CAUTION: The DSG-1301DU, DSG-1301DUP and DSG-1301DUS digital setpoint gauges are suitable for use in Class I, Group D, Division 1 and 2 hazardous locations when installed in accordance with these instructions.

The thermocouple leads connected to this device operate at a very low voltage and power levels and MUST NOT CONTACT any external voltage source. Damage to the system will result from connection between the thermocouple and the ignition system or any AC or DC power source.

WARNING: DEVIATION FROM THESE INSTALLATION INSTRUCTIONS MAY LEAD TO IMPROPER OPERATION OF THE MONITORED MACHINE WHICH COULD CAUSE PERSONAL INJURY TO OPERATORS OR OTHER NEARBY PERSONNEL.

1.0 DESCRIPTION

1.1 The Altronic DSG-1301DU/DUP/DUS digital setpoint gauge is an electronic instrument designed to monitor temperature using an industry standard J-type or K-type thermocouple. The gauge uses a microcontroller to process the input signal and a nonvolatile memory to store the gauge setup and setpoint values. An LCD display is used to display the numeric temperature value in °F or °C. A front mounted keypad serves as the user interface. The instrument can read Type J thermocouples between −76°F and 1382°F (−60°C and 750°C) and Type K thermocouples between −76°F and +1472°F (−60°C and 800°C).

1.2 The monitored temperature is continuously compared against two adjustable setpoints. Each setpoint can be individually configured as high or low. Configuration and adjustment of setpoints is performed through the keypad. Setpoint status indicators are provided on the LCD display. The DSG-1301DU/DUP/DUS also provides two form C outputs, one for each setpoint.

1.3 A 4-20 mA current loop output is provided in model DSG-1301DUP. The current loop output can be configured anywhere within the temperature range of the gauge, and can be forward or reverse acting. If the 4-20 mA current loop output is configured for reverse acting, the current loop output would decrease or go towards the 4 mA point as temperature increases. The current loop is also easily configured through the keypad.

1.4 RS-485 serial communication is provided in model DSG-1301DUS. This allows the gauge to communicate to other instruments, PC's or PLC's via the two serial RS-485 communication wires.

1.5 The Altronic DSG-1301 digital setpoint gauge is designed to be simple to use and includes several other features. An escape key is provided to permit the user to exit any configuration function and return to the normal display. A bar graph is available on the LCD display which can be set up for bar mode, single bar between two selected points, or single bar between the setpoints. A programmable software filter is also provided which can be used to stabilize readings where the thermocouple signal is fluctuating. Calibration can be performed using the keypad. Factory default configurations, including factory calibration settings, can be recalled for easy setup.

1.6 The power requirement for the DSG-1301DU/DUP/DUS gauge is 12 to 36 Vdc, 50 mA max.

1.7 For proper operation, these installation instructions must be adhered to strictly.

2.0 THERMOCOUPLES

2.1 The DSG-1301 gauge is designed to operate with industry standard grounded or ungrounded Type J or K thermocouples; ungrounded thermocouples are recommended where possible.

3.0 MOUNTING

3.1 Mount the gauge inside a control panel or to a suitable flat surface so that the display is at a convenient viewing height. A drilling template is provided. NOTE: Avoid mounting gauge with the LCD display facing direct sunlight. The display temperature range is -40°F to +175°F (-40°C to +80°C).

4.0 WIRING (SEE WIRING DIAGRAMS)

4.1 POWER WIRING - Connect the power input wires to terminals 5(−) and 6(+); power requirement is 12 to 36 Vdc (50 mA max). The minus terminal (−) is connected to panel ground which should be the same as engine ground. DO NOT ground this device directly to the ignition system common coil ground.

4.2 THERMOCOUPLES AND THERMOCOUPLE EXTENSION WIRE - Grounded or ungrounded Type J or K thermocouples may be used. Use thermocouple wire of the same type as the thermocouple probe to connect the thermocouple to the DSG-1301DU/DUP/DUS. Use stranded thermocouple wire having a good moisture-resistant insulation such as PVC; for higher ambient temperatures, teflon or B-fibre insulated thermocouple wire is recommended. To insure an accurate signal is transmitted to the instrument, avoid any added junctions, splices and contact with other metals. Take care not to damage the insulation when installing and take precautions against later damage from vibration, abrasion, or liquids in conduits. In addition, it is essential that the following practices be adhered to:

A. Never run thermocouple wires in the same conduit as the ignition wiring or other high energy wiring such as AC line power.
B. Keep secondary wires to spark plugs and other high voltage wiring at least eight inches (200mm) away from thermocouples and extension wiring.

4.3 OUTPUT SWITCH WIRING - A fault condition will cause one or both of the user programmable output switches to turn ON/OFF to their common. These switches are solid state, Form C (N/O and N/C) break-before-make contacts and are isolated from the power supply. The switches are rated 200 V., 200 mA and the N/O switch has a unique internal overload current protection circuit. If an overload occurs, the internal circuitry limits current to safe levels. When the overload is removed, the relay resumes its normal ON characteristics. These switches can be wired to an Altronic annunciator system or to pilot duty relays as shown in the wiring diagrams.

4.4 OUTPUT CURRENT LOOP WIRING - Model DSG-1301DUP has a 4-20 mA current loop available for the control of valves, actuators, and other devices commonly used in process control. The current loop output is accessible through terminals 7 and 8 and is internally limited to 20 mA. The output is protected against open and short circuits. A 250 ohm loop resistor can be used over the entire supply voltage range from 12 to 36 Vdc. The maximum load resistance that can be tolerated in the loop is determined by the supply voltage. When using the maximum rated loop resistor of 500 ohms with a desired full scale loop output of 20 mA, the supply voltage must be between 15 and 36 Vdc. At 12 Vdc supply voltage, the maximum load resistor for 20 mA loop output current is 350 ohms. Refer to the wiring diagrams for typical hook-up.

4.5 RS-485 COMMUNICATIONS WIRING - Model DSG-1301DUS has RS-485 serial communications available and can communicate to other instruments, PC's or PLC's via the two serial RS-485 communication wires. Use a two conductor shielded cable of fine gauge stranded wire and connect the wires to the terminals marked RS-485 "A" and "B". Connect to the other communication device "A" to "A"(−) and "B" to "B"(+). Connect the shield wire to the master device only.

4.6 HAZARDOUS AREA OPERATION - The DSG-1301DU/DUP/DUS device is CSA certified for CLASS I, DIVISION 2, GROUP D areas when mounted in a suitable enclosure. The device may be operated as CLASS I, DIVISION 1, GROUP D intrinsically safe, if the following conditions are met:

A. The gauge is powered from a CSA-certified zener barrier rated 30 volts max., 120 ohms min. A suitable barrier is a Stahl part no. 9001/01-280-165-10; follow the installation instructions supplied with the barrier.
B. The switch outputs, if used, are connected to the sensor inputs of an Altronic DA or DD annunciator system with the 690 series power supply.
C. DSG-1301DUP: The current loop output is connected to an intrinsically-safe transmitter mounted in a Division 1 area or through a CSA-certified zener barrier rated 30 volts max, 120 ohms min.
D. DSG-1301DUS: The RS-485 communications must be connected through a CSA-certified zener barrier rated 30 volts max., 120 ohms min. A suitable barrier is a Stahl part no. 9001/01-280-165-10; follow the installation instructions supplied with the barrier.

In addition, the following requirements must be met (see NFPA standard no. 493):

1. The intrinsically-safe gauge wires within the panel enclosure must be kept at least two (2) inches away from other wiring. Run thermocouple extension wires leaving the panel in a separate conduit from all other wiring and keep separate throughout the installation.
2. Wiring to the sensors must have a grade of insulation capable of withstanding an AC voltage of 500 volts RMS.
3. Sensor wires must be run in separate conduits and junction boxes from high voltage wires such as Ignition, fuel valve, and other high voltage wiring.

WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY AND/OR SUITABILITY FOR CLASS I, DIV. 2, GROUP D.

DO NOT DISCONNECT EQUIPMENT IN DIV. 2 ENVIRONMENT UNLESS POWER IS SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

5.0 NORMAL OPERATION

5.1 When the DSG-1301 gauge is in the "normal" mode, it displays the numeric temperature, the units °F or °C, and a bargraph of the temperature. If a setpoint value is exceeded, the output switch turns on and the display indicates "L" or "H" (low or high setpoint) and "1" or "2" (switch 1 or 2 has tripped). NOTE: The bargraph can be turned off.

