WOODWARD

Application Note 51215
(Revision A)

Original Instructions

EGCP-3

Configuration of EGCP-3 Controls for Automatic Transfer Switch (ATS) Operation in a Single-Bus Single-Utility Application

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

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Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

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Warnings and Notices

Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Configuration of EGCP-3 Controls for Automatic Transfer Switch (ATS) Operation in a Single-Bus Single-Utility Application

Introduction

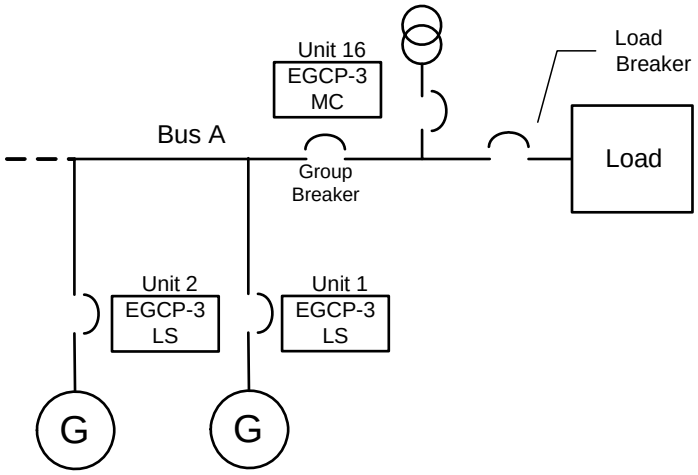
ATS operation using EGCP-3 controls is a powerful way to create a supervisory method of controlling your internal generation system. By applying internal generation to supply the local plant load, companies can save money during times of high load or utility instability. Two methods of applying this operation are available in the EGCP-3:

- Open Transition (no utility parallel)
- Closed Transition (utility parallel)

Because of the configurability of the EGCP-3, the application of these modes can take several forms depending on system configuration and any contractual obligations that a company has with its utility. This document will help configure your control for this operation.

This application note discusses the configuration of the EGCP-3 for ATS operation with a generator group breaker and without a group breaker.

System Configuration
ATS with a Generator Group Breaker



Description of Operation

ATS operation with a group breaker performs well for systems where the load needs to be assumed by the generation units in the fastest possible time. The EGCP-3 MC unit initiates the transfer by asserting Auto and Test inputs (Test ATS mode) or the Auto, Test and Run w/Load inputs (Initiate ATS mode), or by a Time of Day start. The initiation of these modes can be accomplished via digital inputs, Modbus® * or ServLink/Watch Window, and each mode will behave differently depending on how the MC is configured.

*—Modbus is a trademark of Schneider Automation Inc.

Closed Transition

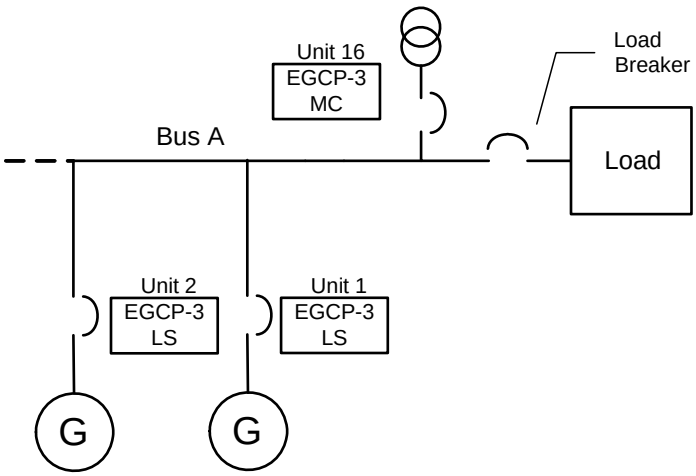
When initiated, the MC sends a Start command to all start-ready EGCP-3 LS units (to be start ready, the LS unit must be in Auto and not have any current shutdowns). The LS unit(s) then start the generators and synchronize them to the bus. The MC unit monitors how many generators are online and compares the load capacity of the generators to a configurable transfer capacity setpoint. Once the capacity on the bus exceeds the transfer capacity configured in the MC, the MC then synchronizes all of the LS units to the mains, and the group breaker is closed. On confirmation of closure from the group breaker, the MC calculates a load ramp rate for the generators so that the utility can be unloaded at the transfer time, which is set by the Fast Transfer Time setting. The timing is set up so that at the end of the fast transfer time, zero power should be flowing through the mains breaker, and the mains breaker will be opened. When the mains opens, the LS units assume the load in isochronous load sharing.

