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Optical Rain Gauge Instrument Handbook

MJ Bartholomew

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ARM CLIMATE RESEARCH FACILITY

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Office of Science, Office of Biological and Environmental Research

Acronyms and Abbreviations

ascii	American Standard Code for Information Interchange
ARM	Atmospheric Radiation Measurement Climate Research Facility
C	centigrade
DOE	U.S. Department of Energy
mm	millimeter
ORG	optical rain gauge
QME	Quality Measurement Experiment
RMSE	root-mean-square error
SGP	Southern Great Plains, an ARM megasite
VAP	value-added product

Contents

Tables

1.0 General Overview

To improve the quantitative description of precipitation processes in climate models, the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility deploys several types of rain gauges (MET, RAIN, and optical rain gauge [ORG] datastreams) as well as disdrometers (DISD and VDIS datastreams) at the Southern Great Plains (SGP) Site. This handbook deals specifically with the independent analog ORG (i.e., the ORG datastream).

2.0 Instrument Title

Optical Rain Gauge

3.0 Mentor Contact Information

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Upton, NY 11973
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4.0 Vendor/Developer Contract Information

Optical Scientific
2 Metropolitan Ct # 6
Gaithersburg, MD 20878
Phone: (301) 963-3630
www.opticalscientific.com

A copy of the instrument manual is provided in Appendix A. An online version (possibly more up to date) is available at http://www.opticalscientific.com/_OSI_Support_Contact.html

5.0 Deployment Locations and History

Deployment of the ORG began at the SGP Site and ARMC1 in November 2007 and is ongoing.

6.0 Near-Real-Time Data Plots

Near-real-time data plots can be viewed at http://plot.dmf.arm.gov/plotbrowser/.

7.0 Data Description and Examples

7.1 Data File Contents

Datastreams are configured as follows: xxx is the three-letter site description and n is the site number.

7.2 Optical Rain Gauge

xxxrorgCn.00 raw data, asci files

xxxorgCn.b1 netcdf version of data

8.0 Primary Variables and Expected Uncertainty

8.1 Optical Rain Gauge Variables

Optical range gauge variables are shown in Table 1.

Table 1. ORG rain gauge variables, ORG datastream.

Quantity	Variable	Measurement Interval	Unit
base time in Epoch	base_time	1 min	seconds since YYYY-mm-dd XX:XX:XX X:XX
time offset from base_time	time_offset	1 min	seconds since YYYY-mm-dd XX:XX:XX X:XX
time offset form midnight	time	1 min	seconds since YYYY-mm-dd XX:XX:XX X:XX
north latitude	lat	constant	degrees
east longitude	lon	constant	degrees
altitude	alt	constant	meters above sea level
rainfall intensity	precip_mean	1 min	mm/hour
maximum rainfall intensity	precip_max	1 min	mm/hour
minimum rainfall intensity	precip_min	1min	mm/hour
rainfall intensity standard deviation	precip_sd	1 min	mm/hour
org gauge carrier level	org_car	1 min	volts
Note: lat/lon/alt refers to the ground where the instrument is sited, NOT the height of the sensor.			

8.2 Expected Uncertainty

Precipitation intensity measured by the analog optical gauge is reported every minute. The manufacturer claims an accuracy of ±5% of observed intensity over a range from 0.1 to 500 mm/hr.

8.3 Definition of Uncertainty

We define uncertainty as the range of probable maximum deviation of a measured value from the true value within a 95% confidence interval. Given a bias (mean) error *B* and uncorrelated random errors characterized by a variance σ^2, the root-mean-square error (RMSE) is defined as the vector sum of *B* and σ^2, as shown below:

$$RMSE = (B2 + \sigma^2)^{1/2}$$

B may be generalized to be the sum of the various contributors to the bias, and σ^2 the sum of the variances of the contributors to the random errors. To determine the 95% confidence interval, we use the Student's *t* distribution—$t_{n;0.025} \approx 2$—assuming the RMSE was computed for a reasonably large ensemble. Then, the *uncertainty* is calculated as twice the RMSE.

8.4 Diagnostic Variables

The "org_car" variable is the one indicator of instrument health. It should always be between 2.5 V and 5 V. Any other values indicate suspect data.

8.5 Data Quality Flags

Data quality flags are shown in Table 2. If data are missing for a sample time, a "missing_value" value of -999 is assigned to that field.

Table 2. ORG data quality flags.

Quantity	Variable	Measurement Interval	Minimum	Maximum	Delta
sample time	qc_time	1 min			
org carrier voltage	qc_org	1 min	2.5volts	5 volts	N/A

8.6 Dimension Variables

Dimension variables are shown in Table 3.

Table 3. ORG dimension variables.

Quantity	Variable	Measurement Interval	Unit
Base time in Epoch	base_time	1 min or 30 min	seconds since YYYY-mm-dd XX:XX:XX X:XX
Time offset from base_time	time_offset	1 min or 30 min	seconds since YYYY-mm-dd XX:XX:XX X:XX
Time offset form midnight	time	1 min or 30 min	seconds since YYYY-mm-dd XX:XX:XX X:XX
north latitude	lat	once	degrees
east longitude	lon	once	degrees
altitude	alt	once	meters above sea level
Note: lat/lon/alt refers to the ground where the instrument is sited, NOT the height of the sensor.			

9.0 User Notes and Known Problems

The ORG performs poorly at ambient temperatures below zero degrees Centigrade (C), and any data collected under those conditions should not be trusted. Other observations of precipitation intensity can be found in the MET, RAIN, DISD, and VDIS datastreams during freezing conditions.

10.0 Data Quality

10.1 Health and Status

The following links go to current data-quality health and status results:

- DQ HandS (Data Quality Health and Status)
- NCVweb for interactive data plotting.

The tables and graphs shown contain the techniques used by ARM's data-quality analysts, instrument mentors, and site scientists to monitor and diagnose data quality.

10.2 Reviews by Instrument Mentor

- *QC frequency*: Once or twice a week
- *QC delay*: Three days behind the current day
- *QC type*: DSview plots for instrument operational status, otherwise DQ HandS diagnostic plots
- *Inputs*: None
- *Outputs*: Data Quality Problem Report and Data Quality Report as needed
- *Reference*: None.

10.3 Assessments by Site Scientist/Data Quality Office

All Data Quality Office and most Site Scientist techniques for checking have been incorporated within DQ HandS, and can be viewed there.

11.0 Value-Added Procedures and Quality Measurement Experiments

Many of the scientific needs of the ARM Climate Research Facility are met through the analysis and processing of existing data products into "value-added" products (VAP). Despite extensive instrumentation deployed at ARM sites, there will always be quantities of interest that are either impractical or impossible to measure directly or routinely. Physical models using ARM instrument data as inputs are implemented as VAPs and can help fill some of the unmet measurement needs of the program. Conversely, ARM produces some VAPs to improve the quality of existing measurements rather than to fill unmet measurement needs. In addition, when more than one measurement is available, ARM also produces "best estimate" VAPs. A special class of VAP, called a Quality Measurement Experiment (QME), does not output geophysical parameters of scientific interest. Rather, a QME adds value to the input datastreams by providing for continuous assessment of the quality of the input data based on internal consistency checks, comparisons between independent similar measurements, or comparisons of measurement with modeled results, etc. For more information, see VAPs and QMEs web page.

12.0 Instrument Details

The ORG measures rainfall by detecting the optical irregularities induced within the sample volume by precipitating particles falling through a beam of partially coherent infrared light. These irregularities are known as scintillation. By detecting the intensity of the scintillation, the actual rainfall rate can be measured.

12.1 Detailed Description

The ORG consists of a frame that contains 1) the transmit head, 2) a receive head and electronics, and 3) a 15-meter-long power/signal cable. The transmit head contains an infrared emitting diode and lens with heater. The other head contains a photodiode, lens and aperture, heater, electronics, and cable connectors. All wiring between the heads runs within the frame.

12.2 List of Components

In addition to the instrument itself, there is a data-acquisition system shared with the weighing bucket rain gauge (RAIN datastream). The observations from both devices are logged on a Campbell Scientific CR1000 data logger housed in a waterproof enclosure within ~20 meters of the sensors. Media converters are used to switch to optical signals, and the computers that operate the system and store data are located within a few hundred meters.

13.0 System Configuration and Measurement Methods

13.1 Data-Acquisition Cycle

During normal operation, the ORG makes one measurement per minute.

13.2 Firmware Overview

The ORG was manufactured by Optical Scientific Inc., and the model is ORG_815-DA.

13.3 Processing Received Signals

The Campbell scientific data logger produces American Standard Code for Information Interchange (asci) files with the results, and no further processing of the data is required. Equivalent data files in netcdf format are produced at ARM's Data Management Facility.

13.4 Siting Requirements

Siting requirements for ORGs include a solid footing with at 10-foot-high mounting pole. Objects such as trees and buildings should be at least twice as far away from a site as their height. If snowfall can be expected at the site, the opening of the gauge should be above average snow level. Optical rain gauges should not be located near exhaust vents of buildings, runways, and roads.

13.5 Calibration

Calibration is done at the manufacturer's facility.

14.0 User Manual

With permission from Optical Scientific, Inc., the user manual for the ORG_815-DA is reproduced in Appendix A.

15.0 Routine Operation and Maintenance

Routine maintenance should be performed weekly.

15.1 Inspection of Site Grounds near the Instrument

Visually check the site grounds around the instrument for hazards such as rodent burrows, buried conduit trench settling, and insect nests.

Checklist response:

No Problems Noted

Problem: Enter any applicable comments for this preventative maintenance activity.

15.2 Visual Inspection of Instrument Components

Check that all the conduits on the bottom of the control boxes are secure. Check all conduits from the control boxes to the sensors for damage. Check all sensor wires inside the control box for tightness and damage. Check all of the connections at the sensors for damage, water intrusion, and tightness.

Checklist response:

No Problems Noted

Problem: Enter any applicable comments for this preventative maintenance activity.

15.3 Check Status of Light Emitting Diode on the CR1000 Data Logger

The light emitting diode should flash once every second during normal operation

Checklist response:

No Problems Noted

Problem: Enter any applicable comments for this preventative maintenance activity.

15.4 Check Clock Values shown on the LoggerNet Screen

The station clock should automatically be set to server clock if times differ by 1 second or more. This automatic check is done once a day by the LoggerNet program. The times should never differ by more than 1 minute.

Checklist response:

No Problems Noted

Problem: Enter any applicable comments for this preventative maintenance activity.

15.5 Active Maintenance and Testing Procedures

Checklist response:

No Problems Noted

Problem: Enter any applicable comments for this preventative maintenance activity.

16.0 Software Documentation

Data logger script

File splitting script

Ingest software

Appendix A

ORG_815-DA User's Guide

Appendix A

ORG_815-DA User's Guide

Optical Scientific Inc.

U S E R ' S G U I D E
ORG-815-DA/DR
OPTICAL PRECIPITATION SENSOR

Revision 02/02/11

OPTICAL SCIENTIFIC, INC
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Revision Record

Rev Date	Description of Changes
6/28/00	Changes company name from ScTi to OSI, added revision log
7/25/00	Added new mounting bracket details to Sec 2.2, updated TST-700 to TST-800 and PSB-715 to PSB-815
05/05/10	Re-edit User's guide to current level.
02/02/11	Take out –DS references – keep for –DA & -DR

Read the entire User's Guide before proceeding with installation or maintenance of the ORG!

TABLE OF CONTENTS

LIST OF FIGURES

CAUTIONARY NOTES

Note :
Used to call attention to a special feature or procedure which must be followed for correct operation of the equipment

Caution :
Used to call attention to a concern where damage to the equipment or injury to personnel may occur unless certain steps are followed

Warning :
Used to call attention to a concern where serious personal injury or death may occur unless basic safety procedures are followed

WARRANTY

Optical Scientific warrants its products to be free of defects in workmanship and material for a period of 12 months from date of shipment. During the warranty period, OSI will repair or replace defective products at its own expense, subject to the following conditions:

1. The Buyer prepays all shipping, insurance, and associated costs to return the defective item to OSI. OSI pays return shipping and insurance.
2. The product must not have experienced misuse, neglect, accident or have been altered or repaired by the Buyer during the warranty period.
3. This warranty and OSI's obligation are in lieu of all other warranties. Implied warranties shall not apply.
4. OSI is not liable for consequential or incidental damages, labor performed in conjunction with removal and replacement, loss of production, or any other loss incurred because of interruption of service or production of incorrect or incomplete weather information.