5.2 If the thermocouple temperature is below the minimum range of the instrument (−76°F or −60°C), the display will read "tc.lo" to identify this condition. If the thermocouple temperature exceeds the maximum range of the instrument (1382°F or 750°C for Type J, 1472°F or 800°C for Type K) the display will read "tc.hi". When nothing is connected to the thermocouple input terminals, or if the thermocouple is open or becomes disconnected from the gauge, the display will also read "tc.hi". NOTE: An output switch configured as a high setpoint will also fault if a thermocouple is open.

6.0 KEYPAD DESCRIPTION

6.1 The DSG-1301 gauge contains a six-key front keypad which is used to view or change the setpoint values, configure the gauge, and to calibrate the gauge. The six front panel keys are MODE, ENTER, SETPTS, ESC, and ▲, ▼ (up and down arrow keys). Only one key should be pressed at a time.

6.2 MODE - The MODE key is used to enter setup mode and to scroll through the gauge setup menu.

6.3 ENTER - The ENTER key is used in the setup mode to proceed through the configuration and to accept the data. It is used in the setpoint mode to accept and save the new setpoint value. At the end of a configuration when a new setup has been entered, press ENTER and the display will read "SAVE", then "donE", and the new data or configuration will be stored in the nonvolatile memory.

6.4 SETPTS - The SETPTS (setpoints) key is used to view or change each setpoint value and configuration. When in the normal mode, press the SETPTS key; the value and configuration for setpoint no. 1 are displayed. Press the SETPTS key again; the value and configuration for setpoint no. 2 are displayed. Press SETPTS key one more time to return to the normal mode.

6.5 ESC - The ESC (escape) key can be used at any time during the setup or setpoint mode to return to the normal mode. When the ESC key is pressed in any configuration mode, any changed values are ignored (not stored in memory), the configuration returns to the previous values and the display returns to the normal reading.

6.6 ▲ ▼ - The up and down arrow keys are used to scroll through the selections in the setup mode and to increase or decrease values in the setup, setpoint, and calibration mode. These two keys when held will rapidly increase or decrease display values

7.0 DEFAULT FACTORY SETTINGS

7.1 The DSG-1301 series gauge contains two default settings that are available to the user anytime during the life of the gauge. Upon receipt, the gauge is set to one of these settings. These default settings will provide factory calibration for both Type J and K thermocouples.

7.2 SELECTING A DEFAULT SETTING - From the normal mode, press the MODE key until the display reads "tyPE" and press ENTER. Use the ▲ and ▼ keys to select either a Type J or K thermocouple and press ENTER. All of the configuration parameters as well as the calibration values will automatically be reset to the factory settings for that thermocouple type.

7.3 DEFAULT SETTINGS - Listed below are the factory default settings stored in permanent memory.

UNITS:	Degrees F (°F).
SETPOINT CONFIGURATION:	SETPOINT 1 - Low, with the setpoint value of 0°F. SETPOINT 2 - High, with the setpoint value of 1000°F.
BARGRAPH:	The bargraph is set for a single bar scaled proportionally between the setpoints described above.
OUTPUT CURRENT LOOP: (DSG-1301DUP)	The 4 mA point is set at 0°F. The 20 mA point is set at 1000°F.
COMMUNICATIONS NODE: (DSG-1301DUS)	01, Checksum disabled
SETPOINT HYSTERESIS:	The setpoint switch hysteresis is set at 10°F. Example: setpoint 2 will trip at 1000°F and clear at 990°F.
DISPLAY FILTER:	The filter control is set for 230 out of 255, which provides a moderate amount of dampening.

8.0 INITIAL OPERATION

8.1 Mount and wire the gauge as described above. Upon power-up all segments of the display will turn on for a display check. The display will then proceed to read the value for the thermocouple type set at the factory. To check the thermocouple configuration, press the MODE key until the display reads "tyPE", then press ENTER. The display will read "J-tc" or "k-tc". Press the ▲ or ▼ (up or down arrow keys) to view the thermocouple options. Press ENTER when the correct thermocouple type is displayed to load the default data for that type. This procedure also loads the factory default calibration parameters. No additional calibration should be required.

9.0 ADJUSTING SETPOINTS

9.1 There are two adjustable setpoints which can be set anywhere within the range of the gauge. To view or change the setpoint values, press the SETPTS key one time to view the first setpoint; press it again to view the second setpoint. The LCD indicators "1" or "2" and "L" or "H" will come on to indicate which setpoint switch and what type of setpoint is being displayed. To adjust the displayed value, press ▲ or ▼ (up/down arrow keys) to increase or decrease the value until the desired trip point for that switch is reached. Press ENTER to accept and save the new value. The new setpoint value will change only if the ENTER key is pressed; it will not be changed if either the SETPTS key or the ESC key is pressed.

NOTE: When in the setpoints mode, the previous setpoint values are monitored, and the new value is monitored only when the ENTER key is pressed. If no key is pressed for 15 seconds, the display will return to the normal mode and the configuration will revert back to the previous parameters.

10.0 GAUGE CONFIGURATION

10.1 The following are the headings for each configuration menu of the gauge. Press the MODE key to reach any of these configuration headings from the normal display mode. After a selection has been made and configuration performed, press the ENTER key; the display will read "SAVE/donE". It is at this time the new data is saved. The ESC (escape) key can be used at any time to abort the configuration mode and return to the normal reading. During configuration, the gauge allows 15 seconds for first level and 2 minutes for other levels between keystrokes to change or save a new configuration. If the time lapses without a keystroke, the gauge will automatically return to the normal mode without making any changes. The new information is saved only if the ENTER key is pressed and the gauge reads "SAVE/donE". A flowchart is provided that shows step-by-step progression through the gauge configuration procedure.

10.2 CALIBRATION - For calibration procedures, see Section 11.0 on calibration.

10.3 TYPE - The "type" configuration mode is used to select the transducer type. To view or change the thermocouple type, press the MODE key until the display reads "tyPE" and press ENTER. Use the ▲ or ▼ arrow keys to select a thermocouple type and press ENTER to accept and save the new thermocouple type. NOTE: Pressing ENTER while in the "type" mode will return all of the adjustable parameters of the device to factory default values. When just verifying the type, press ESC to exit without reloading default values.

10.4 UNITS - The available unit indicators are: °F and °C. The indicators appear on the right side of the display. When changing temperature units, the displayed temperature is automatically converted to the new unit value. To change the unit indicator, press the MODE key until the display reads "Unit"; the previously programmed unit indicator will appear. Use the ▲ or ▼ arrow keys to select one of the available indicators, and press ENTER to accept and save the change. The display will read "SAVE/donE" and return to the normal mode displaying the new unit indicator selected and the numeric value converted to the selected units.

10.5 SETPOINT CONFIGURATION - The setpoint configuration allows the user to select each output switch as either a Low or High setpoint. To change the setpoint configuration, press the MODE key until the display reads "SP.CF", press ENTER and the display will read "SP-1" or "SP≡1", "L" or "H", indicating the outputs are in the shelf state or fail-safe state when the gauge is powered; setpoint 1 is set to either a High or Low setpoint. The previous setup will appear. Use the MODE key to place the outputs in either shelf-state (outputs are in same condition when powered), or fail-safe (outputs are in opposite state when powered); switch 1 and 2 are configured the same. Use the ▲ or ▼ arrow keys to select either L or H. Press ENTER to accept the selected configuration for switch 1, the display will then read "SP-2", "L" or "H", repeat the same procedure and press ENTER to accept the configuration. The display will enter the bargraph configuration mode; follow the instructions for configuring the bargraph described below.

10.6 BARGRAPH - The bargraph appears across the bottom of the display and can be configured in four different modes. The selections are:

"On.SP I I I"	Single bar between the setpoints
"On IIIIII"	Bar mode between two points
"On I I I"	Single bar between two points
"OFF"	No bargraph displayed

To change the bargraph mode, press the MODE key until the display reads "bAr" and press ENTER. Use the ▲ or ▼ arrow keys to select a bargraph mode. A description of each mode follows:

"On.SP I I I" - On between the setpoints: press ENTER and the display will return to the normal mode with the bar set between the setpoints. If the setpoint values are changed, the two bargraph end-points will change accordingly. NOTE: If both setpoints are configured the same, either Low or High, the single bar between the setpoints is not available.

"On IIIIII" - Bar mode between two points: press ENTER and the display will read the Low bar value. Use the ▲ or ▼ arrow keys to adjust the low bar value. Press ENTER and the High bar value will be displayed; follow the same procedure to adjust this value. Press ENTER to return to the normal display mode with the new bargraph configuration.

