TechnicalResources

15353 E. Hinsdale Cir, Unit D, Centennial, Co 80112, 303-814-0307, fax 303-814-3719

ELECTRICAL TERMINOLOGY USED IN THE IRRIGATION INDUSTRY

Comparisons between irrigation & electrical terminology

Irrigation terminology	Vs.	Electrical terminology
Pressure (PSI)		Voltage (volts—V)
Friction Loss (PSI)		Resistance (ohms—R)
Flow (GPM)		Current (amps—A)

ALTERNATING CURRENT (AC)—Standard household current. Most irrigation systems use AC current.

AMPERAGE (AMPS)—quantitative measurement of flow of electricity, similar to Gallons Per Minute in irrigation.

CIRCUIT—in irrigation terms the electrical wiring path from the station output terminal to and through the solenoid back to the common terminal

CONNECTION—connection of one wire with one or more wires inside of an approved wire nut or other connecting device

DIRECT CURRENT (DC)—directional flowing electricity: i.e. current flowing from the positive terminal of a battery through a device and back to the negative terminal

FIELD WIRING—the wiring between the controller and any device/valve installed in-ground

GROUND—in electricity it is always earth ground

MULTIMETER (VOLT OHM-METER)—a digital or analog testing device for measuring electricity's characteristics (voltage, amperage, resistance)

OHMS/RESISTANCE—the resistance encountered by electricity in wiring or devices on a circuit, similar to friction loss in irrigation terms

OPEN CIRCUIT—term given to a circuit when the pathway for electricity has been severed or is not completed

PRIMARY SIDE—the side of the transformer that is connected to the 120vac supply.

SECONDARY SIDE—in the irrigation industry it is the 24vac output side of the transformer

SHORT CIRCUIT—term given to a circuit where electricity bypasses the intended and goes directly from the hot to the common wire

SHORT TO GROUND—the electricity has a direct path from the wire through the insulation to ground

SOLENOID—an electrical device on valves that when electrified creates a magnetic field that pulls a metallic plunger

TERMINAL STRIPS—a collection of terminals numbered to differentiate zones

TERMINALS—the connecting device on the panel of the controller that the field wires are attached into. There are station output terminals and common terminals

VOLTAGE (VOLTS)—quantitative measurement of the power of electricity, similar to water pressure (PSI)

ZONE—irrigation term used to differentiate one circuit from another: i.e. zone 5, or zone 12

ZONE WIRE VS. COMMON WIRE—the zone wire is the wire connecting a station output terminal on a controller to a solenoid or device. The common wire is the wire connecting the solenoid or device to the common terminal.

EVENTS THAT AFFECT ELECTRICAL SYSTEMS

EVENTS	CAUSES	EFFECTS
• **SAGS** Also known as brownouts, sags are short-term decreases in voltage levels. This is the most common power problem, accounting for 87% of all power disturbances according to a study by Bell Labs.	Typically caused by the start-up power demands of many electrical devices (including motors, compressors, elevators, shop tools, etc.), sags are also the electric utilities' means of coping with extra ordinary power demands. In a procedure known as "rolling brownouts," the utility will systematically lower voltage levels in certain areas for hours or days at a time. Hot Summer days, when air conditioning requirements are at their peak, will often prompt rolling brownouts.	A sag can "starve" a computer of the power it needs to function, causing frozen keyboards and unexpected system crashes with the end result being the loss of/or corruption of data. Sags also reduce the efficiency and life span of electrical equipment, particularly motors.
• **BLACKOUT** Total loss of power.	Excessive demand on the power grid, lightning storms, ice on power lines, car accidents, backhoes, earthquakes, etc.	Loss of current work in RAM or cache, possible loss of hard drive File Allocation Table (FAT) resulting in total loss of data stored on drive.
• **SPIKE** Also referred to as an impulse, a spike is an instantaneous, dramatic increase in voltage. Akin to the force of a tidal wave, a spike can enter electronic equipment through AC, network serial or phone lines and damage or completely destroy components.	Typically caused by a nearby lightning spike, spikes can also occur when utility power comes back on line after having been knocked out in a storm or as the result of a car accident.	Catastrophic damage to hardware. Loss of data.
• **SURGE**		

A short term increase in voltage, typically lasting at least $1/120^{th}$ of a second.	High-powered electrical motors, such as air conditioners, and household appliances in the vicinity. When this equipment is switched off, the extra voltage is dissipated through the power line.	Computers and similar sensitive electronic devices are designed to receive power within a certain voltage range. Anything outside of expected peak and RMS (considered the "average" voltage) levels will stress delicate components and cause premature failure.
• **NOISE** More technically referred to as ElectroMagnetic Interference (EMI) and Radio Frequency Interference (RFI), electrical noise disrupts the smooth sine wave one expects from utility power.	Many factors and phenomena, including lightning, load switching, generators, radio transmitters and industrial equipment, cause electrical noise. It may be intermittent or chronic.	Noise introduces glitches and errors into executable programs and data files.

