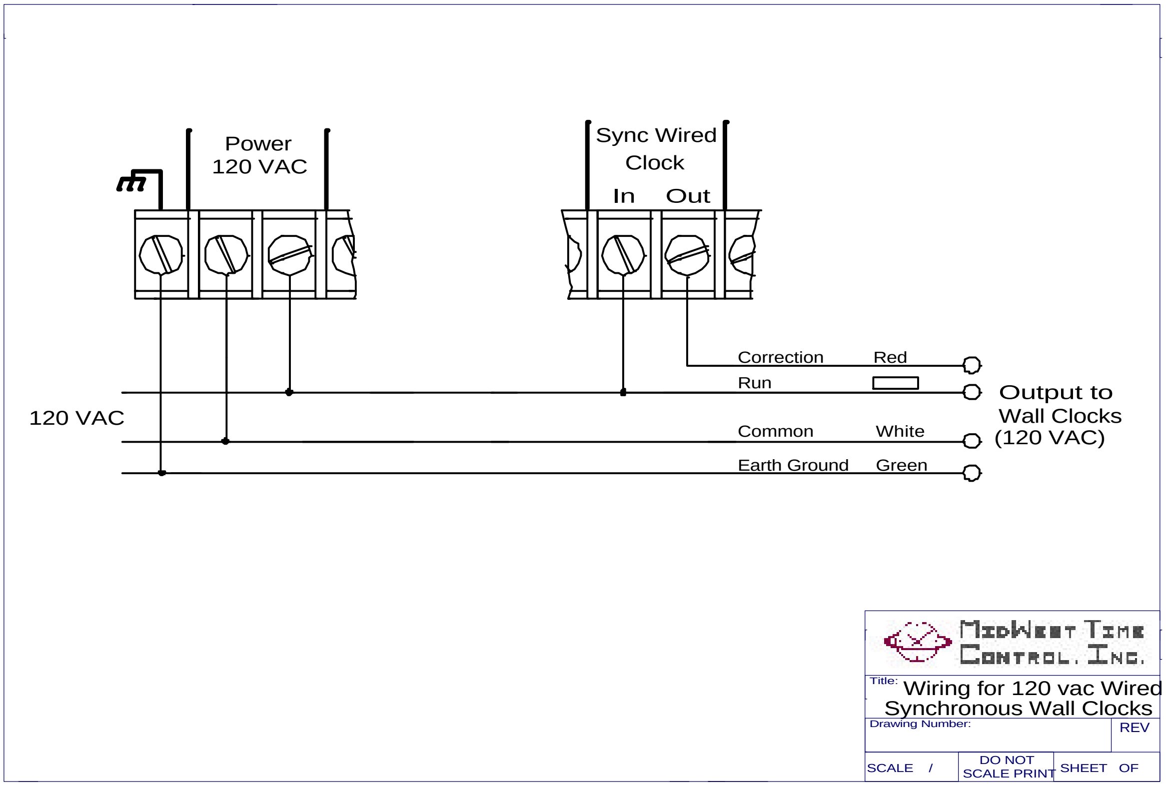
Impulse Power for
ASC-3 or ASC-6 Clocks
Drawing Number:
REV
SCALE /
DO NOT
SCALE PRINT
SHEET OF


