ULTRA*MOIST* MICROWAVE MOISTURE MONITOR

DESCRIPTION OF OPERATION AND SPECIFICATIONS

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1.0 Introduction

1.1 Moisture Measurement – an important process parameter

Moisture measurement has always been an important process parameter. Traditionally this has been carried out using the conventional laboratory analysis of a manual sample. Not only is this an expensive and time consuming process but the time taken to provide the result means that the information is only of historical value. During the time interval between taking the sample and reporting the result, operational conditions may have changed so that the reported result is no longer valid to the changed conditions.

The ultra***MOIST*** On-Belt Moisture Measurement System now allows the accurate measurement of moisture in realtime. This ready availability of moisture information allows proactive process control actions. The information can be used in a number of ways including:

- metallurgical/process accounting
- diverting excessively moist material away from vulnerable downstream processes
- feedback control to a dryer circuit
- feed forward/back control to spray bars for dust control
- product net weight monitoring for quality control purposes
- product moisture/dry mass contract compliance
- etc., etc.

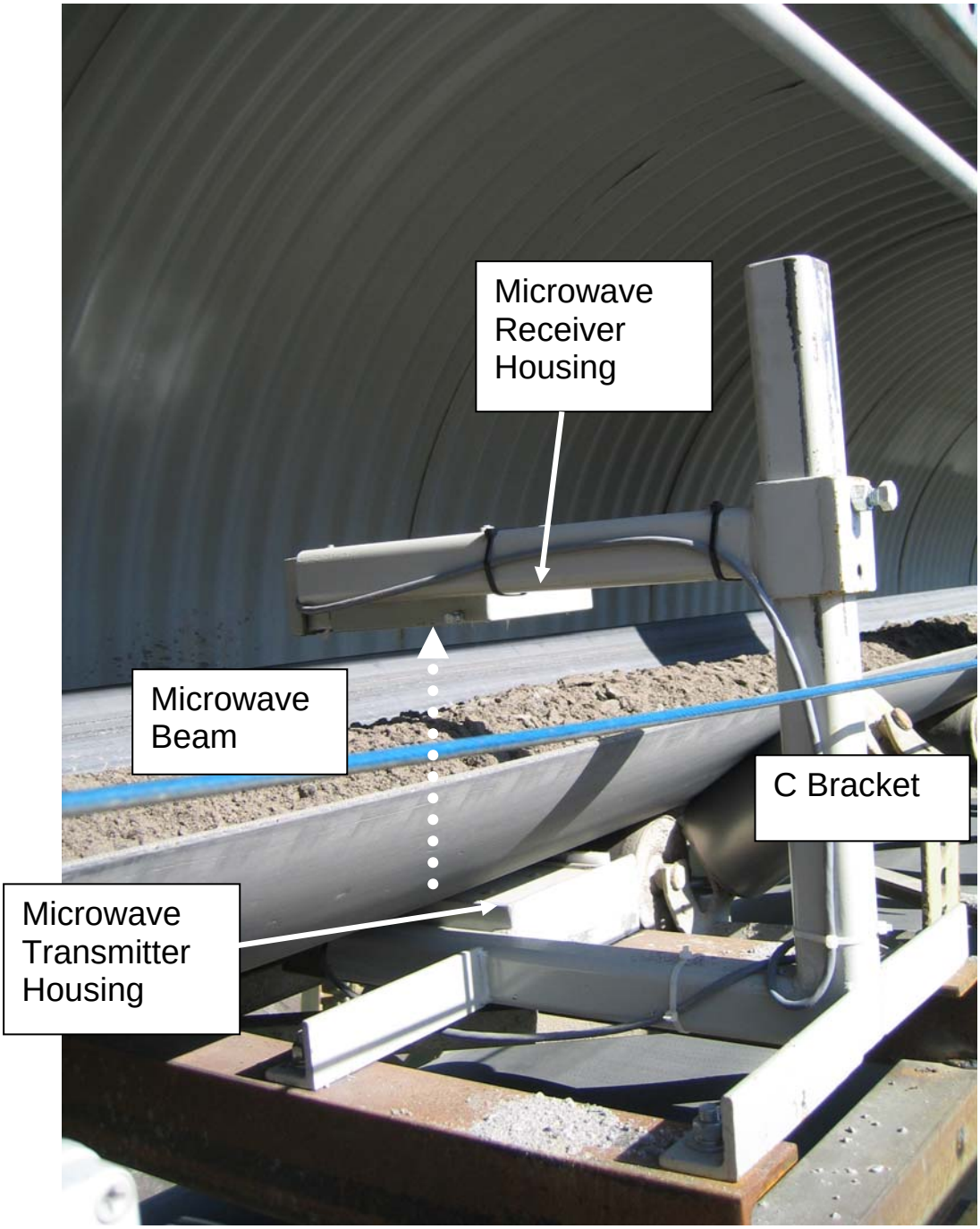
The microwave moisture technique has been found to be suited to a wide range of non-conducting materials including; coal, wood flake, bauxite, sugar, bagasse, sand, mineral sands, foods, chemicals, etc. etc.

Competitive Advantages Compared to Near Infra Red Technology:

Potential Limitation	ultra***MOIST***	**Near Infra Red**
Vertical segregation	Unaffected – beam penetrates full bed of material	Reflectance technique from surface molecules only
Sample presentation	Unaffected by position of material	Distance of material surface to receiver important
Colour	Unaffected	Significant effect
Ambient lighting	Unaffected	Requires shielding
Wear	No moving parts	Mechanical filter system
Presence of steam	Unaffected	Can cause interference
Dirty atmosphere	IP65 enclosures	Window requires to be kept clean
Technical support	Excellent - Australian design and manufacture	Imported technology

1.2 The Microwave Moisture Measurement Technique

The moisture content of the material is determined by measuring the transmission of a microwave beam through the process material. This beam is emitted from a transmitter located in the lower arm of the Measurement C-Bracket located under the conveyor belt. The transmitted microwave signal is detected by the receiver located in the upper arm of the Measurement C-Bracket. The effect on the microwave signal by the material it passes through is recorded and used in the determination of the moisture content.