CONTROLLER DIAGNOSTICS
CONTROL TECH USA, INC.

PROCEED WITH THE FOLLOWING DIAGNOSTIC STEPS AFTER REMOVING AC POWER FROM THE CONTROLLER, REMOVING THE BACKUP BATTERY, AND DISCONNECT THE COMMON WIRE. LET THE CONTROLLER SET FOR APPROXIMATELY ONE MINUTE, APPLY AC POWER, CONNECT THE COMMON WIRE AND RETEST THE CONTROLLER FUNCTIONS.

STEP 1: SNIFF AND VISUAL TEST. DOES THE CONTROLLER HAVE A BURNT SMELL OR PHYSICAL SIGNS OF DAMAGE?

YES- SEND IN FOR REPAIR. **NO**-PROCEED TO STEP 2.

STEP 2: POWER UP THE CONTROLLER. DOES THE CONTROLLER HAVE A DISPLAY AND DOES IT DISPLAY ALL THE INFORMATION CORRECTLY?

YES- PROCEED TO STEP 3.
(IF YOUR CUSTOMERS COMPLAINT IS THAT THE CONTROLLER DID NOT HAVE A DISPLAY, ASK HIM IF HE CHECKED HIS TRANSFORMER FOR 24VAC AND/OR DID HE CHECK THE FUSE IF THE CONTROLLER HAS ONE?)
NO- PROCEED TO STEP 2A.

STEP 2A: IS THE DISPLAY COMPLETELY BLANK?

YES- SEND IN FOR REPAIR **NO**- PROCEED TO STEP 2B.

STEP 2B. IS THE DISPLAY DISPLAYING UNLEDGEABLE GARBAGE?

YES- SEND IN FOR REPAIR **NO**- PROCEED TO STEP 2C.

STEP 2C. IS THE DISPLAY DISPLAYING MOST OF WHAT IT SHOULD, BUT MISSING SOME OF IT SEGMENTS OR CHARACTERS?

YES- WARRANTY REPAIR OR EXCHANGE.
(SEND IN TO CONTROL TECH FOR WARRANTY REPAIR IF EXCHANGED)

STEP 3. TEST THE OUTPUTS. DO ALL THE OUTPUTS TURN A SOLENOID ON AND OFF?

YES- PROCEED TO STEP 4. **NO**- SEND IN FOR REPAIR

STEP 4. CHECK SWITCHES, KEYPAD KEYS, AND FUNCTIONS. DO ALL THE SWITCHES, KEYPAD KEYS, AND FUNCTIONS OPERATE NORMALLY?

YES- PROCEED TO STEP 5. **NO**- PROCEED TO STEP 4A.

STEP 4A. CHECK CONTROLLER FOR WATER DAMAGE (WHITE CRUSTY BUILD UP ON PRINTED CIRCUIT BOARD AND/OR COMPONENTS, DIRT, INSECT REMAINS, SPIDER WEBS, FOREIGN OBJECTS, OR BURN MARKS. IS ANY OF THE ABOVE MENTIONED PRESENT?

YES- SEND IN FOR REPAIR **NO**- WARRANTY REPAIR OR EXCHANGE.

STEP 5. CHECK THE PROGRAM. DOES THE PROGRAM HAVE ANY ERRORS?

YES- CORRECT THE ERRORS. **NO**- PROCEED TO STEP 6.
PROCEED TO STEP 6.

STEP 6. SIMPLE PROGRAM TEST. SET DAY, SET CORRESPONDING DAY ON, SET START TIME, SET STATION 1 WATER TIME TO 1 MINUTE, SET TIME TO ONE MINUTE PRIOR TO START TIME, PUT SOLENOID ON ZONE 1, AND LET IT AUTOSTART AND TIME THE RUN TIME FOR ACCURACY.