Power
120 VAC
Sync Wired
Clock
In
Out
Correction
Red
Run
Output to
Wall Clocks
(120 VAC)
120 VAC
Common
White
Earth Ground
Green
MidWest Time
Control, Inc.
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Synchronous Wall Clocks
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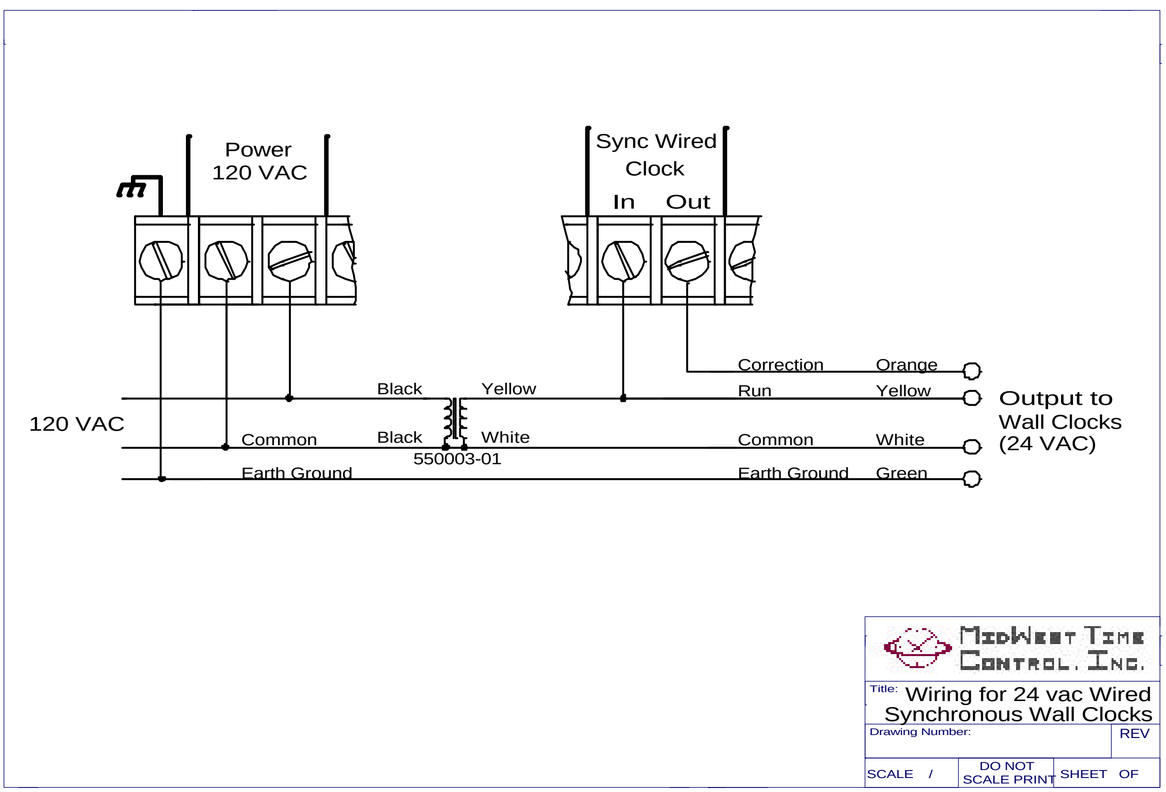
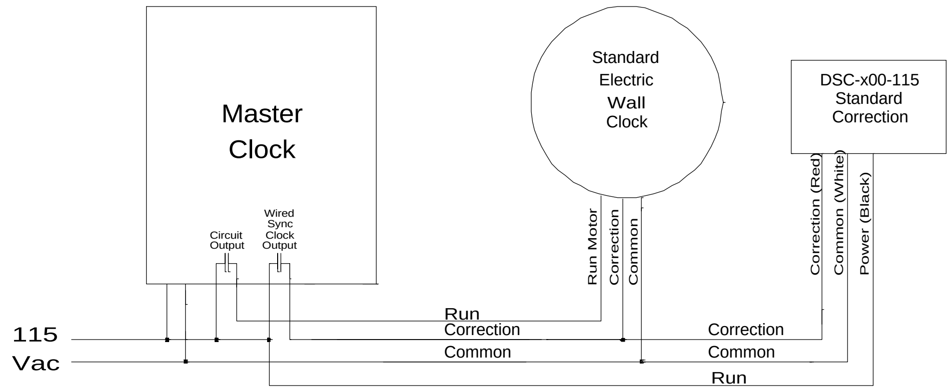
REV
SCALE /
DO NOT
SCALE PRINT
SHEET OF


Power
120 VAC
Sync Wired
Clock
In
Out
Correction
Orange
Black
Yellow
Run
Yellow
Output to
Wall Clocks
(24 VAC)
120 VAC
Common
Black
White
Common
White
550003-01
Earth Ground
Earth Ground
Green
MidWest Time
Control, Inc.
Title: Wiring for 24 vac Wired
Synchronous Wall Clocks
Drawing Number:
REV
SCALE /
DO NOT
SCALE PRINT
SHEET OF