"On I I I" - Single bar mode between two points: press ENTER and the display will show the Low bar value. Use the ▲ or ▼ arrow keys to adjust the low bar value. Press ENTER and the High bar value will be displayed, follow the same procedure to adjust this value. Press ENTER to return to the normal display mode with the new bargraph configuration.

"OFF" - No bargraph: press ENTER and the display will return to the normal mode and the bargraph will be off.

10.7 OUTPUT CURRENT LOOP (DSG-1301DUP ONLY) - The 4-20 mA current loop output allows the user to output a signal proportional to the temperature being measured and displayed. To configure the current loop, press the MODE key until the display reads "LOOP" and press ENTER. The display will read the value for the previously set 4 mA point, "L", and the unit indicator the gauge is configured for. Use the ▲ or ▼ arrow keys to adjust the numeric value for the 4 mA point. Press ENTER and the numeric value for the 20 mA point will be displayed along with "H" and the unit indicator. Again use the ▲ or ▼ arrow keys to adjust the desired 20 mA numeric value. Press ENTER to save the new 4-20 mA configuration and return to the normal reading. NOTE: The 4-20 mA current loop can be configured for reverse action; simply configure the "L" or low point with the 20 mA value and the "H" or high point with the 4 mA value.

10.8 RS-485 COMMUNICATIONS NODE NUMBER "nodE" (DSG-1301DUS ONLY) - For RS-485 serial communications each unit must be assigned a node or identification number so that a gauge or monitor can be identified by the device communicating with it. Any unique number from 01 to 99 may be used.

10.9 HYSTERESIS - Hysteresis sometimes is referred to as a deadband value. It is a numeric value that is added to a low setpoint value and subtracted from a high setpoint value before the switch returns to the normal condition (clears). The hysteresis is common to both setpoints. To set the hysteresis value, press the MODE key until the display reads "HySt" and press ENTER. The display will read the value for the previously set hysteresis. Use the ▲ or ▼ arrow keys to increase or decrease the hysteresis value and press ENTER to save the new value. The hysteresis value is displayed in the units that the gauge is configured for. The hysteresis value range is 0 to 1458°F (810°C) for Type J and 0 to 1548°F (860°C) for Type K. NOTE: If the hysteresis value is set for a number greater than the range of the gauge, the gauge will have to be powered-down to clear the switch. This can be used to determine if a high or low limit was ever reached (in effect, a latching output).

10.10 DISPLAY FILTER - The display filter can be used to stabilize the display reading of a changing input. Filtering is done in both hardware and software. The software filter is an adjustable filter; the rate of change is less for large values. The filter value is read-out in a number from 1 to 255; 1 being no filter value and 255 being maximum filter value. Below are some typical filter values and their effect on the display reading. Settling values are approximate times in seconds to reach 90% of new reading. To set the filter value press the MODE key until the display reads "FILt" and press ENTER. The display will read the previously set filter value. Use the ▲ or ▼ arrow keys to increase or decrease the filter value and press ENTER to save the new filter value.

FILTER VALUE	1	128	200	210	220	230	240	250	252	253	254	255
SETTLING, SEC.	.33	.33	.50	.65	.80	1.0	1.5	4.0	6.0	8.0	11.0	22.0

11.0 CALIBRATION

11.1 The instrument is calibrated at the factory and should not require additional calibration. However, calibration can be performed in the field many times over the life of the gauge. The calibration mode is used to calibrate the zero and span values of the gauge. Calibration can be performed from the front keypad without disassembling the gauge. A thermocouple calibrator or simulator is required to provide a calibration reference. NOTE: During calibration, the gauge allows 2 minutes between keystrokes to change or save a new calibration. If 2 minutes lapse without a keystroke, the gauge will automatically return to the normal mode with the previous values. The new calibration information is saved only if the ENTER key is pressed and the gauge reads "SAVE/donE".

11.2 CALIBRATION PROCEDURE - To calibrate the gauge, press the MODE key until the display reads "CAL" and press ENTER. The display will read "CAL.1" and "L" for the low or zero calibration value. Adjust the simulator for a very low reading (0°F) and press ENTER. Use the ▲ or ▼ arrow keys to increase or decrease the display reading to match the setting of the simulator and press ENTER. The display will now read "CAL.2" and "H" for the high or span calibration value. Adjust the simulator for a very high reading (1000°F) and press ENTER. Again use the ▲ or ▼ arrow keys to increase or decrease the display reading to match the simulator and press ENTER. The display will read "SAVE/donE" and will return to the normal reading with the new calibration values stored in permanent memory. NOTE: Be sure that the units of the calibrator match the units of the DSG instrument before performing a calibration.

11.3 The DSG-1301 series gauge has a feature that allows a slight adjustment of either the zero or span values individually. This type of calibration can be used to "tweak" the readout to match that of a known value without actually performing a formal calibration procedure. NOTE: This type of adjustment will invalidate calibration settings resulting from the procedures in section 11.2.

A. ZERO ADJUSTMENT ONLY - To make a small adjustment on the zero calibration value of the gauge, enter the calibration mode by pressing the MODE key until the display reads "CAL" and press ENTER; the display will read "CAL.1" and "L" for the low or zero calibration value. With the standard at or near zero, press ENTER and use the ▲ or ▼ arrow keys to increase or decrease the display reading to match the standard and press ENTER. The display will read "CAL.2"; press the MODE key and the display will read "SAVE/donE" and will return to the normal reading with the new zero calibration value stored in permanent memory.

B. SPAN ADJUSTMENT ONLY - To make a small adjustment on the span point of the gauge, enter the calibration mode by pressing the MODE key until the display reads "CAL" and press ENTER; the display will read "CAL.1". Press the MODE key and the display will read "CAL.2" and "H" for the high or span calibration value. With the standard at or near the desired span value press ENTER and use the ▲ or ▼ arrow keys to increase or decrease the display reading to match the standard and press ENTER. The display will read "SAVE/donE" and will return to the normal reading with the new span calibration value stored in permanent memory.

12.0 RS-485 COMMUNICATIONS

12.1 The DSG-1301DUS series gauge is part of a system that has been carefully designed to easily interface to popular computers, terminals, programmable controllers and future Altronic instruments. The data and status as well as the setpoint values can be read remotely. The setpoints can also be adjusted remotely.

12.2 MASTER/SLAVE OPERATION - The RS-485 communication system in the DSG gauge is designed as a master/slave system; that is, each unit responds to its own unique address (node number) only after it is interrogated by the master (computer). One master and up to 32 slaves can communicate in the system. The units communicate with the master via a polling system. The master sends a command and only the polled slave responds. The slave modules can never initiate a communications sequence. A simple command/ response protocol must be strictly observed.

12.3 NODE NUMBER - The node number is used in the system to identify the desired slave unit being polled. The node number can be any numeric value from 01 to 99 although only 32 devices can be served on a single communications port. This number range (01 to 99) is allowed so that if device grouping by function or application is desired it can be implemented using the first digit as the group or engine number and the second as the unit number. For example, 53 could be used to identify the number 3 slave unit mounted on engine number 5.

12.4 ASCII COMMUNICATION - All communication to and from the monitors is performed using ASCII characters. This allows the information to be processed with the "string" functions common to high level computer languages such as BASIC and C. For computers that support standard serial port interfaces, no special machine language software drivers are required. The use of the ASCII format also allows for the connection of these devices to an auto answer modem for long distance operation without the need for a local supervisory computer. The ASCII characters also make system debugging easy using standard terminal emulation software.

12.5 HALF DUPLEX OPERATION - The RS-485 system employed uses two wires for communication and cannot send and receive data at the same time over the same two wires making it a half duplex system. When the master is in the transmit mode, the slave is in the receive mode and visa-versa.

12.6 ELECTRICAL OPERATING RANGE - RS-485 is a communications standard to satisfy the need for multi-dropped systems that can operate at high speeds over long distances. RS-485 uses a balanced differential pair of wires switching from 0 to 5 volts to communicate data. RS-485 drivers can handle common mode voltages from −7 to +12 volts without loss of data, making them an excellent choice for industrial environments.