Disclaimer

Optical Scientific, Inc. will not be held liable for any accident, injury, or damage incurred while installing, operating or servicing this equipment; or as a result of improper installation or operation. Implementation and enforcement of proper safety procedures is solely the responsibility of the user, user employees or contracted personnel.

GLOSSARY

AC	Alternating Current
AGC	Automatic Gain Control
AWG	American Wire Gauge
ASCII	American Standard Code For Information Exchange
ASOS	Automated Surface Observing System
CR	Carriage Return
CTRL	Control
CXR	Carrier Signal
CW	Continuous Wave
DC	Direct Current
FAA	Federal Aviation Administration
IRED	Infrared Light Emitting Diode
LDM	Limited Distance Modem
LED	Light Emitting Diode
IR	Infrared
MOV	Metal Oxide Varistor
NEMA	National Electrical Manufacturer's Association
NWS	National Weather Service
ORG	Optical Rain Gauge
PSB	Power Supply Box
PTC	Positive Temperature Thermistor
RX	Receiver
OSI	Optical Scientific, Inc.
TX	Transmitter
VDC	Voltage Direct Current

ENGLISH/METRIC CONVERSION FACTORS

1 inch = 25.4 mm	1 mm = 0.039 in
1 foot = 0.305 m	1 meter = 3.28 ft
1 pound = 0.454 kg	1 kilogram = 2.2 lbs
°F = 9/5 °C + 32	°C = 5/9(°F – 32)

1 INTRODUCTION TO THE ORG-815 OPTICAL PRECIPITATION GAUGE

1.1 THE ORG-815 IMPROVES YOUR ABILITY TO MEASURE RAIN AND SNOW

The ORG® measures rain and snow and applies algorithms to automatically determine the precipitation type, rate, and water equivalent accumulation. The ORG is vastly superior to traditional type sensors and offers the reliability and proven performance you need!

OSI's ORG-815 precipitation sensor provides accurate measurement of precipitation in all weather conditions. Designed for rugged, unattended operation, ORGs have been field proven in adverse environments around the world and, unlike other sensors, on ocean deployed data buoys and ships.

There are two ORG-815 types:

Digital: ORG-815-DR[1] measures both rain and snow precipitation
Analog: ORG-815-DA[2] measures precipitation without differentiating type.

Optical Measurement Benefits

OSI Optical Rain Gauges are not affected by many of the environmental factors which cause significant errors with traditional rain and snow gauges. Applications using traditional gauges such as tipping bucket, siphon, weighing, and electrical grid type gauges can all be upgraded with the OSI ORG sensors. OSI ORG's have many advantages including:

- ✓ **Easy Installation**
- ✓ **High Sensitivity**
- ✓ **Low Maintenance**
- ✓ **Minimal Wind Effects**
- ✓ **Wide Dynamic Range**
- ✓ **No Evaporation or Splash Errors**
- ✓ **Works on Ships & Buoys**
- ✓ **Operates 24/7/365**

Now with available 5-sec update rates for fine structure analysis of rain intensity!

Reliability

The electro-optical design provides for an extremely reliable sensor with a calculated MTBF in excess of 60,000 hours. Unlike mechanical gauges which collect precipitation to measure it, the ORG has no collectors, buckets, or siphons to corrode or clog. The sensors use AGC circuitry to eliminate the effects of LED output power or dirty optics. In fact, sensor performance is maintained even when over 75% of the light is blocked! Diagnostics alert the user if the signal strength is too low for normal operation. Preventative maintenance, suggested every 6 months, is as simple as cleaning the 2 optical windows on the unit. The calibration can be verified on an annual basis using the optional OSI TST-800 Series Test Kit. This test can be performed in the field without removing the sensor from the system.

Proven Technology

The ORG-815 sensors are based on technology developed and patented by OSI. OSI has been granted patents in the following countries: USA 4754149, UK 22001510, and Canada 1285044. This technology is the basis for the present weather sensor supplied to the FAA/NWS/U.S. Navy for the Automated Surface Observing System (ASOS).

[1] The ORG-815-DR has been superceded by the ORG-815-DS which is identical in form, fit, function and performance to –DR with updated internal electronic components and minor cabling change. OSI will continue to support –DR models.

[2] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

Description of Available Versions[1]

All versions are available with 500 mm/hr calibration (standard) or 2000 mm/hr calibrations (optional). In addition, a number of output versions are available to provide a wide variety of interface options to commonly available protocols. Versions are denoted by the part number suffix "-xx or -xxx" as shown in the table.

ORG-815-xx	Description	Precip (*)	Special Features
-DR	RS-232 Output	R/S/P	Standard version
-DC[1] (obsolete – see note)	RS-485 Output	R/S/P	Addressable ID for multidrop systems
-DA[1] (obsolete – see note)	Analog Output	P	User can choose to disconnect lens heater for very low power operation

(*) R = Rain, S = Snow, P = Unknown Type

Figure 1.1 OSI ORG-815 Series Optical Sensor

ORG® is a registered trademark of OSI.

[1] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

1.2 PERFORMANCE SPECIFICATIONS FOR THE ORG-815

The ORG-815 is designed to measure rain and snow in all weather conditions.

Performance Specification	Digital Output ①	Analog Output ②
Rain Dynamic Range	0.1 to 500 mm/hr	0.1 to 500 mm/hr
Rain Accumulation	0.001 to 999.999 mm	0.001 to 999.999 mm
Rain Accuracy	5% Accumulation	5% Accumulation
Rain Resolution	0.001 mm	Depends on user equipment
Snow Dynamic Range	0.01 to 50 mm/hr water eq.	n/a
Snow Accumulation	0.001 to 999.999 mm water eq.	n/a
Snow Accuracy	10%	n/a
Snow Resolution	0.001 mm	n/a
Time Constant	10 seconds	10 seconds
ORG Data Update Rate	Once per minute - typical Every 5 seconds - available	Depends on user equipment

Electrical Specification	Digital Output ①		Analog Output ②
	-DR	-DC[1]	-DA[1]
Supply Voltage	11 - 16 VDC		
Current Drain (Current drain depends on ambient temperature - see Section 1.3 for details)	500-800 ma	500-800 ma	30 ma w/o heaters, 400-600 ma w/ heaters
Fusing	User supplied 1.0 A Slow Blow		
Signal Output	RS-232	RS-485	0-5 VDC
Relay Control Output (CTRL1 pulled to ground under control of firmware)	Yes	Yes	n/a
User Heater Control	n/a	n/a	Yes
Transient Protection	All power and signal lines protected by MOV		

[1] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

Environmental Specification	
Temperature	-40 to 50°C (-40 to 122°F)
Humidity	0-100%
Precipitation/Dust	NEMA-4 type protection

Physical Specification	
Size	730 mm W x 115 mm H x 264 mm D
Weight	3 kg w/o cables
Cable Length	15 meter

① Digital Output Versions include - ORG-815-DR, ORG-815-DS, ORG-815-DC[1]
② Analog Output Versions include - ORG-815-DA[1]

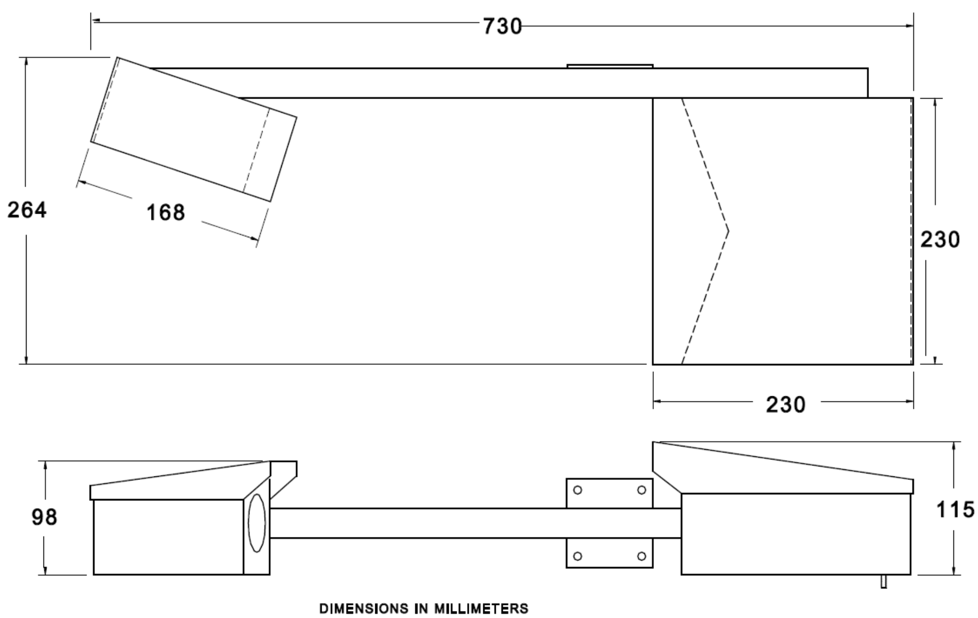

Figure 1.2 ORG-815 Dimensions

[1] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

1.3 Basic Sensor Description

Precipitation is measured by detecting the optical irregularities induced by drops falling through an infrared optical beam. These irregularities, known as scintillation, have characteristic patterns which are detected by the sensor and converted to precipitation rate.

OSI's optical precipitation sensors measure rain and snow by detecting the optical irregularities induced within the sample volume by precipitation particles falling through a beam of partially coherent infrared light. These irregularities are known as scintillation. The twinkling of stars is a familiar example of scintillation. By detecting the intensity of the scintillations which are characteristic of precipitation, the actual rainfall rate can be determined.

The ORG consists of 1) a head frame which contains the transmit head, receive head, and electronics and 2) a 15 meter long power/signal cable, P/N 1102-302. The small box (transmit) contains an IRED diode and lens with disk heater. The large box (receive) contains a photodiode, lens with aperture slit, disk heater, electronics, external thermistor probe (except "-DA" version), and connector for the signal/power cable. All wiring between the transmit and receive heads is within the frame.

The transmit and receive lenses are heated by self-regulating positive temperature coefficient (PTC) thermistor disks, to a point above ambient temperature to reduce dew, frost, and snow buildup on the lenses. Depending on the ambient temperature, the current drain for the lens heaters can change more than 200 ma.

Depending on the version, the output may be analog (-DA)[1], RS-232 digital (-DR), or RS-485 digital ("-DC")[1].

The ORG is completely sealed from water intrusion at the factory. Care should be taken to maintain the unit's watertight integrity.

Note :
The ORG contains no user-serviceable parts - do not attempt to open it!
Doing so will compromise watertight seals and void any warranty.

[1] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

Caution :
Do NOT drill holes in any portion of the ORG frame! Doing so will void the warranty and may allow water to enter the enclosure!

Figure 1.3 ORG-815 Major Components

1.4 ACCESSORIES FOR THE ORG

Several accessories are available from OSI for the ORG. Contact the Sales Office for more information.

Electrical Box

The 815 Power Supply Box (815 PSB) is a NEMA-4 type enclosure with a hinged door for easy access. It houses a 12 VDC power supply, terminal strips for connecting the ORG to the user supplied equipment, an optional control relay (except "-DA"[1] versions), and an optional limited distance modem (LDM) for long distance communications up to 10 km over 2 #24 AWG twisted wire pairs (except "- DA"[1] version). Figure 1.4 shows a typical PSB box. The PSB box operates with 100 to 230 VAC line voltage.