Microwave Receiver Housing
Microwave Beam
C Bracket
Microwave Transmitter Housing

2.0 System Description

The ultra***MOIST*** On-Belt Moisture Analyser operates automatically under computer control. The functions and operations of the individual units are described as shown:

2.1 Measurement C-Bracket

The measurement C-Bracket provides the means of mounting ultra***MOIST*** on the conveyor as well as accurate alignment of the microwave microwave transmitter and receiver subsystems. The measurement systems are accurately aligned during the manufacturing process which means that there is no need for lengthy setting up on site. The Measurement C-Bracket is normally arranged so that these measurement systems are aligned with the centre of the belt. The Measurement C-Bracket is designed to fit directly to the conveyor stringers.

The lower arm of the Measurement C-Bracket contains the microwave transmitter. The upper arm of the Measurement C-Bracket contains; the microwave receiver and the microwave electronics.

The Measurement C-Bracket and Electronics Control Cabinet are designed to meet IP65 standard for dust and moisture intrusion.

2.2 Electronics Control Cabinet

The standard ultra***MOIST*** is supplied with the Electronics Control Cabinet which is usually mounted on the Measurement C-Bracket. This cabinet contains electrical and electronic hardware which consists of:

- Micro Processor / PLC.
- Power supply
- Electrical terminations.
- Display Panel and terminal.

If necessary the Electronics Control Cabinet can be mounted at a convenient location adjacent to the C Bracket.

2.3 Mass Flow Measurement

ultra***MOIST*** provides a measurement of total moisture analysed in the microwave beam. Since most applications require the measurement of varying quantities of material fed to the conveyor belt, this variation has to be measured in order that a weight percent moisture is reported. In a number of these cases a device for measuring mass flow is already available eg belt scale or weigh feeder. For these applications ultra***MOIST*** is able to interface with this device for the calculation of weight percent moisture.

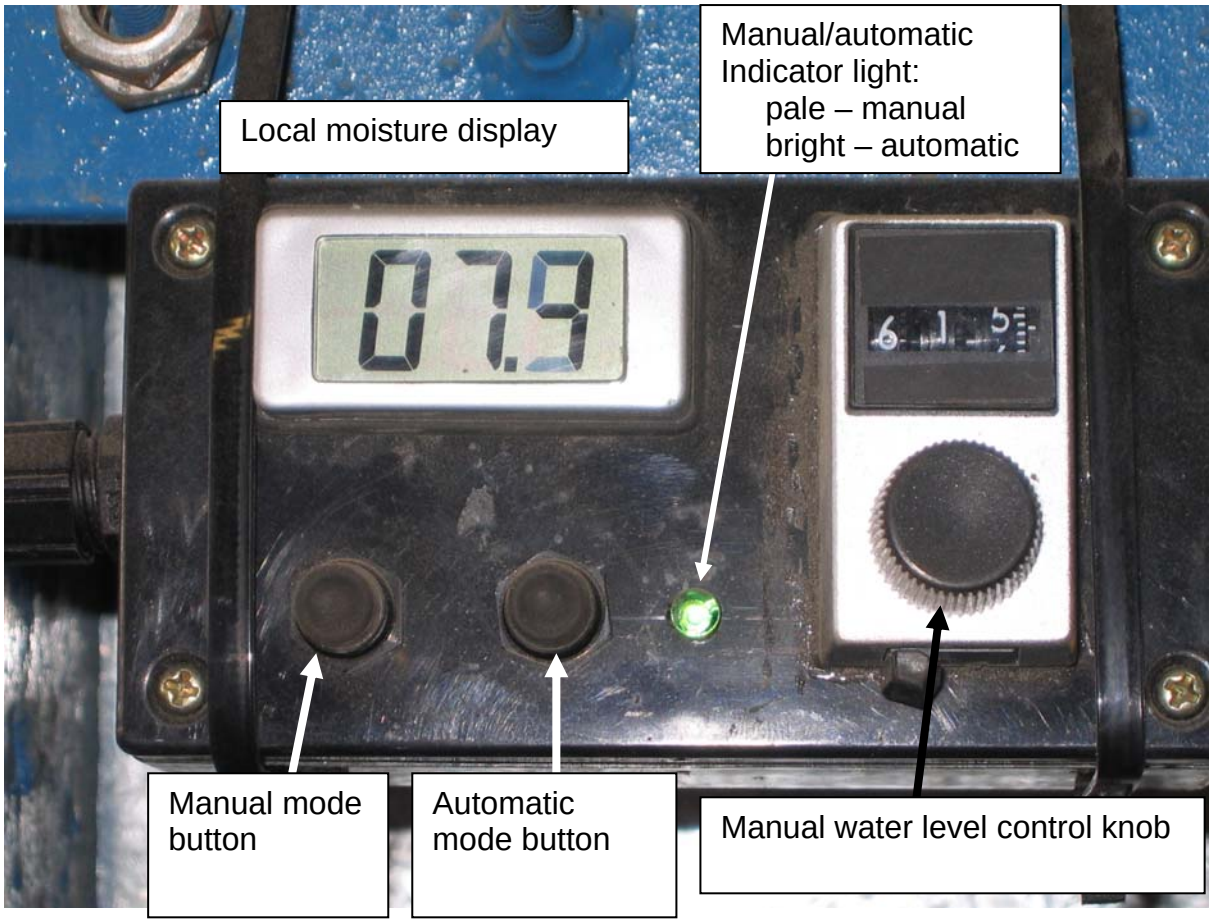
For applications with varying mass flow and no measurement device ultra***MOIST*** can be supplied complete with a beltscale as an integrated unit together with the microwave measurement system.