YES- RETURN TO CUSTOMER, NO TROUBLE FOUND
NO- WARRANTY REPAIR OR EXCHANGE

THIS SIMPLE TEST WILL ALLOW YOU TO FIND 99% OF THE PROBLEMS WITH A CONTROLLER. DOING THIS WILL ALSO SHOW YOUR CUSTOMER YOU CARE ABOUT HIS SERVICE NEEDS!

Solenoid Ohm Resistance Values

Asco(Bermad/ClaVal)	14.4 *ohms*
Champion	21.7 *ohms*
Greenlawn	22.7 *ohms*
Griswold	21.1 *ohms*
Hardie/Irritrol	24.6 *ohms*
Hunter	29.7 *ohms*
Imperial ATTV	21.7 *ohms*
Nelson	22.2 *ohms*
Orbit	20.2 *ohms*
RainBird A series coil	28.5 *ohms*
Rainbird B series coil	23.8 *ohms*
RainBird DV series	51.8 *ohms*
Superior	23.1 *ohms*
Toro 1"	+/- 28 *ohms*
Toro 3/4"	+/- 23 *ohms*
Weathermatic	34.1 *ohms*

Field Circuit Resistance(*Ohms*) Test Worksheet

This is a test of the field wiring attached to the controller. This test guides you though the process of measuring the ohms resistance in the field wiring through each zone. Using the guidelines below determine if each circuit/zone is good or bad.

Step 1.--**Disconnect the common field wire(s)** from the common terminal on the controller.
Step 2.--Set your multimeter to a Resistance range of 0 to 100 ohms.
Step 3.--Hold one lead against the bare wire on the common wire. With the other lead touch the terminals of the controller one by one. Mark down on this sheet the Resistance(ohms) with the corresponding zones.

ZONE	Ohms Reading	ZONE	Ohms Reading	ZONE	Ohms Reading
1		17		33	
2		18		34	
3		19		35	
4		20		36	
5		21		37	
6		22		38	
7		23		39	
8		24		40	
9		25		41	
10		26		42	
11		27		43	
12		28		44	
13		29		45	
14		30		46	
15		31		47	
16		32		48	

Rule of Thumb:

0-6 ohms -- a shorted circuit-bad solenoid or shorted wiring
6-12 ohms -- a slow burn solenoid or Asco solenoid
12-20 ohms -- normal/possible two solenoids on circuit
or an Asco solenoid connected on circuit
20-60 ohms --**Normal operating range**
60 ohms + -- open circuit

Those circuits which fall in the Normal range are good circuits. The rest need to have the solenoids and field wiring tested separately. Follow the **Field Test Flow Chart** to find the problem.

IRRIGATION ELECTRICAL SYSTEM FIELD TEST
FLOW CHART

STEP 1: DO YOU HAVE A CORRECTLY FUNCTIONING DISPLAY ON CONTROLLER WHEN YOU OPEN DOOR?

YES: JUMP TO STEP 5

NO: CONTINUE TO STEP 2

STEP 2: SNIFF AND VISUAL TEST. DOES THE CONTROLLER HAVE A BURNT SMELL OR PHYSICAL SIGN OF DAMAGE?

YES: SEND IN CONTROLLER FOR REPAIR.

NO: PROCEDE TO STEP 3

STEP 3: DO YOU HAVE 24VAC ON SECONDARY SIDE OF TRANSFORMER?

YES: CHECK TERMALS AND OTHER CONNECTIONS BETWEEN TRANSFORMER & CONTROLLER. IF ALL TESTS GOOD AND CONTROLLER STILL DOES NOT WORK, CHECK FUSE OR CIRCUITBREAKER. POWER DOWN THE CONTROLLER FOR ABOUT A MINUTE BY REMOVING 24VAC POWER, BACK UP BATTERY, AND THE COMMON WIRE(S). RECONNECT 24VAC, THEN COMMON THE BATTERY. IF YOU HAVE DISPLAY, COMPLETELY CHECKOUT CONTROLLER, IF NO DISPLAY SEND CONTROLLER IN FOR REPAIR.

NO: CHECK FOR 120VAC ON PRIMARY SIDE OF TRANSFORMER
CHECK PRIMARY SIDE AND SECONDARY SIDE FOR CONTINUITY, IF ONE SIDE IS OPEN, TRANSFORMER IS BAD. REPLACE TRANSFORMER AND START AT STEP 1 AGAIN.