Open Transition

The EGCP-3 offers two methods of operation for Open Transition for this application with a group breaker. First, the MC can be configured to open the mains immediately upon ATS initialization, or second, the MC will command the LS units to start the generators first and wait for the transfer capacity and bus stabilization to be achieved before opening the mains breaker. When the MC is configured to open the mains immediately, the MC opens the mains and then gives a Start command to all LS units. The LS units then start and synchronize the generators to the bus. Once the transfer capacity is reached, the group breaker is closed onto the dead load bus and the LS units assume isochronous load sharing. When the MC is configured to start the LS units first, it sends a Start command to the LS units, which then start and synchronize the generators to the bus. When the transfer capacity is reached, the mains breaker is opened and the fast transfer time begins to count down. When the fast transfer time expires, the group breaker closes onto the dead bus and the LS units assume the load in isochronous load sharing.

The ATS is not limited to having a group breaker. The system can also be configured to operate without this breaker.

System Configuration
ATS without a Group Breaker



Description of Operation

ATS operation without a group breaker works well for systems where the load on the bus can be assumed by one generator if other units fail to start or cannot synchronize to the bus before the fast transfer time expires. For this type of operation, the Transfer Capacity setting in the MC should be set to its lowest value.

Closed Transition

When initiated, the MC sends a Start All command to all start-ready LS units, which in turn start and synchronize to the bus. When the first LS unit closes onto the bus and the MC receives confirmation that at least one unit is ready to assume load, the MC then begins to count down its fast transfer time and ramp the LS unit to assume the entire load on the bus. If another LS unit synchronizes to the bus before the mains is opened, it will also assume load. The timing is set up such that when the first LS unit closes onto the bus, the MC determines a loading rate based on the capacity of the LS unit for the first generator that closed on the bus, and begins to load that LS unit. At the end of the fast transfer time, zero power should be flowing through the mains breaker, and the mains breaker will be opened. When the mains opens, the LS units assume the load in isochronous load sharing.

Open Transition

For this application with no group breaker, there is no way to achieve an open transition for more than one generator. The MC opens the mains immediately upon ATS initialization. The MC opens the mains and then gives a Start command to all LS units. The LS units then start and synchronize to the bus and assume the load in isochronous load sharing.

EGCP-3 LS Configuration

Before discussing the configuration of the LS unit, some important operation characteristics need to be reviewed. When an ATS is initiated by an MC control, the MC sends a Start command to the LS units. This is seen by the LS as an Mstart Cmd through the LON. All LS units that are Start Ready (Auto input closed and no active shutdowns) are then started and synchronize to the bus individually. The MC then performs the transition depending on its configuration. When the LS units finally assume isolated operation, they will be in control of the load on the bus and will be able to perform their load-dependent sequencing. The LS units will perform the start/stop sequencing configuration and the measured kVA. If the Run Time Manager is set for Disabled, no sequencing occurs on that LS unit. If the LS unit has its Run Time Manager set for one of the other five possible sequencing algorithms, it can be sequenced on and off of the bus.