2.4 Multi-Sensor Head Capability

ultra***MOIST*** can be supplied with up to 4 multiple Measurement C Brackets each containing microwave transmitter and receiver sub-systems which are connected to a central PLC in the main Electronics Control Cabinet. This can provide an economical way of providing multiple measurement points at a lower cost than purchasing full ultra***MOIST*** systems.

3.0 Control Functionality

ultra**MOIST** can be supplied with optional process control capability such as; control of spray bars, water addition using control valves, feed back/forward control of driers etc.
The photograph below shows an operator control panel which is being used to control the water addition to a sand and cement mix.



Photograph Showing an Operator Control Panel for Water Addition Control

4.0 Installation

4.1 Mechanical

Installation is straight forward and consists of mounting the Measurement C Bracket to suitable supports attached to the stringers. The Measurement C Bracket is installed so that the microwave transmitter and receiver are located in the centre of the conveyor belt. Once installed, the upper arm is lowered to a minimum position above the conveyor using the adjustment bolts provided, taking care to make sure that there is no possibility that process material will hit the upper arm.

4.2 Electrical

The ultra***MOIST*** requires a 240 volt or 110 volt, 50Hz, 2 Amp power supply at the Measurement Cabinet.

The moisture signal is output from the Measurement Cabinet via two 0 to 10 Volt signals (optionally 4 to 20 mA current loops). These outputs can be scaled easily onsite to meet customer requirements. The moisture result is output as a running average and can be configured over varying time periods, i.e. 1 min, 5 min, 15 min, etc.

Discrete digital outputs can be supplied for control purposes such as activating diverter gates or spray bar control.

5.0 Inputs and Outputs

Inputs

ultra***MOIST*** can accept up to 4 digital inputs for mass flow, conveyor running condition etc.

Up to 2 analogue inputs can also be accepted which enables an analogue signal to be input from a beltscale etc

Outputs

ultra***MOIST*** is supplied with two industry standard 0 to 10 volt outputs (optionally available 4 – 20mAmp). Both outputs can be configured to the customer's specific requirements at the time of commissioning

ultra***MOIST*** also can provide up to 4 digital outputs eg "High Moisture", "Low Moisture" etc. The moisture results are also displayed locally on a panel in the control cabinet.

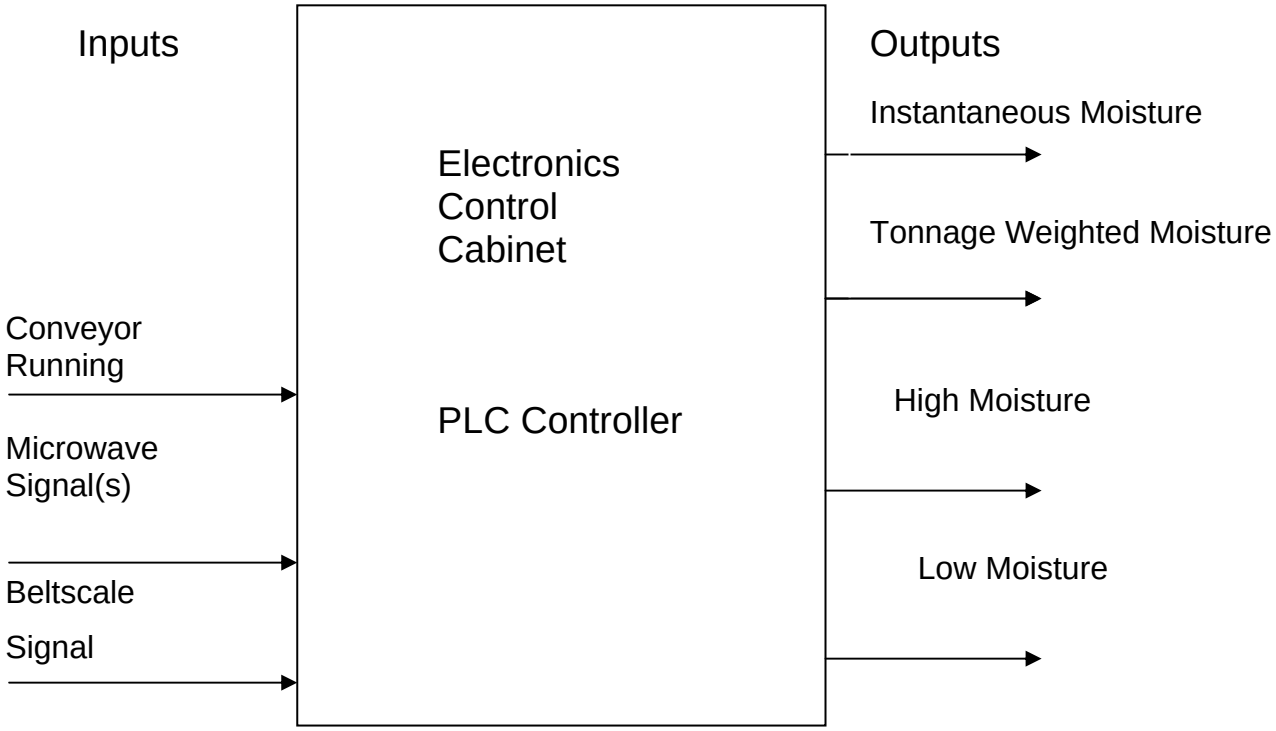


Diagram Showing the Inputs and Outputs for a Single Head ultraMOIST System

For systems with multiple measurement heads the inputs and outputs are duplicated as a function of the number of heads supplied.

