



RADARTRON 1400C MOISTURE SENSOR

USER'S MANUAL

Accurate moisture measurement is critical to the production of high quality concrete. The RadarTron 1400 measures the moisture of fine aggregates such as sand and crushed stone. Its microwave technology eliminates the errors associated with resistance and capacitance methods, giving an accurate reading every time. The system is independent of impurities in the aggregate and does not require frequent recalibration. It is easily installed in any bin wall and is suitable for both digital display and direct connection to a computerized batching system.

Microwave energy is absorbed by water. By sending a microwave beam into moist aggregate and measuring the energy returned, the quantity of water in the material can be measured precisely. Accuracy is further enhanced by averaging the readings during material feed and holding the result for later use.

FEATURES:

- 1/10 to 1/4% accuracy, depending on type of material.
- 0-5 volt, 0-10 volt and 4-20 mA outputs for use with computers and PLCs.
- Optional digital display is wall or panel mountable.
- Adjustable length allows insertion into material flow region of bin.
- Special circuitry ignores erratic readings from loose material during flow.
- Connection to feed gate or conveyor activates sampling cycle and averages readings during feed period. Alternatively, can be made to continuously average, whether flowing or static.
- When sampling is discontinued, reading gradually adapts to material in contact with sensor.

- Low bin level detector holds reading when bin is low, preventing spoiled batches.
- Computer-aided calibration; just take readings from dry and moist aggregate. The RadarTron calibration program graphs results and gives adjustment instructions.

THE IMPORTANCE OF ACCURATE MOISTURE MEASUREMENT

Your mix design assumes that aggregates, cement and water are present in the correct proportions. If your sand moisture decreases by 2% without being noticed, which can often happen in practice, the batching system will batch 2% more sand than you require and will add substantially less water than required, making a dry batch. If the operator corrects this by adding more water, the water/cement ratio will increase, reducing the strength of your product. If the moisture had been measured accurately, the proportions would all have been correct and there would have been no need to add more water.

The aggregate moisture sensor ensures that the batch is proportioned according to the DRY WEIGHT MIX DESIGN.

SPECIFICATIONS:

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|-----------------|---|
| Size: | 3-1/2" diameter, 25" long with 7" adjustable flange for correct positioning. |
| Material: | 304 stainless steel body and flange with shatterproof extra hard ceramic faceplate. |
| Sensing volume: | 2" X 2" X 4" at 4% moisture. |
| Moisture range: | 0 - 20% for zero to full scale output. (actual upper limit is |

	dependent on moisture retaining ability of material, typically 10-12% for medium sand.)
Output:	0-5 volt, 0-10 volt, 0-16mA or 4-20mA full scale; suitable for most computers, PLCs and automatic batching controllers.
Power:	120V/240V 50/60Hz, 5 Watt.
Sampling signal:	120V/240V 50/60Hz, or 24V AC/DC, 3mA max.
Cable length:	2000 ft (600m) max.
Temperature:	32 - 140°F (0 - 60°C).

INSTALLATION

The RadarTron is designed for installation in the aggregate holding bin. It is essential to have at least 18 inches of unobstructed material in front of the faceplate when installed. This precludes use on conveyor belts in most cases, where only a thin layer of material exists.

Refer to fig. 1 and drilling template attached. The RadarTron must be positioned in the holding bin so that the sensing plate is in the material flow region. This region extends vertically above the outlet opening. It is also important for the faceplate to be at an angle of 30 to 60 degrees to the direction of flow for best results. Do not install the RadarTron on the same bin wall as a vibrator; this will shorten the life of the electronic components and is not covered by warranty. Choose a location where the sensor will not be hit by the feed gate as it opens and where there is enough room to remove the end cap and draw out the circuit board for calibration. Estimate the insertion length by holding a tape measure at right angles to the bin wall and measuring to the centre of the flow region.

Installation can be done with material in the bin, provided it is moist, although it will be easier if empty. Using the template provided, mark and burn the central hole. Grind the edges to remove lumps. Using the template or the actual flange, mark the mounting holes. Mount the flange using four 1/2" mounting bolts which should be inserted from the inside of the bin, as shown in the attached sketch, to facilitate future replacement. Position the low, wide seat against the bin and the narrower radius skirt facing

out. Tighten the four bolts equally. If the bolts are sealed in place with silicone sealant or epoxy, water leakage and rusting will be prevented. Grease the threads. Alternatively, the bin wall can be drilled and tapped.