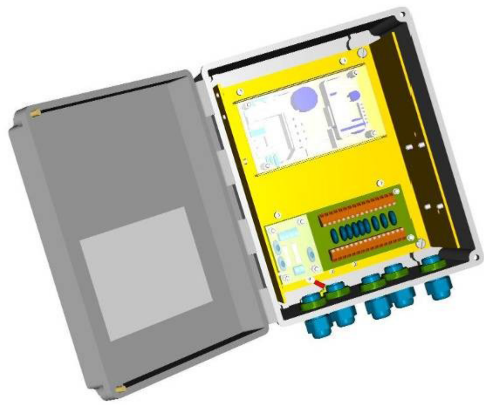

Figure 1.4 PSB Electrical Box

[1] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

QwikCollect for Windows® Data Acquisition Software
(except "-DA" versions)

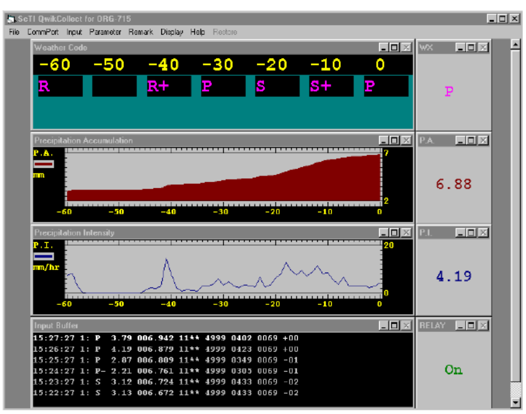

Figure 1.5 QwickCollect Software

The software runs on any IBM compatible personal computer with Microsoft Windows version 3.1 or above. The software automatically collects the ORG data, stores it on the hard drive, and displays it both graphically and as text in real time. As shown on the graph, the program displays precipitation type, precipitation accumulation, and precipitation intensity. Statistical data such as maximum precipitation rates, daily totals, and related information are also computed by the program.

Field Test Kit

The TST-800 Series Test Kit provides a convenient way to verify the ORG operation and calibration. It connects in-line with the ORG power/signal connector and draws power from the ORG. Figure 1.6 shows the TST-800.

Figure 1.6 TST-800 Series Test Kit

2 INSTALLATION OF THE ORG-815 ORG

2.1 SITING AND INSTALLATION GUIDELINES

The ORG may be installed almost anywhere outdoors, but an area free and clear of obstructions and contamination sources will help insure good sensor performance.

In general, ORG should be located on level or slightly sloping ground where the sensor site will be exposed to the same environment as the area around it. Ideally, the area around the site should be free of buildings, trees, and other obstructions.

OSI recommends that the siting and installation follow the general guidelines established by the Office of the Federal Coordinator for Meteorology (OFCM). The Federal Standard for Siting Meteorological Sensors at Airports, OFCM document # FSM-S4-1987, makes the following recommendations:

1. **Distance from Obstructions** - The distance between the sensor and obstructions such as trees or buildings should be at least 2 times the height of the obstruction on all sides. For example, if a 20 meter high tree is located alongside the ORG, the ORG should be at least 40 meters away from the tree. This restriction reduces the affects of wind turbulence created by the nearby obstruction and makes the ORG precipitation measurement more representative. Do not locate the ORG where tree branches or wires will hang over the sensor!

2. **Separation from Turbulence & Contamination Sources** - Do not mount the ORG near building exhaust vents, strobe lights, or sources of smoke or steam. Where possible, locate the ORG as far away from runways and roads as possible to reduce optics fouling from wind blown road dirt. An ideal minimum distance is at least 30 meters.

3. **Sensor Height, Rigidity, Verticality, and Orientation** - The OFCM recommends that the present weather sensor be mounted at a height of 10 feet (3 m). This height is not always possible due to constraints imposed by the site. Mounting the ORG head lower than 2 m or higher than 5 m is not generally recommended.

✓ The ORG installation must be rigid so that wind-induced vibration does not cause false alarms. This can be accomplished by mounting the sensor to a thick wall pipe such as "Schedule 40" type or to a rigid boom arm of 1 meter length or less. Mounting the ORG on the top of a building is acceptable if it is located near the center of the building away from the wind turbulence that may occur near the edges.

✓ The sensor head must be mounted vertical within +/- 2 degrees so that the line aperture on the in-beam lens is horizontal.

✓ The ORG is generally oriented with the TX head on the north side (in Northern hemisphere) so that the receiver optics face north. Align the sensor head so that the receive lens faces north. If the orientation can be altered to either side of north to obtain a "view" with fewer or more distant obstructions, it is generally acceptable to alter the orientation up to +/- 30 degrees from north.

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1. **Distance from Obstructions** - The distance between the sensor and obstructions such as trees or buildings should be at least 2 times the height of the obstruction on all sides. For example, if a 20 meter high tree is located alongside the ORG, the ORG should be at least 40 meters away from the tree. This restriction reduces the affects of wind turbulence created by the nearby obstruction and makes the ORG precipitation measurement more representative. Do not locate the ORG where tree branches or wires will hang over the sensor!

2. **Separation from Turbulence & Contamination Sources** - Do not mount the ORG near building exhaust vents, strobe lights, or sources of smoke or steam. Where possible, locate the ORG as far away from runways and roads as possible to reduce optics fouling from wind blown road dirt. An ideal minimum distance is at least 30 meters.

3. **Sensor Height, Rigidity, Verticality, and Orientation** - The OFCM recommends that the present weather sensor be mounted at a height of 10 feet (3 m). This height is not always possible due to constraints imposed by the site. Mounting the ORG head lower than 2 m or higher than 5 m is not generally recommended.

✓ The ORG installation must be rigid so that wind-induced vibration does not cause false alarms. This can be accomplished by mounting the sensor to a thick wall pipe such as "Schedule 40" type or to a rigid boom arm of 1 meter length or less. Mounting the ORG on the top of a building is acceptable if it is located near the center of the building away from the wind turbulence that may occur near the edges.

✓ The sensor head must be mounted vertical within +/- 2 degrees so that the line aperture on the in-beam lens is horizontal.

✓ The ORG is generally oriented with the TX head on the north side (in Northern hemisphere) so that the receiver optics face north. Align the sensor head so that the receive lens faces north. If the orientation can be altered to either side of north to obtain a "view" with fewer or more distant obstructions, it is generally acceptable to alter the orientation up to +/- 30 degrees from north.

Hint - Standing at the ORG site, take a picture in each direction (north, east, south, & west) to record the topography and obstructions for future reference.

Siting Guidelines To Remember
✓ **Sensor head mounted 2-5 meters high** ✓ **Rigid mounting pole** ✓ **In-beam lens aperture horizontal to +/- 2 degrees** ✓ **In-beam lens facing north (in northern hemisphere)** ✓ **No overhanging trees, wires, or roof lines** ✓ **Distance between ORG and closest obstruction at least 2 times obstruction height** ✓ **As far from road, runway, and contamination sources as possible**

2.2 MOUNTING THE ORG-815 ORG

The ORG-815 installation is simple but a few precautions will help insure good sensor performance.

The ORG is packed in one (1) heavy walled corrugated carton. Included in the carton are the sensor head, 15-meter cable, grounding wire, U-Bolts (2), Mounting Bracket, User's Guide, and any accessories that were ordered. When opening the carton be careful to avoid spilling the contents. Report any shortage or shipping damage to the shipping company and OSI within 3 days.

User Supplied Items Required

✓ Mounting pole or tower to install sensor head.

✓ A copper-clad ground rod and large diameter copper wire if needed to properly ground the ORG per local electrical codes.

CAUTION :
Do NOT drill holes in any portion of the ORG head! Doing so will void the warranty and may allow water to enter the enclosure !

Step-By-Step Installation

1. Carefully choose the site using the guidelines in Section 2.1.

2. Attach the 2 ea U-bolts to the ORG mounting plate with the 1/4-20 hex locking nuts with the stainless-steel mounting bracket sandwiched between as shown in Figure 2. 1. To mount the ORG to a vertical pipe, install the U-bolts horizontally as shown. To mount to a horizontal pipe or boom arm, install them vertically using the same holes. Do not tighten the nuts completely until the sensor head is installed on the pole.

Figure 2.1 Installing Mounting Bracket & U-Bolts

3. Attach the sensor head to the mounting pole using the two (2) U-bolts. Do not tighten the U-bolt nuts completely until the head is oriented.

4. Rotate the sensor head until the receive lens is facing north as shown in Figure 2.2.

5. Tighten the U-bolt nuts when the orientation is correct. (Do not over tighten the bolts or the mounting plate may warp)

6. Plug the P3 end of the P/N 1102-302 cable into the J3 connector on the bottom of the ORG sensor head.

7. If required, connect a large diameter (8-12 AWG) ground wire to the 1/4-20 ground stud on the bottom of the ORG sensor head using the hardware supplied with the ORG.

8. Secure the head cables to the pole every 1-meter using tie-wraps or other straps.

9. A typical installation is shown in Figure 2.3.

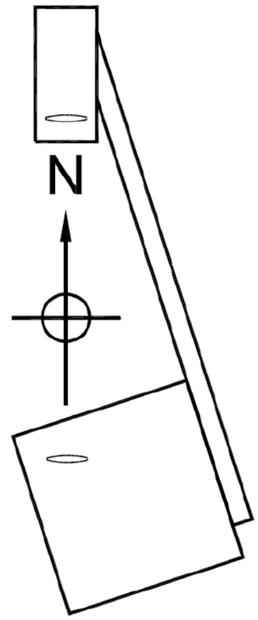


Figure 2.2 Sensor Orientation

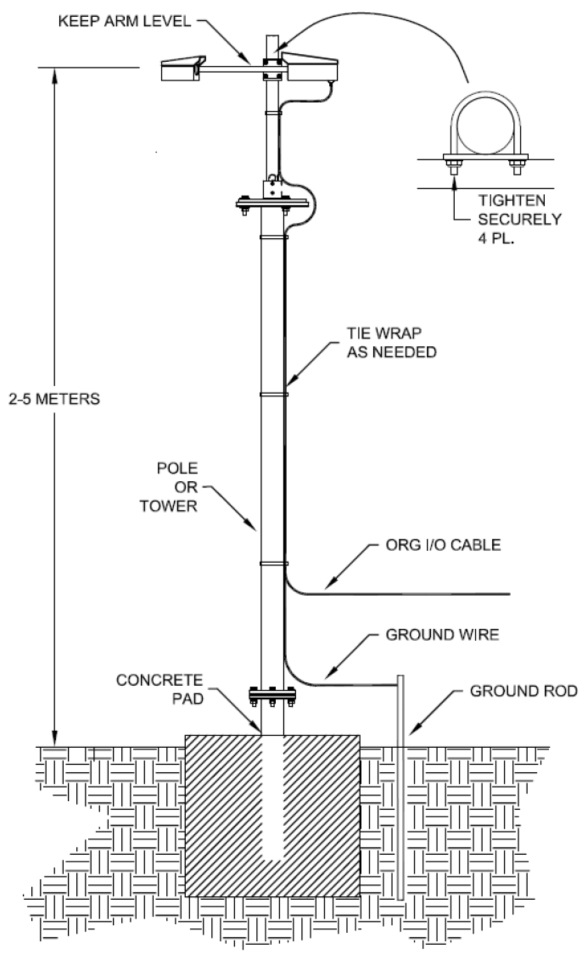


Figure 2.3 Typical ORG Installation

2.3 CONNECTING THE ORG SENSOR

2.3.1 Connecting the Digital ORG Sensor

Connections for the digital –DR/-DS, and -DC[1] sensors are made to the free end of the ORG cable for all power, signal, and control functions.

The normal installation of the ORG requires a fused 12 VDC power source and junction box at the end of the cable. The customer may choose to provide these items, or the ORG sensor may be purchased with an Optical Scientific Inc. ORG 815 Power Supply Box (PSB).

In either case, proper wiring configuration is shown in the following pages.

Connect the wires in the ORG cable as shown in the table below and in Figure 2.4 and 5.5

ORG Wire Color	Function	User Connections With PCAT DB9 Type Data Connector	User Connections With PC DB25 Type Data Connector
Red (RD)	+ 12 VDC	DC Power Supply	DC Power Supply
Black (BK)	12 VDC Common	DC Power Supply	DC Power Supply
Green (GR)	Sensor TX	Pin 2 of DB9 Data Connector	Pin 3 of DB25 Data Connector
Blue(BL)	Sensor RX	Pin 3 of DB9 Data Connector	Pin 2 of DB25 Data Connector
Black (BK)(2 ea)	TX/RX Common	Pin 5 of DB9 Data Connector	Pin 7 of DB25 Data Connector
White (WH)*	CTRL1	See PSB-815 User's Guide	See PSB-815 User's Guide
Use Black Wire From 12 VDC Common	CTRL1 Common	See PSB-815 User's Guide	See PSB-815 User's Guide
Black (BK)	Cable Shield	Earth Ground	Earth Ground

* Insulate the white wire if not used

Note :
Signal and power lines are protected from surge damage within the ORG sensor head. It is recommended that surge protection be provided at the user equipment end as well.