6.0 Operation

The ultra***MOIST*** operates completely automatically and starts to analyse when the conveyor running signal indicates that material is present on the conveyor belt, this prevents the possibility of the system analysing stationary material when the belt is stopped.

Values for the parameters are entered via the keypad located in the control cabinet.

7.0 Commissioning and Calibration

The system is factory aligned and tested before shipment from the manufacturing facility. The customer advises when installation is complete and arrangements are made for a specialist engineer to travel to site and carryout the commissioning and calibration work.

Following power up, the system is commissioned and then calibrated by following the procedure shown:

- Static calibration
    - A suite of samples are collected and presented to the gauge whilst the conveyor belt is stopped. These are used to establish the initial calibration parameter set (ie slope and offset).
- Dynamic calibration
    - The system is then calibrated dynamically using an automatic sampler (if available). Usually a sample period of 15 to 30 minutes is used. This sample is then analysed in a laboratory for moisture and the result compared to the gauge response.
- After the collection of the samples a slope/offset adjustment can be made as necessary.
- After calibration the required filtering parameter is entered into the gauge.
- Current loops are scaled correctly and tested in the plant PLC.

The method of calibration can be varied depending on the availability of sampling facilities and access to the stopped belt. This is usually the subject of further discussion with the customer.

8.0 Maintenance

The ultra***MOIST*** is a robust and reliable system, once commissioned and calibrated, it will provide reliable and precise moisture measurements of the material for which it has been calibrated.

It is recommended that the system be checked for satisfactory operation every 3 months. This work can be assumed to require approx 1 hour of site work.

The only time that a recalibration will be necessary is if the process material changes or some other factor (external to the ultra***MOIST***) changes the relevance of the calibration parameter set. In such an event some calibration samples should be collected and the parameter set revised. The time required to carryout this work will be dependent on the sampling facilities available.