If the bin is full, use a crowbar or trowel to make a recess slightly larger than required. Insert the RadarTron and tighten the clamping screw.

ELECTRICAL CONNECTIONS

The RadarTron has been pre-connected and calibrated to make installation as simple as possible. If you can use it with the cable supplied, please disregard the following section. If you need to use a longer cable or conduit, proceed as follows:

Place the RadarTron on a clean, flat surface, release the strain relief to prevent the cable twisting and unscrew the cap from the rear of the sensor. Remove the retaining spring and carefully withdraw the plastic retainer and circuit board. Take care not to apply any strain on the cable which extends within the sensor. Measure and cut 6 wires (or a piece of multi-conductor cable) to run from the RadarTron to a convenient junction box. Connect per fig. 2., using coloured or numbered wires for later identification. Incorrect connection of power will damage or destroy the electronics.

INTERNAL SETTINGS

The RadarTron has the following operating modes. Factory settings are shown in bold type; do not open the unit unless you need to change them:

SAMPLING - readings are sampled and averaged during material flow, the result being held for later use (in the following batch, for example). Sampling requires a material flow time of between 5 and 20 seconds (not including jogging, if used) for best results. If flow does not occur for several minutes, readings will gradually revert to that of the material currently on the sensor faceplate.

DIRECT FAST - Readings follow variations in moisture with a response time of 0.3 second.

DIRECT SLOW - As above but with response time of 3 seconds.

4-20 mA - Output mode used with the

1278 and 1279 digital displays as well as most computer and PLC applications. This mode is the best when using long cable runs. In this case, if the computer/PLC requires a voltage input, use a terminating resistor (see fig. 2.) of 250 ohm for 1-5 volt, 500 ohm for 2-10 volt, 1/4 watt 1% metal film. Note: this resistor is not needed for the 0-5 and 0-10 volt settings below.

0-16 mA - Similar to above, allows use with 0-5 volt and 0-10 volt inputs. Use terminating resistor values of 312 and 624 ohms respectively.

0-5 V - For applications where a 5 volt input is required but the cable run is short (less than 200 ft.) and/or no terminating resistor is available.

0-10 V - As above, for 10 volt inputs.

Change the jumper settings as required. Ensure that there is a jumper on one of the DIRECT FAST, DIRECT SLOW or SAMPLING positions and on one of the 0-5V, 0-10V, 4-20mA or 0-16mA positions.

To reinstall the circuit board, ensure that the internal sensor cable is folded UNDERNEATH the board, to avoid it catching on the components, and slide the complete assembly into the tube, using the pull wire provided to pull the loop of sensor cable out, preventing it from blocking the path of the circuit board holder. When correctly inserted, the end of the circuit board holder should be 1" inside the tube. Make a loop of the main connecting cable and push it into the end of the plastic retainer. Insert the retaining spring. Apply Teflon plumbing tape to the external tube threads and screw on the end cap hand tight only. This joint is not intended to be fully watertight. Retighten the cable strain relief.

The plastic cable strain relief can be replaced by any standard 1/2" conduit fitting. Flexible conduit will give better protection than the cable alone. Take care to ensure that water cannot enter the RadarTron via the conduit. Leave enough excess cable to allow the circuit board to be drawn out later without disconnection, for calibration.

WIRING TO POWER SOURCE AND INDICATOR

Refer to fig. 2. The RadarTron requires a source of 110/120 VAC or 220/240 VAC power which

is not turned off at night. The power voltage is not jumper selectable and must be ordered as required. Connect as shown, paying attention to the colours of the wires. Incorrect connection of power will damage or destroy the electronics. The analog output is isolated from ground and the AC supply, allowing it to be connected to any input device with complete safety. The optional 1280/1290 digital display requires 2-wire connection to ANALOG OUTPUT and COM only; no power is required.

CALIBRATION

The RadarTron is factory calibrated to give accurate readings when used with the same type of sand, at the same density as when calibrated. The sand in most places will give results within $\pm 2\%$ of the true value, but the readings should always be checked and recalibrated if necessary. Stone and other materials will usually require an adjustment but may require factory recalibration for the specific material in use. To be sure, submit a sample of 1 cu. ft. or more to Scale-Tron's test lab for proper setup. After installation, check operation by comparing results with an accurate moisture measurement system such as the "Oven Dry" weighing method below. The popular "Speedy model ELE 23-7450" system can be used for an approximate check only, since its accuracy is poor when compared to the RadarTron or oven dry method.