12.7 COMMUNICATIONS PARAMETERS - The following must be set by the master to communicate with the slaves:

Baud Rate: 9600
Data Bits: 8
Stop Bits: 1
Parity: None

12.8 COMMUNICATIONS WIRING - The RS-485 wiring diagram illustrates the wiring required for multiple slave unit hookup. Note that every slave unit has a direct connection to the master. This allows any one slave unit to be removed from service without affecting the operation of the other units. Every unit must be programmed with a unique address or node number, but the addition of new units or nodes can be in any order. To minimize unwanted reflections on the transmission line, the bus should be arranged as a trunk line going from one module to the next. Random structures of the transmission line should be avoided. Special care must be taken with long busses (500 feet or more) to ensure error free operation. Long busses must be terminated with a 120 ohm resistor between the terminals marked RS-485 "A" and RS-485 "B" at the master only. The use of twisted pair shielded cable will enhance signal fidelity and is recommended. To prevent ground loops the shield should be connected to the shield terminal at the master only.

12.9 RX, TX INDICATORS - An RX and TX (receive and transmit) LED is visible on the back of the DSG-1301DUS unit to indicate when the unit is either receiving or transmitting data.

12.10 CONNECTING TO A PC - When connecting the DSG-1301DUS gauge to the RS-232 port on a PC, an RS-232 to RS-485 converter must be used for the communication interface. See wiring diagram for details.

12.11 LOADING - RS-485 uses a balanced differential pair of wires switching from 0 to 5 volts to communicate data. In situations where many units (32 max.) are connected together on a long run, voltage drop on the communications leads becomes a major problem. Voltage drops on the RS-485 minus lead appear as a common mode voltage to the receivers. While the receivers are rated to a maximum voltage difference of +/– 7 volts, –7V to +12V, a practical system should not have a voltage difference exceeding +/– 3 volts under normal conditions. The wire gauge used for the connections therefore limits the maximum number of units or the maximum length of wire between units in each application. The following formula can be used as a guideline to select the appropriate wire gauge.

For 18 AWG wire No. of DSG units = (4000) / (ft of wire used)
For 20 AWG wire No. of DSG units = (3600) / (ft of wire used)
For 22 AWG wire No. of DSG units = (2400) / (ft of wire used)

NOTE: The maximum number of units connected together in a system is 32.

12.12 COMMAND STRUCTURE - The DSG gauges operate with a simple command/response protocol to control all functions. A command must be transmitted to the unit by the master (computer or PLC) before the slave can respond with useful data. A slave unit can never initiate a communications sequence. A variety of commands exist to fully exploit the functionality of the individual units.

Communication of functions to the DSG is performed with two character ASCII command codes. The general format used for the commands is illustrated below using the READ DATA command as an example. The hexadecimal values for the characters are shown only as a reference for those using low level (assembly language) decoding and will not appear on the communications terminal screen. All of the characters used in the communications protocol are standard ASCII characters and appear on the computer keyboard as shown with the exception of the "not acknowledge" (NAK) which is the industry standard "control U".

	header	**start**	**node**	**space**	**command**	**space**	**end**
ASCII	>	(	0 1		R D		)
HEX	3Eh	28h	30h 31h	20h	52h 44h	20h	29h

Command Header ">" (3Eh) - Each command must begin with the command header sometimes referred to as a prompt character. The ASCII character used is the ">" which means that a command message will be sent from the master to the slave.

Start of Text "(" (28h) - The command header must be followed by the start of text indicator.

Node Number 01 - 99 - The node number or address of the device being contacted is next. A two digit number from 01 to 99 can be used.

Space (20h) - Following the node number is an ASCII space character (not printable, value 20h) to act as a delimiter between the node number and the two character command word. For the balance of this document the space character will be shown normally without a specific description of each occurrence.

Command Word "RD" (52h, 44h) - The command words are standard two letter (upper case) commands sent by the master for gathering specific information about the status of a slave. The commands are listed under STANDARD COMMANDS below.

Space (20h) - Following the command word is another ASCII space character to act as a delimiter between the command word and the channel number.

End of Text ")" (29h) - The end of text indicator says this is the end of the command.

STANDARD COMMANDS - The standard commands available are:

RD for **R**ead **D**ata	>(01 RD)	Read the value for the unit at node 01.
RS for **R**ead **S**etpoint 01 value	>(02 RS 01)	Read setpoint 01 for the unit at node 02.
RS for **R**ead **S**etpoint 02 value	>(15 RS 02)	Read setpoint 02 for the unit at node 15.
SP for **S**et**P**oint 01 adjustment	>(02 SP 01 sxxxx.)	Send new value for setpoint 01 for unit at node 02.
SP for **S**et**P**oint 02 adjustment	>(15 SP 02 sxxxx.)	Send new value for setpoint 02 for unit at node 15.

NOTES: For the SP 01 and SP 02 setpoint adjustment commands, the variable data is of the form: sign (+/–) followed by the four most significant digits and a decimal point. It is recommended that the gauge always be read immediately prior to adjusting setpoints via the RS-485 link. Digits to the left of the most significant non-zero number must be filled with zero's for place holders (Ex: +0325.). A plus sign must be used for a setpoint value of zero (Ex: +0000.).

STANDARD RESPONSES - The standard responses to the commands above are:

<(01 1301 sxxxx. DegF OK OK)	Node 01, unit type 1301, x value, DegF units, setpoint 01 status indicator, setpoint 02 status indicator.
<(02 sxxxx. DegF LS)	Setpoint 01 at node 02 has a setpoint value of x amount, DegF units and is set for a low setpoint.
<(15 sxxxx. DegF HS)	Setpoint 02 at node 15 has a setpoint value of x amount, DegF units and is set for a high setpoint.
<(02 SP 01)	Made setpoint 01 adjustment at node 02.
<(15 SP 02)	Made setpoint 02 adjustment at node 15.

SETPOINT STATUS INDICATORS FOR THE READ RESPONSE - Setpoint status indicators consist of two ASCII characters. The first is setpoint 01's indicator, the second is setpoint 02's indicator. The valid status indicators are:

OK	No faults detected
HI	Measured value is above its setpoint value
LO	Measured value is below its setpoint value

VALID RESPONSE - A command/response sequence is not complete until a valid response is received. When a slave unit receives a valid command, it interprets the command, performs the desired function and then communicates the response to the master within the specified time. The master may not initiate a new command until the response from a previous command is completed.

A valid response can occur in three ways:
1) a normal response indicated by a "< " header and "( )" beginning and end of text
2) an error response indicated by a "§" NAK (not acknowledged)
3) a communications time-out error

Each command has an associated delay time before a response can be made from the slave unit. If the response does not occur within the time specified for the commands as given, a communications time-out error occurs. This error is usually caused by an improper command header or possibly an improper or non-existent node sent by the master. The commands and their associated maximum response delay times are listed below.

RD, RS, CD, CE commands	20 msec. max.
SP command	100 msec. max.

An NAK error response will be sent by the DSG-1301DUS gauge when it has received a command with an error in the message. All commands must be of the format above. The header, start-and-end of text characters, a valid node number and spaces must be sent and correct to receive an NAK; if not, no response will be sent.

12.13 CHECKSUMS - Two additional commands are provided so that the user may enable or disable the communication checksum routines. When enabled, the messages include an error-checking checksum that is based upon an Exclusive-OR, Modulo 100 conversion sum of the characters in the message string between and including the start of text "(" character and the end of text ")" character. The checksum number is a decimal number that is appended to the message. The slave unit calculates the checksum of the message and compares the calculated value to the actual value it received from the master in the checksum field. If the two values are not equal, an error results and no response is sent.

CE for **C**hecksum **E**nabled	>(01 CE)	checksum enabled for node 01
CD for **C**hecksum **D**isabled	>(01 CD)	checksum disabled for node 01

To calculate the Exclusive-OR, Modulo 100 checksum, take the binary value of the 8 bit ASCII character "(" and XOR it with the next binary value of the ASCII character in the string. Take the result and XOR it with the next. Continue these calculations until the end of text ")" character and that is the checksum value. If the decimal number of any of the calculations are greater than 99, use Modulo 100 math. For example, for decimal 154, use 54.

The Exclusive-OR is a binary Boolean operator. The XOR truth table is as follows:

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

XOR EXAMPLE FOR "(" XORed WITH "0":

00101000
00110000
00011000 = 24 (DECIMAL)

An example of the calculation of the checksum is below:
Command: >(01 RD)

ASCII CHAR	BINARY EQUIV.	CHECKSUM (DECIMAL)
>	Not used	---
(	00101000	---
0	00110000	24
1	00110001	41
SPACE	00100000	9
R	01010010	91
D	01000100	31
SPACE	00100000	63
)	00101001	22

The checksum value will be sent at the end of the command, so the command will look like: >(01 RD)22.