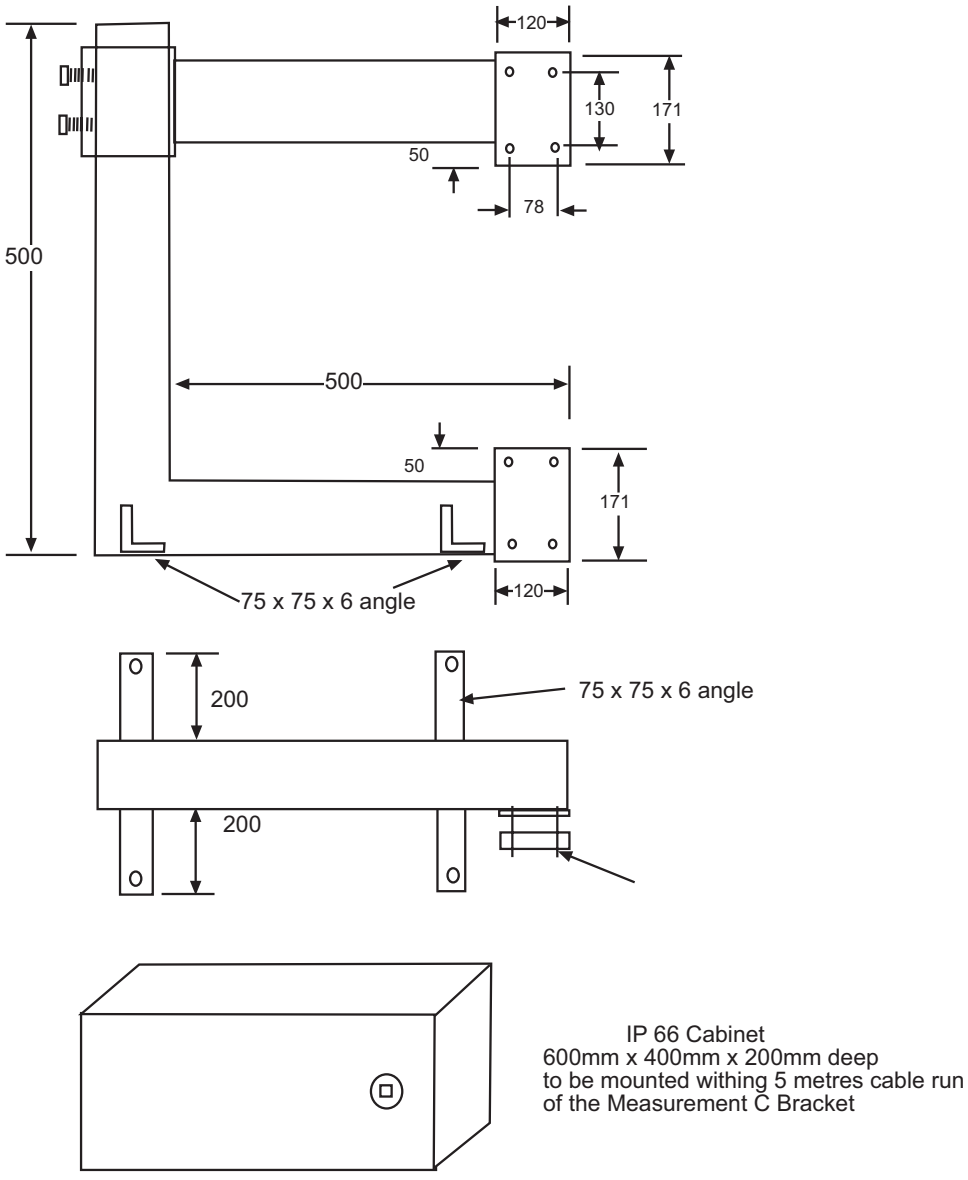
9.0 Specifications

Operational	
Conveyor width	Up to 1,400mm as standard (over 1,400 mm requires a customised On-belt C-Bracket
Conveyor speed	No limit
Material top size	Typically up to 300mm (material dependent)
Bed depth range	Typically 20mm to 300mm (material dependent)
Moisture range	0 to 80%
Measurement update time	Typically 1 minute user configurable
Instrument precision	Typically 0.3% at 1 standard deviation (ultimate precision achievable 0.1%)
Electrical Requirements	
At the Electronics Control Cabinet	240 volt or 110 volt, single phase, 2 amp supply
Environmental Requirements	
Operating temperature range	0 to 45°C with protection from direct sun and rain
Humidity	0 to 95% relative (non condensing)
Outputs	
Instantaneous moisture	0 to 10 volts or 4 to 20 mA current loop indicating the moisture content accumulated over any period.
Tonnage weighted moisture	0 to 10 volts or 4 to 20 mA current loop indicating the accumulated moisture content since the last reset
High moisture	Relay closure
Low moisture	Relay closure
Shipping mass	50 kg
Shipping dimensions	900mm long x 700mm wide x 650mm high

10.0 Drawings

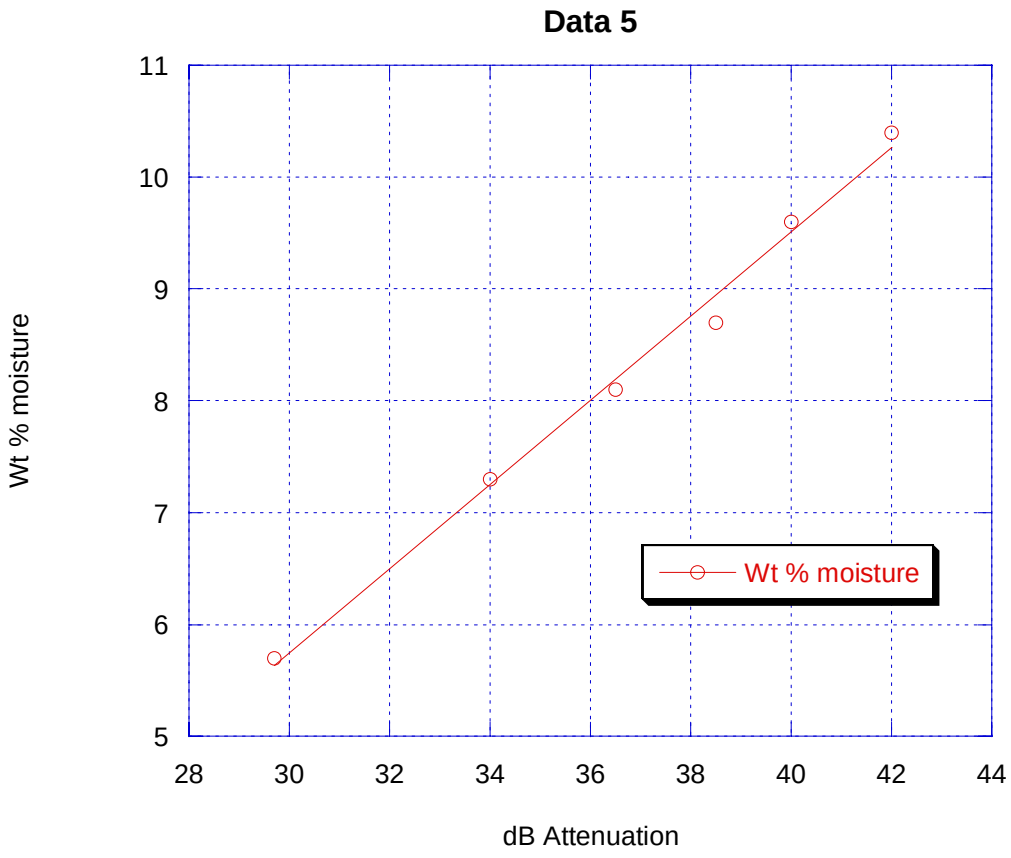
Typical Mechanical Installation

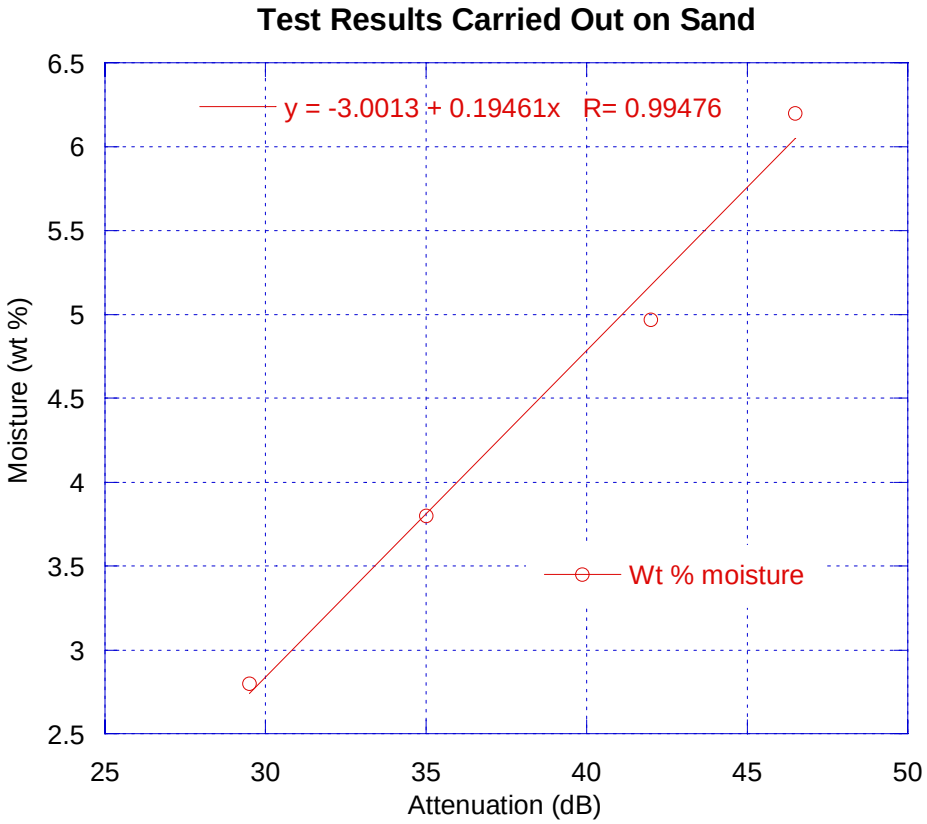
Mechanical Installation Sketch Showing ultraMOIST Major Components Dimensions

