OVERVIEW OF THE MMT-900

The ATSI Manual Monitor Tester (MMT-900) is designed to apply test conditions to and indicate responses from the many types of conflict monitors and MMUs that are being used in today's traffic signal industry. The MMT is compatible with all published standards including both NEMA TS1/TS2 and FHWA/CalTrans' 170/2070 systems.

This tester has been designed as a companion tester to automated conflict monitor testers that are widely used throughout the United States and Canada. While automated testers provide a thorough test of any conflict monitor and are recommended for monitor certification, the MMT will take you the extra step and allow complete flexibility and repeatability in creating and applying test conditions. This is extremely valuable when you are trouble shooting a single function of the monitor.

Even though the MMT provides complete testing of monitors and MMUs, we do not recommend that a manual tester from any manufacturer be used to certify a conflict monitor or MMU for intersection use. Not only would it be much slower, but you would have to take great care to create all the tests required for comprehensive testing. We recommend only that an automated monitor tester such as our PCMT-2000 or its equal to be used to test and certify anything you want to utilize in an intersection.

For those of you who are not familiar with our PCMT-2000, the cables used to connect the monitor with the MMT are also used in the same manner with our PCMT. The cable's DB connectors are labeled with A, B, C, or D to coincide with the mating connector on the MMT panel. Be sure to verify that the two DB25 connectors are inserted correctly. If you need additional cables, contact your local distributor or ATSI directly for details.

The MMT's capabilities can be broken down into two basic groups of tests: Timing and Voltage. These tests can then be further broken down into either AC tests or DC tests. The next couple of sections will provide you with an overview of the Timing and Voltage testing functions.

TIMING TESTS

Timing tests may be of two different types for conflict monitors. The more common is the presentation of a fault condition for a specified time, remove the fault, and wait to see if the monitor goes into transfer (or other appropriate states).

The second type of timing test is the presentation of an enabling condition to allow detection of existing faults. Examples here are applying red enable (from an off-state) in the presence of an existing red fail condition, or enabling DC detection (from a DC Monitor Inhibit state) in the presence of an existing DC fault condition. In this second case, the enabling condition is applied for a specified time, then removed, and the monitor's response is observed.

In accordance with prevailing standards, timing is based on the local line frequency, nominally 60Hz. The tester creates timing intervals in multiples of AC line zero-crossings (half-cycles), nominally 8.33mS. The user can create timed events from 25mS to 9992mS by 8.33mS steps. To allow quick setup, the timed interval is selected by push buttons that select seconds (0 thru 9Sec), tenths of seconds (0 thru 900mS), and 120ths of seconds (00 thru 92mS). Pushing any of these buttons increases the timed interval by one unit of its timing interval. A fourth push-button, held down while the timing buttons are pushed, will decrease the time *(rather than increase)* by its corresponding interval. This makes it much easier, for instance, to backup a tenth of a second when needed.

In normal operation, the user will apply timed fault (or fault-enable) conditions of increasing duration, starting from an interval presumed to be below the critical interval, until a transfer condition is found. Frequently, a small spread of intervals serves to define the critical interval. For example, one 210 monitor tested always produced transfer on a 292mS conflict, sometimes produced transfer on a 283mS conflict, and never produced transfer on a 275mS conflict. In this case, one could state that the conflict timing for the lamp pair tested was 283mS.

In order to achieve complete separation of timing and threshold tests, described below, voltages used during timing tests are well above or well below their threshold values. Similarly, during threshold tests, any reasonable time interval is allowed to verify the recognition or non-recognition of the signal level being tested.