FIGURES SECTION:

MOUNTING DIMENSIONS AND SPECIFICATIONS

CONFIGURATION WORKSHEET

FLOWCHART (DSG-1301DU/DUP)

FLOWCHART (DSG-1301DUS)

GENERAL ELECTRICAL CONNECTIONS (DSG-1301DU/DUP)

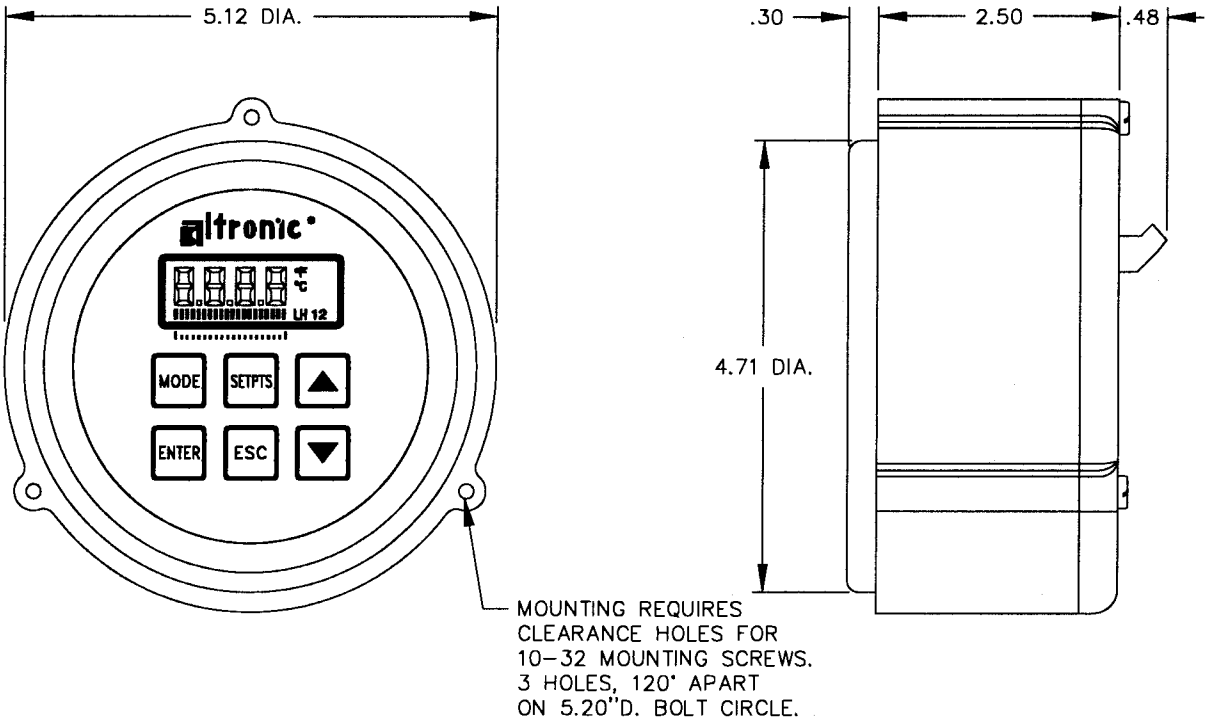
GENERAL ELECTRICAL CONNECTIONS (DSG-1301DUS)

WIRING DIAGRAM - ALTRONIC ANNUNCIATOR SYSTEMS

WIRING DIAGRAM - DC RELAY
WIRING DIAGRAM - CURRENT LOOP OUTPUT

WIRING DIAGRAM - RS-485 COMMUNICATIONS

MOUNTING DIMENSIONS AND SPECIFICATIONS



SPECIFICATIONS:

POWER REQUIRED: 12–36 VDC 50mA MAX.

THERMOCOUPLE TYPE: "J" (IRON–CONSTANTAN) OR "K" (CHROMEL–ALUMEL).

UNITS: PROGRAMMABLE °C OR °F.

DISPLAY: .4" 4 DIGIT LCD WITH DISPLAY INDICATORS AND 20 SEGMENT BARGRAPH.

DISPLAY RATE: 3 UPDATES PER SECOND NOMINAL.

RANGE: TYPE "J" THERMOCOUPLE – 60°C TO 750°C OR –76°F TO 1382°F.
TYPE "K" THERMOCOUPLE – 60°C TO 800°C OR –76°F TO 1472°F.

OUTPUT SWITCH: FORM C (N/O AND N/C) RATED 200 VDC 200mA CONTINUOUS.
OPTICALLY ISOLATED FROM POWER SUPPLY.

SWITCH RESPONSE TIME: TIED TO DISPLAY READING.

LOOP OUTPUT: 4–20mA CURRENT LOOP, 500Ω MAX. LOOP RESISTANCE.

AMBIENT TEMPERATURE RANGE: –40° TO 175°F (–40° TO +80°C)

INSTRUMENT ACCURACY: ±.5% OF SPAN OVER TEMPERATURE RANGE
EXCLUSIVE OF TRANSDUCER ERROR.

LOOP ACCURACY: ±.5% OF SPAN (DSG–1301DUP)

RS–485 COMMUNICATIONS: 9600 BAUD, HALF DUPLEX (DSG–1301DUS)

HAZARDOUS AREA CLASSIFICATION: CLASS I, GROUP D, DIV. 2
CLASS I, GROUP D, DIV. I WHEN POWERED
FROM A CSA CERTIFIED ZENER BARRIER
RATED 30 VOLTS MAX., 120Ω MIN.

DSG 1301 - CONFIGURATION WORKSHEET

SITE:_____

MODEL# DSG-1301DU__ **SERIAL#** _____

TYPE
__ "J" THERMOCOUPLE (iron-constantan)
__ "K" THERMOCOUPLE (chromel-alumel)

UNIT
__ °F
__ °C

SP.CF

Shelf Mode		Fail Safe Mode	
__ SP-1 L	__ SP-1 H	__ SP≡1 L	__ SP≡1 H
__ SP-2 L	__ SP-2 H	__ SP≡2 L	__ SP≡2 H

BAR
__ OFF __ ON.SP (between setpoints)

__ ON __ ON (between bar-L,bar-H)
bar-L _____ bar-H __

LOOP _____ L (4 ma) _____ H (20 ma) (in display units)

RS-485 COMMUNICATIONS NODE NUMBER: _____

HYST _____ (in degrees F or C, default = 10°F)

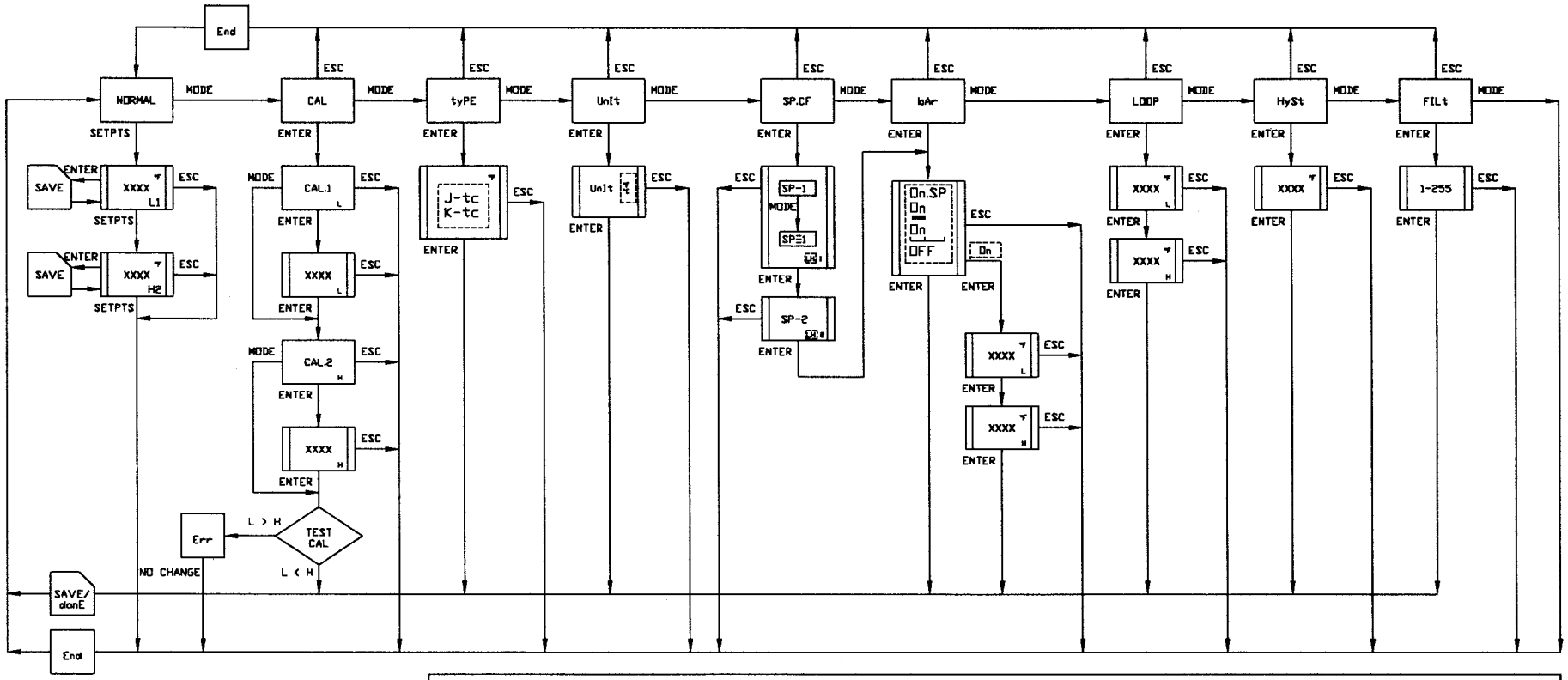
FILT _____ (1=min filtering, 255=max filtering, default = 230)