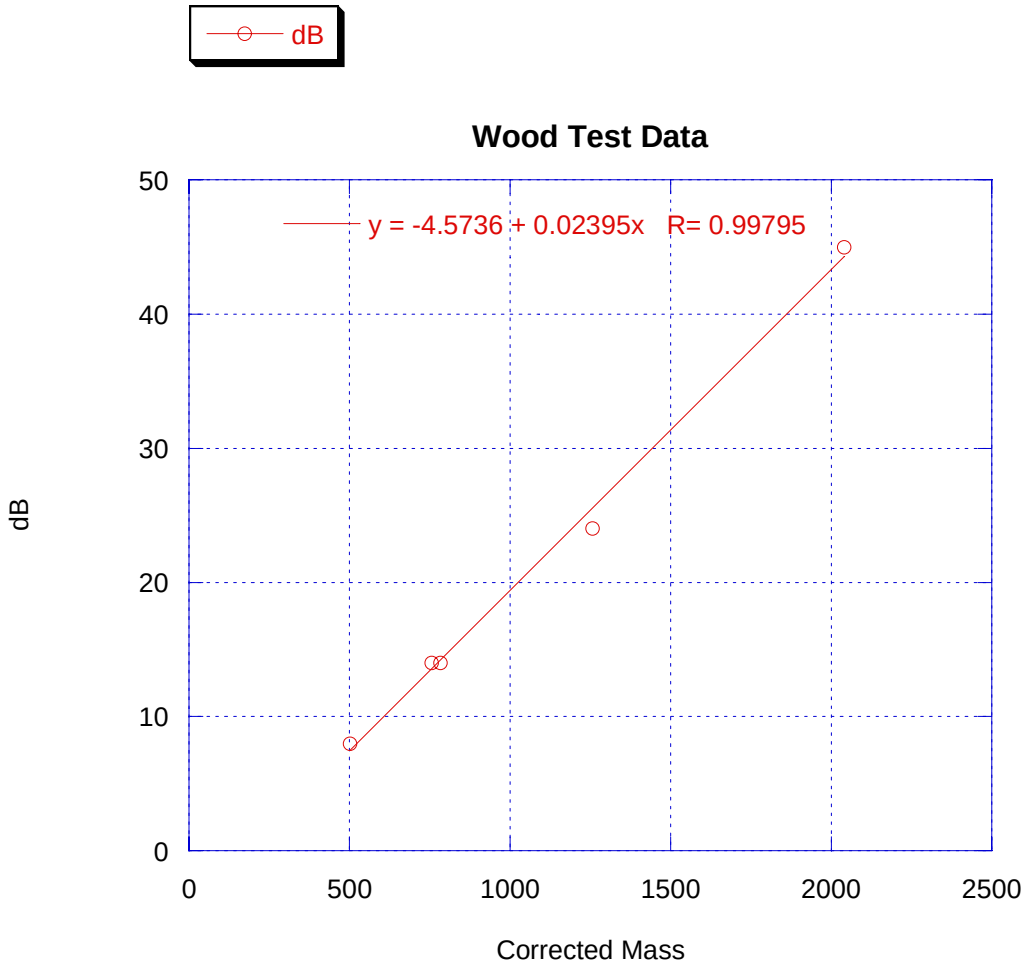


IP 66 Cabinet
600mm x 400mm x 200mm deep
to be mounted withing 5 metres cable run
of the Measurement C Bracket