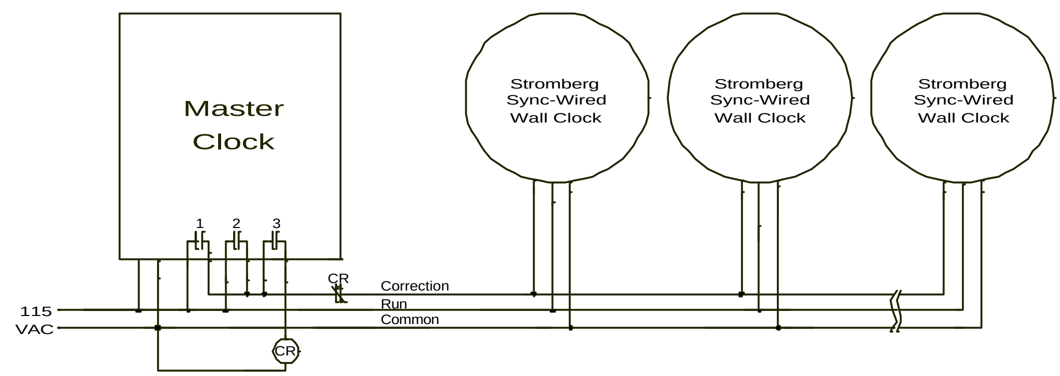
Wiring Shown for MTC-200, 400, or 600
with Correction Code 02 programmed

MidWest Time Control, Inc.

Title: Wiring for Standard Electric Clocks and Digital Clocks

Drawing Number: REV

SCALE / DO NOT SCALE PRINT SHEET OF



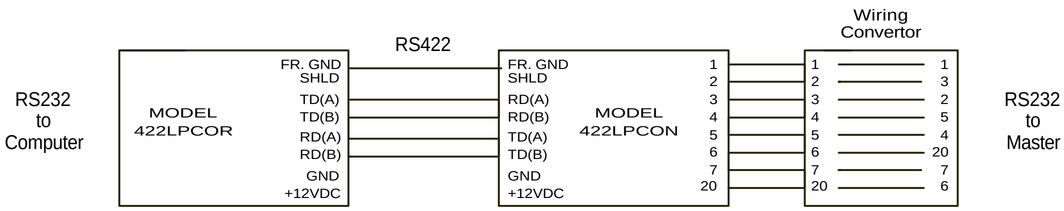
Channel #	1	2	3
Duration	24 sec	18 sec	10 sec
	11:56		11:56
ON TIMES		12:56	12:56
(AM & PM)		1:56	1:56
		2:56	2:56
		3:56	3:56
		4:56	4:56
		5:56	5:56
		6:56	6:56
		7:56	7:56
		8:56	8:56
		9:56	9:56
		10:56	10:56

MidWest Time Control, Inc.

Title: Correction for Stromberg 58th Min. Sync-Wired Clocks

Drawing Number: REV

SCALE / DO NOT SHEET OF



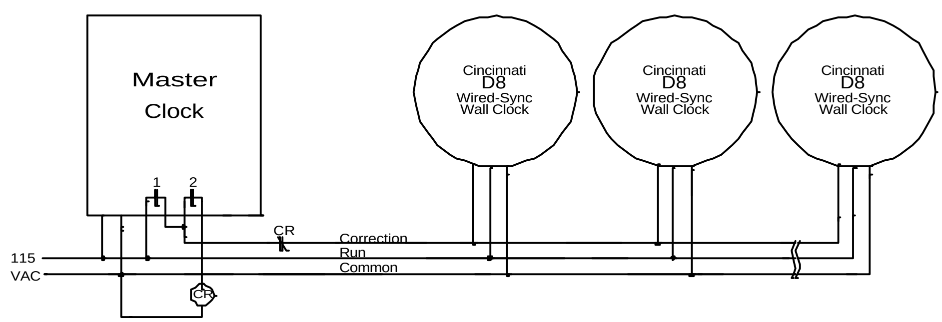
Convertors manufactured by B & B Electronics

MidWest Time Control, Inc.

Title: RS422 Convertor Wiring

Drawing Number:	REV

SCALE /	DO NOT SCALE PRINT	SHEET OF



The basic Hourly correction is a 55 second signal at xx:58:05. This correction signal will synchronize the minute and second hands at the 59th minute. The 12 hour correction is accomplished between 5:02 and 5:35.

