www.magwerks.com
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# User's Guide
## Shunt Meter Test Kit
## Model SMTS-25 & (eXtened Range XR)


SMTS-25 Shown with and without the shot timer option

**Features:**

- Compact size.
- One unit capable of measuring AC, HWDC and FWDC using the same shunt.
- Optional integrated shot duration timer records shot lengths as the part sees it; no external wires needed for this.
- Mag shot time measured to a 0.001 second resolution with optional shot duration meter.
- Default mag pulse capture-time setting is for a 0.5 sec mag shots, however it is equipped with an adjustment pot for all other mag shot duration times. (This feature will allow accurate readings on slower responding MPI machines such as saturable-reactor designs.)
- Large .562 high green 3-½ digit meter for current measurements.
- Operator control panel equipped with easy to use controls.
- Meter hold over-ride switch for checking demag decay cycle down to zero.
- Test kit can be used for mobiles, portables and wet horizontals.
- Fast acting ammeter takes 12 samples per second.
- Integrated battery indicator shows full charge state, 50% charge state and low charge (do not use) state.
- Optional rechargeable batteries and wall charger available.
- Individual long-form NIST traceable certification sheets included.
- Optional eXtened Range 10X to increase resolution to 1 amp

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# BASIC OPERATION

**AMMETER:**

This meter shows the amount of current that is flowing through the test set shunt. The shunt can either be installed in either the coil line or between the headstock and tailstock to measure current flow.

The meter is a 3.5 digit meter that reads in kilo (1000) amp units. The last digit is truncated and the least significant digit (LSD) is rounded to the nearest 10 amps. This means that if 2002 amps pass through the shunt the meter will read 2.00 and if 2008 amps pass through the shunt, the meter will read 2.01. A reading of 0.20 represents 200 amps, and 0.02 represents 20 amps. The decimal point remains fixed.

The magnetic particle inspection machine also has a 3.5 digit meter that truncates the last digit and rounds the LSD. It is possible to get a two digit difference between the two meters when differences of only a few amps exist depending on the actual amperage value at the point of rounding. This is considered normal and after charting the machine at 500 amp increments, a pattern will develop showing the accuracy of the machine meter. A maximum of 10% differential is acceptable before repair of the machines meter and/or shunt is necessary.

**OPTIONAL XR (eXtened Range)**

Multiply by 10X the meter sensitivity. Meters reads 0 to 1,999 amps least significant digit is now 1 amp.

**OPTIONAL SHOT DURATION TIMER**

This 6 digit meter shows the length of the magnetizing pulse in seconds. The display is in the format of “xxx.xxx” with the decimal point always in the same place. It measures the shot time to 0.001 seconds and holds the value until the next shot. The pick up for the timer is through the current shunt so the meter shows the *actual* length of time the current is flowing through the part. This is accurate in all three waveforms, and no conversion is necessary.

**POWER**

This toggle switch is the master power switch that controls the incoming power to the meter.

**SHUNT**

This BNC connector is used to connect the current shunt provided in the kit.

**Any shunt by definition is a resistor and hence will generate heat with the passage of current. Under no conditions should the manganin shunt strip be allowed to surpass 293°F (145°C), as this will cause a permanent change in resistance and also permanent damage to the shunt. At approximately 650°F the solder will melt out of the shunt. The milli-volt drop of the shunt is adjusted at the factory to within ±0.5% accuracy and exceeding these temperature values will cause a loss of accuracy.**

**The temperature rise of the shunt is based on three things.**

1) The amount of current passed through the shunt – the current control setting of the power supply.
2) The length of time the current is passed through the shunt – the mag pulse length.
3) The length of time the shunt is allowed to cool between mag pulses – or duty cycle.

**HOLD OVERRIDE**

This toggle switch disables the hold function built into the test meter.

In the *off* position, the meter captures and holds the last mag shot reading until the meter is automatically reset by the next mag shot. This is the normal operating position during testing.

In the *on* position, the hold function is overridden and the unit acts as a fast ammeter. This function is useful for checking the decay rate of the de-mag cycle on the machine. The amperage value can be seen decaying from the set point to zero over the time constant. This can also be used to see if the amperage overshoots the set point before stabilizing.

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## OUTPUT TYPE

This toggle switch selects the electrical current output type. On the shunt kit the same switch position is used to test AC and FWDC, while the opposite position is used for the measurement of a HWDC waveform.

**Note:** Most portable and mobile equipment outputs both AC and HWDC. Wet horizontal machines can have any combination of the three output types (AC, HWDC, FWDC). If the output type is unknown, consult the machine manual or a technical representative of the machine manufacturer. If the shunt kit output switch is in the incorrect position no damage to the shunt kit will occur, however an erroneous reading will result.