SETPOINTS

#1 _____ (in degrees F or C)

#2 _____ (in degrees F or C)

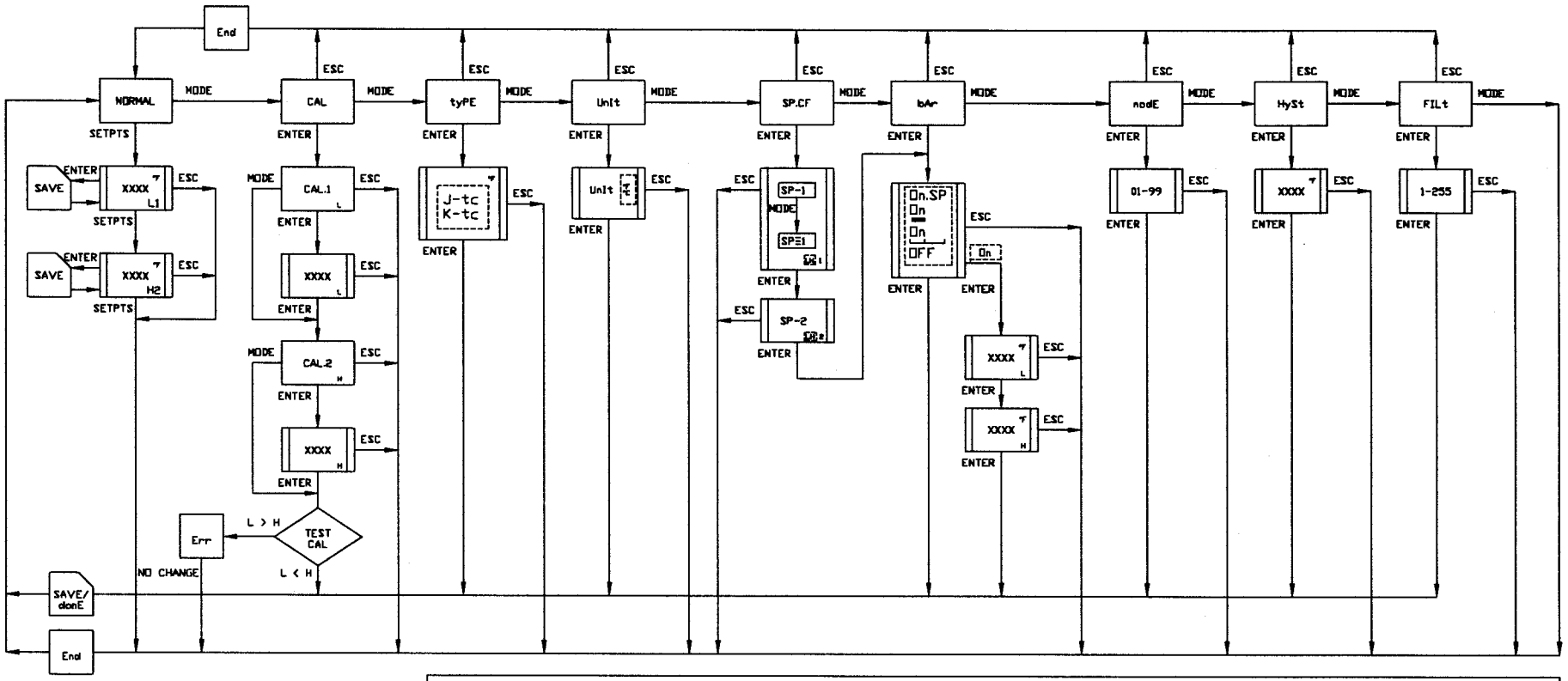
DSG-1301DU/DUP - FLOWCHART



DEFAULT SETTINGS	FOR DEFAULT SETTINGS, SELECT A THERMOCOUPLE TYPE	TYPE	UNITS	SETPOINT CONFIG.	BARGRAPH	CURRENT LOOP	HYSTERESIS	FILTER
		J K	°F	SETPNT 1 - LOW, 0°F SETPNT 2 - HIGH, 1000°F	SINGLE BAR BETWEEN SETPNTS	4 mA - 0°F 20 mA - 1000°F	10°F	230

FLOWCHART KEY		SETPOINT CONFIGURATION
XXXX H	△ DOUBLE BARS- USE UP AND ▽ DOWN ARROW KEYS TO SCROLL	DASHED LINES- MAKE SELECTION	SP-1 OUTPUTS - SHELF STATE SP≡1 OUTPUTS - FAIL SAFE

DSG-1301DUS - FLOWCHART



DEFAULT SETTINGS

FOR DEFAULT SETTINGS, SELECT A THERMOCOUPLE TYPE

TYPE	UNITS	SETPOINT CONFIG.	BARGRAPH	RS-485 NODE	HYSTERESIS	FILTER
J K	°F	SETPNT 1 - LOW, 0°F SETPNT 2 - HIGH, 1000°F	SINGLE BAR BETWEEN SETPNTS	01	10°F	230

