Ascel Electronic Æ20218 Milliohm Meter Build

Figure 1 - Ascel Æ20218 milliohm meter

I just realized that I was remiss in having not written an article regarding the build of the Ascel Æ20218 Milliohm Meter a while back, when I actually built the kit. I am remedying that oversight now.

The Æ20218 Milliohm Meter is a product available in either fully-assembled or kit form from Ascel Electronic in Germany, primarily though by far not only through their website (www.ascel-electronic.de). As I recall, it took a couple of weeks for the package to arrive due to Customs delays, but it arrived in good condition.

The cost of this test instrument can vary from a low of $89.73 for the bare kit, to $145.14 (current pricing) if the buyer opts to include the USB connectivity, the handsome enclosure, the Kelvin four-lead test lead set, and the power supply. I ordered the whole package, as I wanted this unit to match the other Ascel products on my bench. I have previously written about the Æ20204 LC Meter and the Æ20401 5.8GHz Frequency Counter & Power Meter, both of which I own and have built from kits.

The Æ20218 is a high-precision resistance measuring device that is capable of measuring to the nearest one-ten-thousandth of an ohm (0.0001Ω). This value, also known as a milli-ohm or as 100 µΩ (one hundred micro-ohms), is an infinitesimally small value of resistance, not normally measurable by conventional ohmmeters. In addition, because of the fact that the Æ20218 uses a four-wire *Kelvin* sensing system, the inherent resistance of the test leads is not included in the actual resistance measurement as it is with a conventional ohmmeter. This means that the indicated resistance is the actual resistance of the device under test (DUT).

Figure 2 - Æ20218 PCB component side

The heart of the Æ20218 is the Atmel Atmega168 microcontroller and its attendant custom firmware. The unit has two ranges, 0 to 24Ω and 0 to 240Ω, with resolutions that vary by range. The 24Ω range has a resolution of 0.00001Ω (0.1 milliohm) at a 100mA test current, while the 240Ω range has a resolution of 0.0001Ω (1 milliohm) at a 10mA test current. The display, delivered via a 16x2 character backlit LCD panel, is based on 240,000 counts, and test measurements are made at a rate of one per second.

The color of the LCD panel is user-selectable at time of purchase with no price difference for the various options. At the time of this writing, YEL/GRN and BLU/WHT were the available display color options. As mentioned earlier, there is also an optional USB interface, which is useful for communications with the included PC-based control and data acquisition software. That software, together with manuals and drivers, are all provided on a CD-ROM that ships with every kit.

Figure 3 - Æ20218 PCB foil side

This being my third Ascel kit assembly, I was quite familiar with their methodologies, which made the kit assembly process slightly simpler for me. For example, knowing that they use multi-piece banana jacks, I already knew that I could mount the metal tubular portion of the jacks to the PCB and install the plastic components of the jacks afterwards. This also makes assembling the PCB to the front panel simpler, as the front panel is held on only by the threaded caps of the banana jacks. An added advantage is that this method prevents heat damage to the plastic parts of the banana jacks while soldering.

All of the SMT devices are pre-installed, leaving only through-hole components for the builder to install. Most of these components will be installed to the component side of the single PCB (Figure 2), though there are some parts that do get mounted to the foil side. These parts include the four banana jack tubes, the two calibration potentiometers, the two tactile switches, the pin header for the LCD panel, and the USB jack (Figure 3). In addition, the LCD panel will be installed to the foil side of the PCB, so the stand-off nuts are mounted on that side and held in place by screws inserted from the component side through the board. The LCD pin header is installed with its shorter end through the board, leaving the longer end to mate with the LCD panel when that item is installed.

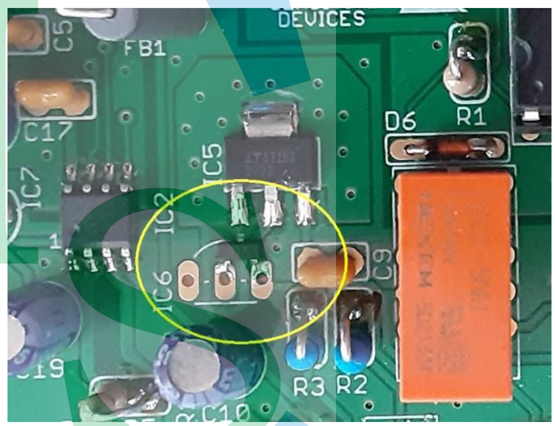

Figure 4 - SMT IC6 PCB update

There was a production change in which IC6, a component that used to be a through-hole type has been replaced by a surface-mount device (Figure 4). As a result, the pads and holes for the original IC type remain, but are unpopulated, and the SMT IC is installed on the edges of two of those pads. The µC is socketed to the PCB.