The EGCP-3 LS has several configurables that can affect the operation of the ATS function. Because the LS units do not perform the transition but instead listen to the MC's commands, it is helpful to understand the communication between the two during this operation. The communication between the LS and MC takes place over the LON network. This communication can be monitored using the Woodward Watch Window software by viewing the variables in the LON Messaging Service Header. All communication troubleshooting should initially begin with this menu, and the important variables to look at for this application are:

LON Inputs:

- 15 Start Rdy
- 19 Capacity
- 20 Pwr Units
- 27 SS Arb Alg

LON Outputs

- 37 Proc Slave
- 45 Sys_PF
- 46 Sys_Load
- 47 Sync_Bias
- 59 Err Flag
- 60 Mstart Cmd
- 61 Mstop Cmd
- 62 Error Number
- 63 Sync Mstr in Control

These variables are defined as follows:

1. Start Rdy—A start ready node is any LS unit that has the following attributes:
   First Time Config—LON Start Sequencing—ENABLED
   Auto mode is enabled
   The generator breaker is open
2. Capacity—This is the rated watts of the generator in the units dictated by the PT and CT ratio and seen in Units–Gen Power.
3. Pwr Units—This is the integer value of the units for capacity:
   (1=W, 2=kW, 3=MW, 4=GW)
4. SS Arb Alg—Start/Stop Arbitration Algorithm. This is the integer value given to the LON for LS sequencing. Sequencing–Run-Time Manager:
   0 = Disabled, 1 = Staggered, 2 = Equal Time, 3 = Large 1st,
   4 = Small 1st, 5 = Unit Number
5. Proc Slave—This output tells an LS unit if it is being controlled by either a process master LS unit or an MC. The process master controls the Sys_PF and Sys_Load commands.
6. Sys_PF—This is the PF reference that the LS unit is to control at when it is a process slave.
7. Sys_Load—This is the load reference that the LS unit is to control at when it is a process slave.
8. Sync_Bias—This is the sync (speed) command sent by a process master to its slaves for synchronization to another bus.
9. Err Flag—The error flag states that an error was found on the LON network. The most common error flag is that all LS units do not have the same SS Arb Alg or that two LS units have the same node number.
10. Mstart Cmd—This is a start sent by an MC.
11. Mstop Cmd—This is a stop sent by an MC.
12. Error Number—This number helps the user troubleshoot an Err Flag. The most common numbers are those node numbers where an LS unit sees two numbers. An error of 261 indicates mismatched values for the SS Arb Alg.
13. Sync Mstr in Control—This field indicates that an MC is actively trying to synchronize the LS units in its control.

*See chapter 4 of manual 26194 for a complete listing of all variables.

The following is a simple example of sequencing:

Example—A plant operator has a continuous load of 2.5 MW and a variable load of 1 MW depending on time of day. The plant has been contracted by the utility to use its in-house generation during peak utility demand, and the plant manager has decided to use EGCP-3's to accomplish this task. Because of the variable load, and to improve overall plant efficiency, all units do not need to be online all of the time. The operator makes the decision to operate two 1.5 MW units all of the time and use two 500 kW units depending on system load levels.

Configuration:
This is a simple configuration where the two larger units need to have their Run Time manager set for Disabled, therefore they will stay on during the ATS isolated operation. The smaller units are then set for an actual arbitration algorithm. A good algorithm in this example would be Staggered operation so that the smaller units could be serviced at different intervals without interfering with the ATS during maintenance.

This example is only one way to configure the system. Depending on plant specifications, a number of different methods of performing sequencing could be applied to the system.

Configuration Points

The important configuration variables for the ATS operation in the EGCP-3 LS are:

First Time Configuration:
- Bus Segment
- LON Start Sequencing

Synchronizer:
- Synchronizer Mode
- Dead Bus Closure

Transfer Switch:
- Gen Stable Delay

The MC only communicates with LS units on its active bus segment and those that have their LON start sequencing enabled—therefore the Bus Segment of the LS and MC must be the same, and LON Start Sequencing must be enabled to operate properly. For more information about the LON communications and bus segments, see chapter 23 of manual 26194. In order for the LS unit to operate its generator breaker, the Synchronizer mode must be set to Run. Any other setting will require some other device or individual to close the generator breaker. For any Open Transition ATS operation, Dead Bus Closing must be enabled. The Gen Stable Delay is the amount of time that the voltage and frequency of the generator must be within specifications before it will be allowed to close its breaker onto a dead bus or to synchronize onto a live bus.