[1] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

> ***Warning :***
> *Remember, the ORG-815 requires 12 VDC power.*
> ***Do not apply 110/220 VAC to the ORG cable!***

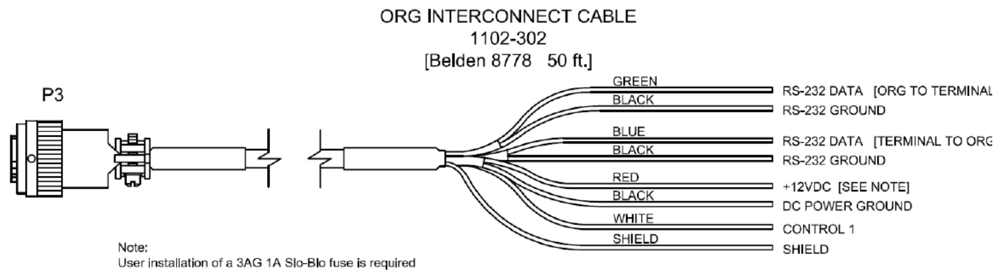


Figure 2.4 Digital ORG Interconnect Cable

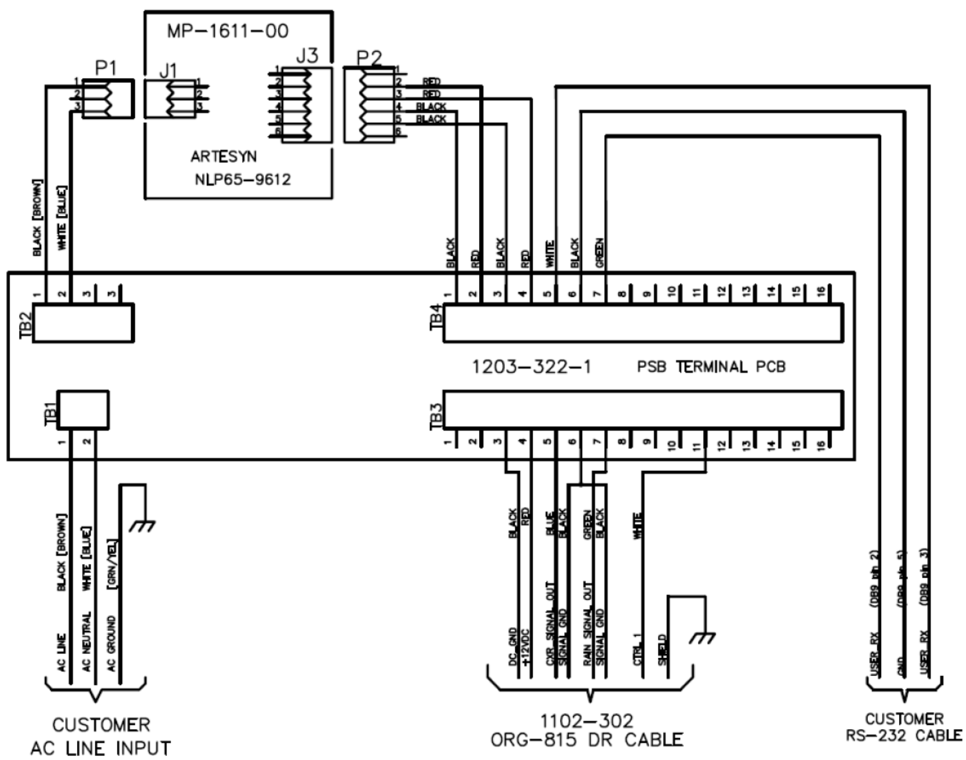


Figure 2.5 Power Supply Box Wiring Connections for ORG 815-DR

2.3.2 Connecting the Analog ORG Sensor

Connections for the analog "-DA"[1] sensors are made to the free end of the ORG cable for all power, signal, and control functions.

The normal installation of the ORG requires a fused 12 VDC power source and junction box at the end of the cable. The customer may choose to provide these items, or the ORG sensor may be purchased with an Optical Scientific Inc ORG 815 Power Supply Box (PSB).

In either case, proper wiring configuration is shown in the following pages.

Connect the ORG sensor cable as shown in the table below and in Figure 2.6 and 2.7.

MINI-ORG Wire Color	Function	Connect To User Equipment
Red (RD)	+ 12 VDC	+12 VDC Power Supply
Black (BK)	12 VDC Common	Common
Green (GR)	Analog Signal Output	Analog Signal Input
Blue (BL) (*)	Carrier (CXR) Signal Output	Analog Signal Input (Optional)
Black (BK)	Signal Ground	Common
White (WH)	Lens Heater Power	Connect to 6 - 12 VDC to operate heaters or...Isolate to Deactivate Heaters
Black (BK)	Signal Ground	Common
Black (BK)	Cable Shields	Earth Ground

(*) The blue wire carries a diagnostic signal (CXR) that represents the strength of the IRED signal level between the transmitter and receiver. If this signal will not be connected to the user supplied equipment, isolate the wire with electrical tape to prevent it from shorting to another wire.

[1] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

Warning:
Remember, the ORG-815 requires 12 VDC power.
Do not apply 110/220 VAC to the ORG cable!

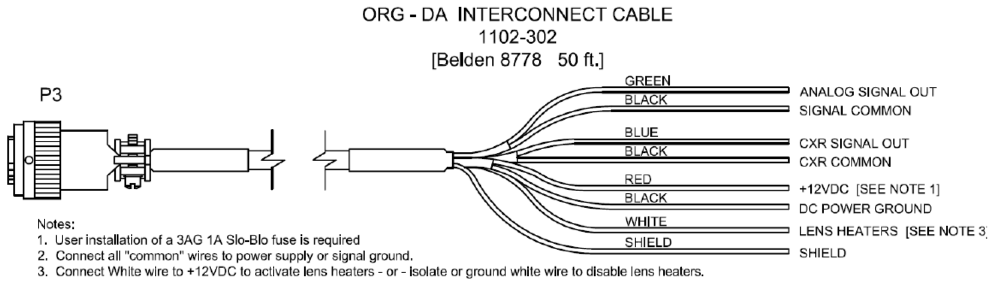


Figure 2.6 Analog ORG Interconnect Cable

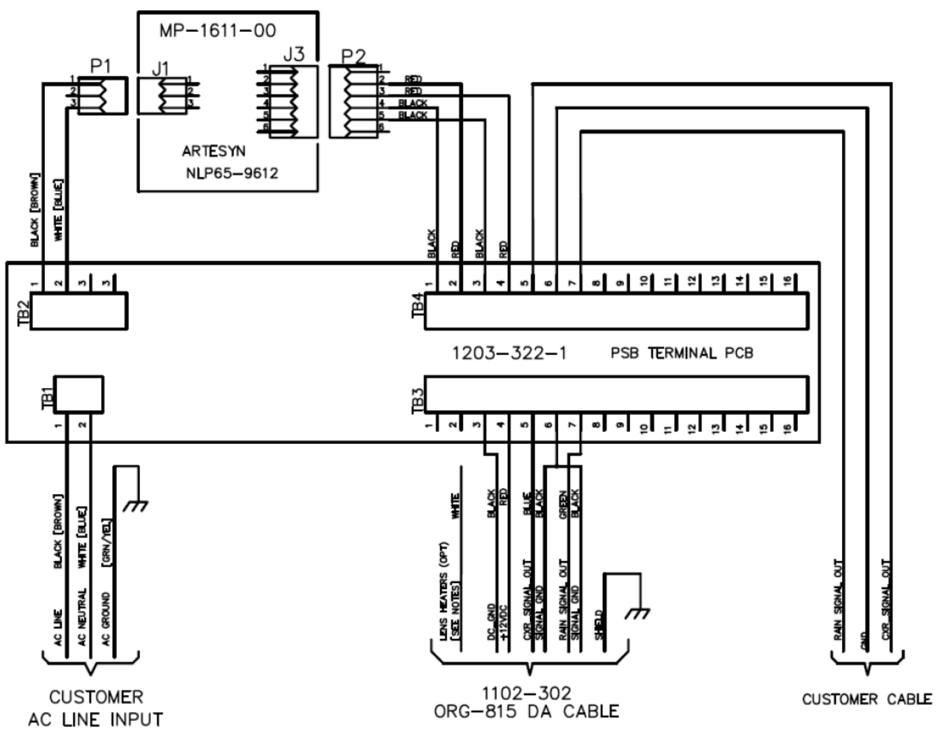


Figure 2.7 Power Supply Box Wiring Connections for ORG 815-DA

Note: Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

3 ORG THEORY OF OPERATION

3.1 OVERALL SYSTEM THEORY

The ORG is an electro-optical sensor consisting of optics, analog signal processing electronics, and a digital microprocessor.

A block diagram of the ORG-815 Sensor is shown in Figure 3.1. The sensor consists of:

- A transmit modulator and IR Light Emitting Diode (TX)
- A transmitter optical lens assembly
- A receiver optical lens assembly
- A PIN photo detector and preamplifier (RX)
- An Automatic Gain Controlled (AGC) normalizer
- Signal processor
- Temperature probe (except "-DA"[1] version)
- Microprocessor and communications subsystem (except "-DA"[1] version)

The ORG uses an infrared light emitting diode (IRED) as a light source. The IRED is modulated to eliminate interference in the system caused by background light. The IRED has a very long lifetime, is relatively low power, invisible to the eye, and presents no radiation hazard to the user.

The IRED is housed in the smaller of the two boxes, the entire subassembly being referred to as the transmitter or source. The IRED is driven by a square wave continuous wave (CW) modulation circuit at 50 percent duty cycle and at a fixed frequency. A lens is used to collimate the IRED's CW modulated light into a slightly diverged beam. The transmit and receive lenses are both heated by a self-regulating positive temperature coefficient (PTC) thermistor disc, to a point above ambient temperature to reduce dew and frost on the lenses.

The larger rectangular box houses the receive optics, DC regulator, the AGC, signal processing electronics, temperature probe, and microprocessor. The receive lens focuses the transmitted light onto a photo diode. The scintillations in light intensity are thus detected and amplified. A wide dynamic range Automatic Gain Control (AGC) circuit normalizes the precipitation induced scintillation signal to the (CW modulated) carrier. Thus errors from variations in the source intensity caused by LED aging or dirt on the lenses are eliminated. The demodulated scintillation signal is then further filtered, processed, and averaged. The statistical average of the measured scintillation signals give an accurate measurement of the instantaneous rain rates. For the analog "-DA"[1] version, the signal output is scaled to a 0-5 VDC output.

For the digital versions, a microprocessor uses an adaptive baseline technique to continually optimize the sensitivity of the ORG. This technique ensures that the ORG sensitivity is not affected by normal atmospheric turbulence and it minimizes the chance of false alarms (i.e.; reporting precipitation when none occurs). Using the scintillation signal and temperature probe data, the processor determines the precipitation type and calculates the total water equivalent by the following formula:

[1] Manufacture of the ORG-815-DA and -DC has been discontinued. However, *OSI still supports these models* and references have been retained in this manual for the benefit of our customers.

$$W\ (mm) = k * RR\ (mm/hr) * Time\ (hour)$$

where RR is the precipitation intensity and k is a constant dependent on the ambient temperature as follows:

For T > 30 C	k = 1
For T < -40 C	k = 0.607
For -40 C < T > 30 C	k = exp{(T - 3) / 12}

The ORG microprocessor also provides diagnostic data to the user about the condition of the sensor. The output of the digital ORG-815 is either an RS-232 or RS-485 data string.