TIMING TESTS – LAMPS

Reds – Since RED lamps create transfer conditions by their absence (REDFAIL), a timed-OFF state is available to all RED lamps. The full range of OFF-intervals (25mS to 9992mS) is available for this purpose, and easily includes the 700mS to 1000mS standard, as well as the 1200mS to 1500mS standard used in some 2010 monitors. After selecting the RED channel(s) to be tested, the TIMED-OFF interval is started at an OFF-TIME that is not expected to produce REDFAIL, such as 700mS, and a timed-OFF-event is initiated by pressing the START TIMED EVENT push-button. Assuming this fails to produce a RED-FAIL transfer, we would probably choose to raise the interval to 800mS by pressing the tenth-seconds push-button. The tenth-second steps will quickly establish a 'box' around the desired interval. If the 800mS interval produces the RED-FAIL transfer, we can go back to 700mS on the tenth-second button, and start adding 8.3mS increments, 708mS, 717mS, 725mS, etc. until the critical timing is defined.

Yellows, Greens, and Walks – These lamps create fault conditions by their presence, the opposite condition from REDs. Accordingly, the timed conflict event available to these lamps is a timed-ON condition. As an example, let's check Chan 1 Green's conflict timing. Standards require this to lie in the timing window of 200mS to 450mS (NEMA) or 200mS to 500mS (System 170/2070). We select Channel 1 by placing its Green toggle switch to the test position to create a timed-ON event. To avoid dual-display and/or redfail contentions, we will turn off RED-ENABLE during this test. Next create a conflicting channel by turning ON Chan 3's Green. If the monitor goes into transfer during these setups, simply push the MONITOR RESET button on the tester's panel, or you can wait until you are fully set-up to reset the monitor. As with Reds above, we can build a box around the conflict transfer interval with the 100mS button, then shrink the box with the 8.33mS button until the critical timing is defined.

Red Enable – While no timing standards are defined for a recognition interval for the Red Enable signal, it may be important under some circumstances to know this value. To measure this interval, one or more channels can be placed into a Red Fail condition by setting their Red toggle switch to the OFF position, and the Red Enable selector switch to the Timed On position. All passage lamp switches (yellow, green, and walk) should be in the OFF position for these tests. If the tester went into a transfer condition during setup, press the tester's Reset button to clear the transfer state. A response of a few hundred milliseconds is expected, so a starting value of 200mS may be a good choice. As above, increase or decrease the timing interval as needed to define a timing box around the activation interval. If multiple channels were involved, the box will be larger, since some channels will transfer faster and some slower. Your monitor (by its panel display) will tell you which channel (or channels) put the monitor into transfer, thus having the fastest activation times.

AC Power Interrupt – All monitors of current and recent manufacture have defined intervals of AC power interrupt which must be ignored by the monitor and longer intervals which must cause the monitor to execute all steps of a cold-start power-up. This latter condition is readily recognized by the initial flash (or minimum flash) transfer state executed by modern monitors. Setup for this test is straightforward. To keep all lamps out of "mischief", place all Reds in the ON state and all YGW lamps in the OFF state. Then place the Monitor Power rotary switch to the Timed Off position. Red Enable, Red Source, and YGW Source switches can be placed at AC+ Sinusoidal. Timing intervals of 200/500mS (post 1989 210s and all 2010s) and 450/500mS (all NEMA monitors) are most common. Pick a starting value for the power interrupt within these ranges, and increase it until the startup transfer occurs, or decrease it until the startup transfer fails to occur.

TIMING TESTS – DC SIGNALS

DC1 and DC2 – These 24V DC sources are provided to power load switches, rack-mount loop detectors, bus interface units, and other small components in the signal cabinet. The monitor continuously samples these sources to verify that their outputs lie above 18V DC, and creates a DC-FAIL transfer if a below-18V condition exists for a specified interval. The interval is undefined in NEMA TS-1 standards, but NEMA TS-2 and 210/2010 monitor standards define fault intervals in the range of 125-500mS. Sensing of low 24V is always active in 210/2010 monitors, but the NEMA DC MONITOR INHIBIT line must be high (inactive) to enable 24V monitoring. The tester provides a timed-OFF condition for DC1 and DC2 to facilitate these tests. Testing proceeds in a manner similar to the above examples, increasing the timed-OFF interval until a VDC-FAIL transfer occurs.