Sequencing Configuration (LS)

Configuration of the LS units follows the same methods of setting up an isolated system; the sequencing of the units is documented here. The operator has several configurations to work with in the sequencing menu:

- Run Time Manager—Type of sequencing performed by LS units
- Max Load Delay—Time above the Max Gen Load Level before the next unit is started
- Rated Load Delay—Time above rated load before the next unit is started
- Reduced Load Delay—Time below the Min Gen Load Level before the next unit is stopped
- Max Gen Load Level—Percent of system load at which another unit should be sequenced on
- Min Gen Load Level—Percent of system load at which one unit should be sequenced off

The sequencing type found in the Run Time Manager is the operator's preference. The only requirement is that this setting must either be set to disable or the same as the other units in the system. It is not possible to have mixed sequencing types. The delays and levels are important for operation, and care must be taken to select values that will not overload units or create start/stop cycling. Usually the most important point of operation is the transition between a single unit and two units online. In this example the operation of the units at close to their rated load would be desirable. If the Max Gen Load Level is set at 90% in all the LS units, the LS units will start the next available generator when the system load exceeds 90% for the Max Load Delay time.

Starting with one unit online, once its load travels above 90%, the LS unit begins to count down its Max Load Delay time. When that time expires, the next available unit is told to start. The second unit synchronizes onto the bus and ramps its load to a point where both units are controlling the same percentage of load; the system load level will be approximately 45%. Now, if the Min Gen Load Level is set at or above 45%, there is a possibility that the LS units would start their Reduced Load Delay timer and possibly stop one of the two units. This sequencing cycle would continue between starting and stopping of that unit until there is a change in the load. To avoid that possibility, the Min Gen Load Level setting should be set at 40% or less to allow some room for a cushion.

Consider another programming mistake. Suppose the same two units are online at a system load of 55% and the Min Gen Load Level is set at 56%. The total load at this point is 2.75 MW, and the next unit is told to stop. Once the second unit unloads and is removed from the bus, a single unit is controlling the 2.75 MW, which would be a load of 110% on the generator, an unacceptable level. Using simple math we can avoid these problems.

First select a Max Gen Load level to operate the system, in this example 90%. At 90% load on one unit, the load would be 2.25 MW. If two units were sharing this load, the system load would be:

$$\frac{2.25\,MW}{2\_units} \bullet \frac{1\_unit}{2.5MW} = 0.45 = 45\%$$

Setting the Min Gen Load Level below this value would assure that a single unit would not be overloaded.

It is also important to note that the sequencing is determined by each LS unit on the bus. There is no master unit in this scenario that is making decisions. For example, if there were five units currently online, each of the five could make decisions about starting or stopping the next unit. So it is very important that each unit be set exactly the same. Otherwise, the LS units themselves could disagree, and the cycling of units could result.

EGCP-3 MC Configuration

The MC control performs all sequences of the ATS function, so it is critical that proper configuration be applied to the control. All of the configurables for this operation are found in the Transfer Switch Menu in the MC Operation Manual. Instead of repeating this information here, this publication presents a few simple application examples and how to configure them.

Application 1—Closed Transition ATS with a Group Breaker

A large hospital contains three generation units of 2.5 MW. Lately the utility has been somewhat unreliable and has had difficulty meeting its load obligations. The utility has asked the hospital to supply its own load during work hours and then transition back to the utility during the night when load is at a minimum. The total hospital load is 7 MW. Because the hospital would like to limit fuel costs, the manager would like for the units to run at their most efficient points most of the time. Also, contractual obligations with the utility only allow the hospital's generation units to be in parallel with the utility for 10 seconds. The manager would also like to save the hospitals' breakers from large current interruptions by having a zero power transfer through the mains breaker when it is opened.