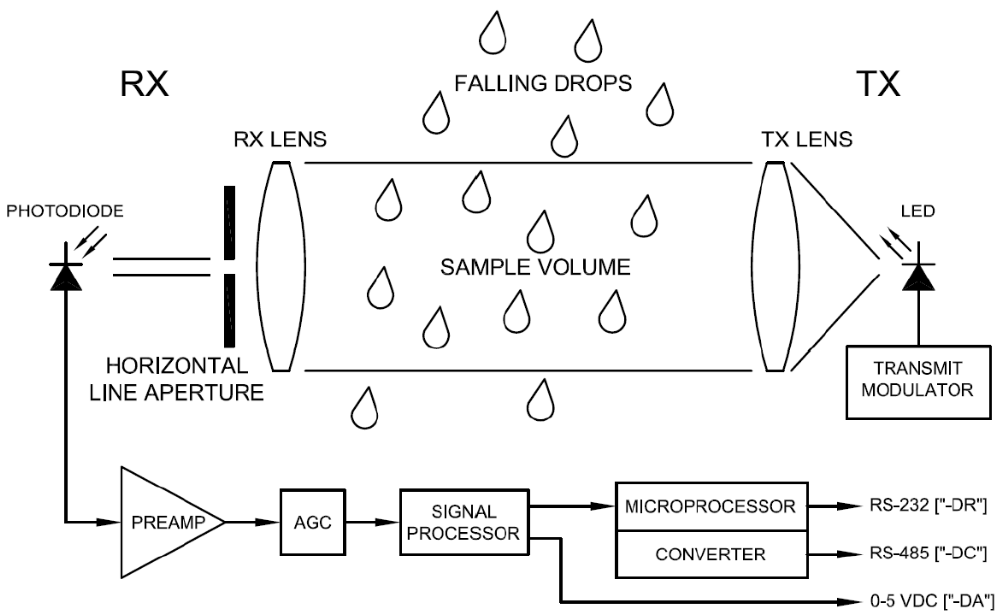


Figure 3.1 ORG 815 Sensor Block Diagram

4 USER INTERFACE / ORG OPERATION

4.1 RS-232 "-DR" ORG INTERFACE

The ORG responds to a series of computer commands that the user may select during set-up, operation, and maintenance of the sensor.

✓ Physical Level

The Serial Input/Output (SIO) signal interface consists of a 3-wire RS-232-C connection. If cable length must exceed 100 feet between the ORG and computer, contact OSI about using limited distance modems (LDM).

✓ Link Level

Data transfer across the ORG / computer interface is implemented via a serial, ASCII encoded , full duplex, 1200 baud, asynchronous transfer link. Data transfer in the computer-to-ORG direction is limited to a simple, single character poll. Data transfers in the ORG-to-computer direction are simple fixed-format ASCII strings, terminated with a carriage return (<CR>).

✓ Frame Format

The standard ORG output frame format is shown below. Details of the data fields are presented in a later section. Each of the transmitted characters are eight (8) bit (msb -- bit 7 -- always 0), no parity ASCII (decimal codes 0 to 127), with 1 stop bit. The status code and other information, is formatted in this way as printable ASCII characters to aid in system debugging and field maintenance.

The typical ORG transmit data string consists of a fixed number of characters, including the CR (ASCII 0DH)and is formatted as shown:

Data:	S	S	_	R	R	R	R	_	A	A	A	.	A	A	A	[CR]
Position:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

The actual data field format is as follows:

SS	2 character alphanumeric field containing weather & status code information
_	Indicates ASCII space (20H), used as data field separator
RRRR	4 character numeric field indicating instantaneous rain rate / liquid water
AAA.AAA	7 character numeric field indicating total accumulation since reset or rollover

✓ Protocol

In order to keep the interface design effective and simple, the protocol does not support unsolicited ORG messages to the computer. In other words, the only time the ORG is allowed to transmit a message to the computer via this link is in direct response to single character poll transmission from the computer which requires the return of the standard data reply string.

Note that the ORG is continually sampling data (every 5 seconds) and processing the precipitation algorithm (once a minute typical). In most cases, the ORG's response time to a poll will begin within a second or two of having received the poll. On infrequent occasions, it is possible that the response time could be as long as several seconds. To avoid system hang-ups, the computer should poll the ORG and wait for 5-10 seconds before timing-out and trying a new poll.

✓ Poll / Frame Formats

The ORG responds to several different types of single character ASCII polls issued by the computer. The poll character transmitted to the ORG should be a single character only (also transmitted at 1200 baud, 1 start bit, 8 data bits, no parity, and 1 stop bit), not followed by any other characters or control codes. The poll codes (case sensitive) and description are listed below:

REQUEST	DESCRIPTION
A	Send routine data
B	Send accumulation data
C	Send routine and diagnostic data (NWS Codes)
D	Send routine and diagnostic data (WMO Codes)
Q	Send 5-sec average data
R	Reset accumulation counters
T	Test CTRL1 line
V	Send Software Version
#	Change sensor set-up configuration
*	Send sensor set-up configuration

Note that the ORG commands are case sensitive and unless otherwise noted, require the use of capital letters, i.e.; "C" rather than "c".

4.1.1 "A" Poll Response

The "A" poll is used for normal operation to receive the precipitation type, rain rate and accumulated precipitation.

This poll should be issued once every 60 seconds, and in response, the ORG will transmit a 16 character string that contains status, instantaneous rain rate, and accumulated rain (or liquid water equivalent). Note that the ORG algorithm recalculates precipitation data every 60 seconds. Therefore, it serves no purpose to poll the sensor more than once a minute. In fact excessive polling (once per 15 seconds, for example) could actually induce a minor sample-timing error on the sensor.

This section explains the format of the ORG data frame that is transmitted in response to a type "A" poll. The ORG ASCII Routine data string is sixteen (16) bytes long and is formatted as shown below:

Format:	S	S		R	R	R	R		A	A	A	-	A	A	A	[CR]
	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Byte:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Byte	Description	Value
1-2	Present weather condition code	SS
3	Separator space	
4-7	Instantaneous precipitation rate	RRRR
8	Separator space	
9-15	Precipitation accumulation with fixed decimal point at position 12	AAA.AAA
16	Carriage Return	[CR]

SS is a two (2) byte field indicating present weather condition. Possible weather values are:

R- Light Rain	R Moderate Rain	R+ Heavy Rain
S- Light Snow	S Moderate Snow	S+ Heavy Snow
P- Light Precipitation	P Moderate Precipitation	P+ Heavy Precipitation (Note)

"P" is output when the ORG can not determine with certainty whether the precipitation is rain or snow. During normal operation with no precipitation, the data field SS is blank. If an error condition exists (usually something obscuring the optics), the output will be "ER". The present weather data field is updated once per minute.

RRRR is a four byte field indicating the instantaneous (one minute block average) rain rate or liquid water equivalent for frozen precipitation in millimeters per hour. It is a four digit floating point number that will vary from ".000" to "9999". This number is updated once a minute.

AAA.AAA is a seven byte field indicating the total accumulation of precipitation in millimeters. The number is a fixed decimal point format that will vary from "000.000" to "999.999". Accumulation is reset by an "R" poll from the computer, automatically at power on, or when accumulation exceeds 999.999 (i.e., rolls over). This number is updated once a minute.

At power turn-on this poll returns the following response for the first 2 minutes:

**** ---- ---.---**

4.1.2 "B" Poll Response

The "B" poll is used to obtain accumulated rain or liquid water equivalent.

This poll can be used when it is impractical to obtain data from the ORG on a continuous basis. An example would be a remotely located site where total precipitation was desired. In such a case, the ORG totalizes the precipitation accumulation and will transmit it when a "B" poll is received. This poll can be from a locally connected terminal or PC or remotely over a cable.

This section explains the format of the ORG data frame that is transmitted in response to a "B" poll. The ORG ASCII precipitation accumulation data string is eight (8) bytes long and is formatted as shown below:

Format:	A	A	A	-	A	A	A	[CR]
	|	|	|	|	|	|	|	|
Byte:	1	2	3	4	5	6	7	8

Byte	Description	Value
1-7	Precipitation accumulation with fixed decimal point at position 4	AAA.AAA
8	Carriage Return	[CR]

AAA.AAA is a seven byte field indicating the total accumulation of precipitation in millimeters. The number is a fixed decimal point format that will vary from "000.000" to "999.999". Accumulation is reset by the "R" poll from the computer, automatically at power on, or when accumulation exceeds 999.999 (i.e., rolls over). This number is updated once a minute.

At power turn-on this poll returns the following response for the first 2 minutes:

---.---

4.1.3 "C" Poll Response

The "C" poll is used to obtain routine data in NWS weather code format and detailed system diagnostic data.

This section explains the format of the ORG data frame that is transmitted in response to a "C" poll. The ORG ASCII Routine and Diagnostic data string is 40 characters long and is formatted as shown below:

Format:	S	S		R	R	R	R		A	A	A	-	A	A	A	
Byte:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Format:	X	X	*	*		X	X	X	X		X	X	X	X		X
Byte:	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Format:	X	X	X		X	X	X	[CR]								
Byte:	33	34	35	36	37	38	39	40								

Byte	Description	Value
1-2	NWS Present weather condition code	SS
3	Separator space	
4-7	Instantaneous precipitation rate	RRRR
8	Separator space	
9-15	Precipitation accumulation with fixed decimal point at position 12	AAA.AAA
16	Separator space	
17	CTRL1 line status 1 -- CTRL1 line is pulled to ground 0 -- CTRL1 line is high impedance CTRL1 is active when status bit is 1	X
18	Relay sensitivity	X
19-20	Not used / Reserved	*
21	Separator space	
22-39	Additional diagnostic data	X...X
40	Carriage return	[CR]

Bytes 1-15 are identical to those described in the "A" response described above with the bytes 1-2 in NWS weather code formats as shown.

R- Light Rain	R Moderate Rain	R+ Heavy Rain
S- Light Snow	S Moderate Snow	S+ Heavy Snow
P- Light Precipitation	P Moderate Precipitation	P+ Heavy Precipitation

(Bytes 1-2 are blank for no precipitation)

Byte 17 is the status of the control line. Certain applications use a control relay to energize heaters or warning devices. When byte 17 displays a "1", the control line is pulled to ground potential (~0 VDC) by the ORG microprocessor indicating an "ON" condition. When byte 17 displays a "0" the control line is set to 12 VDC by the ORG microprocessor indicating an "OFF" condition.

Byte 18 indicates the relay closure sensitivity selected by the user with the "#" command as described in Section 4.1.5. The table lists the selectable values of relay sensitivity and a description of each.

Value	Description
1	Most sensitivity (factory default)
2	Moderate sensitivity
3	Least sensitivity

Bytes 19-20 are reserved for future use and should normally display an asterisk (*) in each byte.

Bytes 21-39 contain additional system diagnostic information.

Bytes 22-25 are the carrier channel signal strength (typical value is 4999). Dust accumulation on the lenses and LED aging will cause this value to drop over time from 4999. Acceptable values during no precipitation range from 3000 to 4999. When the value is <1000, the ORG will output "ER" in the present weather field.

Bytes 27-30 contain the one minute averaged raw data. The value is typically <100 when there is no precipitation.

Bytes 32-35 contain the rain channel adaptive baseline data. When the sensor is first powered up, this value is typically 200 for the first 30 minutes. Then it decreases to a slow moving value typically around 100 (+ 50) when there is no precipitation. When precipitation begins, this field "locks-on" and does not begin to adaptively adjust until the precipitation ends.

Bytes 37-39 are the temperature data from the probe located on the underside of the ORG. The data is displayed in degrees C with byte reserved for the plus (+) or minus (-) sign. This temperature should not be used by the user as the true meteorological temperature.

At power turn-on the "C" poll returns the following response for the first 2 minutes:

**** ---- ----.---- 01** 0000 0000 0000 +00**

4.1.4 "D" Poll Response

The "D" poll is used to obtain routine data in WMO weather code format and detailed system diagnostic data.