Controller Voltage Monitor (NEMA only) – The CVM signal is generated in the controller, and is sent to the monitor to report the presence of any malfunction in the controller. The no-fault condition is a logical 'true' (low) signal, and the malfunction causes a logical 'false' (high) signal to be sent to the monitor. The monitor's task is to time the duration of the fault condition, and to place the signal into a flasher state if the fault duration exceeds the standards. The tester provides a timed-HIGH state to facilitate measurement of the CVM fault timing in a manner similar to that of the DC-fault timing above.

Watchdog (210/2010 only) – The Watchdog signal is generated in the controller and passed on to the monitor to report any problems in the controller. It is functionally similar to NEMA's CVM signal above, but implemented as the presence of a continuous square-wave signal at 5Hz. The monitor measures the time interval between successive edges of the square-wave, and reports an error if this interval reaches 900 to 1100mS (1400 to1600mS in some variants). The tester provides the full range of user-selectable OFF-intervals (high state) for this square-wave using the same programmable timer as used in the above intervals.

Startup — Standards for NEMA and 2010 monitors define timing intervals for Initial Flash (Minimum Flash and for Start-Delay (NEMA only). These intervals are creatd by the monitor following a cold-start power-up and passed on to the controller and to the flasher relay to provide a safe and orderly transition from flasher state to normal signal operation. The MMT provides a special test that places the power interrupt, then tracks both signals as power is restored. Each signal time is then reported from power-up to restoration of normal operation.

THRESHOLD TESTS

Threshold tests allow the user to measure the voltage required for recognition of the many AC and DC voltages sensed by a conflict monitor. Recognition thresholds are defined by both NEMA (TS1 & TS2) and System 170/2070 standards for lamp voltages, internal operating voltages, and inputs from other units within the signal cabinet with the monitor. As noted above, response time (within reasonable limits) is not a factor in determination of voltage thresholds.

In normal operation, the user will raise or lower the voltage in question to a value that produces a change in recognition state, as verified by the monitor going into transfer. For example, one (or more) red channel (s) may be tested for recognition threshold (s) by decreasing the REDSOURCE voltage, controlled by the variac, down from a voltage of 70V RMS until a REDFAIL transfer occurs. Both sets of prevailing standards require that redfail transfer occur at or above 50V RMS but below 70V RMS.

Similarly, the 24 VDC threshold can be tested for compliance by running down the DC voltage, controlled by the DC voltage control knob, down from 24 VDC until a 24 VDC transfer occurs. Both sets of standards require that such transfer must occur at or above 18 VDC, but below 22 VDC. (If a NEMA monitor is being tested, the DC monitor inhibit must be OFF to allow recognition of low DC conditions).

In many cases, more than one test may be used to measure a threshold. For example, a GREEN threshold may be measured by running up the voltage on the tested GREEN until a CONFLICT condition is created between the tested GREEN and an active GREEN, YELLOW, or WALK on any other channel that is not a permissive channel with the tested channel. The same GREEN threshold may be measured (assuming it is the only active signal on that channel) by running its voltage down until a REDFAIL transfer occurs. It can also be measured by creating a dual indication fault with another lamp in the same channel, etc. Any of these measurements should provide the same recognition threshold.

To facilitate metering of the various AC voltages, the MMT provides tip jacks for each of the four AC variable voltages: Monitor Power, Red Source, YGW Source, and Red Enable. Your true-RMS multi-meter can be plugged in to read any of these voltages. Similarly, tip jacks are provided for metering the variable regulated DC source (1.2-30 volts) used for DC threshold testing.

THRESHOLD TESTS – AC

Reds – RED recognition thresholds may be measured for sinusoidal, positive half-wave, and negative half-wave voltages from zero to 140V RMS (up to 98V RMS for half-wave voltages). Both nationally accepted sets of standards require recognition of RED voltages of 70V RMS or more, and ignoring of REDS of 50V RMS or less. Older standards do not address recognition thresholds for half-wave RED voltages. For these tests, Red Enable should be at the AC+ Sinusoidal position.