Before making any corrections, you must collect and compare readings at both low and high moisture. Ideally, collect a set of readings varying from 2% moisture to 8 or 10%. Your calibration will only be correct within the range of moisture over which you take readings. We have made the adjustment procedure as simple as possible by providing both a graph and computer analysis of your comparative readings, together with recommended adjustment procedure. When you have obtained a set of 10 good comparison measurements, plot them on the graph provided (see Figures 3 and 4) or insert the calibration disk into your computer (IBM compatible) and follow the instructions. Alternatively, fax them to Scale-Tron at (514) 639 6945. We will return a table showing the adjustments to make; this should result in accurate readings after only one adjustment if carried out correctly.

To make calibration corrections, proceed as follows:

NOTE: Removal of the RadarTron circuit board with power applied is dangerous and can result in injury or death. Turn off AC power before removal or reassembly. When making calibration adjustments, do not touch the circuit board other than with an insulated screwdriver or adjustment tool.

At the end of the day's production, when no further material is to be taken from the bin, turn off power. Release the cable strain relief to prevent the cable twisting and unscrew the cap from the rear of the sensor. Remove the retaining spring and carefully withdraw the plastic circuit board carrier far enough to expose the SPAN and ZERO adjustment pots. Take care not to apply any strain on the cable that extends within the sensor. If the jumper is on the SAMPLING position, temporarily move it to the DIRECT FAST position to facilitate adjustments. Note the SENSOR NULL MOISTURE value, shown on a label on the RadarTron's power transformer (near the connector) on units with serial numbers 990100 and above. If this reading is not available, use the default value of 2.00 in the computer program. If a digital display is available, connect it to the Radartron output as directed; otherwise have someone call out or relay the readings from the batching computer. Apply power and allow a few minutes for warmup.

If you are making corrections based on the graph or calibration software, proceed according to the instructions supplied. A summary is given in ADJUSTMENT USING COMPUTER DISK following.

If you wish to make adjustments without the graph or calibration software, proceed as follows:

If the readings taken show that both low and high readings are in error by the same amount, a ZERO adjustment is required. Observe readings and rotate the ZERO adjustment pot until the required correction is made. For example, if all readings are shown to be 0.5% higher than actual, turn the adjustment pot to reduce the reading by 0.5% regardless of the actual reading at this time.

If the readings are good at low moisture levels but are in error at high levels, adjustment can only be done when the material in the bin has a high moisture content. Note that most types of sand cannot retain water above 10% moisture; the readings will be erratic due to water soaking through. adjust the SPAN adjustment pot in the

same way as for ZERO above; for example, if readings have been consistently 0.4% low at 8% moisture, increase the reading by 0.4%.

After calibration, remove power and replace the DIRECT FAST jumper to its normal position. Check that the internal sensor cable is folded UNDERNEATH the board, to avoid it catching on the components, and slide the complete assembly into the tube, using the pull wire provided to pull the loop of sensor cable out, preventing it from blocking the path of the circuit board holder. When correctly inserted, the end of the circuit board holder should be 1" inside the tube. Make a loop of the main connecting cable and push it into the end of the plastic retainer. Insert the retaining spring. Apply Teflon plumbing tape to the external tube threads and screw on the end cap hand tight only. This joint is not intended to be fully watertight. Retighten the cable strain relief.

ACCURACY CHECKING

It is often desirable to know the measurement accuracy of the RadarTron sensor, in order to compare it with others or to calculate the effects of errors on the process. This testing can give misleading results, however, and should never be used as proof of accuracy or to compare one system with another. The reason is that it is impossible to take a perfect sample every time. Usually the gate from which the material is batched is much bigger than the sensor and therefore the sensor cannot measure exactly the same material as is taken for the sample. For example, in a sand bin, the sand in one side may be wetter than that at the other side. The sensor measures sand from the middle of the gate while the manual sample is taken at the side. The sample, therefore, can be quite different from the measured material. This will appear from time to time as a large error in the comparative measurements. In these cases, it is usually the sensor that gives the best result.