FLOWCHART KEY

XXXX

△ DOUBLE BARS- USE UP AND ▽ DOWN ARROW KEYS TO SCROLL

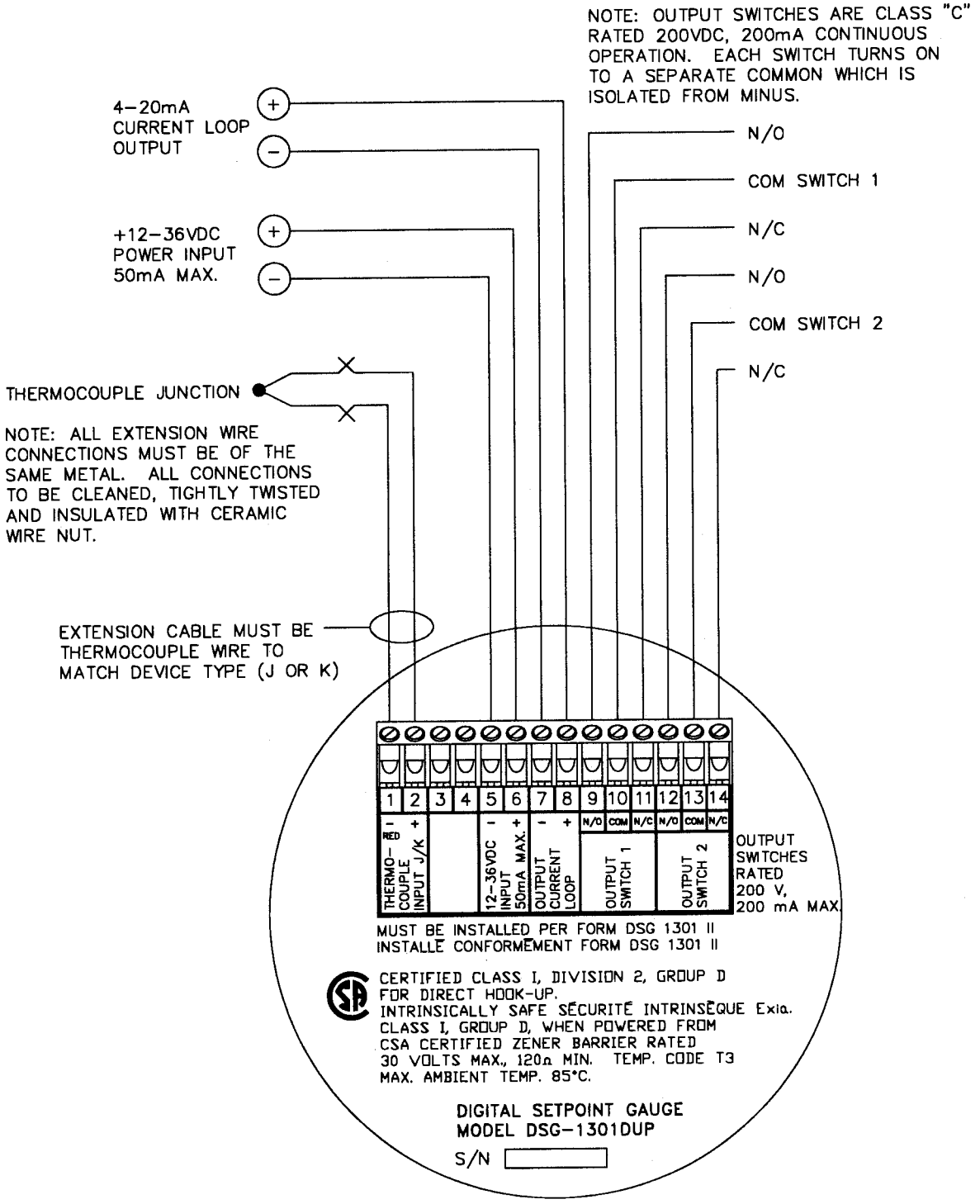
DASHED LINES- MAKE SELECTION

SETPOINT CONFIGURATION

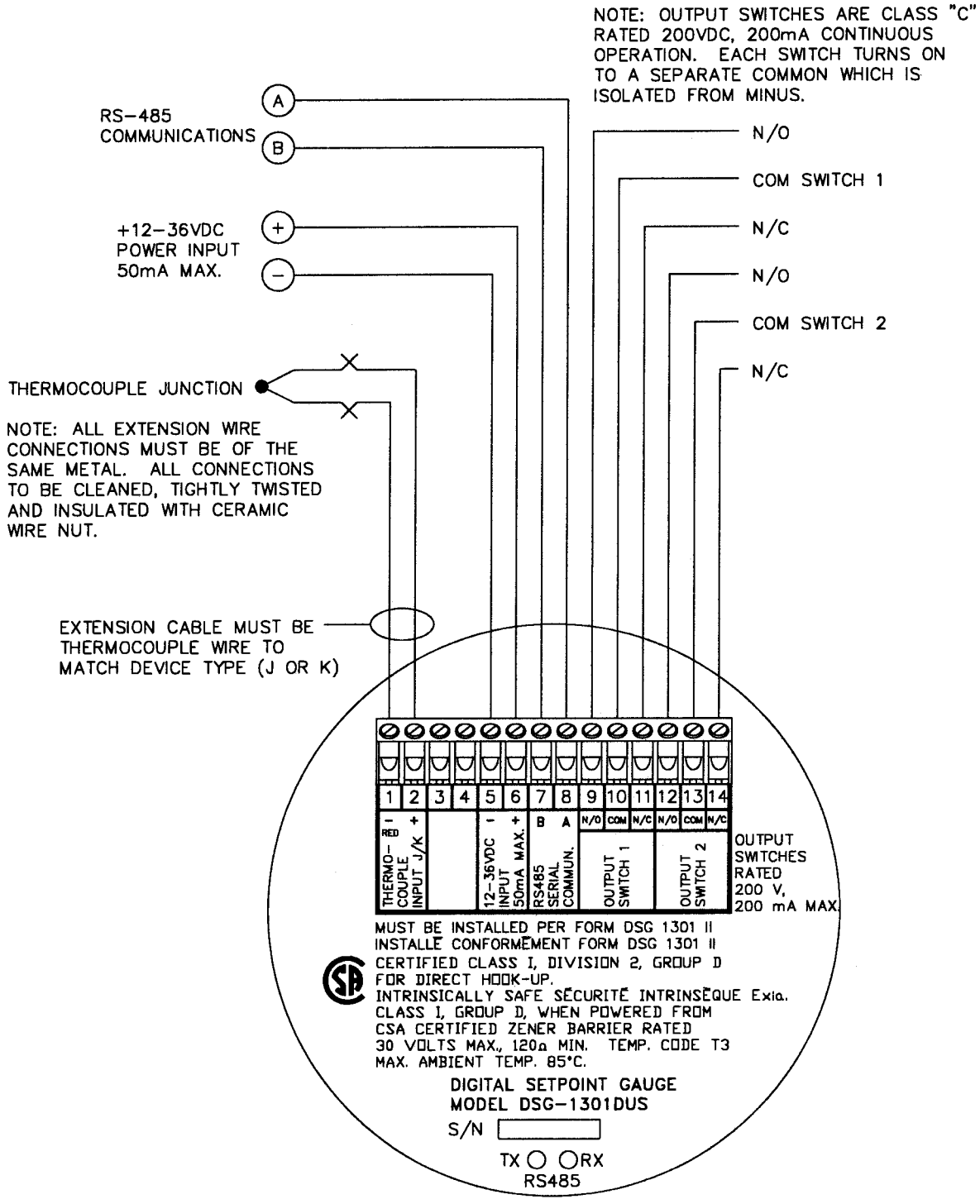
SP-1 OUTPUTS - SHELF STATE

SP=1 OUTPUTS - FAIL SAFE

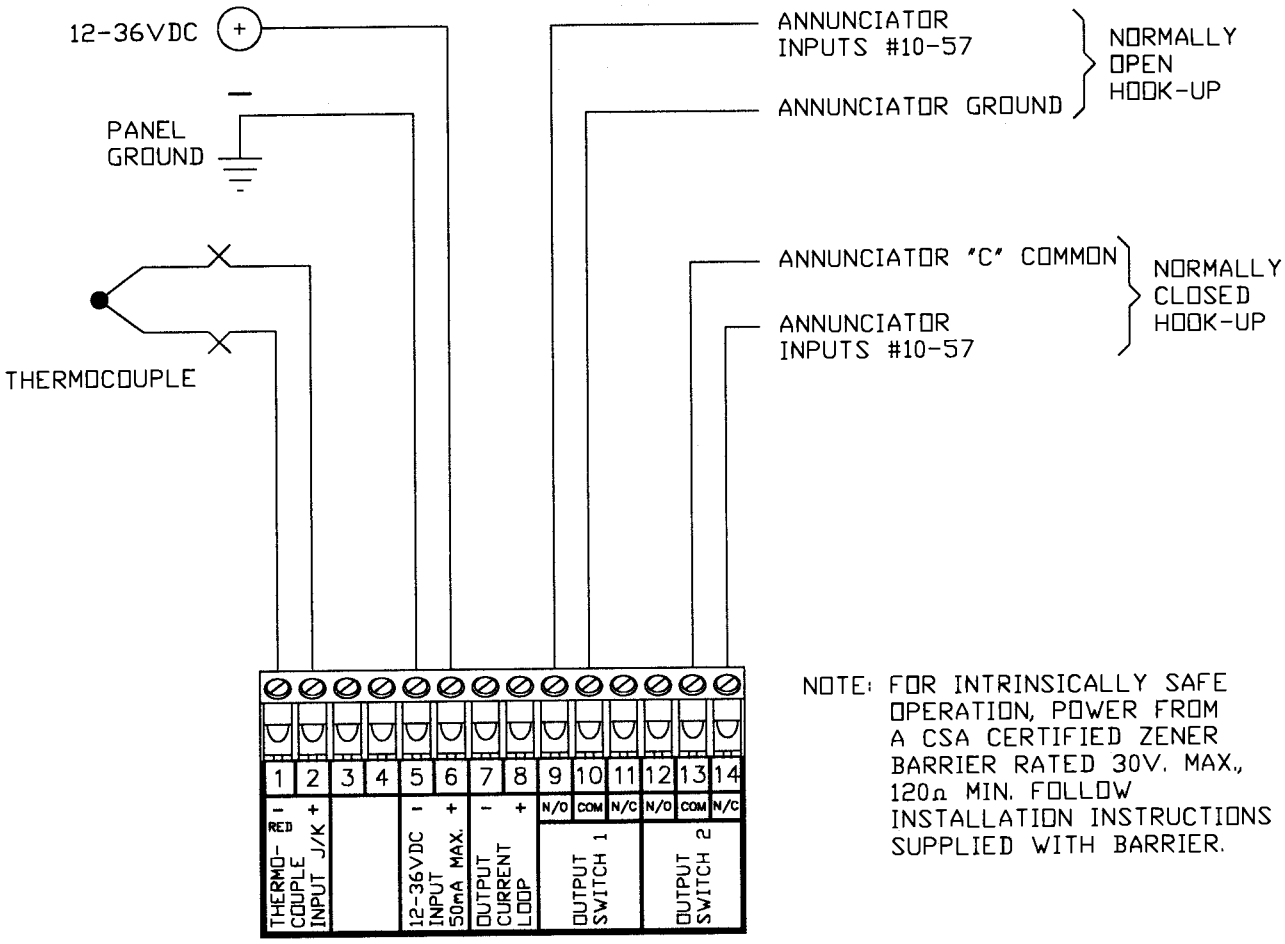
GENERAL ELECTRICAL CONNECTIONS
DSG-1301DU/DUP