Configuration (MC):
The system configuration in this example assumes that a group breaker is used to separate the generator bus from the load bus. To configure the breaker, configure the following items (Watch Window example):

Digital Inputs:
One digital input needs to be configured for GRP (GROUP) BKR AUX
(#Digital Inputs ## - Digital Input 6 = 2 Group Breaker Aux)

Digital Outputs:
Contactor
One digital output needs to be configured for GRP BRKR CLOSE CMD
(#Digital Outputs ## - Digital Output 1 = 2 Group Breaker Close Command)
Breaker
One digital output needs to be configured for GRP BRKR CLOSE CMD
(#Digital Outputs ## - Digital Output 1 = 2 Group Breaker Close Command)
One digital output needs to be configured for GRP BRKR SHUNT TRIP
(#Digital Outputs ## - Digital Output 2 = 3 Group Breaker Trip Command)

The next step is to configure the Transfer Switch. The application calls for a closed transition of 10 seconds with a zero power transfer (ZPT) across the mains breaker. The MC has two methods of performing this action. Test ATS (Auto and Test) waits for ZPT and then opens the mains breaker—if the ZPT does not occur, the system remains in parallel with the mains. Initiate ATS (Auto, Test, Run w/Load) attempts to create a ZPT, but if the transfer time expires before ZPT, the mains breaker is opened even if the load through the mains breaker has not been fully reduced. Clearly the contractual agreements with the utility warrant an Initiate ATS, which will open the breaker after the 10 seconds.

The hospital also has a load of 7 MW. If a genset fails to start or synchronize to the bus, it is clear that the operator would like to maintain parallel operation with the mains because two gensets cannot support the total load. To accomplish this task, the transfer capacity is used to prevent a transition. If the capacity on the bus does not meet or exceed the transfer capacity, the transition will not occur and the hospital will stay connected to the utility.

Transfer Switch:
ATS Mode needs to be configured for CLOSED TRANSITION
(Transfer Switch – ATS Mode = 3 Closed Transition)
Fast transfer delay needs to be configured for 10 Sec
(Transfer Switch – Fast Transfer Delay = 10)
Transfer capacity needs to be greater than the capacity of 2 units (> 5 MW), or the total plant load (7 MW)
(Transfer Switch – Transfer Capacity = 7)
Transfer capacity units need to be MW
(Transfer Switch – XFER Capacity Units = 3)

An operator can accomplish initiation of the ATS, but the process can also be automated by using a Time of Day start.

IMPORTANT **The Time of Day start always proceeds through an Initiate ATS sequence.**

The hospital wants to run on the gensets during working hours. Setting up a Time of Day start for Monday–Friday from 8:00–17:30 (8 am to 5:30 pm) can be set up as follows.

Peaking:
Peak shaving mode needs to be TIME ONLY
(Peaking – Peak Shaving Mode = 1)
Select program 1 for:
MONDAY PROGRAM
TUESDAY PROGRAM
WEDNESDAY PROGRAM
THURSDAY PROGRAM
FRIDAY PROGRAM

Set the start hour at 8 in PROG 1 START 1 HR
(Peaking – Prog 1 Start 1 Hr = 8)
Set the start minute at 0 in PROG 1 START 1 MIN
(Peaking – Prog 1 Start 1 Min = 0)
Set the stop hour at 17 in PROG 1 STOP 1 HR
(Peaking – Prog 1 Stop 1 Hr = 17)
Set the stop minute at 30 in PROG 1 STOP 1 MIN
(Peaking – Prog 1 Stop 1 Min = 30)

The MC is now configured for the application and is ready for testing.

