Effective: September, 1992 (replaces April, 1992) **EX-1737**

5352 Series Digital Tank Processors

Installation/Operations Manual for KING-GAGE Digital Tank Processors

KING ENGINEERING CORPORATION
Since 1937

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The information contained in this manual was accurate at the time of release. Specifications are subject to change without notice.

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Seller will not be liable for consequential damages resulting from breach of this agreement. The term "consequential damages" shall include but shall not be limited to damage to all machines, equipment and goods other than the goods sold hereby, interruption of production, loss of profits, delays of any kind, administrative expense and overhead.

Revisions:

October, 1991 – Original Release.
April, 1992 – Added 5352-11 and new board set.
September, 1992 – Revised circuit diagrams

Table of Contents:

Specifications 5352-1 Digital Tank Processor (DC Powered Version)

Power Requirements
5-6 Vdc; 0.25 Amp max. (5.0 Vdc min, 6.5 Vdc max.) fused @ 0.5 Amp

Temperature Range (Environmental)
30ºF to 120ºF / -1ºC to 49ºC operating

Signal Input
4-20 milliamperes (mAdc)

Current Limiting (Overload)
70 mAdc maximum; automatic trip/reset using PTC resistor (positive temperature coefficient) circuit

Input Impedance (Resistance)
120 ohm nominal (2.4 Vdc drop @ 20 mAdc)

Memory (Non-Volatile)
Factory programmed PROM

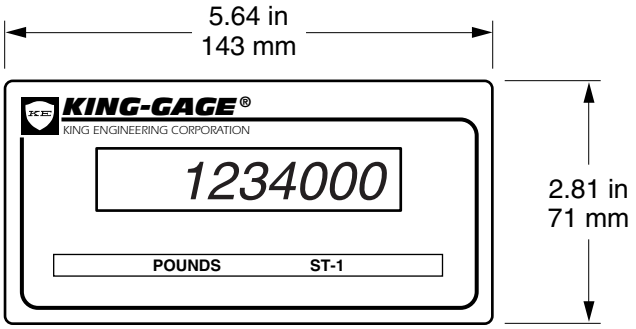
Digital Output
Serial ASCII communication via RS-232/RS-422 using K.E.C. Communications Module, 8050-2

Accuracy
± 0.048% FS (± 0.024% FS, typical)

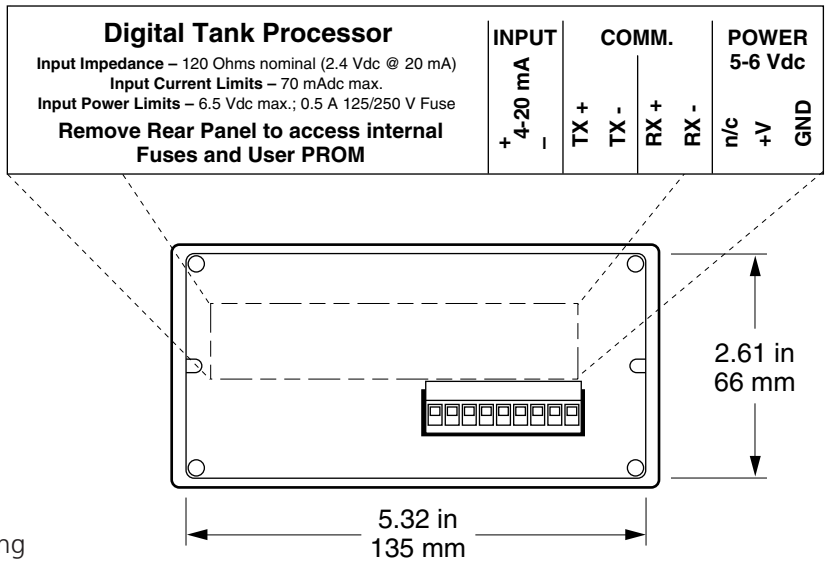
Resolution
± 0.024% FS maximum (± 0.004 mA)

Digital Readout
1/2 in. (12.7 mm) LCD; transflective type, with integral backlight, 7-digit (4 fully active), maximum 9999000 display value

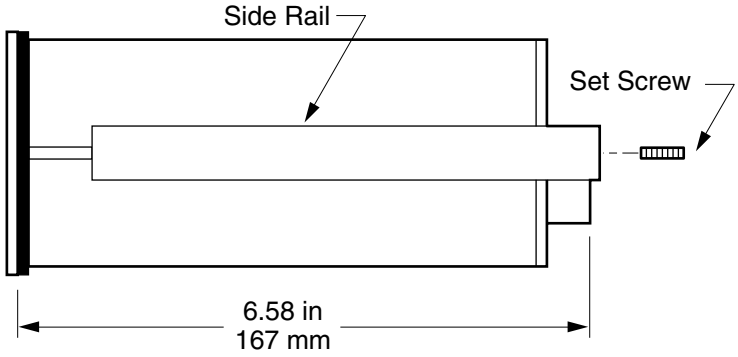
Mounting
Model No. 5352-1 flush mount housing assembly w/gasket sealed (water-resistant) front panel bezel. Intended to meet NEMA 4 for indoor/outdoor locations providing a degree of protection against windblown dust and rain, splashing water, and hose-directed water when properly installed.