## AMMETER TIME AND TIME ADJUSTMENT

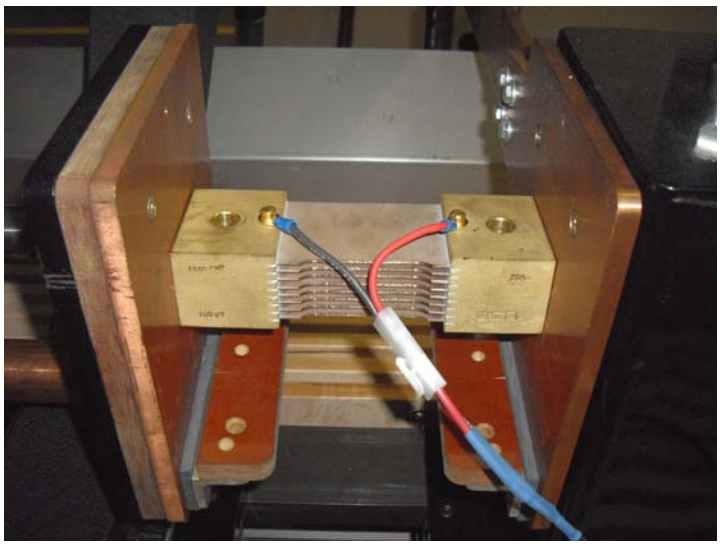
This toggle switch sets the internal meter timer that captures the mag shot. In most instances this will be left in the 0.5 sec. position unless a shorter / longer than 0.5 sec. mag shot is used.

If you have a saturable reactor machine such as a typical *Magnaflux H-700* the mag current ramp up time is much longer and in most cases it takes longer that 0.5 sec. to reach the set point (The ramp up time is the time it takes to reach the current set point and stabilize). This type usually takes about 1 sec. total time to give the part a good 0.5 sec. mag shot at the set point.

The shunt meter timer pot next to the toggle switch is set equal to, or slightly less than the machine mag timer value. If the shunt tester does not hold the reading lower the pot value slightly. By using the hold override feature and setting the mag time up you can also see if the analog meter overshoots the actual value by comparing the two during the ramp up period.

## HOOK-UP AND USE

Remove any consumables from the headstock and tailstock (Lead plates, and Copper braided pads).



Note: Leaving the copper braided pads in place will cause considerable errors due to recirculating eddy currents within the braided pads when measuring AC, and to a lesser extent HWDC. Place test kit's shunt between the headstock and tailstock and clamp into place as shown to the left.

Attach the BNC cable from SMTS-25 panel and connect into the shunt leads as necessary. Set the machine's current control pot to a value of approximately 500 amps and set the machine's vector selector to the contact (Head-Shot) position.

Turn the SMTS kit on using the "Power" Switch on the SMTS kit. The SMTS-25 kit can be powered by the on-board 3.6V batteries OR an external 120V adapter.

Set all the SMTS-25 panel switches to the appropriate positions.

Depress the MPI machine's "MAG" button. Compare and record both the SMTS-25 ammeter reading, as well as the Machine's ammeter reading. Repeat this process in 500 amp intervals until the maximum output value has been reached. Take care to check the shunt temperature of the manganin as these tests are being performed. As the current value increases, the heat produced through the shunt will also increase as a natural result. Once the shunt becomes too hot to touch, allow shunt to cool before continuing. (See note in red on page 2).

When finished with the head-shot readings, it is standard practice to also check the coil vector(s) using the same methodology.

*(continued)*

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Remove either coil lead, then bolt the shunt between the coil termination and the coil lead as seen below in fig. 2.0 A & B. (The shunt is connected as a series wired circuit in all situations and polarity is not important.)