Yellows, Greens, and Walks – YGW thresholds may be measured using the same variable full-wave and half-wave voltages noted above for REDS. Both nationally accepted sets of standards require recognition of YGW voltages of 25V RMS or more, and ignoring of YGW voltages of 15V RMS or less. Since conflict is the transfer mechanism for the YGW lamps, at least one YGW lamp should be held at the AC+ Sinusoidal position as the “other half” of the conflict.

Red Enable – the enabling level for this signal can be measured using the tester’s variable full-wave voltage source, zero to 140 VRMS. This range covers all standards-defined enabling thresholds.

Monitor AC Disable Level – the monitor's test switch provides for running the monitor from the same variable full-wave AC source noted above. As the AC input is reduced, a level is reached (usually 85V) at which the monitor stops sensing external faults and transfers the signal to flasher.

The variable monitor power source can also be used in conjunction with the monitor's indicators, to measure brownout disable and recovery thresholds.

THRESHOLD TESTS – DC

A variable regulated DC source provides an output of 1.2V DC up to 30.0V DC. This allows threshold detection for the DC input(s) of both NEMA and 210/2010 monitors. It also allows threshold detection for the CVM and DC monitor inhibit functions of NEMA monitors.

DC1 and DC2 testing – As noted above, DC1 and DC2 thresholds are normally measured by running down the variable DC voltage source from above 22V DC until a DC FAIL transfer is observed. Standards require that such a threshold lies between 22V DC and 18V DC.

CVM testing (NEMA only) – The Controller Voltage Monitor signal is generated in the controller, and passed on to the Monitor. When the signal is in its NO-FAULT (low) state, the controller is operating properly. If the controller's internal fault detection circuitry finds a problem, the CVM signal is changed to FAULT (high) and the monitor enters a CVM-FAULT transfer state. For this test, the variable DC voltage is applied to the monitor's CVM input and raised from a low (NO-FAULT) value until the monitor reports a CVM FAULT state by going into transfer. Standards specify that a NO-FAULT state must exist below 8V, and a FAULT state must exist above 16V.

DC Monitor Inhibit (NEMA only) – The DC MONITOR INHIBIT input can be asserted (low) to prevent the monitor from going into transfer if DC1 or DC2 goes below the acceptable value of 18V dc. The enabling threshold for the DCM INHIBIT signal is found by setting the variable DC input below 8V DC (inhibit=true) and creating a DC fault by turning off the DC1 or DC2 input. As the variable DC to the DCM INHIBIT input is raised, a point will be reached where the DCM INHIBIT will cease to be true, and the existing DC fault will be recognized and produce a DC FAIL transfer state. The same 8V (true) and 16V (false) standards noted above also apply to this input.

PREPARING THE MMT TO TEST

The MMT does not have to have any of the knobs or switches in a particular position to setup a test. However, for the manual's purpose, there needs to be a no-fault "Startup State" that can be referenced when describing how to setup for a test. The table below shows the "Startup State" used within this manual:

Rotary Switches

Monitor Power	AC+
Red Source	AC+
YGW Source	AC+
Red Enable	AC+
Mode Selector	NORMAL

Toggle Switches

Red Test	THRESHOLD
YGW Test	THRESHOLD
Red Channels	ALL ON
YGW Channels	ALL OFF
Ground Shorts	OPEN
DC1	24V
DC2	24V
CVM	ON
DC INH	OFF
DC Threshold/Timing	THRESHOLD

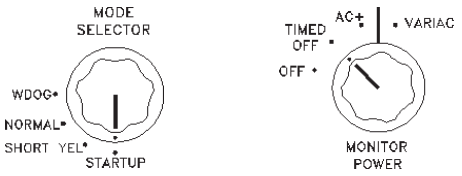
The following sections will take you through the setup of tests that can be performed. Associated with each test description are diagrams depicting the proper placement of the switches for the test.

TIMING TESTS SETUPS

AC Timing Tests

INITIAL FLASH & START DELAY TIMINGS

These tests apply to NEMA only. Another name for Initial Flash that you may be more familiar with is Minimum Flash.



1. Place the Mode Selector switch in the *Startup* position.
2. Set the Monitor Power switch to the *Timed Off* position.
3. Press the *Start Timing Event* pushbutton.

