3M™ Ground Pro Ground Integrity Meter

Customer Demonstration Procedures

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1. Take a measurement from an AC outlet and measure AC voltage levels between hot and neutral.

a) Use the V button to take this measurement. In most cases, you should see between 110-120 volts AC. Record the AC voltage measured.

b) Keeping the leads inserted into the Hot and Neutral lines, press the EMI button until you read V, not dBµV (the EMI button allows you to read two scales: dBµV and V. In order to change from dBµV to V, press the EMI button one time to get on the correct scale once you are in the EMI mode).

c) What you should see on the screen is EMI voltage. This value could be stable, going up and down or bouncing. This value represents the broadband EM signal noise between the Hot and Neutral line (many would consider this to be EMI garbage).

Figure 1 is an example of a clean sine waveform:

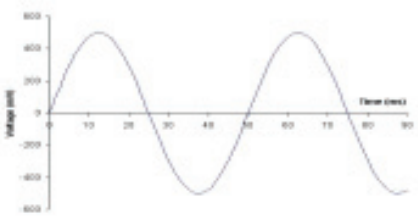

Figure 1

Figure 2 is an example of a sine waveform with EM signal noise on the line between Hot and Neutral:

Figure 2

d) To stabilize the reading, press the HOLD button, which will hold the given value on the scale as seen at the moment you press the HOLD button. Press the HOLD button for a second time and the 3M™ Ground Pro Ground Integrity Meter will calculate and hold the maximum spike peak voltage for the period of time you do the measurement. On the same screen, you will see a MAX value on voltage (the top number on the screen), and the RMS (average) value on voltage (the bottom number screen). Record the PEAK MAX and the RMS value.

Q: Why it is so important to identify EMI voltage (garbage) on the line?

A: It is important to identify the level of EMI voltage on the line because if the tool does not have any filtering, such signal will be going into the automated tool, bench, bench tools, etc. The moving voltage induced into the workplace raises the opportunity of an ESD event being created or worse induced EOS signals into the customer's working environment. The IPC-A-610D standard states: "current research indicates that voltages and spikes less than 0.5 volts are acceptable. However, an increasing number of extremely sensitive components dictate that equipment must never generate spikes greater than 0.3 volts."

With this measurement, you're trying to establish the value of the readings that a Ground Pro meter can identify for your customer what a multi-meter cannot. You are also showing the customer if the AC outlet is supplying the proper signal to the production.

NOTE: It is important to identify the level of EMI voltage on the line because, absent filtering, such signal will be going into the automated tool, bench, bench tools, etc., that are connected to this power source. The moving voltage induced into the workplace raises the opportunity of an ESD event being created or worse, induced EOS signals entering into the customer's working environment. The IPC-A-610D standard states; "Current research indicates that voltages and spikes less than 0.5 volts are acceptable. However, an increasing number of extremely sensitive components dictate that equipment must never generate spikes greater than 0.3 volts."

April 2010
98-0799-1062-0-A

2. The next step is to take an impedance measurement from the Neutral to Ground connection on the AC outlet.

a) Use the Ohm button to take this measurement. According to ANSI ESD S6.1 or ANSI/ESD S20.20, this value should be less then 1 Ohm impedance. Your measured impedance may not be compliant with this standard; do not be alarmed if the measured value is higher than 1 ohm. Some companies have their own standard on this parameter and this number could be up to 10 Ohms depending on the industry. Please understand that less then 1 Ohm is best, but 5 or 10 Ohms is not bad. This value could be stable or bouncing. If this value is bouncing, then this is an indication that there is EMI voltage between the Neutral and Ground leads. Record the measured ohm value.

b) Keeping the leads inserted into the Neutral and Ground lines, press the EMI button until you read V not dBµV (the EMI button allows you to read two scales dBµV and V. In order to change from dBµV to V, press the EMI button one time to get on the correct scale once you are in the EMI mode).

c) What you should see now on the screen is EMI voltage. This value could be stable, going up and down, or bouncing. This value represents the broadband EMI signal noise between the Neutral and Ground line (many would consider this "EMI garbage"). See Figures 1 and 2 for an understanding of the clean sine waveform and a sine waveform with an EMI signal noise on it.

d) To stabilize the reading, press the HOLD button, which will hold the given value on the scale as seen at the moment you press the HOLD button. Press the HOLD button for a second time and the 3M™ Ground Pro Ground Integrity Meter will calculate and hold the maximum spike peak voltage for the period of time you do the measurement. On the same screen, you will see a MAX value on voltage (the top number on the screen), and the RMS (average) value on voltage (the bottom number on the screen). Record the PEAK MAX value and the RMS value.

Q: Why do I need to measure impedance and EMI voltage between Neutral and Ground?

A: Measurement of impedance is dictated by ANSI/ESD S6.1 and referenced in Table One: Grounding / Equipotential Bonding Requirements of ANSI/ESD S20.20-2007. The required limit is less than 1.0 Ohm impedance. Depending on the industry and the company's standards, if the tool is less than 10 ohms, that could be acceptable. Measurement of impedance gives you information on the connectivity between Neutral and Ground. Adding to this information to the measurement of the EMI voltage between Neutral and Ground, informs you of the reliability of the connection. Now that you know the connection exists, and if the EMI voltage between the two points is low, you know that when a tool is connected to the AC outlet there will not be a voltage transferred to the work environment (automated tool, bench, bench tools, etc.).