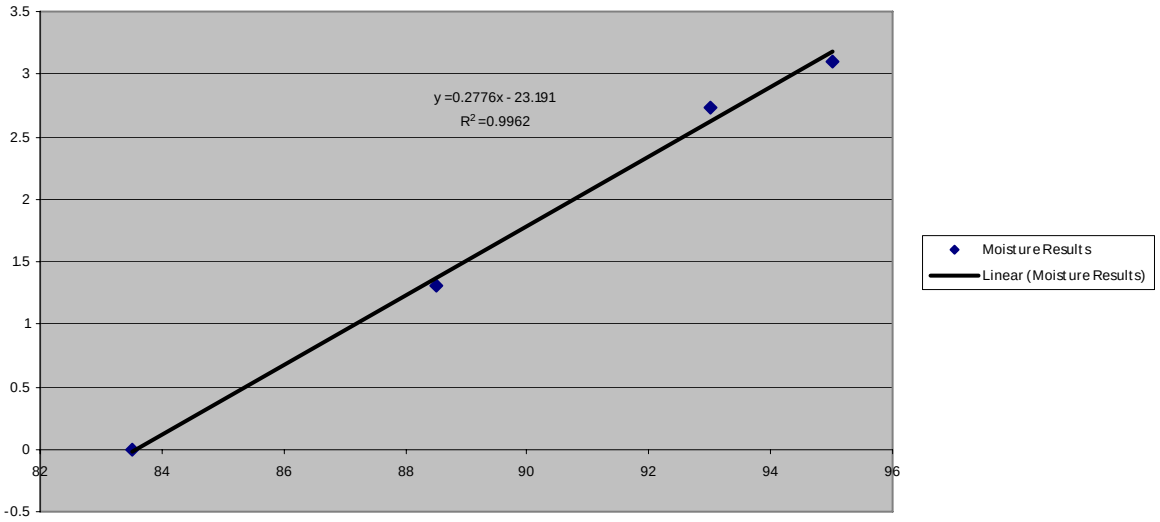
11.0 Typical Results

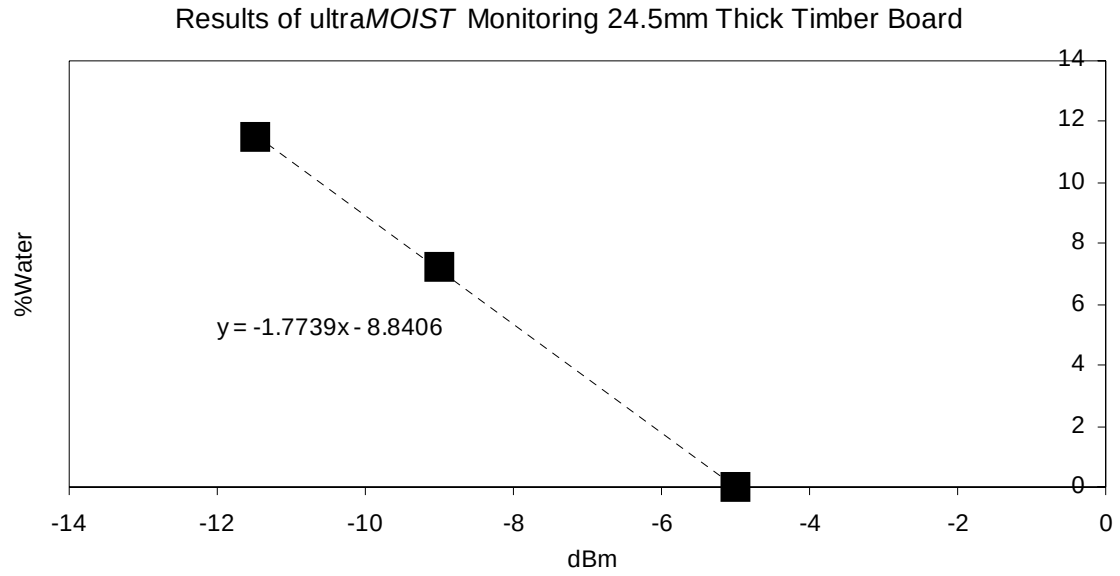



Test Results Carried Out on Sand
y = -3.0013 + 0.19461x R= 0.99476
Wt % moisture
Moisture (wt %)
Attenuation (dB)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
25
30
35
40
45
50