The schedule shown, programmed for both AM & PM, will correct for at least a 3 hour error between 5:05 and 6:59 each day. It also provides 6 hourly corrections each day.

This schedule consumes 462 memory exents in the standard MTC series Master Clock. This leaves 188 memory events for programing of output circuits. If this is insufficient to accomplish the output circuit programing needed, the options are:

1. Omit one or more of the 12 hour correction cycles (between 5:05 and 5:30 AM and PM). Each cycle deleted will free up 42 memory events.
2. Omit one or more of the Hourly correction cycles (between xx:58 and xx:59 AM or PM). Do not omit the 5:58 and 6:58 cycles. Each cycle dleted will free up to 21 memory events.
3. Expand the MTC Master Clock memory to 2600 events with the optional memory expantion option.

The inherent correction of this clock can result in an error of up to 5 seconds slow. This can be corrected by unplugging the wall clock until the second hand is slow by 5 to 59 seconds. It will then be corrected at the next hourly correction from the master clock.

Manual Clock Corrections can be made by positioning Circuit Control 1 switch to ON.

In normal operation, Circuit Control switches 1 and 2 must be set to AUTO.

OPERATION: At the 58th minute of each programmed hour, both output circuits will close. The NC contact of the control relay will open until circuit 2 times out (5 seconds). With this program, a correction signal will be sent out between xx:58:05 and xx:59:00.

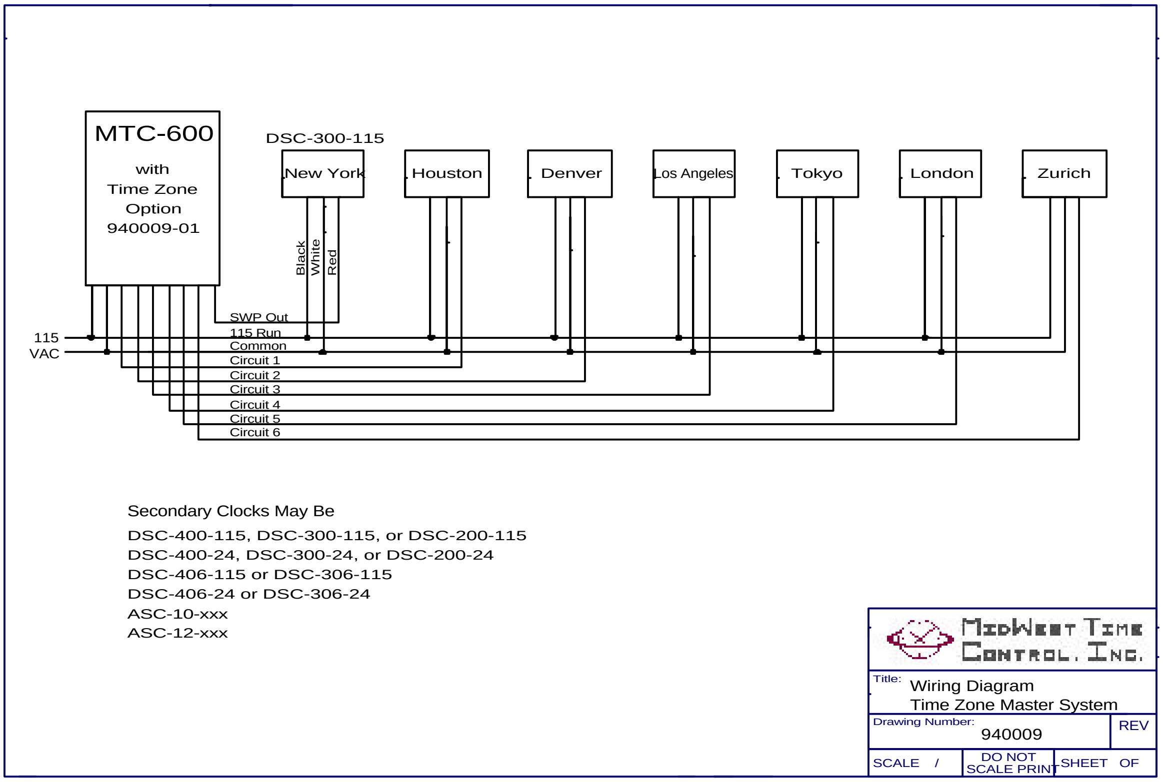
1		2	
ON Time	OFF Time	ON Time	Duration
12:58	12:59	12:58	5 Seconds
3:58	3:59	3:58	
5:05	5:06	5:05	
5:09	5:10	5:09	
5:13	5:14	5:13	
5:17	5:18	5:17	
5:21	5:22	5:21	
5:25	5:26	5:25	
5:58	5:59	5:58	
6:58	6:59	6:58	
9:58	9:59	9:58	