STEP 4: CHECK FOR 120VAC AT CONNECTIONS ON PRIMARY SIDE OF TRANSFORMER

YES: SHUT OFF 120VAC POWER SUPPLY TO CONTROLLER. DISCONNECT TRANSFORMER WIRES FROM 120VAC SUPPLY WIRES. DISCONNECT WIRES ON SECONDARY SIDE OF TRANSFORMER. CHECK FOR CONTINUITY THROUGH PRIMARY SIDE WIRES. CHECKCONTINUITY THROUGH SECONDARY WIRES. IF EITHER SIDE SHOWS “OPEN”, REPLACE TRANSFORMER THEN START AT STEP 1.

NO: CHECK TO MAKE SURE SWITCH FOR POWER SUPPLY IS ON. IF IT IS AND YOU STILL DO NOT HAVE 120VAC AT CONNECTIONS TO TRANSFORMER, CALL YOU FAVORITE ELECTRICIAN. **DO NOT** WORK WITH 120VAC UNLESS YOU HAVE AN ELECTRICIANS LICENSE.

STEP 5: TEST THE OUTPUTS. DO ALL THE OUTPUTS TURN A SOLENOID ON AND OFF?

YES: CHECK CONTROLLER SWITCHES, KEYPAD KEYS, AND FUNCTIONS. IF ALL FUNCTIONS WORK NORMALLY, CHECK PROGRAM, CLOSE DOOR AND GO TO NEXT JOB.

NO: TEST NON WORKING ZONES’ OUTPUT TERMINALS FOR 24V OUTPUT.

STEP 6: DO ALL TERMINALS HAVE 24VAC OUTPUT?

NO: SEND IN FOR REPAIR. IF CONTROLLER HAS UPPER AND LOWER BOARDS, SEND BOTH
BOARDS IN TO BE REPAIRED.
YES: TEST ALL NONWORKING ZONES FIELD WIRING ACCORDING *TO* ***CONTROLLER FIELD CIRCUIT RESISTANCE(Ω) TEST WORKSHEET.***

STEP 7: DID ALL FIELD CIRCUITS TEST OK?
YES: CHECK ALL CONTROLLER OUTPUT CONNECTIONS AND RETEST ACCORDING TO STEP 5.
NO: DISCONNECT VALVE WIRES FROM BAD CIRCUITS AND COMMON WIRE(S) FROM CONTROLLER. FIND VALVES ON BAD CIRCUIT. DISCONNECT VALVE WIRES FROM FIELD WIRES. TEST OHMS VALUE OF VALVE SOLENOID.

STEP 8: DOES SOLENOID HAVE CORRECT OHMS RATING?
NO: REPLACE WITH CORRECT SOLENOID AND RETEST
YES: TEST FIELD WIRING FOR OHMS

STEP 9: DOES FIELD WIRING HAVE PROPER OHMS READING?(SHOULD READ "OPEN")
YES: RECONNECT ZONE VALVE WIRE AND COMMON WIRE TO THEIR CORRECT TERMINALS AT CONTROLLER. TURN ON ZONE FROM CONTROLLER. TEST FOR 24VAC AT FIELD WIRES NEAR VALVE.
NO: YOU MAY HAVE A SHORT. FIND PROBLEM WITH FIELD WIRING, REPAIR AND RETEST ACCORDING TO FIELD TEST WORKSHEET.

STEP 10: IS THERE 24VAC ON FIELD WIRES AT ZONE VALVE?
YES: RECONNECT VALVE SOLENOID WIRES TO FIELD WIRES. TURN ON ZONE AT CONTROLLER.
NO: YOU MAY HAVE A BROKEN WIRE. FIND PROBLEM USING PROGRESSIVE ELECTRONICS OR SIMILAR EQUIPMENT, REPAIR AND RETEST FROM STEP 9.

STEP 11: DID ZONE VALVE TURN ON?
YES: GO TO NEXT BAD CIRCUIT AND TEST ACCORDING TO STEP 7
NO: CHECK FOR 24VAC AT SOLENOID/FIELD WIRES CONNECTIONS

STEP 12: IS THERE 24VAC AT SOLENOID/FIELD WIRE CONNECTIONS
YES: FEEL AND LISTEN FOR VIBRATION/HUM OF SOLENOID. IF NONE, CHECK FOR MECHANICAL OPERATION OF SOLENOID AND/OR VALVE ACCORDING TO THE MANUFACTURES RECCOMMENDATIONS.
NO: YOU MAY HAVE A SHORT TO GROUND SITUATION. TEST WITH PROGRESSIVE ELECTRONICS OR SIMILAR EQUIPMENT, REPAIR, AND RETEST FROM STEP 11