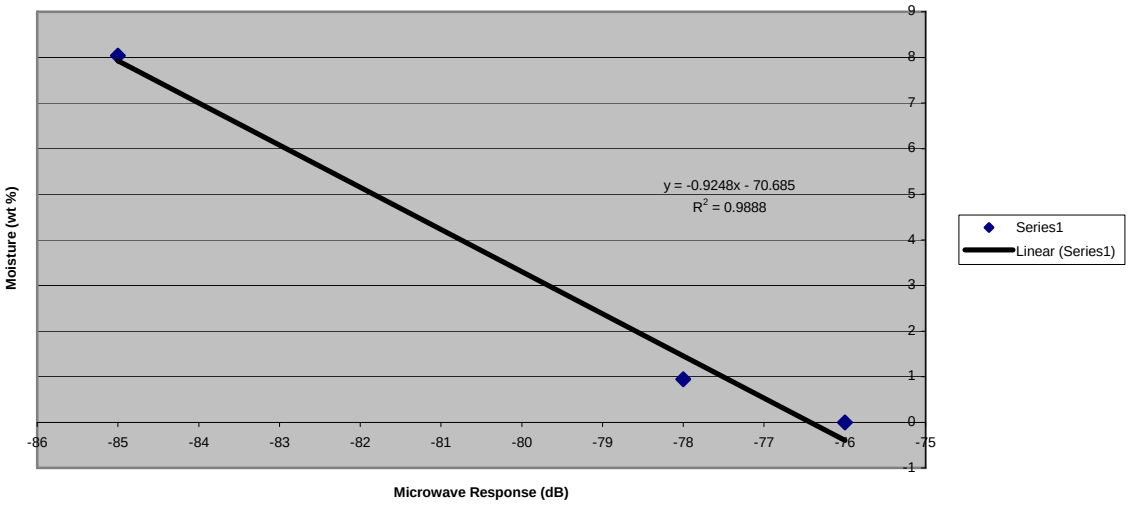


Results Obtained for Sand Using ultra**MOIST**

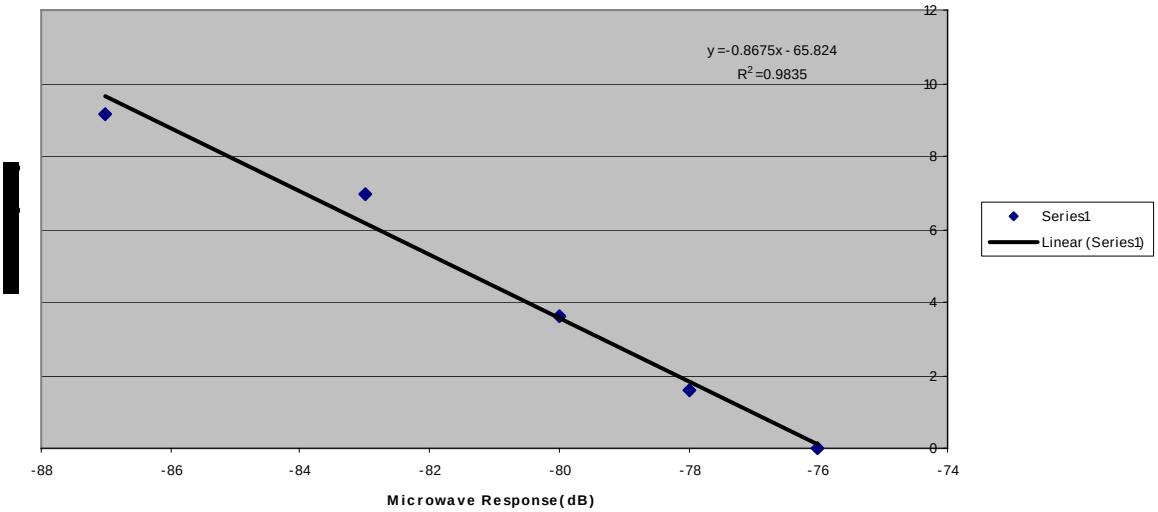




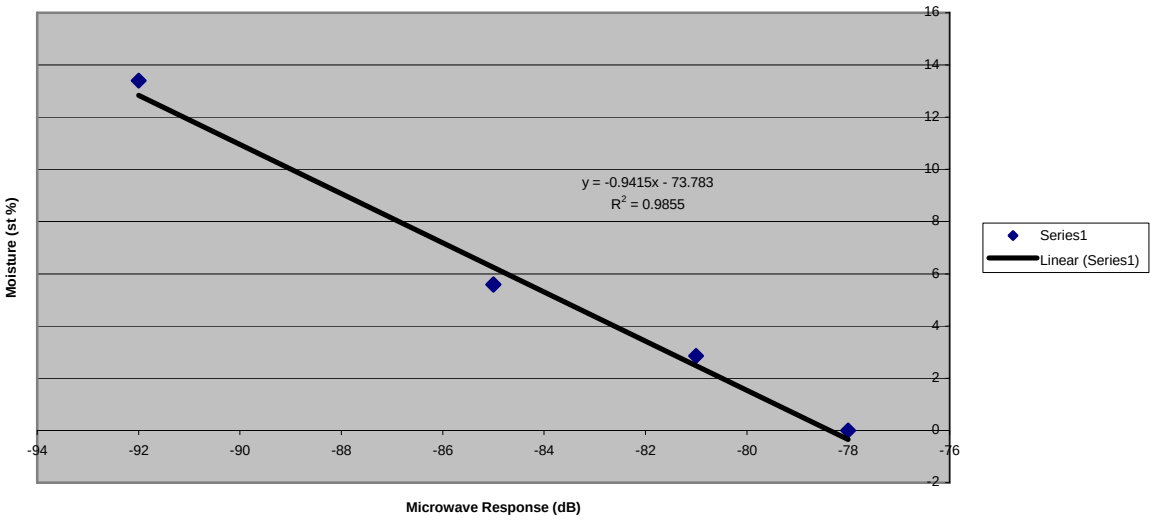
Results for Barley

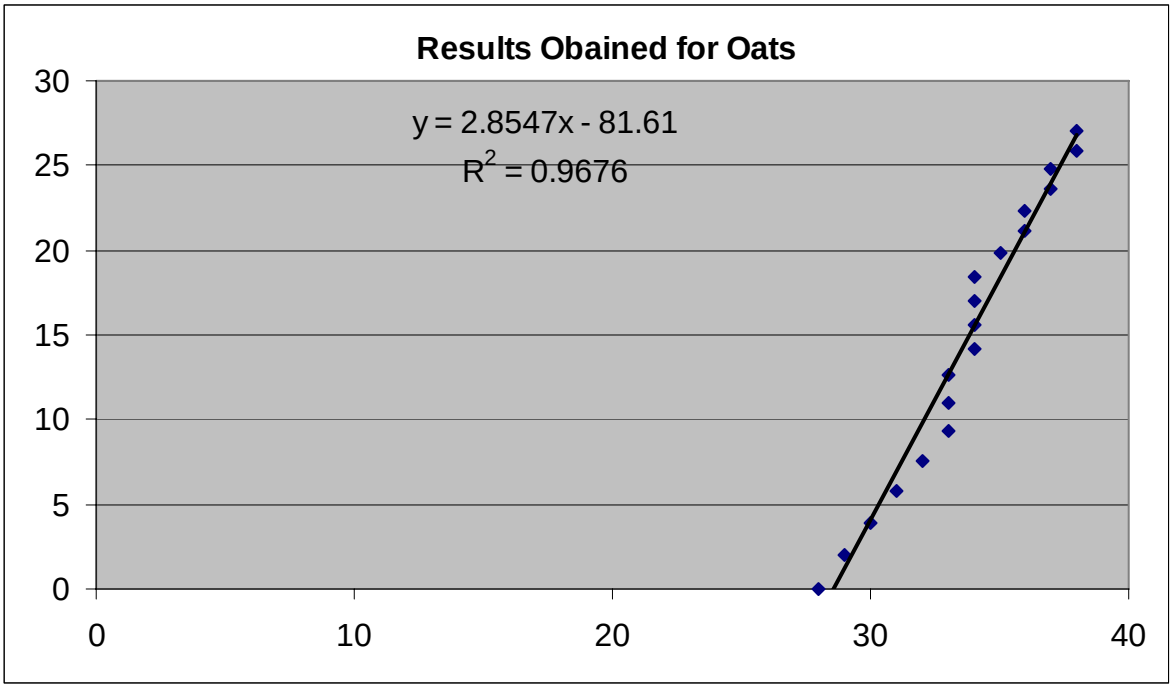


Results for Wheat



Results for Sorghum




Results Obained for Oats
y = 2.8547x - 81.61
R2 = 0.9676
30
25
20
15
10
5
0
0
10
20
30
40