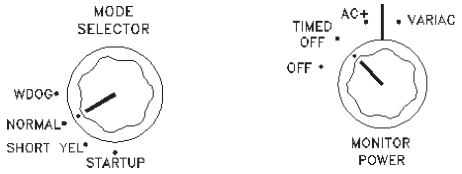
Initial Flash

TS1: Initial Flash Time should match the switch setting on the monitor.
TS2: Initial Flash Time should match the program card setting.
210: No Standard
2010: Should be in the range of **5.9-7.1** seconds.

Start Delay

TS1: Should be in the range of **1500-3500mS**.
TS2: Should be in the range of **1500-2500mS**.
210: No Standard
2010: No Standard

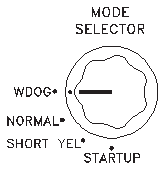
POWER INTERRUPT TIMING



1. Place the Mode Selector switch in the *Normal* position.
2. Set the Monitor Power switch to the *Timed Off* position.
3. Enter the desired length of power interrupt time you want to test.
4. Press the *Start Timing Event* pushbutton.

TS1: Should be in the range of **450-500mS**.
TS2: Should be in the range of **450-500mS**.
210: (older) Should ignore a 50mS or less interrupt.
210: (newer) Should be in the range of **200-500mS**.
2010: Should be in the range of **300-500mS**.

WATCHDOG TIMING (210/2010 only)



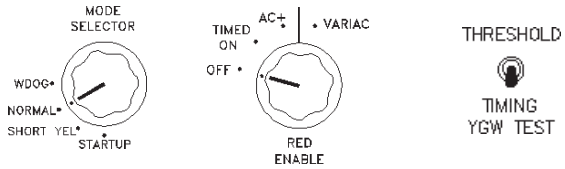
1. Place the Mode Selector switch in the *WDog* position.
2. Enter the desired length of watchdog time you want to test.
3. Press the *Start Timing Event* pushbutton.

210: Should be in the range of **1400-1600mS** (or 900-1100mS).
2010: Should be in the range of **1400-1600mS** (or 900-1100mS).

Note: some monitors can be set for either watchdog timing.

To verify that the monitor latches the fault through a Power Interrupt, simply turn the Monitor Power switch to the off position until the displays extinguish on the monitor and then turn the switch back to the AC+ position. Older standards (CalTrans) require resetting the fault condition, but some newer monitors offer a WD Latch option which retains the fault after a power interrupt.

CONFLICT TIMING

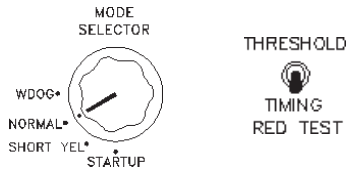


1. Turn the Red Enable switch to the *OFF* position.
2. Place the YGW Threshold/Test Switch in the *Timing* position.
3. Place the switch of the channel to be tested in the *Test* position.
4. Place any other YGW channel to the *ON* position.
4. Enter the desired length of conflict time you want to test.
5. Press the Start Timing Event pushbutton.

TS1: Should be in the range of **200-450mS**.
TS2: Should be in the range of **200-450mS**.
210: Should be in the range of **200-500mS**.
2010: Should be in the range of **200-500mS**.

To verify that the monitor latches the conflict through a Power Interrupt, simply turn the Monitor Power switch to the off position until the displays extinguish on the monitor and then turn the switch back to the AC+ position. The monitor should still be in the conflict state prior to the Power Interrupt.

REDFAIL TIMING



1. Place the Red Threshold/Timing switch in the *Timing* position.
2. Place the switch of the channel to be tested in the *Test* position.
3. Enter the desired length of redfail time you want to test.
4. Press the Start Timing Event pushbutton.

TS1: Should be in the range of **700-1000mS**.
TS2: Should be in the range of **700-1000mS**.
210: Should be in the range of **700-1000mS or 1200-1500mS** (depends on monitor)
2010: Should be in the range of **1200-1500mS**.