This section explains the format of the ORG data frame that is transmitted in response to a "D" poll. The ORG ASCII Routine and Diagnostic data string is 40 characters long and is formatted as shown below:

Format:	S	S		R	R	R	R		A	A	A	-	A	A	A	
	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Byte:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Format:	X	X	*	*		X	X	X	X		X	X	X	X		X
	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Byte:	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Format:	X	X	X		X	X	X	[CR]								
	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Byte:	33	34	35	36	37	38	39	40								

Byte	Description	Value
1-2	WMO Present weather condition code	SS
3	Separator space	
4-7	Instantaneous precipitation rate	RRRR
8	Separator space	
9-15	Precipitation accumulation with fixed decimal point at position 12	AAA.AAA
16	Separator space	
17	CTRL1 line status 1 -- CTRL1 line is pulled to ground 0 -- CTRL1 line is high impedance CTRL1 is active when status bit is 1	X
18	Relay sensitivity	X
19-20	Not used / Reserved	*
21	Separator space	
22-39	Additional diagnostic data	X...X
40	Carriage return	[CR]

Bytes 1-15 are identical to those described in the "A" response described above with the bytes 1-2 in NWS weather code formats.

61	Light Rain	62	Moderate Rain	63	Heavy Rain
71	Light Snow	72	Moderate Snow	73	Heavy Snow
41	Light Precipitation	41	Moderate Precipitation	42	Heavy Precipitation (Note)
00	No Precipitation				

Byte 17 is the status of the control line. Certain applications use a control relay to energize heaters or warning devices. When byte 17 displays a "1", the control line is pulled to ground potential (~0 VDC) by the ORG microprocessor indicating an "ON" condition. When byte 17 displays a "0" the control line is set to 12 VDC by the ORG microprocessor indicating an "OFF" condition.

Byte 18 indicates the relay closure sensitivity selected by the user with the "#" command as described in Section 4.1.5.The table lists the selectable values of relay sensitivity and a description of each.

Value	**Description**
1	Most sensitivity (factory default)
2	Moderate sensitivity
3	Least sensitivity

Bytes 19-20 are reserved for future use and should normally display an asterisk (*) in each byte.

Bytes 21-39 contain additional system diagnostic information.

Bytes 22-25 are the carrier channel signal strength (typical value is 4999).Dust accumulation on the lenses and LED aging will cause this value to drop over time from 4999.Acceptable values during no precipitation range from 3000 to 4999.When the value is <1000, the ORG will output "ER" in the present weather field.

Bytes 27-30 contain the one minute averaged raw data.The value is typically <100 when there is no precipitation.

Bytes 32-35 contain the rain channel adaptive baseline data.When the sensor is first powered up, this value is typically 200 for the first 30 minutes.Then it decreases to a slow moving value typically around 100 (+ 50) when there is no precipitation.When precipitation begins, this field "locks-on" and does not begin to adaptively adjust until the precipitation ends.

Bytes 37-39 are the temperature data from the probe located on the underside of the ORG.The data is displayed in degrees C with byte reserved for the plus (+) or minus (-) sign.This temperature should not be used by the user as the true meteorological temperature.

At power turn-on the "C" poll returns the following response for the first 2 minutes:

**** ---- ----.---- 01** 000000000000+00**

4.1.5 "Q" Poll Response

The "Q" poll is used for special operation when 5-second instantaneous rain rate and accumulated precipitation are needed.

This poll can be issued as often as every 5 seconds, and in response, the ORG will transmit a 16 character string that contains the instantaneous rain rate and accumulated rain (or liquid water equivalent).Using “Q”, the ORG algorithm recalculates precipitation data every 5 seconds.

This section explains the format of the ORG data frame that is transmitted in response to a "Q" poll. The ORG ASCII Routine data string is sixteen (16) bytes long and is formatted as shown below:

Format:				R	R	R	R		A	A	A	-	A	A	A	[CR]
	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Byte:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Byte	Description	Value
1-3	Separator space	
4-7	Instantaneous precipitation rate	RRRR
8	Separator space	
9-15	Precipitation accumulation with fixed decimal point at position 12	AAA.AAA
16	Carriage Return	[CR]

RRRR is a four byte field indicating the instantaneous (5 second block average) rain rate or liquid water equivalent for frozen precipitation in millimeters per hour.It is a four digit floating point number that will vary from ".000" to "9999".This number is updated every five seconds.

AAA.AAA is a seven byte field indicating the total accumulation of precipitation in millimeters. The number is a fixed decimal point format that will vary from "000.000" to "999.999".Accumulation is reset by an "R" poll from the computer, automatically at power on, or when accumulation exceeds 999.999 (i.e., rolls over).This number is updated every 5 seconds.

At power turn-on this poll returns the following response for the first 2 minutes:

**** ---- ---.---**

4.1.6 "R", "T", & "V" Poll Responses

These miscellaneous polls are used during check-out and test of the ORG.

"R" Poll

The type "R" poll (reset accumulation) is used to reset the accumulation to zero. In response, the ORG will transmit a 16 character data string (same format as "A" poll) of total accumulated rain or liquid water equivalent prior to resetting the accumulator to zero. Note that accumulation is automatically reset to zero in any of the following conditions:

✓ At ORG power up
✓ Upon processor reset in the case of unrecoverable error detection, and
✓ Upon accumulation reaching and going over 999.999 (millimeters of precipitation).

In response to the "R" command, the ORG returns the final accumulation in the format shown in Section 4.1.1 above.

"T" Poll

The type "T" poll is normally used to test an external device (i.e.; relay) connected to the CTRL1 output line. Upon receiving the "T" poll, the CTRL1 line is pulled to ground (from high impedance state) for approximately 2 minutes. Testing is automatically terminated if any of the following conditions exist:

✓ P-,P, P+ or S-, S, S+ weather condition is detected. In this case, CTRL1 line will remain "low" for 10 minutes after the weather condition changes to R-, R, R+ or no precipitation.
✓ If another "T" poll is received during 2-minute test mode (i.e.; a second "T" toggles the line off)
✓ If CTRL1 line is already low.

No data is transmitted by the ORG when the "T" poll is sent.

"V" Poll

The type "V" poll is used to check the software version of the ORG.In response to the "V" command, the ORG returns the following response:

ORG-815D_Ver._X.XX__ /__DD-MM-YY

where "X.XX" is the software version number, "DD-MM-YY" is the day, month, and year of the revision, and _ is a space character.

"#" Poll Responses

This poll allows the user to change certain ORG sensor set-up parameters as they relate to the operation of the control line and other special functions.

The "#" sensor configuration poll provides a useful way to change the user selectable parameters which determine how the sensor operates. This command is mainly used for applications using the CTRL1 output to control a relay. This command does not effect the normal precipitation output data for accumulation or rate. The configuration data is stored in nonvolatile memory and will not be altered if the ORG loses power.

In the procedure below, the user is asked to press <CR>.<CR> is the carriage return (enter) key on the computer keyboard. If an invalid character is entered the ORG will respond with "TRY AGAIN". In response to the "#" command, the ORG returns the following responses:

*** **System Configuration** ***

Precipitation Activation Temp. ==>_TT_C
Enter C to change or <CR> to continue

If the CTRL1 control line activation temperature "TT" is correct, press<CR> to go to the next set-up parameter. If you want to change the "TT" temperature, press "C" and <CR>.Then the ORG will respond with...

Enter new Precipitation Activation Temp.
Between -5 to +5 C ==> ____

Enter the correct temperature you want and press <CR> to change the temperature at which the CTRL1 line activates. Then the ORG will respond with...

Turn-On Delay__==>__XX_Min
Enter C to change or <CR> to continue

If the delay to activate the CTRL1 control line is correct, press<CR>to go to the next set-up parameter. If you want to change the "XX" turn-on delay time, press "C" and <CR>.Then the ORG will respond with...

Enter new Turn-On Delay
Between 0 and 30 minutes ==> ____

Enter the correct turn-on delay time you want and press <CR> to change the time to delay CTRL1 line activation. Then the ORG will respond with...

Turn-Off Delay__==>__XXX_Min
Enter C to change or <CR> to continue

If the delay to deactivate the CTRL1 control line is correct, press<CR>to go to the next set-up parameter. If you want to change the "XXX" turn-off delay time, press "C" and <CR>.Then the ORG will respond with...

Enter new Turn-Off Delay
Between 0 and 180 minutes ==> ____

Enter the desired turn-off delay time and press <CR> to change the CTRL1 line deactivation delay time. Then the ORG will respond with...

Relay Closure Sensitivity__==>X
Enter C to change or <CR> to continue
If the relay sensitivity is correct, press<CR>to go to the next set-up parameter.If you want to change the "X" relay sensitivity, press "C" and <CR>.Then the ORG will respond with...
Enter new Relay Closure Sensitivity
1 TO 3 where 1 is most sensitive ==> _
Enter the desired sensitivity of 1, 2, or 3 and press <CR> to change the CTRL1 line relay sensitivity. Then the ORG will respond with...

Date_MM-DD-YY_Time_HH:MM:SS
Enter D to change Date of
T to change Time or <CR> to continue
If the date and time are correct, press <CR> to complete the configuration set-up.If you want to change the date, press "D" and <CR>.Then the ORG will respond with...
Enter current DATE (1 to 31)
Type the correct data from day 1 to 31 (i.e.; 5 for the fifth day of the month) and press <CR>.Then the ORG will respond with...
Enter current MONTH (1 to 12)
Type the correct month from 1 to 12 (i.e.; 3 for March) and press <CR>.Then the ORG will respond with...
Enter current YEAR (4 Digits)
Type the correct year in 4 digits (i.e.; 1994) and press <CR>.Then the ORG will respond with...

Date_05-03-94_Time_HH:MM:SS(Note that the date is now as entered)
Enter HOURS 24 hour format (0 to 23)
Type the correct hour (local time) from 0 to 23 (i.e.; 5 for 5 AM) and press <CR>.Then the ORG will respond with...
Enter MINUTES (0-59)
Type the correct minutes (local time) from 0 to 59 (i.e.; 22 for 22 minutes past the hour) and press <CR>.Then the ORG will respond with...
Enter SECONDS (0 to 59)
Type the correct seconds (local time) from 0 to 59 (i.e.; 15 for 15 seconds after the minute) and press <CR>.Then the ORG will respond with...
Date_05-03-94_Time_05:22:15 (Note that the date & time are now as entered)

Enter D to change Date of
T to change Time or <CR> to continue
If the date and time are correct, press <CR> to complete the configuration set-up.Then the ORG will respond with...

System Configuration:
Date_DD-MM-YY_Time_HH:MM:SS
Precipitation Activation Temp.==>_TT_C
Turn-On Delay__==>__XX_Min
Turn-Off Delay__==>__XXX_Min

The ORG is now fully customized to the user-defined parameters for operation of the CTRL1 control line.

"*" Poll Responses

This poll lists the ORG sensor set-up parameters as currently configured.

The "*" sensor configuration poll provides a useful way to review the user selectable parameters which determine how the sensor operates. This command is mainly used for applications using the CTRL1 output to control a relay. This command does not effect the normal precipitation output data for accumulation or rate.

In response to the "*" command (for most keyboards press shift and 8 keys), the ORG returns the following response:

System Configuration:
Date_DD-MM-YY_Time_HH:MM:SS
Precipitation Activation Temp.==>_TT_C
Turn-On Delay__==>__XX_Min
Turn-Off Delay__==>__XXX_Min
Relay Closure Sensitivity__==>__X

where:

"Date_MM-DD-YY" is the calendar date in units of day-month-year.

"Time_HH:MM:SS" is the local time in units of hour:minute:second in 24 hour format.

"Precipitation Activation Temp." is the temperature TT in degrees Celsius at which the CTRL1 control line is activated (pulled low) to indicate a snow event (if precipitation is present). This parameter makes it possible to fine-tune the sensor to meet the local environmental conditions. For instance, if it does not snow in your area when the temperature is above 1 degree C, change the default setting from 3 C to 1 C.

"Turn-On Delay" is the amount of time XX in minutes that must pass before the CTRL1 line is activated (pulled low) to indicate a snow event. This parameter delays the CTRL1 activation. For instance, if you don't want immediate CTRL1 line activation when snow starts but would prefer a 5 minute delay, change the default setting from 1 minute to 5 minutes. This setting will cause the ORG to wait 5 minutes before pulling the CTRL1 line low (activation).