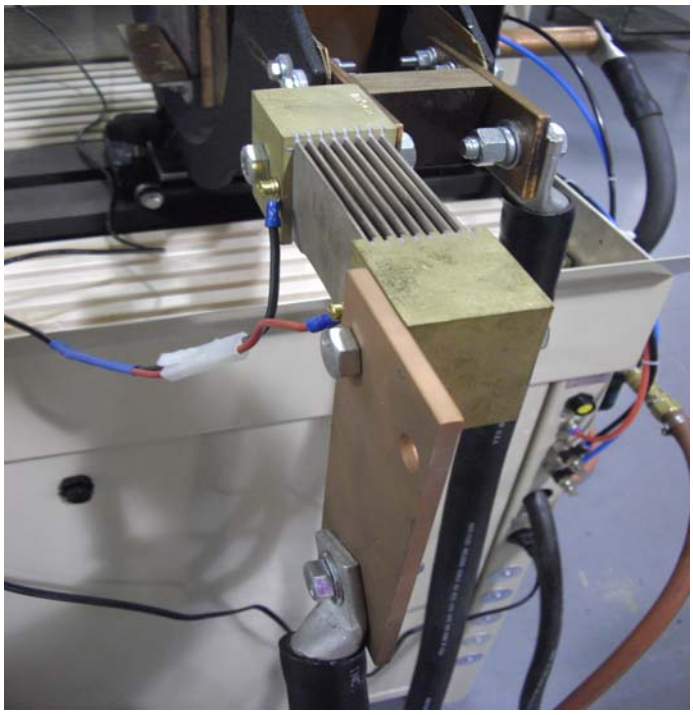

**Figure 2.0A**

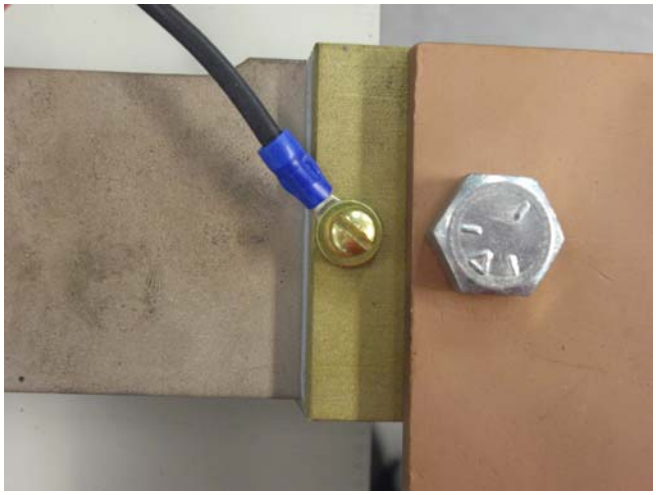

**Figure 2.0B**

**** Note: When hooking up shunt to copper busswork or secondary cabling, make sure that the shunt leads are not touching the sense screw terminals or measurement errors will result. This same condition needs to exist if any other connectors (such as cable lugs) are bolted to the shunt.***

Repeat the testing sequence in 500 amp intervals as before, compare results and record.

This process will take care of your “before” data on the machine.

If the machine’s and SMTS-25 meter results vary by more than 10% or 50 amps whichever is greater, (as defined in ASTM E1444) adjustments to the machine’s ammeter will be necessary.

After making calibration changes re-run tests as before, compare and record results as “after calibration” numbers.

When you are finished using the test kit, let the shunt cool to room temperature before you repackage all components.

With proper care and maintenance this unit should last for a very long time.

If you have any questions or comments regarding this product please feel free to give us a call.

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## BATTERY LIFE INDICATOR


Battery indicator showing Green Status
When the meter is being used with battery power the LED lamp above the power switch indicates battery charge condition. When this lamp is green it indicates the instrument's batteries are in good charge state and will give reliable readings.


Battery indicator showing Blinking Red Status
This indicates the instrument will need charging or battery replacement soon but will give reliable readings.

Battery indicator showing Solid Red Status
This indicates the instrument will no longer give reliable readings.

**Note: Although the batteries are a "AA" sized battery, they are NOT 1.5 volt batteries.**
**Use only 3.6 Volt Lithium or 3.6 Volt Rechargeable Li-Ion batteries.**

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## SMTS-25 & (XR) Specifications:

| | |
|---|---|
| Power Requirements: | 4- 3.6V Batteries |
| Metering, Current: | 3-1/2 Digit Green Backlit LCD Meters |
| (XR) Metering, Current | Scale Multiplier 10 X 3-1/2 digit 0 – 1999 1 amp resolution in this mode |
| Metering, Time: | 6 Digit Green Backlit LCD Meters |
| Trigger Sensitivity | Approximately 1-1/2mv |
| Current Resolution: | SMTS-25: 10 Amps, SMTS-25XR:1 Amp |
| Time Resolution: | 0.001 Second (Optional Feature) |
| Current Measurement Capability: | 10,000 Amps[1] |
| Battery Life with Shot Timer Option: | 4.5 Hours Typical Continuous Use with Standard Batteries.* |
| Battery Life with Shot Timer Option: | 6 Hours Typical Continuous Use with Rechargeable Batteries.* |
| Battery Life without Shot Timer Option: | 4 Hours Typical Continuous Use with Standard Batteries.* |
| Battery Life without Shot Timer Option | 6.5 Hours Typical Continuous Use with Rechargeable Batteries.* |
| Input Waveform Scaling: | AC-RMS, FWDC – Average, HWDC – RMS X2 |
| Current Accuracy: | Better that 1% of Test Point, plus ±1 Count LSD |
| Time Accuracy: | Better that 1% of Test Point, plus ±1 Count LSD |
| Repeatability: | ±1 Count LSD >750 Amps |
| Case Size: | 7.5" D x 9" W x 3.5" H |
| Net Weigh without Shunt: | 3.2 Lbs. |
| Standard Shunt Weight: | 6 Lbs. |
| | |
| | |