To verify that the monitor latches the fault through a Power Interrupt, simply turn the Monitor Power switch to the off position until the displays extinguish on the monitor and then turn the switch back to the AC+ position. The monitor should still be in the fault state prior to the Power Interrupt.

SHORT YELLOW TIMING

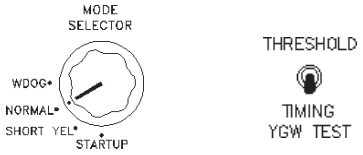
1. Turn the Mode Selector switch to the *Short Yellow* position.
2. Enter the desired length of Short Yellow time you want to test.
3. Press the Start Timing Event pushbutton.
4. Verify that the Red and YGW Threshold/Timing toggle switches are in the *Threshold* position.
5. Place the Red, Yellow, & Green toggle switches of the channel to be tested in the *Test* position.
6. Press the Start Timing Event pushbutton.

TS1: No Standard.
TS2: Should be in the range of **2600-2800mS**.
210: No Standard.
2010: Should be in the range of **2600-2800mS**.

DUAL DISPLAY (NO STANDARD)

There are multiple setups for Dual Display tests. To determine if a channel will respond with a dual display error, simply turn on two lamps on the same channel. If you want to verify the timing of a dual display error, you can set up a channel to be "on" and then time another "face" of the same channel to be on. Below is an example of a timing setup to determine the Dual Display time for a Green/Yellow Dual Display on channel 2.

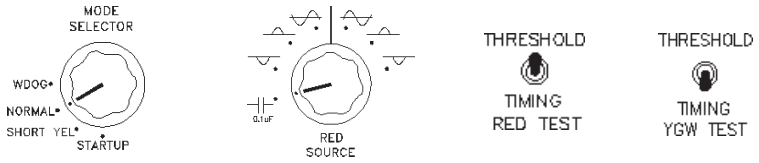
Note: Dual Display tests require Red Enable to be on for a proper test setup.



1. Place the YGW Threshold/Timing switch in the *Timing* position.
2. Place channel 2's Green toggle switch to the *On* position.
3. Place channel 2's Yellow toggle switch to the *Test* position.
4. Place channel 2's Red toggle switch to the *Off* position.
5. Reset the monitor.
6. Enter the desired length of Dual Display time you want to test.
7. Press the Start Timing Event pushbutton.

RED OPEN – GREEN DUAL DISPLAY (NO STANDARD)

Note: this test is equivalent of a Red/Green dual display test, where the Red lamp is burnt out. Additionally, verify the monitor's dip switches or programming are set correctly before beginning this test.



1. Turn the Red Source switch to the *0.1uF* position.
2. Verify that the Red Threshold/Timing switch is in the *Threshold* position.
3. Place the YGW Threshold/Timing switch in the *Timing* position.
4. Turn the Green channel toggle switch to be tested to the *Test* position.
5. Enter the desired length of Dual time you want to test.
6. Press the Start Timing Event pushbutton.

DC Timing Tests

DC1 AND DC2 TIMING

1. Place the DC Threshold/Timing switch in the *Timing* position.
2. Place the appropriate DC1 or DC2 (or both) switch in the *Test* position.
3. Enter the desired length of DC time you want to test.
4. Press the Start Timing Event pushbutton.

TS1: No Standard.
TS2: Should be in the range of **125-175mS**.
210: Should be in the range of **200-500mS**.
2010: Should be in the range of **200-500mS**.

CVM TIMING

This test applies to NEMA only.

1. Place the DC Threshold/Timing switch in the *Timing* position.
2. Enter the desired length of CVM time you want to test.
3. Press the Start Timing Event pushbutton.

TS1: No Standard
TS2: Should be in the range of **125-175mS**.

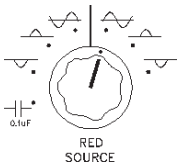
TS2 Note: If the VM Latch has been programmed with a jumper on the program card, then a CVM fault should be latched. The NEMA TS2 standard states that a Power Interrupt should not reset a latched CVM failure. To verify that the monitor latches the conflict through a Power Interrupt, simply turn the Monitor Power switch to the off position until the displays extinguish on the monitor and then turn the switch back to the AC+ position. The monitor should still be in the conflict state that existed prior to the Power Interrupt.