"Relay Closure Sensitivity" uses the snow fall rate to determine when the CTRL1 control line will be activated. Setting the option to "1" makes the CTRL1 line the most sensitive and it will activate within minutes of the start of light snow. Setting the option to "2" makes the CTRL1 line less sensitive and it will not activate until moderate or heavy snow is falling. Setting the option to "3" makes the CTRL1 line the least sensitive and it will not activate until heavy snow is falling.

"Turn-Off Delay" is the amount of time XXX in minutes that the CTRL1 control line waits before deactivating after the snow event is over. This parameter causes the ORG to keep the CTRL1 activated after the snow event is stopped. For instance, if you want the CTRL1 line to stay active for 1 hour after the snow has stopped, change the default setting from 10 minutes to 60 minutes.

When the ORG sensor is shipped from OSI the parameters are set to factory defaults as shown below:

Date	Calendar Date
Time	EST Time
Precipitation Activation Temperature	3 C
Turn-On Delay	1 Min
Turn-Off Delay	10 Min
Relay Closure Sensitivity	1

4.2 ANALOG ORG (-DA) SENSOR OPERATION

4.2.1 Analog ORG Interface

The analog ORG (“-DA”) output is designed to interface with commercially available data acquisition systems.

The rain signal output of the ORG-815-DA Sensor is a DC voltage that is proportional to the power raised to the “1.87" of the rain rate. The actual output level at the signal output pair will vary from 0 VDC to +5 VDC at the extreme limits. The ORG output specification is shown below.

Output Impedance:	50 Ohms
Signal Output:	0 to 5 VDC
Time Constant:	10 seconds
CXR Output	O to 5 VDC
Time Constant	120seconds

The signal output of the ORG is described by the following formula:

Standard Calibration (500 mm/hr) **Rain Rate (mm/hr) = 25(Vout1.87) - 0.15**

where Vout is the sensor output in volts DC as the rain varies over the range of 0.1 to 500 mm/hr. The table that follows and Figure 4.1 illustrate the rain rate to sensor voltage relationship.

ORG Out VDC	Rain Rate mm/hr
0.085	0.099
0.25	1.721
0.5	6.689
1	24.850
1.5	53.212
2	91.233
2.5	138.554
3	194.905
3.5	260.074
4	333.885
4.5	416.189
5	506.857

Note that the signal output is always positive, with voltages under 85 millivolts corresponding to a "no-precipitation" (NP) condition. This allows use of the most common 0 to 5 VDC unipolar type input of a data acquisition system.

During normal operation, the sensor always puts out some voltage (background noise), even during clear sky conditions. The user should apply the above rain rate equation only for voltages equal to or above a fixed threshold of 85 mVDC. Otherwise, the user's equipment will report a small amount of rain at all times, due to the "clear sky" output voltage level. ("Clear sky" is defined as the absence of precipitation, turbulence, and other beam disturbances).

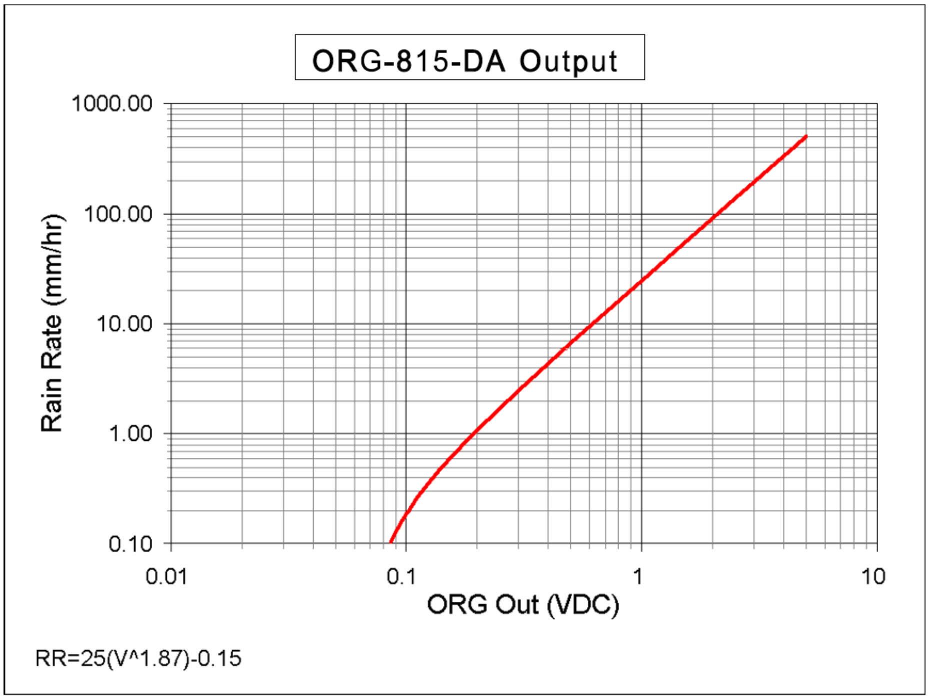


Figure 4.1 Analog ORG Voltage vs. Rain Rate

The diagnostic (CXR) output is an analog signal that can be used to monitor the strength of the IR carrier level. The carrier will fluctuate during rain and therefore should not be used for diagnostic purposes when precipitation is falling. The following table provides a series of thresholds which can be used (optional) by the user. They should be considered a general guideline - for more information, contact the OSI Service Department.

CXR Voltage	Description
4.0 to 4.99 VDC	Acceptable Range
2.5 to 3.99 VDC	Acceptable Range, Check Unit if Decrease Continues
Less Than 2.5 VDC	Maintenance Indicated

4.2.2 Data Acquisition Requirements

The ORG can connect to any analog input data acquisition device capable of receiving 0-5 VDC full scale signals.

The data acquisition system used to interface to the ORG may be a commercial data logger such as those manufactured by Handar, Sutron, Coastal Environmental, or similar, PC based A/D boards, or any such device which has an analog-to-digital (A/D) input. To properly sample and record the sensor data, four parameters must be addressed; input voltage range, sample resolution, sample rate, and averaging techniques.

✓ Range & Resolution

For best results, the sensor's output should be digitized with a 10 bit or higher, unipolar analog-to-digital converter (ADC) at an input range of 0-5 VDC. This would be an optimum setup. For a unipolar 10 bit ADC, the digitization error would be 10 bits over 0 to 5 V range = 4.9 mV / step, or about 0.1 % of reading.

At the minimum, the ADC should be a single ended input, 8 bit resolution ADC over the range of 0 to +5 VDC. The error in this case would be 0.4 % of reading.

When connecting the sensor's output to a differential type input, the signal common leg of the input pair is typically not connected to the earth ground because a return path is provided in the sensor. When using single ended inputs, careful cabling and installation practices should be followed to avoid introducing ground loops.

✓ Sample Rate

Since the ORG final output stage has a 10 second time constant, the output should be sampled at a minimum of twice that rate, or once every 5 seconds to prevent aliasing. This is suitable for all but the most demanding applications where there is an interest in the fine structure of high rate precipitation events. If there is an interest in the fine structure of rain events, sample at a faster rate, such as every 1 second. Many applications do not require such high resolution data so sample rates as infrequent as once per minute may be acceptable.

✓ Averaging Techniques

If any averaging or processing of the data is to be done by the user's host system, then the raw sensor output data must first be converted to rain rate prior to averaging. If the conversion to rain rate is not done first, the average will always underestimate the true rain rate. For example, averaging the raw voltages of 1.00 VDC & 2.00 VDC (= 1.5 VDC) and then converting to rain rate yields the incorrect value 44.95 mm/hr. Done correctly, converting the voltages to rain rate first (19.95 and 79.95 mm/hr, respectively) and then averaging yields the correct value of 49.95 mm/hr.

Partial List of Available Data Logger Manufacturers

Manufacturer	Phone Number
Campbell Scientific, Inc	http://www.campbellsci.com
Climatronics, Inc	http://www.climatronics.com
Coastal Environmental Systems	http://www.coastalenvironmental.com
Qualimetrics, Inc	http://www.qualimetrics.com
Sutron Corporation	http://www.sutron.com/

4.3 ORG OPERATION EXAMPLES

4.3.1 Typical Digital ORG

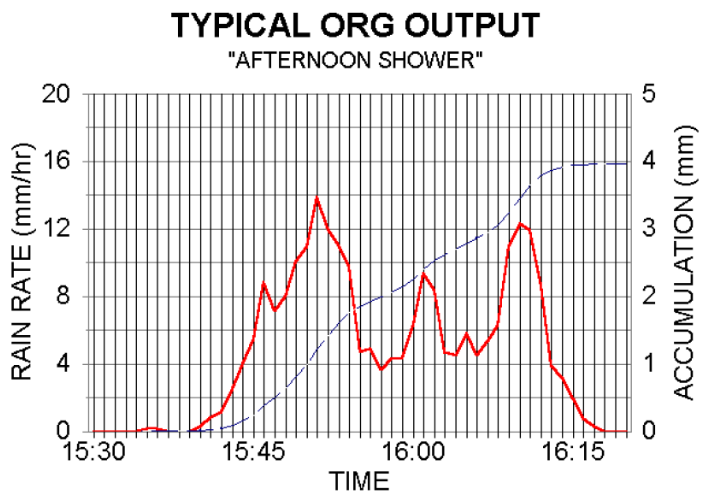
The digital ORG transmits a wealth of data including type of precipitation, rate, accumulation, as well as various raw and diagnostic information.

Below is a listing of one-minute "C" poll output from the ORG. The time field was added by the data acquisition software used in the OSI PC and is not a part of the ORG output. A description of some of the key events of the brief summer shower depicted in the data is provided to the right of the table.

Time	WX	RR	Accum	Status	Carrier	Raw	Baseline	Temp	
15:30:02		0	0.000	01**	4999	0058	0060	+31	← No Precipitation
15:31:02		0	0.000	01**	4999	0058	0060	+31	
15:32:02		0	0.000	01**	4999	0058	0060	+31	
15:33:02		0	0.000	01**	4999	0058	0060	+31	
15:34:02		0	0.000	01**	4999	0070	0060	+31	← Light rain(R-)starts at 15:35
15:35:02	R-	0.149	0.002	01**	4999	0090	0060	+31	
15:36:02	R-	0.149	0.004	01**	4999	0090	0060	+31	
15:37:02		0	0.004	01**	4999	0078	0060	+31	
15:38:02		0	0.004	01**	4999	0078	0060	+31	
15:39:02		0	0.004	01**	4999	0078	0060	+31	
15:40:02	R-	0.323	0.010	01**	4999	0117	0060	+31	
15:41:02	R-	0.800	0.023	01**	4999	0171	0060	+31	
15:42:02	R-	1.17	0.043	01**	4998	0206	0060	+31	← Rain switches to moderate (R)
15:43:02	R	2.56	0.086	01**	4999	0303	0060	+31	
15:44:02	R	3.95	0.151	01**	4998	0379	0060	+30	
15:45:02	R	5.47	0.243	01**	4999	0449	0060	+30	← Rain switches to heavy (R+)
15:46:02	R+	8.82	0.390	01**	4999	0577	0060	+30	
15:47:02	R	7.15	0.509	01**	4999	0517	0060	+30	
15:48:02	R+	8.03	0.641	01**	4999	0549	0060	+29	
15:49:02	R+	10.1	0.812	01**	4999	0620	0060	+29	
15:50:02	R+	10.9	0.994	01**	4999	0647	0060	+29	← Max rain rate (13.9 mm/hr) at 15:51
15:51:02	R+	13.9	1.227	01**	4999	0735	0060	+28	
15:52:02	R+	12.0	1.428	01**	4999	0680	0060	+28	
15:53:02	R+	11.0	1.611	01**	4999	0649	0060	+28	
15:54:02	R+	9.72	1.773	01**	4999	0607	0060	+28	
15:55:02	R	4.72	1.852	01**	4999	0416	0060	+27	
15:56:02	R	4.92	1.934	01**	4999	0425	0060	+27	← Accumulation exceeds 2 mm
15:57:02	R	3.65	1.995	01**	4999	0364	0060	+27	
15:58:02	R	4.28	2.067	01**	4999	0395	0060	+27	
15:59:02	R	4.38	2.140	01**	4999	0400	0060	+26	
16:00:02	R	6.34	2.254	01**	4999	0485	0060	+26	
16:01:02	R+	9.37	2.402	01**	4999	0596	0060	+26	
16:02:02	R+	8.35	2.541	01**	4999	0561	0060	+26	
16:03:02	R	4.72	2.620	01**	4999	0416	0060	+25	
16:04:02	R	4.50	2.695	01**	4999	0406	0060	+25	
16:05:02	R	5.78	2.791	01**	4999	0462	0060	+25	
16:06:02	R	4.52	2.867	01**	4999	0407	0060	+25	
16:07:02	R	5.36	2.956	01**	4999	0444	0060	+25	
16:08:02	R	6.28	3.061	01**	4999	0483	0060	+25	
16:09:02	R+	11.0	3.245	01**	4999	0650	0060	+25	
16:10:02	R+	12.3	3.451	01**	4999	0689	0060	+25	
16:11:02	R+	11.9	3.650	01**	4999	0678	0060	+24	← Rain begins to taper off
16:12:02	R+	8.65	3.794	01**	4999	0571	0060	+24	
16:13:02	R	3.90	3.860	01**	4999	0377	0060	+24	
16:14:02	R	3.16	3.912	01**	4999	0338	0060	+24	
16:15:02	R-	1.91	3.944	01**	4999	0262	0060	+24	← Rain ends at 16:18; total accumulation of 3.961 mm
16:16:02	R-	0.729	3.956	01**	4999	0164	0060	+24	
16:17:02	R-	0.289	3.961	01**	4999	0112	0060	+24	
16:18:02		0	3.961	01**	4999	0076	0060	+24	
16:19:02		0	3.961	01**	4999	0060	0060	+24	
16:20:02		0	3.961	01**	4999	0058	0060	+24	