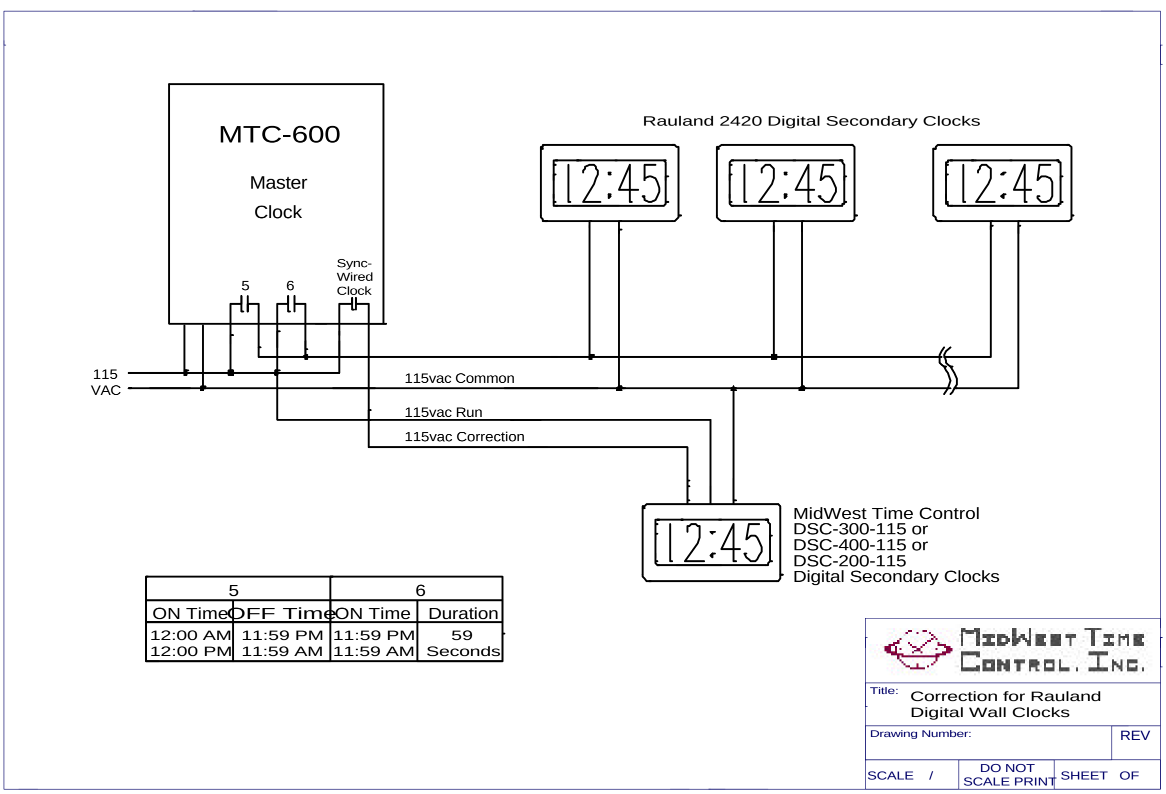
MidWest Time Control, Inc.

Title: Correction for Cincinnati D8 Wired-Sync. Wall Clocks

Drawing Number:	REV

SCALE /	DO NOT SCALE PRINT	SHEET OF





5		6	
ON Time	OFF Time	ON Time	Duration
12:00 AM	11:59 PM	11:59 PM	59
12:00 PM	11:59 AM	11:59 AM	Seconds