Voltage Tests Setup

AC Threshold Tests

- Voltage Tests require you to have a True RMS multi-meter to verify rectified voltages.
- All Threshold Tests require the Red and YGW Threshold/Timing switches to be the Threshold position.
- All AC Voltage Tests require the Mode Selector switch to be in the Normal position.

REDS (recognition)

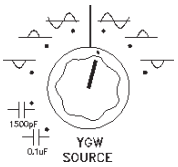


1. Place the multi-meter's leads into the appropriate jacks above the Red Source switch (white = common and red = hot).
2. Turn the Red Source selector switch to the *Variac Sinusoidal* position.
3. Place the Red channel toggle to be tested to the *Test* position.
4. Lower the AC Adjust Variac knob until the desired channel produces Red Fail.

TS1: Should be in the range of **50-70 VAC**. (Sinusoidal only)
TS2: Should be in the range of **50-70 VAC**.
210: Should be in the range of **50-70 VAC**. (Sinusoidal only)
2010: Should be in the range of **50-70 VAC**.

To test the Half-Waves on a TS2 MMU or a 2010 monitor, turn the Red Source selector switch to the appropriate positive or negative position.

YELLOW, GREEN, WALKS (recognition)



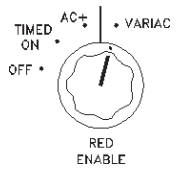
1. Place the multi-meter's leads into the appropriate jacks above the YGW Source switch (white = common and yellow = hot).
2. Turn the YGW Source selector switch to the *Variac Sinusoidal* position.
3. Place the YGW channel toggle to be tested to the *Test* position.
4. Lower the AC Adjust Variac knob until the desired channel produces Red Fail.

TS1: Should be in the range of **15-25 VAC**.
TS2: Should be in the range of **15-25 VAC**.
210: Should be in the range of **15-25 VAC**.
2010: Should be in the range of **15-25 VAC**.

To test the Half-Waves, turn the YGW Source selector switch to the appropriate positive or negative position.

RED ENABLE

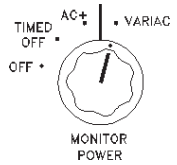
TS2 and 2010 are the only standards that state the Red Enable signal must be present at certain voltages to enable the MMU to detect the absence of voltage on all field signal inputs of a channel.



1. Place the multi-meter's leads into the appropriate jacks above the Red Enable switch (white = common and red = hot).
2. Turn the Red Enable selector switch to the *Variac* position.
3. Adjust the AC Adjust Variac knob until the voltage reported on the multi-meter is less than 70 VAC.
4. Turn *Off* the Red Channel toggle switch that is to be tested. No Red Fail transfer should occur.
5. Slowly turn the voltage up until the MMU produces a Red Fail.

TS1: No Standard.
TS2: Should be in the range of **70-89 VAC**.
210: No Standard.
2010: Should be in the range of **50-70 VAC**.

TS2 BROWNOUT (dropout & recovery recognition)

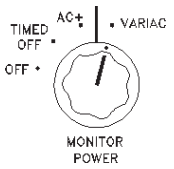


1. Place the multi-meter's leads into the appropriate jacks above the Monitor Power switch (white = common and black = hot).
2. Turn the Monitor Power selector switch to the *Variac* position.
3. Adjust the AC Adjust Variac knob until the voltage reported on the multi-meter is approximately 98 VAC.
4. Slowly turn the voltage down until the MMU's power light begins to blink and the tester's relays A & B are in transfer. This is the dropout voltage.
5. Slowly turn the voltage up until the MMU's power light returns to a solid ON state. This is the recovery voltage.

The disable and recovery voltages must be within the 89-98 volts RMS AC range. The hysteresis from the **Off** state to the **On** state or vice versa must be at least 3 volts RMS AC.

There is no brownout standard for NEMA TS1.