When testing the sensor, do not compare readings with oven dry tests; use the sensor to compensate for the moisture in the process and verify that the process has been improved. This is the only meaningful test that can be done.

ADJUSTMENT FOR NORMAL WEAR

Although the RadarTron is highly resistant to wear, some types of extremely abrasive material will cause wear over a period of time. This results in an off-zero error, noticeable as an equal error at all moisture levels. It can be corrected by following the ZERO adjustment procedure above.

WEAR AND IMPACT DAMAGE

The ceramic faceplate is guaranteed for wear for 5 years after purchase. Excessive wear over many years can damage the waterproof seal around the faceplate, however. Likewise, falling rocks and other objects can crack the faceplate. This type of damage is not covered under the warranty; if this type of damage is possible, you should protect the faceplate by welding an inverted piece of angle above it, but far enough above that material flow is not impeded.

All RadarTron parts are replaceable. The complete unit must be returned to us for replacement of the body or faceplate, however.

"OVEN DRY" TEST FOR OBTAINING PERCENTAGE MOISTURE

EQUIPMENT REQUIRED: Scale, capacity 1 to 10 kg x 1 g graduations. Baking tray 12" square. Stove, microwave oven or heater.

In a concrete plant, the best way to obtain samples is during batching. Before starting, note the moisture display reading (on Genie-II batching controller, press F10 MOISTURE). Prepare a clean container (a bucket is ideal) and use a scoop to take as many scoopfuls as possible from the material coming out of the gate while it flows. Repeat the reading (ESC, F10 on Genie-II) and verify that the change from the previous reading is no more than + 0.1%. If the moisture varies too much, repeat this paragraph until repeatable readings are obtained; dump and refill the container each time.

For other applications, try to obtain as representative a sample as possible, given the process.

Mix the material in the container thoroughly, then mix it again. It takes twice as long as you would think to mix the sample properly.

Remove and bag a quantity suitable for the test below.

Ideally, follow the ASTM standard moisture test. If this is not possible, proceed as follows: place the baking tray on the scale and tare it (adjust the weight to zero). Weigh 1 to 2 lb (500 to 1000g) of material into it, taking care to be accurate. Place the tray on the stove or microwave oven and heat the material until totally surface dry, stirring frequently. Be very careful to ensure that no material is spilled during stirring; place a paper under the heater if possible and return spills to the tray. It is not necessary or desirable to bake the sand to red heat; merely boil off the surface moisture to approximate "saturated, surface dry" conditions. You can test for emission of steam by holding a cold glass plate over the tray; When it fails to mist, no steam is present and saturated surface dry conditions have been obtained.

When cool, return the tray to the scale and re-weigh. Calculate the true "Dry Weight" moisture from the following formula:

$$\% \text{ MOIST.} = \frac{\text{WET WEIGHT} - \text{DRY WEIGHT}}{\text{DRY WEIGHT}} \times 100$$

EXAMPLE:

If WET WEIGHT = 2.000 kg, DRY WEIGHT = 1.815 kg,

$$\% \text{ MOIST.} = \frac{2.000 - 1.815}{1.815} \times 100 = 10.2 \%$$

RADARTRON ADJUSTMENT USING COMPUTER DISK

It is essential to obtain a set of readings over as wide a moisture range as possible. If you do not have readings covering the moisture range over which you will be working, your calibration will not be valid.

Once 8 to 10 readings, together with the oven dry test results, have been taken, they can be entered in the calibration program. Follow the instructions (click on HELP or press F1).

The Adjustment should take place at the end of the shift, when you are no longer using the material in the bin where the Radartron is installed. Refer to CALIBRATION section preceding for the procedure. You should adjust one unit at a time. If several units are installed in the same bin and connected together electrically in order to measure the moisture, you should isolate the unit that has to be adjusted. You will

also need the Radartron adjustment values (from the computer program) and a small flat blade screwdriver.

There are basically two parameters to adjust: the **Offset** and the **Span**.

Let us assume that, several minutes after the jumper has been placed on DIRECT FAST and the power turned on, the readings are stable at a value of 5.22. This will be our Reference Value. Enter this value on the calibration screen.