Note - In the table above, the time was added by the data acquisition system, not the ORG.

The data shown in the table may also be shown in graphical form using commonly available spreadsheet programs. The solid line is the one-minute rain rate in mm/hr while the dashed line is the accumulation in mm. The variability in the event, which is not too noticeable in the tabular data (rain rate switches between R and R+), is very obvious in the graph as three (3) peaks and lulls.



4.3.2 Typical Analog ORG

The analog ORG outputs a voltage which may be converted to rain rate and accumulation.

✓ **Rain Rate:**

To convert the ORG voltage output to an equivalent rain rate, use one of the following equations:

500 mm/hr Standard Calibration:

Rain Rate (mm/hr) = 25(Vout1.87) - 0.15
Rain Rate (in/hr) = (25(Vout1.87) - 0.15) x 0 .03937

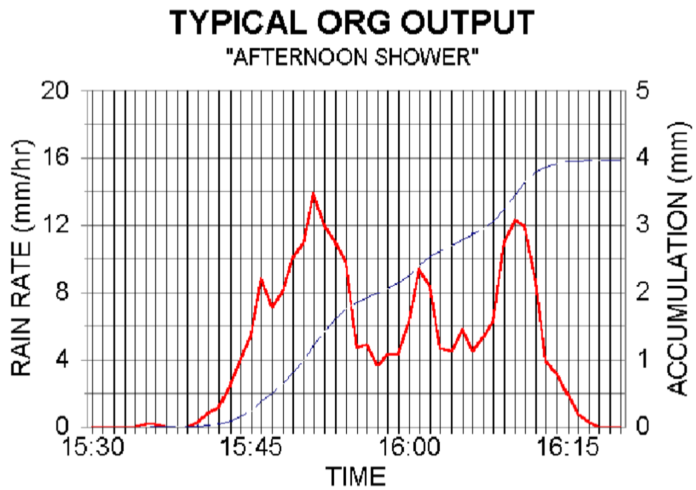
✓ **Accumulation:**

To obtain accumulation, sum the data points for a fixed period of time and divide by the number of data samples in the period.

If the sensor data is collected once per minute, the hourly accumulation is obtained by adding the 60 rain rates obtained in the hour and dividing by 60.

If the sensor is being collected every 5 seconds, the hourly accumulation is obtained by adding the 720 rain rates obtained in the hour and dividing by 720.

A typical rain event was analyzed from data collected by the OSI data acquisition system. A common spreadsheet program was used to generate the graph shown below. Both rain rate (heavy line) and accumulation (dashed line) are shown. Note that the total accumulation for the event was 4 mm.



5 MAINTENANCE & TROUBLESHOOTING THE ORG-815

5.1 ROUTINE MAINTENANCE AND QUICK CHECK

The ORG-815 takes only a few minutes every 3-6 months to maintain.
In most cases, only simple checks are required.

Equipment Required

1. Clean Cloth
2. Glass Cleaner
3. Ice Water and/or Freeze Spray (optional)

The ORG Sensors are designed for high reliability and low operator maintenance. The only scheduled maintenance is to periodically clean the lenses. In most locations, cleaning the lenses every six months is recommended. Historically, the sensors have operated unattended for several years without any degradation in performance. Use the table provided to record the maintenance performed.

✓ Clean Lenses

Cleaning the lenses should be done with lint-free cloth and cleaning solution. Clean the lenses by first spraying the lens cleaner on the lens and then wipe gently to prevent scratching the glass optics. In actual practice, moderate dust buildup and scratches on the lenses will not have any discernible effect on the instrument.

✓ Check Lens Heaters

After cleaning the lenses, a quick check of the lens heaters should be performed. With a clean finger, touch the lenses in front of the disc-shaped heater which is bonded to the lower inside surface of both lenses. The lens surfaces should be slightly warmer to the touch than the ambient temperature.

✓ Carrier Strength Check

Digital ORG: Check the strength of the carrier signal by typing a "C" on the PC. The ORG should respond with a data string of routine and diagnostic data. The carrier strength in bytes 22-25 should be 3000 to 4999 if the optical path between the sensor head is clear and the unit is working well. Partial blocking of the beam will cause the carrier to decrease. If the beam is almost completely blocked for a few minutes or the signal strength is very weak, the carrier will drop below 1000 and bytes 1-2 will report "ER" after several minutes.

Analog ORG: Check the strength of the carrier signal by measuring the carrier (CXR) voltage on the blue wire. The voltage should normally be between 4.0 to 4.99 VDC if the optical path between the sensor heads is clear and the unit is working well. Partial blocking of the beam will cause the carrier to decrease. The carrier circuit uses a time constant on the order of one-minute and therefore will change quite slowly. If, with clean lenses and no precipitation, the carrier value is < 2.5 VDC, contact the factory.

✓ Comb Test

Digital ORG: Using a pocket comb, stroke it up and down vertically in front of the receiver lens as shown below for ~1 minute. Do not block the beam for any length of time. Send an "A" poll from the PC or terminal and verify that the sensor indicates rain rate. A typical sensor response might be R- 12.5 002.005 where the "R-" indicates light rain, "12.5" indicates the rain rate in mm/hr, and "002.005" indicates the accumulation. (The actual rain rate reported will vary from the above number)

To further test the ORG, spray the temperature probe briefly several times over a 1-2 minute period with freeze spray (available at electronic stores) to lower the probe temperature to < 32 degree F. The weather identifier will be one of the "P or S" categories when the comb test is repeated.

Analog ORG: Using a pocket comb, stroke it up and down vertically in front of the receiver lens as shown below for ~1 minute. Do not block the beam for any length of time. The signal output on the green wire referenced to ground should rise from below 85 mV before the comb test to up to several volts during an extended comb test.

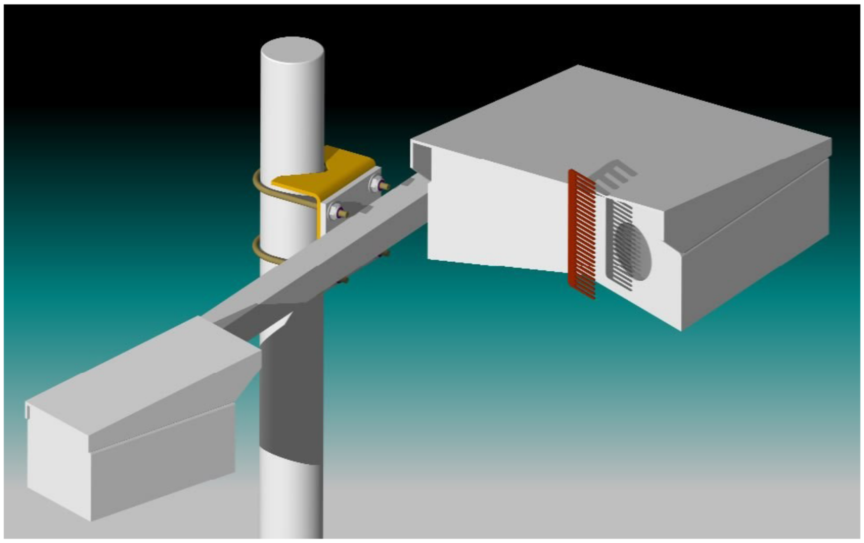


Figure 5.1 Comb Test Illustration

Maintenance Check List

	Date _______	Date _______	Date _______
Clean Lenses			
Verify Lens Heaters			
Check Carrier			
Comb Test			

5.2 ORG CALIBRATION VERIFICATION

The ORG-815 calibration can be verified in the field or lab using the optional TST-800 Series Field Test Kit available from OSI.

Complete ORG calibration is not a user-performed operation. ORG-815 sensors are factory calibrated and sealed and should not be opened. **Opening the unit will void the factory warranty.** OSI provides quick turnaround calibration and repair services for all equipment it sells.

Contact the Sales Department for more information on calibration services. For critical applications, periodic verification of the calibration of the sensor is recommended on an annual cycle. Calibration verification requires the use of a TST-800 Series Test Kit.

An abbreviated procedure for it's use is provided below. For more detail, follow the procedure provided with your Test Kit when making the measurement.

1. Turn **OFF** power to the ORG
2. Connect the Test Kit
3. Turn **ON** ORG power and wait at least 10 minutes
4. Record the ORG indicated rain rate
5. Verify that the measured value is correct
6. Turn **OF**F power to the ORG
7. Disconnect the Test Set
11. Turn **ON** power to the ORG

Figure 5.2 TST-800 Test Kit

Calibration Verification Table

Test Date	TST-800 S/N	Measured Rain Rate	Initial Test Rain Rate	% Delta

6 TECHNICAL SUPPORT

OSI Technical Support
techsupport@opticalscientific.com
Tel: 301 963 3630 xt 216
Fax: 301 948 4670

Calls are monitored
Mon - Fri 9 AM – 10 PM ET
Sat - Sun 12PM - 6PM ET
(except national holidays)

6.1 BEFORE CONTACTING TECHNICAL SUPPORT

Please have, or be able to provide:

- Unit or system model designation: ORG-815-(DA/-DR/-DS etc.)
- Unit or system serial number
- If you have a digital system: (ORG-815-DC/-DR)
  - Data output ASCII text file showing a response to “C” poll. [See Section 4]
  - Software Version from “V” poll. [See Section 4.1.6]
- Details of the site and installation (site location, etc.)
- Your name, phone number, and e-mail address

6.2 FACTORY SERVICE

Warranty Service:
If the unit is within the warranty period OSI will handle the repairs according to the conditions outlined in our warranty guarantee.

Out-of-Warranty Service:
If the unit is out of warranty, OSI will require a purchase order or credit card number for billing purposes.

Returns: To return equipment, parts, or material to OSI, follow the procedure outlined below:

- Contact our customer service staff. [1 301 963 3630 xt 201 sales@opticalscientific.com]
- Determine warranty status and minimum service charge*.
- Get a **R**eturned **M**aterial **A**uthorization (**RMA**) number **.
- Package the unit to prevent damage in shipping and send it to our factory.

Your order will be handled expeditiously on a first-come first-served basis.

* Minimum service charge includes cleanup, calibration, and testing / troubleshooting and minor repairs. Repairs requiring replacement of part will cost extra. Minimum service charge must be paid per standard terms prior to issue of Return Material Authorization (RMA).

** OSI will NOT accept equipment, parts, or material of any kind without an RMA.

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