There is an LM7805 three-pin +5VDC voltage regulator IC installed at one edge of the PCB, where there is just barely enough room for a small heat sink to be applied to the IC if so desired. I have not yet found this to be necessary, so I do not have a heat sink installed to this IC. If I begin to notice issues attributable to overheating of the voltage regulator, I will address that issue. At this point, I see no need for the addition of a heat sink; the tab of the IC seems to be adequate for the cooling needs of this device in this application.

Figure 5 - Rear panel prepared

The enclosure consists of four separate pieces of plastic. There are two enclosure shells, an upper half and a lower half. The difference is that the lower half has provision for a pair of retaining screws to be inserted, while the upper half has the bosses into which those screws will seat. The remaining pieces are the front and rear panels. The front panel is labeled and machined for all of the necessary openings – LCD panel, banana jacks, switches, calibration pot access, and USB jack. The rear panel has two holes machined in it – one for the power inlet jack, and one for the power switch. Once the jack and switch are installed to the panel, it is a simple matter to wire them up and to provide about a six-inch lead pair to connect to the power inlet header on the PCB (Figure 5).

There is a guide tab at the bottom center of the panel opening in the lower enclosure half. This tab (Figure 6) must be removed in order to provide clearance for the banana jacks that are in that area. This is easily done with a pair of pliers or with a knife.

Figure 6 - Tab to be removed

Once all of the small components are mounted to the PCB, it is time to mate the LCD panel with the PCB. This is a simple matter of aligning the LCD panel with the hex standoffs installed to the PCB while also dropping the LCD panels pin header hole row down onto the pin header. Be sure to install and tighten the four retaining screws for the LCD panel before soldering the panel to the pin header. It may be necessary to momentarily loosen the retaining screws for the standoffs in order to position the standoffs in proper alignment with the LCD panel mounting holes.

Figure 7 - Banana jacks ready for panel

Once the LCD panel is installed, run a hex nut down onto the tube of each of the banana jacks, positioning the nut just about even with the edge of the LCD board. Then, place a flat washer on each banana jack tube, and then the plastic "cup" halves of the jack caps, with the open side of the cup facing upwards (Figure 7). Starting from the left side, or nearer the USB jack, the colors should be BLK, RED, BLK, and RED. Finally, thread the caps onto the banana jack tubes, matching the colors to the cups, and centering the pilot of each cap into the hole in the panel and then into the open side of the cup. Make the caps finger tight, but do not over-tighten them or the caps will be damaged. Tighten the hex nuts from underneath to secure the front panel.

At this point, the front panel and PCB are ready for installation into the lower half of the enclosure. Align the front panel into the groove directly behind the front edge of the enclosure, and then position the bottom corners of the PCB into the notches provided for the board (Figure 8). Connect the two wire leads from the rear panel to the power connector at the top of the PCB, observing the polarity of the leads and the connector, and tighten the screws to secure the wire leads. Slide the rear panel down into the groove at the rear edge of the lower enclosure half. Finally, place the top half of the enclosure onto the lower half, aligning the panels and the PCB into their proper grooves, and then install the two retaining screws from underneath the enclosure. Press a rubber foot onto each corner of the lower enclosure half and the unit is complete.

Figure 8 - Front panel and PCB installed

I mentioned something earlier called the *Kelvin measurement system,* and I said that this system eliminated the resistance of the test leads from the measured resistance of the DUT. Let's look a little bit more closely at that system. Please note that I have written a separate article just on this topic, which can be found on my website at https://storage.googleapis.com/production-domaincom-v1-0-0/180/1603180/ZMb5Nhvj/25e8a371f25642848308d72e18779604?fileName=Kelvin%20Resistance%20Measurement%20Method.pdf. Because that article exists, and because it does such a great job of explaining the Kelvin system, I am only going to cover the basics of that system here.

Note that the front panel of the Æ20218 has four banana jacks, two marked as positive and two marked as negative. Note also that the jack pairs are marked I_{OUT} and V_{IN}. This is important, as it tells the story of how the Kelvin system works. The test lead set consists of two alligator-type clamps that each has two wires leading to it. However, these wires are not connected to each other, and in fact, when the clamp is open, there is no connection at all between the wires (Figure 9). The BLK clamp, for example, has a wire coming from the BLK I_{OUT} jack that connects to one side of the clamp jaw, and another wire leading to the BLK V_{IN} jack that connects to the opposite clamp jaw. The same arrangement exists with the RED clamp – one wire from each of the two RED jacks on the panel.

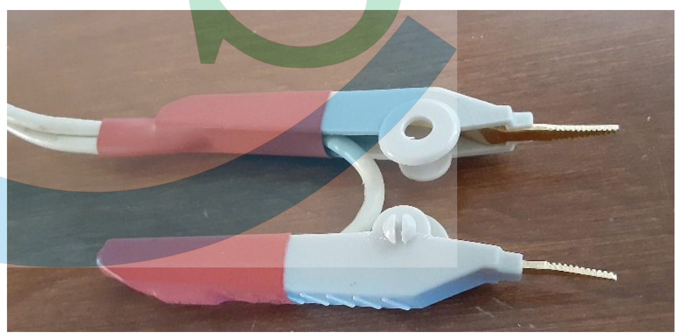
Figure 9 - Test clamp disassembled to show wire connections

In operation, the test instrument puts a specific known test current out on the I_{OUT} wire pair, which then flows through the DUT. The test instrument then measures the voltage developed across the DUT, sending that information back to the meter via the V_{IN} wire pair. Because this voltage is what is being measured *rather than the resistance,* and because the applied test current is known, it is easy for the test instrument to do an empirical Ohm's Law calculation and derive the actual resistance through the DUT.