If you have not already done so, click on the RUN button on the calibration screen to calculate the adjustment values. A graph of your readings will appear. Note the **Consistency** value, which shows how good your results are for making a calibration. If the Consistency is lower than 85%, you should repeat your measurements or examine the graph and delete any values which do not appear to fall in the proper place, followed by the RUN button.

When you have a good set of results, click on the ACTION button. The adjustment procedure will appear.

Locate the potentiometer marked "ZERO" (see Figure 2). Using the screwdriver, turn it slowly until your reading matches the value of step 1.

Locate the potentiometer marked "SPAN" and turn it slowly until your reading matches the value of step 2.

The Adjustment procedure is now complete. Power down the Radartron, return the jumper from the position "FAST" to the position "SAMPLING" and close the unit according to the instructions on page 5 of the manual.

After every adjustment you should check the readings from the Radartron with those from an oven dry or other primary method to prove that the adjustment was done correctly.

Please note that the material in your bin is NEVER perfectly homogenous and does not have the same moisture at every point. This is why you will never have total agreement between the two set of readings. The objective is to have good correlation between the Radartron readings and the primary method. The adjustment procedure is focused on this goal and will give good results when carried out carefully.

RADARTRON ADJUSTMENT USING GRAPHICAL METHOD

Note that the graphical method is not as accurate as the computer program. If the adjustment to be made is small, however, the difference is slight. The Adjustment should take place at the end of the shift, when you are no longer using the material in the bin where the Radartron is installed. Refer to CALIBRATION section preceding for the procedure. You should adjust one unit at a time. If several units are connected together in order to measure the moisture, you should isolate the unit that has to be adjusted. You will also need the Radartron Adjustment Table, a pen, a pocket calculator and a small flat screwdriver.

There are basically two parameters to adjust: the Offset and the Span.

Locate the blank graph (see Figure 3) and plot the readings from the oven dry tests.

Let us assume that, several minutes after the jumper has been placed on DIRECT FAST and the power turned on, the readings are stable at a value of 8.0. This will be our Reference Adjustment Value. Note this reading (value B in the example, Figure 4) and plot it on the line you have drawn on the graph.

Measure where the line crosses the "RADARTRON" axis (value A, 2.5 in the example). Draw a horizontal line through B, extending both ways and subtract value (A) from (B), plotting point (C) as a result (2.5 to the left of B in the example). If the value for A was negative, add it to B and plot the new point C to the right of B. A line from the origin to point C (dotted in the example) should be parallel to the first line if this step was done properly.

Turn the RadarTron's ZERO adjustment to make the reading equal to the C value (5.5 in the example).

Plot point D where the horizontal line through B and C crosses the DESIRED line. Turn the SPAN adjustment to make the reading equal to the D value (10 in example).

The Adjustment procedure is now complete. Power down the Radartron, return the jumper from the position "FAST" to the position "SAMPLING" and close the unit according to the instructions on page 5 of the manual. Sign and date the Adjustment Table and keep it safe for future adjustments. After every adjustment

you should take series of comparative readings from the Radartron and from the oven dry or other primary method. The minimum number of readings you should take is 10.

Please note that the material in your bin is NEVER perfectly homogenous and does not have the same moisture at every point. This is why you will never have total agreement between the two set of readings. The objective is to have good correlation between the Radartron readings and the primary method. The adjustment procedure is focused on this goal and will give good results when carried out carefully.
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FAULT FINDING

See diagram of circuit board on next page.

Sensor gives no output – remove cap (see warning on page 4) and feel temperature of power transformer. If cold (and sensor has been powered up for 30 minutes or longer) this indicates that power is not getting to the circuit board. Test the power input connections with a meter. Test the fuse F1 and replace if necessary with a Picofuse, ¼ amp. This fuse is a solder-in type and can be changed without removing the board from the carrier if done carefully.

If power is verified (transformer is hot) check SAMPLE LED. It should flash once every 15 seconds and light continuously when the SAMPLE signal is applied, or for 30 seconds at startup. With a digital voltmeter, check voltages at TB1. With negative of meter on COM terminal, voltage at +8V OUT terminal should be 8 volts approx., whether sensor is connected or not. Voltage at D1 or D2 terminal should be between +0.5 and +1.5 volts, varying when a hand or wet object is moved to cover the faceplate. When the sensor is sitting on a bed of sand at least 6" deep, with approx. 2% moisture content, the voltages at D1 and D2 should be equal and should change as moisture is increased.