IMPORTANT **When using Time of Day starts, only the Auto switch needs to be set.**

Application 2: Open Transition ATS with a Group Breaker

A large bank has performed some analyses and has realized that it can save money if it runs off of its backup generators during its highest load hours. The bank does not have permission to parallel its gensets to the utility, so the operator wants to perform an open transition. The bank contains a UPS system for short interruptions, but the operator wants to make the transition as short as possible. Six 1 MW units will service the 5 MW load after a 100 ms open transition, and only 5 units need to be online to make the transition. The operator needs these units to make the transition between 9:00–10:00 and 12:30–14:00.

Configuration:
The system configuration in this example assumes that a group breaker is used to separate the generator bus from the load bus. To configure the breaker, see the closed transition application.

Transfer Switch:
ATS Mode needs to be configured for OPEN TRANSITION
(Transfer Switch – ATS Mode = 2 Open Transition)
Fast transfer delay needs to be configured for 100 ms
(Transfer Switch – Fast Transfer Delay = 0.10)
Transfer capacity needs to be at least the capacity of 5 units (5 MW)
(Transfer Switch – Transfer Capacity = 5)
Transfer capacity units need to be MW
(Transfer Switch – XFER Capacity Units = 3)

The operator accomplishes the ATS by automating the Time of Day start. The time of day set up is similar to the closed transition application.

Peaking:
Peak shaving mode needs to be Time Only
(Peaking – Peak Shaving Mode = 2)
Select program 1 for:
MONDAY PROGRAM
TUESDAY PROGRAM
WEDNESDAY PROGRAM
THURSDAY PROGRAM
FRIDAY PROGRAM

Set the start hour at 9 in PROG 1 START 1 HR
(Peaking – Prog 1 Start 1 Hr = 9)
Set the start minute at 0 in PROG 1 START 1 MIN
(Peaking – Prog 1 Start 1 Min = 0)
Set the stop hour at 10 in PROG 1 STOP 1 HR
(Peaking – Prog 1 Stop 1 Hr = 10)
Set the stop minute at 0 in PROG 1 STOP 1 MIN
(Peaking – Prog 1 Stop 1 Min = 0)

Set the start hour at 12 in PROG 1 START 2 HR
(Peaking – Prog 1 Start 2 Hr = 12)
Set the start minute at 30 in PROG 1 START 2 MIN
(Peaking – Prog 1 Start 2 Min = 30)
Set the stop hour at 14 in PROG 1 STOP 2 HR
(Peaking – Prog 1 Stop 2 Hr = 14)
Set the stop minute at 0 in PROG 1 STOP 2 MIN
(Peaking – Prog 1 Stop 2 Min = 0)

The MC is now configured for the application and is ready for testing.

IMPORTANT **When using Time of Day starts, only the Auto switch needs to be set.**

Modes of Initiation

The ATS function has three modes of initiation that can come from three sources.

- Initiation by AUTO and TEST
- Initiation by AUTO, TEST and RUN W/ LOAD
- Initiation by Time of Day Start

Digital Inputs:
Enabling the associated digital inputs can enter the first two modes.

Modbus:
For Modbus initiation, the MC must have its AUTO digital input enabled. The Boolean writes AW-001 (Enable Auto), AW-002 (Enable Test), AW-003 (Enable Run w/Load) can then be enabled to enter the ATS.

ServLink/Watch Window:
For ServLink initiation, the MC must have its AUTO digital input enabled. To enter ATS the AUTO, TEST and RUN W/LOAD inputs can be initiated in the Remote Control service header.

Having the MC in AUTO enters the third mode when a Time of Day start occurs.

Control Input	Digital Initiate ATS	Modbus Initiate ATS	ServLink Initiate ATS	Digital Time of Day Start	Modbus Time of Day Start	ServLink Time of Day Start
DI Auto	X	X	X	X	X	X
DI Test	X					
DI Run W/Load	X					
Mod Auto		X			X	
Mod Test		X				
Mod Run W/Load		X				
Srv Auto			X			X
Srv Test			X			
Srv Run W/Load			X			

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Please reference publication 51215A.

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