The test leads sold with this instrument are of a high-quality plastic construction, which aids in the isolation of the two lead types when the jaws are open. The same technique is utilized on each of the two clamps, and the banana plugs on the cable opposite ends are snug fits into the banana jacks.

Calibration of the unit is required upon first assembly, and it is recommended that the calibration be repeated every six months in use. There are two calibration procedures described, one of which requires the use of a resistance standard which, of course, most folks will not have or to which most of us will not have access. The other calibration procedure requires the use of an ammeter capable of accurately reading a current of 100mA. This is the current output from the instrument when it is set to its 24Ω scale. When set to its 240Ω scale, the instrument current output drops to 10mA, which can also be used for calibration on that scale.

Figure 10 - Calibration access

The basic procedure is to connect the ammeter across the I_{OUT} banana jacks, set the Æ20218 to its 24Ω scale, and adjust potentiometer P1 for an ammeter indication of exactly 100mA. Next, install the test leads and connect a resistor with a nominal value of between 10Ω and 20Ω to those leads. Wait about thirty seconds for the reading to stabilize, and record the resistance reading displayed. Finally, set the instrument to its 240Ω scale, and with that same resistor still in the test clamps, adjust potentiometer P2 to read the same resistance recorded in the previous step. It is also feasible to simply adjust P2 for a current reading of exactly 10mA on the 240Ω scale after adjusting P1 for the 100mA current reading. These two calibration potentiometers are accessible through holes provided in the front panel, and are marked for their proper adjustment values (Figure 10). It may be necessary to go back and forth between the two adjustments a couple of times to get the final adjustment set properly.

There is no contrast adjustment for the front panel display. Instead, the designer chose to use a voltage divider network consisting of R6 (220Ω) and R9 (910Ω) connected across the +5VDC supply and ground connections to the LCD panel. The junction of the two resistors is tied to pin 3 of the LCD panel, the pin that is often powered via a potentiometer to adjust the contrast. This fixed contrast setting eliminates one possible source of "trouble" on initial power-up, as the text will show up on the panel immediately without the need to adjust a potentiometer to achieve a proper display.

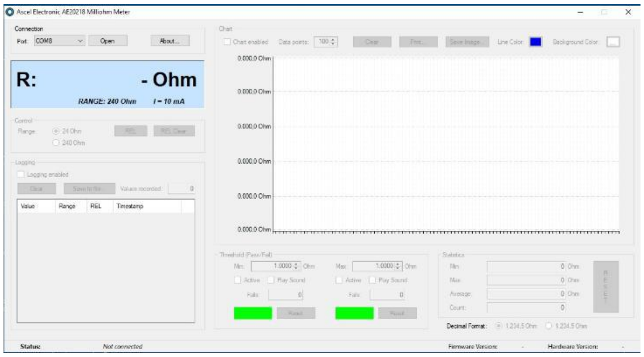

Figure 11 - Software interface

I have used this instrument quite frequently, and I have referred to it in several of the articles that I have written. It is an accurate and reliable piece of test equipment, and I would expect nothing less from the folks at Ascel. So far, all of their products have proven to be of exceptional value and are well designed and documented. Each item has been accompanied by nice Windows® utility software (Figure 11) that makes control of the instrument and data acquisition from it quite simple. I give these guys high marks for their designs and their attention to detail.

I have found the Æ20218 especially useful when testing transformers and other inductors for through resistance, as these values are often so low that it is very difficult to get realistic measurements with conventional ohmmeters. A case in point is the recent diagnosis of the GCARC Yaesu G-5500 rotator controller in which the power transformer had failed. It was only through use of the Æ20218 that I was able to obtain realistic resistance measurements through the various windings of the transformer.

I would recommend this product to anyone who has the need for an accurate low-resistance measurement tool. I would further suggest that anyone purchasing this instrument spend the extra money to buy the whole package. It is far more convenient to use this instrument in its proper enclosure and with the proper Kelvin test lead set. The USB connectivity is also crucial as it makes the computer software communications possible, and the power supply is needed unless the builder decides to power the unit via a battery. In my opinion, these should not be optional items at all, but rather should be a part of the basic package. The *only* option, as I see it, should be the color scheme for the LCD panel.

All things considered, this is a device whose purchase price is quite reasonable, whose assembly is quite simple, and whose operation is extremely intuitive. With all of these things in its favor, I would be hard put to find a reason *not* to buy the Ascel 20218 Milliohm Meter kit.