With sensor sitting on a moist bed of material, or using hand on faceplate, put jumper LK1 onto DIRECT FAST, and select proper mode of output for system or display connected. If nothing is connected to the output, select 0 – 10 V. Using meter, measure output voltage. If no voltage is present, disconnect output terminals, select 0 – 10 V with jumper and try again. If output still does not respond, circuit board is

probably damaged.

Sensor seems to be working but 1278/1279 display does not operate – wrong jumper setting. You must set it for 4 – 20 mA when using the display. Also, when using both display and computer or PLC input, these devices must be connected in series – not parallel.

Output reads 5% low – check output jumper setting – most likely it is in 0-16 mA when it should be in 4 – 20 mA position. If jumper is correct, sensor requires calibration.

Output does not read correctly and responds sluggishly – If sensor is mounted in bin, possible cause is material sticking to faceplate. Remove sensor to verify. Cure for this is to mount the sensor tube at a more horizontal angle so that the faceplate is more vertical, helping it to be cleaned by the passing material.

RADARTRON CIRCUIT BOARD – ADJUSTMENT AND TEST POINTS

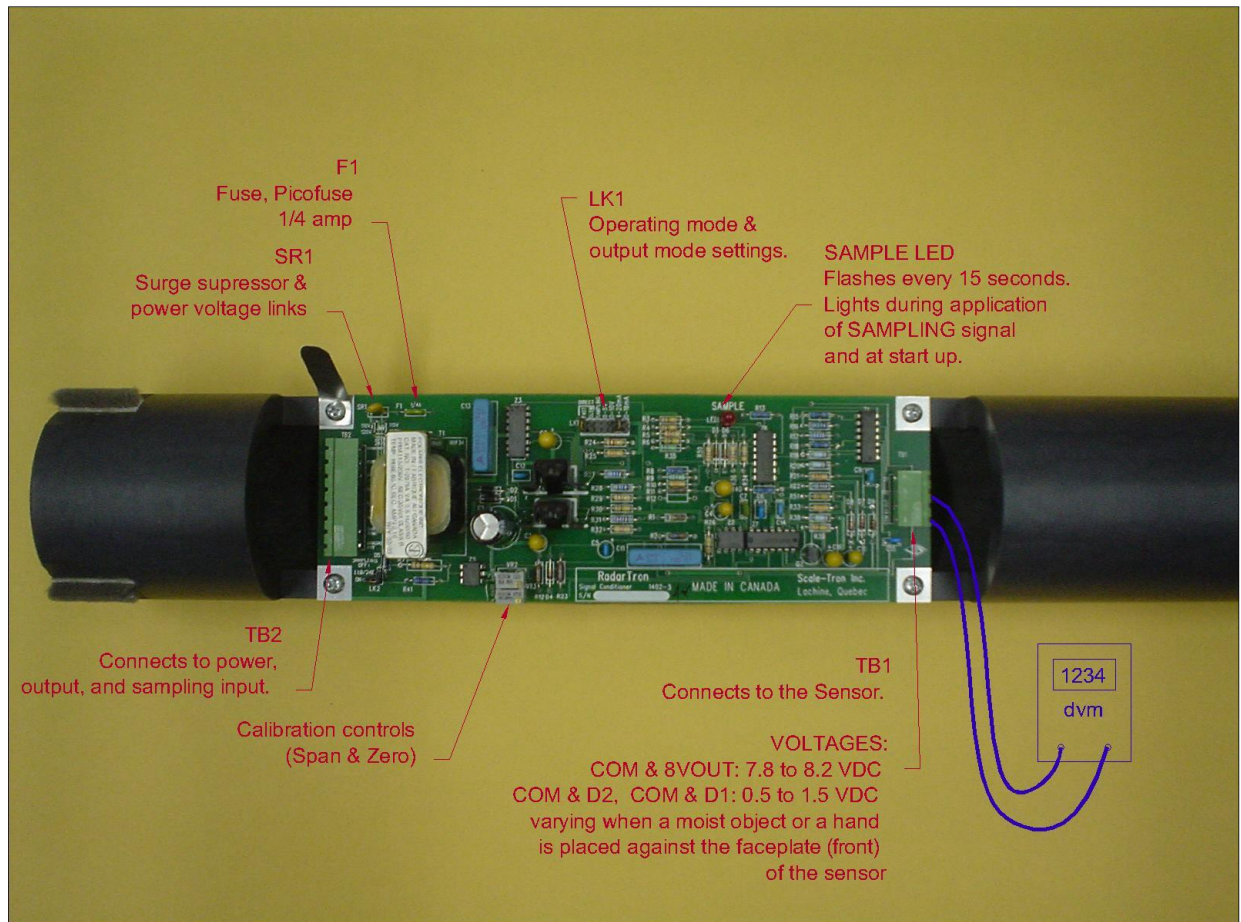


Figure 3, CALIBRATION GRAPH

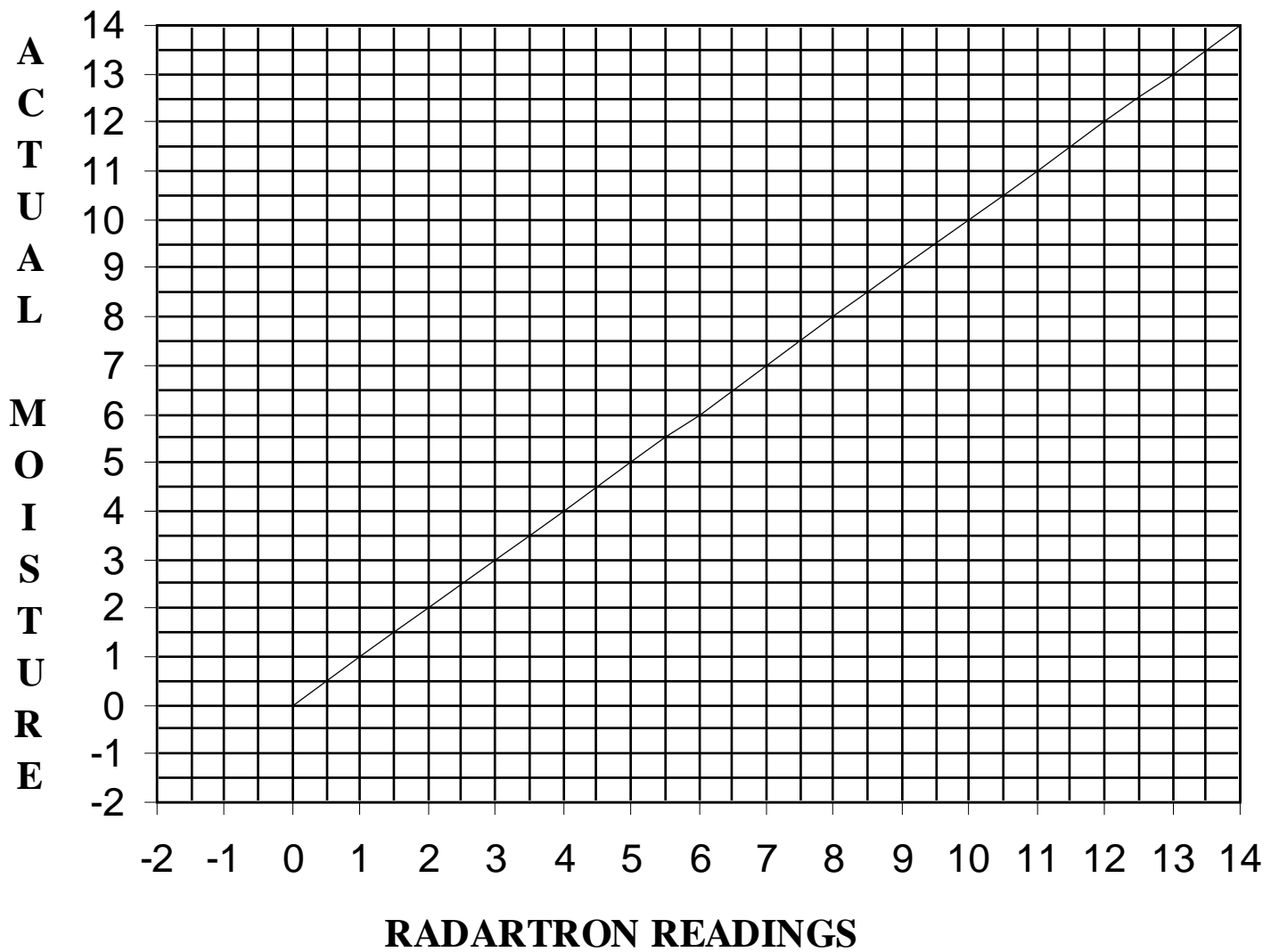
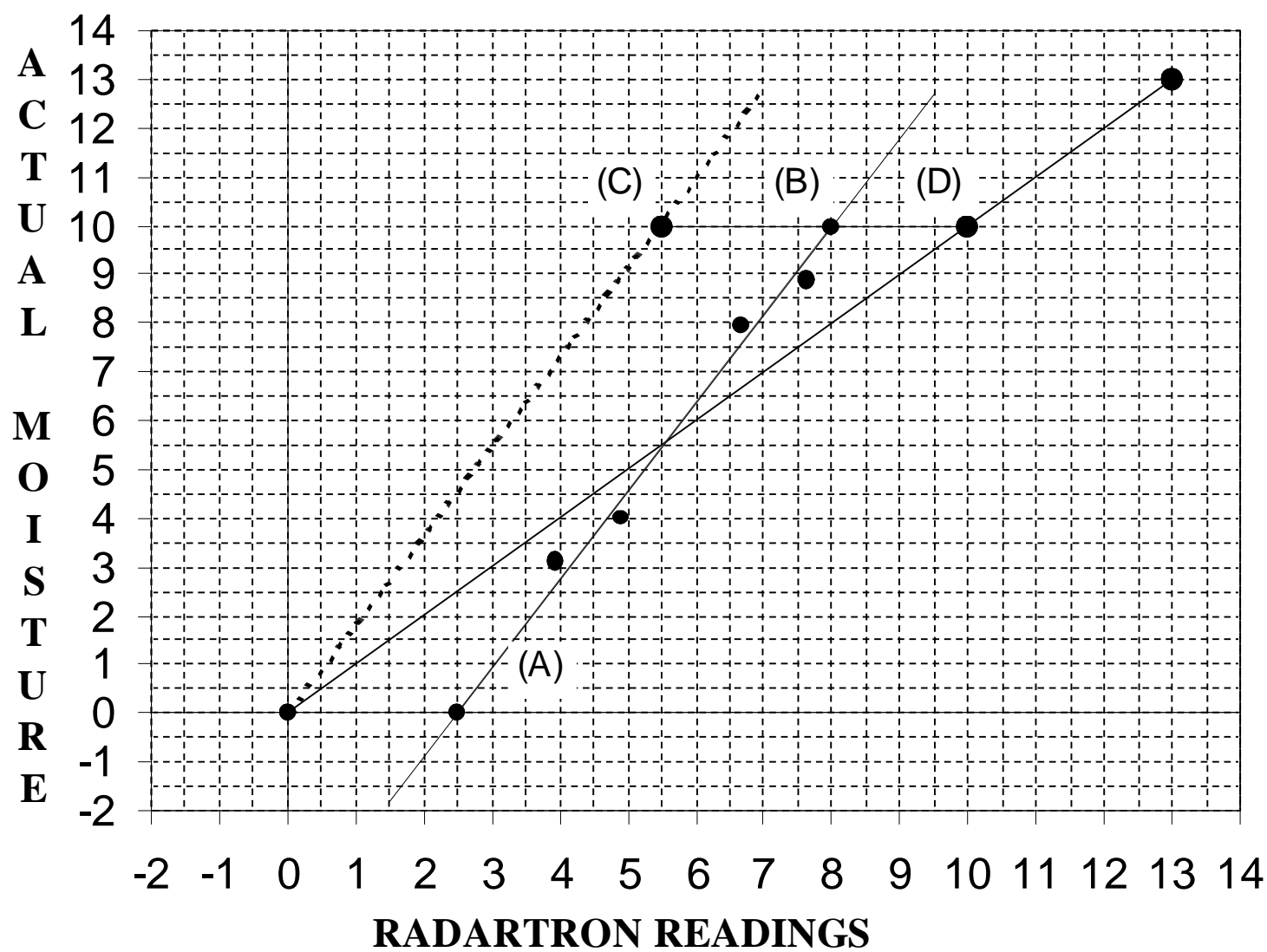


Figure 4, EXAMPLE GRAPH



Legend

DESIRED	_____
SAMPLED	_____
PARALLEL	_____