NOTE: Adding the information about impedance to the measurement of the EMI voltage between Neutral and Ground gives you an indication of the reliability of the ground connection.

3. The next step is to take an impedance measurement between Neutral and the connection on the tool, bench, etc.

a) Use the Ohm button to take this measurement. According to ANSI S6.1 or ANSI/ESD S20.20, this value should be less then 1 Ohm impedance. Your measured impedance may not be compliant with this standard; do not be alarmed if the measured value is higher than 1 ohm. Some companies have their own standard on this parameter and this number could be up to 10 Ohms depending on the industry. Please understand that less than 1 Ohm is best, but 5 or 10 Ohms is not bad. This value could be stable or bouncing. If this value is bouncing, then this is an indication that there is EMI voltage between the Neutral and automated tool leads. Record the measured ohm value.

b) Keeping the leads inserted into the Neutral and on the automated tool line, press the EMI button until you read V not dBµV (the EMI button allows you to read two scales dBµV and V. In order to change from dBµV to V press the EMI button one more time to get on the correct scale once you are in the EMI mode).

c) What you should see now on the screen is EMI voltage. This value could be stable, going up and down, or bouncing. This value represents the broadband EM signal noise between the Neutral and Ground lines (many would consider this "EMI garbage"). See Figures 1 and 2 for an understanding of the clean sine waveform and a sine waveform with EMI signal noise on it.

d) To stabilize the reading, press the HOLD button. That will hold the given value on the scale as seen at the moment you press the HOLD button. Press HOLD button for a second time and the 3M™ Ground Pro Ground Integrity Meter will calculate and hold the maximum spike peak voltage for the period of time you do the measurement. On the same screen, you will see a MAX value on voltage (the top number on the screen), and the RMS (average) value on voltage (the bottom number screen). You can take multiple measurements from multiple locations on the tool. You are looking for potential areas of the tool that may not be grounded properly and your impedance measurements will give you that information. It would be best if you take this measurement on parts inside the automated tool when that part of the tool is moving. Record the PEAK MAX value and the RMS value.

4. **Every SMT line has several tools and conveyers in a series.** Note that each device is not connected to each other; therefore the next step is to take impedance measurements from the automated tool to the conveyer, from a conveyer to an automated tool, and from an automated tool to an automated tool. For example, these measurements can be performed from the pick and place machine to the next conveyer in the line, or from a conveyor to an oven, etc. You want to repeat an impedance Ohms reading (less than 10 ohms may be acceptable depending on the industry and the customer) and also an EMI V reading, (remember to press Hold button twice to get you to "hold" and "maximum"). The acceptable amount of voltage spike or average will be determined by your internal standards; however we can reference IPC-A-610D which states that tools should not induce more then 0.5 V (500 mV) on the board or component. Follow the steps indicated on point number 3 and write down the measurements as indicated.

5. **If the 3M Ground Pro is able to measure substantial impedance differences between two tools, it is a good idea to next bring in the 3M™ EM Eye Meter to the work area.** Set the EM Eye meter in CDM mode to take measurements for ESD events. 3M recommends that you put the EM Eye meter antenna in the area where the board transfers from one automated tool to the conveyer, or from a conveyer to the automated tool. If there is more than one ESD event associated with the movement of the board across tools, press the memory icon and copy the ESD event levels for the ESD assessment you are performing. Take note of the application for future review.

6. **You can also determine the EM Field in the area by using the Electromagnetic Field Sensor that came with the EM Eye meter. Here are the steps you should follow:**

a) Attach the electromagnetic field sensor and turn on the EM Eye meter.

b) If you see dBµV in the lower end of the screen of the EM Eye meter, press the touch screen and change it to V/m.

c) Put the EM Eye meter about one meter from the automated tool in question and record the value you see on EM Field. This value may be bouncing. You do not need to be precise with this number - just record the average value.

d) Come closer to the tool that you are trying to measure and see if there is any difference between the value measured at one meter away from the tool and the measurement taken closer to the tool. Make a note if there is a difference.

e) Bring the antenna of the EM Eye meter to within ½ inch from a metal tool, or metal parts of a conveyor. Identify again the differences between the value measured at one meter away from the tool and the measurement taken ½ inch from the metal part of the tool. Make note of the numbers.

Q: What do the V/m values measured by EM Eye meter at one meter away from the tool and ½ inch from the tool show?

A: When measuring EM Field at one meter away from an automated tool, metal bench or metal part of a conveyer, we are able to identify the ambient EM noise in the production area. When we bring the EM Eye meter within ½ inch from the metal part of the automated tool, we measure the reflection from that metal part. If the metal part is grounded properly, then the EM field from the ambient noise will reach the metal part and will dissipate to the ground. In this case, EM Eye meter should show either the same numbers as we saw one meter away or lower. If the tool is not grounded properly, then the metal part will reflect back the EM Field from the ambient noise and the EM Eye meter will indicate higher EM Field numbers in V/m. This procedure gives us an understanding of whether or not the automated tool is properly grounded to the facility ground, and if the integrity of the ground connection is well maintained.

NOTE: When measuring at one meter away, we are able to identify the ambient EM noise in the work area.

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98-0799-1062-0-A