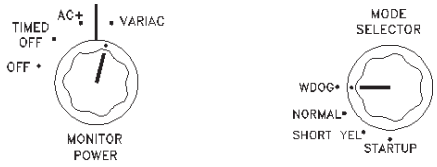
2010 BROWNOUT (dropout & recovery recognition)



1. Place the multi-meter's leads into the appropriate jacks above the Monitor Power switch (white = common and black = hot).
2. Turn the Monitor Power selector switch to the *Variac* position.
3. Adjust the AC Adjust Variac knob until the voltage reported on the multi-meter is approximately 107 VAC.
4. Slowly turn the voltage down until the monitor's AC Power light begins to blink. This is the dropout voltage.
5. Slowly turn the voltage up until the monitor's AC Power light begins to blink faster (about twice as fast). This is the recovery voltage.

The AC dropout voltage must be 98±2 VAC.
The recovery voltage must be 103±2 VAC.

210 BROWNOUT (dropout & recovery recognition)



1. Place the multi-meter's leads into the appropriate jacks above the Monitor Power switch (white = common and black = hot).
2. Turn the Monitor Power selector switch to the *Variac* position.
3. Turn the Mode Selector switch to the *WDOG* position.
4. Adjust the AC Adjust Variac knob until the voltage reported on the multi-meter is approximately 107 VAC.
5. Set the timing in the the LCD Display to 9992 mS.
6. Press the Start Timing pushbutton. This will change the text in the Display to show "210-BROWN". Press the Monitor Reset pushbutton if necessary to clear the WD failure.
7. While slowly turning the AC voltage down, press the Monitor Reset pushbutton each time the monitor goes into a WD failure. Stop when the monitor fails to transfer. This is the dropout threshold voltage.
8. Slowly turn the voltage up until you hear the monitor's relay click. This is the recovery threshold voltage.

The AC dropout voltage must be 98±2 VAC.
The recovery voltage must be 103±2 VAC.

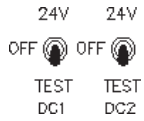
To exit this test, press any of the timing buttons and reset the monitor.

Note: There are some agencies using 210 monitors that have specified brownout voltages to be 93±2 VAC and 98±2 VAC. All standards require a minimum hysteresis of 3 volts between drop-outs and recovery voltages.

DC Threshold Tests

- All Threshold Tests require the DC Threshold/Timing switch to be the Threshold position.
- All DC Voltage Tests require the Mode Selector switch to be in the Normal position.

DC1 OR DC2 (recognition)



1. Place the multi-meter's leads into the DC Meter jacks in the lower left-hand corner of the tester.
2. Place the DC1 or DC2 switch in the *Test* position.
3. Adjust the DC Adjust knob until the voltage reported on the multi-meter is approximately 24V DC.
4. Slowly turn the voltage down until the monitor produces a 24V DC error.
5. A 24V DC error is a non-latching error, so now turn the voltage up and verify that the 24V DC error is removed.

All of the standards require that the DC threshold lie between **18-22V DC**.

DC MONITOR INHIBIT (NEMA only)

1. Place the multi-meter's leads into the DC Meter jacks in the lower left-hand corner of the tester.
2. Place the DC Inhibit switch in the *On* position.
3. Adjust the DC Adjust knob until the voltage reported on the multi-meter is approximately 24V DC.
4. Turn the voltage down to less than 18V DC.
5. No error or transfer should occur.
6. The DC fault is non-latching, and will reset when the voltage is returned to 22 volts, although it may require up to a full Initial-Flash time to reset.

CVM (NEMA only)

1. Place the multi-meter's leads into the DC Meter jacks in the lower left-hand corner of the tester.
2. Adjust the DC Adjust knob until the voltage reported on the multi-meter is approximately 7V DC.
3. Place the CVM switch in the *Test* position.
4. Slowly turn the voltage up until the monitor produces a CVM error.
5. The CVM fault is non-latching, and will reset when the voltage is returned to 22 volts, although it may require up to a full Initial-Flash time to reset.

All of the standards require that the CVM threshold lie between **8-16V DC**.