GENERAL ELECTRICAL CONNECTIONS
DSG-1301DUS

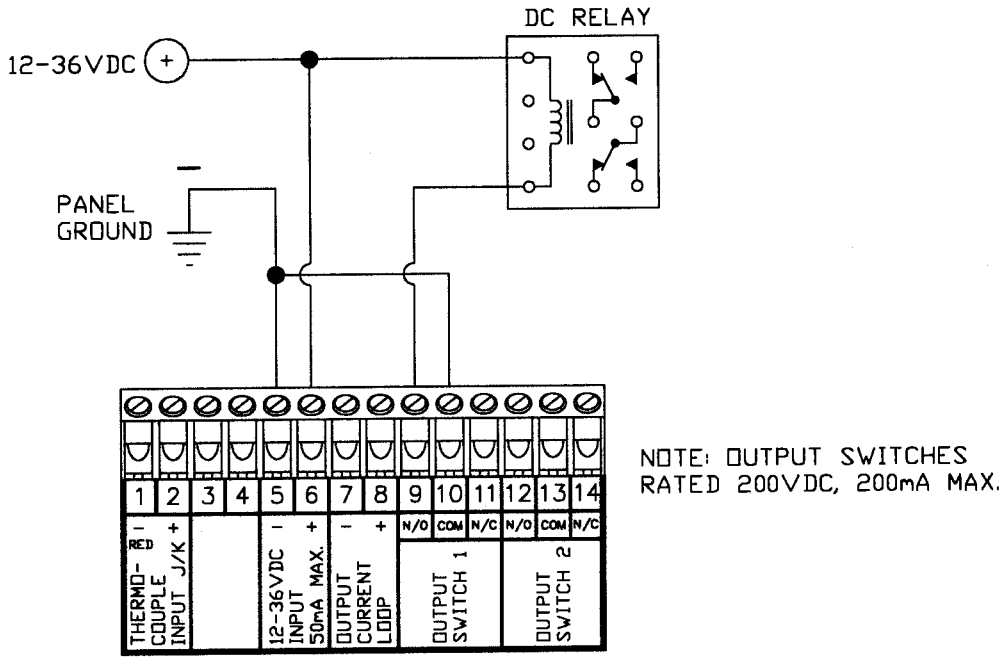


WIRING DIAGRAM
ALTRONIC ANNUNCIATOR SYSTEMS

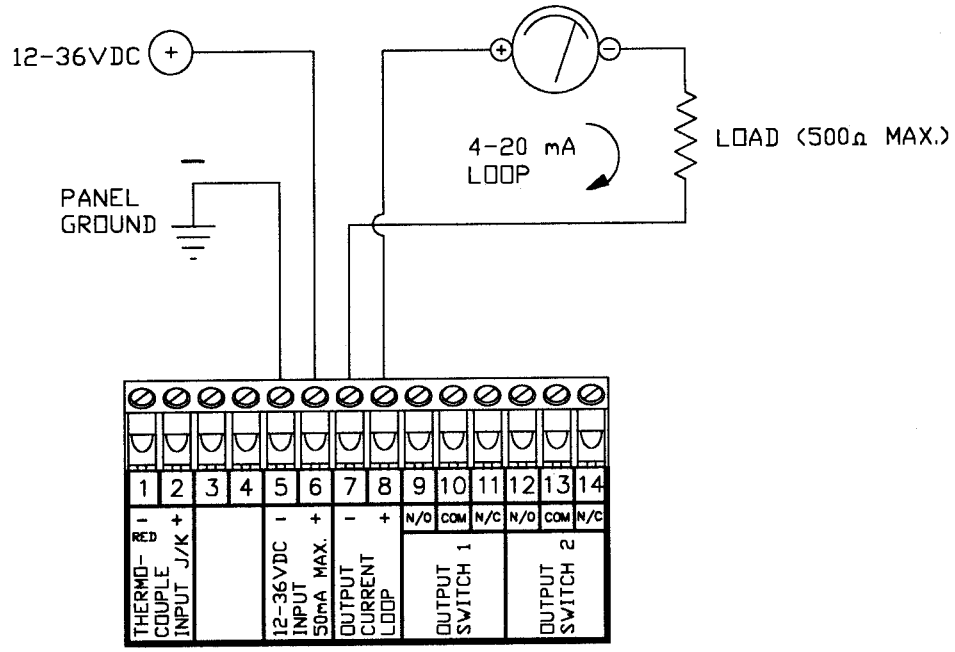


NOTE: FOR INTRINSICALLY SAFE OPERATION, POWER FROM A CSA CERTIFIED ZENER BARRIER RATED 30V. MAX., 120Ω MIN. FOLLOW INSTALLATION INSTRUCTIONS SUPPLIED WITH BARRIER.

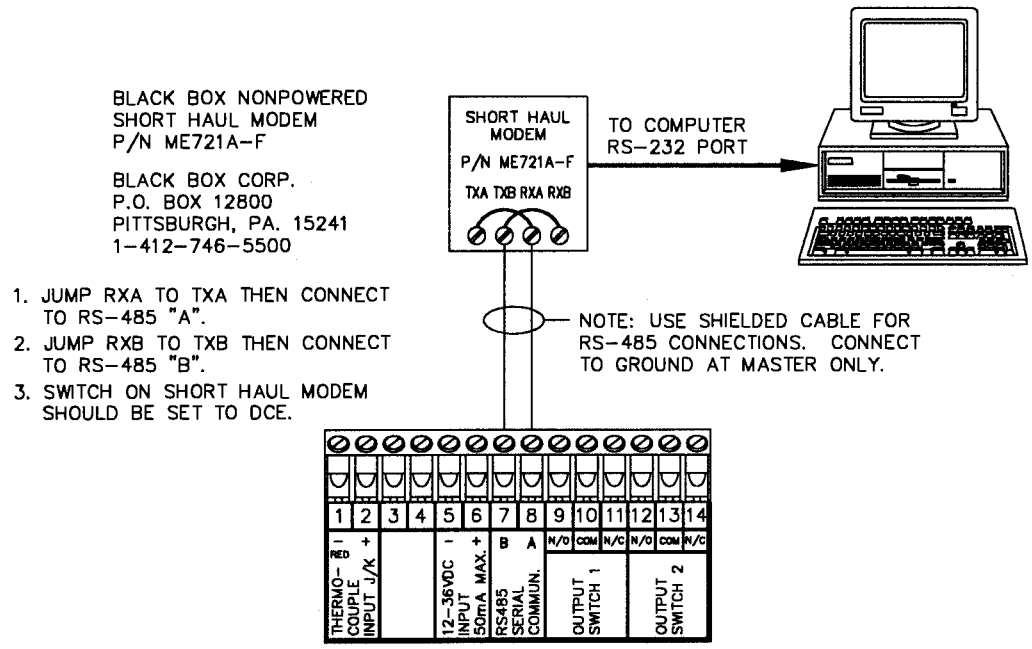
WIRING DIAGRAM – DC RELAY



WIRING DIAGRAM – CURRENT LOOP OUTPUT



RS-485 COMMUNICATIONS (PC HOOK-UP)



RS-485 COMMUNICATIONS (MULTIPLE SLAVE UNITS)