[1] 10,000 Amps when paired with the standard shunt.
* Average battery life, results may vary depending on battery condition.

Table 1 Specifications

**Definitions:**

**Resolution:** Smallest discernible change of measurement result due to a minimum change in the input.
**Accuracy:** Deviation from the actual value as fixed by universally accepted standards.
**LSD:** Least significant digit.

**Note:**

As with any piece of electronic test equipment, keep this unit clean and dry. Do not subject the unit to any excessive shock or shaking. The shunt that is supplied with this kit is calibrated to a higher standard than an ordinary shunt and must be kept with this unit to assure accurate readings. Re-certification of the test kit should be done at least once a year for proper certification maintenance.

**Standard Packaging Includes:**

- SMTS-25 or SMTS-25XR Instrument with 120VAC power adaptor
- Shunt Assembly, 10kA Capacity
- Shunt Cabling
- Users Guide
- Long Form NIST Traceable Certifications with Data.

**Part Numbers for Meters, Options and Spare Parts**

| Description | Part No. |
|---|---|
| SMTS-25 with 10kA Shunt package | 11-01-04 |
| SMTS-25XR with 10kA Shunt package | 11-01-05 |
| Shot Timer Option (Standard on SMTS-25XR) | 11-01-04-01 |
| Rechargeable Battery Kit Option with charger | 11-01-44-02 |
| Nanuk fitted hard case | 11-01-44-06 |
| Extra Rechargeable 3.6v Li-Ion Battery (4 Req.) | 02-22-45-09 |
| Spare Battery Charger | 11-01-04-02-06 |
| 20kA Capacity Shunt with case. | 11-01-51-10 |

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**TROUBLE SHOOTING**
**Ammeter reads erratically or is not consistent.**

1. There is enough SCR leakage in the MPI machine to cause a 1 – 1.5 mV rise on the shunt and reset the ammeter capture circuitry. This has been observed in many types of machines that do not have drain resistors installed on them (Generally on the headstock vector). This can also cause some minor sparking to occur when the headstock is opened.

Solution: Clip a 25-watt, 15-ohm external drain resistor from headstock to tailstock and energize the mag pulse again. If the problem goes away, install the resistor on the busswork that runs the headstock and attach the other end of the resistor to ground. This should permanently cure the problem as long as it is only a leaky SCR and not a shorted SCR.

2. The SCR control circuitry is not shutting all the way off.

Solution: Check waveform between headstock and tailstock with oscilloscope and if necessary install a drain resistor. Repair machine as necessary.

3. The ramp-up time of the MPI machine may be to slow, or not consistent for the standard ½ second capture time of the instrument. This is especially true if the machine is a saturable-core reactor design.

Solution: Increase the shot time of the MPI machine to about 1 second and increase the setting of the mag shot capture time, on the Ammeter, so that the small LED on the meter shuts off slightly before the mag pulse ends. See Fig 1.

4. Mag pulse duration is falling below the minimum time required to capture the value less than ½ seconds. This often happens on certain brands of equipment at low amperage values, as the feedback circuitry is not fast enough to respond at these low values. See chart 2.

Solution: Same solution as #3.

5. Mag pulse may not be consistent on the MPI machine. This often happens on certain brands of equipment especially at low amperage values, as the feedback circuitry is not fast enough to respond at these low values. It can also happen through out the entire range if there is no feedback circuitry or the gate drive not operating properly.

Solution: Check the machine's output-waveform across the shunt with an oscilloscope. Repeat the mag shot several times and look for consistent amplitude on the waveform. The hold override can also be activated on the ammeter so that the maximum mag pulse may be read and compared to the oscilloscope. When the **MPI machine** is operating properly, typical expectations of repeatability is about 3 counts (30 Amps). Repair the machine as necessary.

**Recommended Equipment list for Calibration of Ammeter**

| Description | Make | Model |
|---|---|---|
| Standard Reference Source | Datron / Fluke / Wavetec | 5100B or 5700 |
| Multi-meter 8-1/2 digit | Agilent | 34401A |

Table 3 Recommended Current Calibration Equipment

| Shunt Meter Reading AC | Precision Power Reference AC | Shunt Meter Reading FWDC | Precision Power Reference FWDC | Shunt Meter Reading HWDC* | Precision Power Reference HWDC* |
|---|---|---|---|---|---|
| 500 A | 25.00mv | 500 A | 25.00mv | 500 A | 12.50mv |
| 1000 A | 50.00mv | 1000 A | 50.00mv | 1000 A | 25.00mv |
| 1500 A | 75.00mv | 1500 A | 75.00mv | 1500 A | 37.50mv |
| 2000 A | 100.00mv | 2000 A | 100.00mv | 2000 A | 50.00mv |
| 2500 A | 125.00mv | 2500 A | 125.00mv | 2500 A | 62.50mv |
| 3000 A | 150.00mv | 3000 A | 150.00mv | 3000 A | 75.00mv |
| 3500 A | 175.00mv | 3500 A | 175.00mv | 3500 A | 87.50mv |
| 4000 A | 200.00mv | 4000 A | 200.00mv | 4000 A | 100.00mv |
| 4500 A | 225.00mv | 4500 A | 225.00mv | 4500 A | 112.50mv |
| 5000 A | 250.00mv | 5000 A | 250.00mv | 5000 A | 125.00mv |
| 5500 A | 275.00mv | 5500 A | 275.00mv | 5500 A | 137.50mv |
| 6000 A | 300.00mv | 6000 A | 300.00mv | 6000 A | 150.00mv |
| 6500 A | 325.00mv | 6500 A | 325.00mv | 6500 A | 167.50mv |
| 7000 A | 350.00mv | 7000 A | 350.00mv | 7000 A | 175.00mv |
| 7500 A | 375.00mv | 7500 A | 375.00mv | 7500 A | 187.50mv |
| 8000 A | 400.00mv | 8000 A | 400.00mv | 8000 A | 200.00mv |
| 8500 A | 425.00mv | 8500 A | 425.00mv | 8500 A | 212.50mv |
| 9000 A | 450.00mv | 9000 A | 450.00mv | 9000 A | 225.00mv |
| 9500 A | 475.00mv | 9500 A | 475.00mv | 9500 A | 237.50mv |
| 10,000 A | 500.00mv | 10,000 A | 500.00mv | 10,000 A | 250.00mv |

Table 4 Input Voltage to Current Conversions

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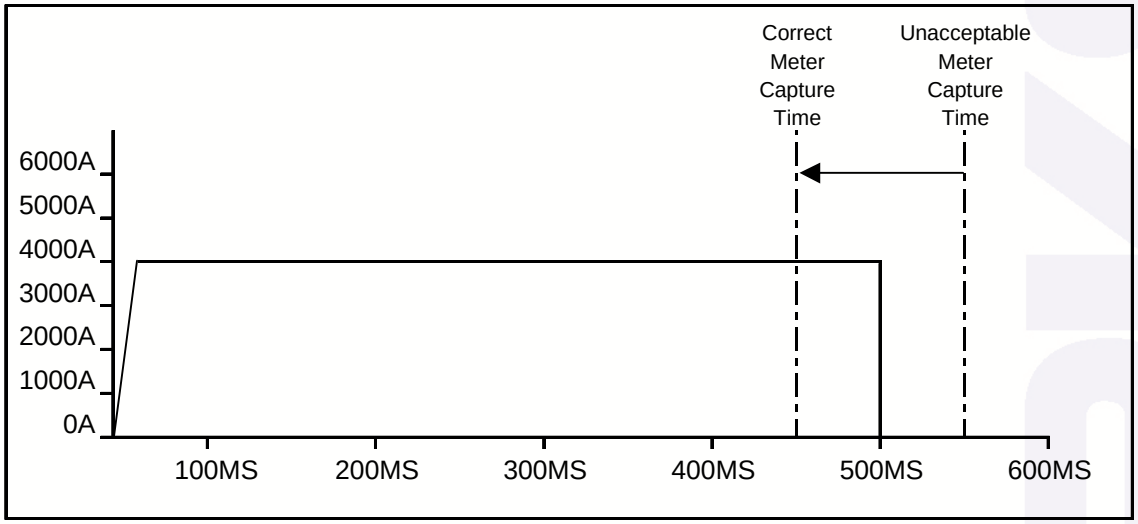


Figure 1.0 Proper Mag Capture Time