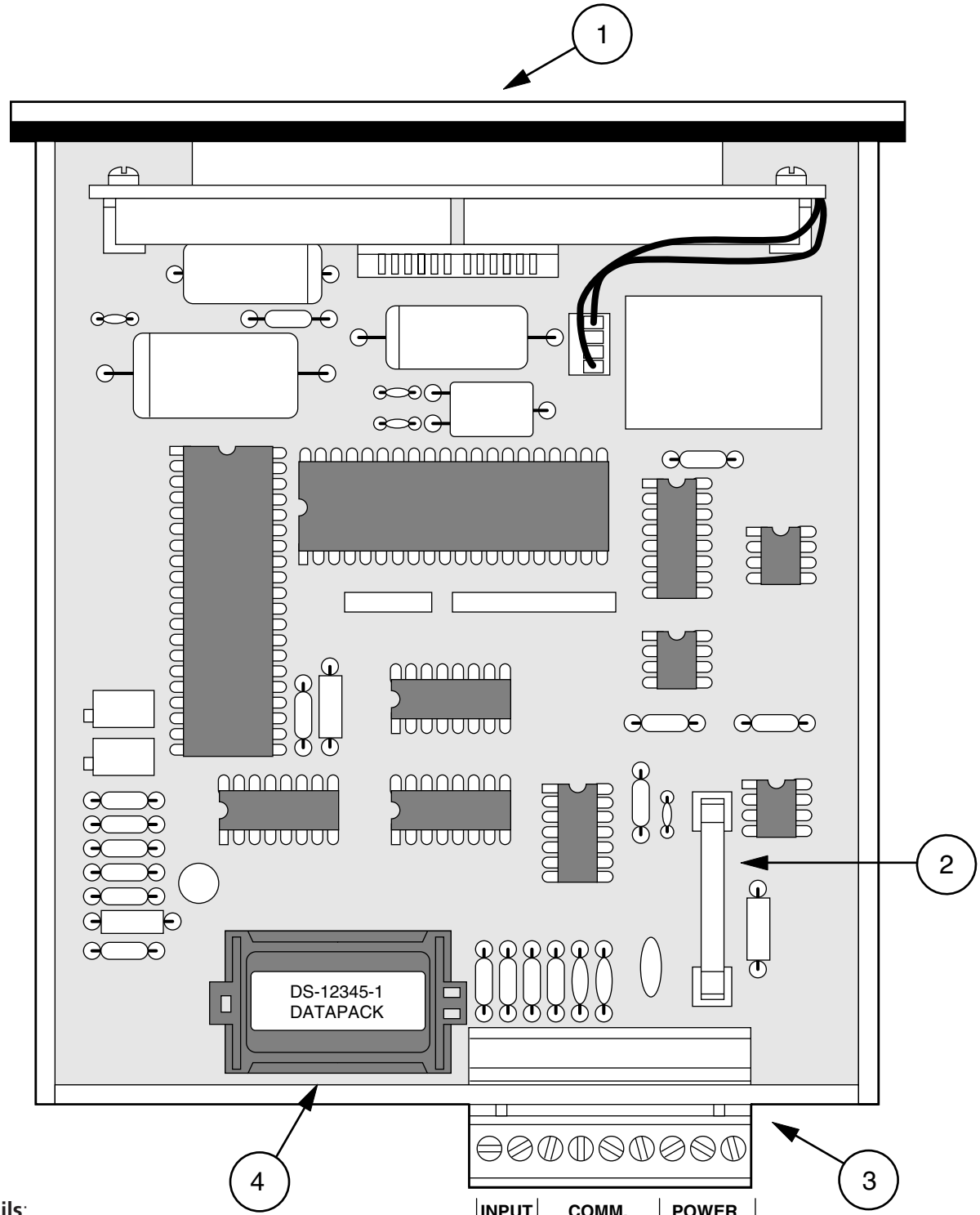
Front View



Rear View



Right Side View



User Details:

1. LCD Readout
2. 1/2 Amp Fuse–120/250 Volt Fast-Blo
   Order No. 7469-21-0 (5-pack)
3. User I/O Connections–Plug-in type terminal
   connections
4. Personality Datapack (PROM)

Specifications 5352-2 Digital Tank Processor (DC Powered Version)

Power Requirements
5-6 Vdc; 0.25 Amp max. (5.0 Vdc min, 6.5 Vdc max.) fused @ 0.5 Amp

Temperature Range (Environmental)
30ºF to 120ºF / -1ºC to 49ºC operating

Signal Input
4-20 milliamperes (mAdc)

Current Limiting (Overload)
70 mAdc maximum; automatic trip/reset using PTC resistor (positive temperature coefficient) circuit

Input Impedance (Resistance)
120 ohm nominal (2.4 Vdc drop @ 20 mAdc)

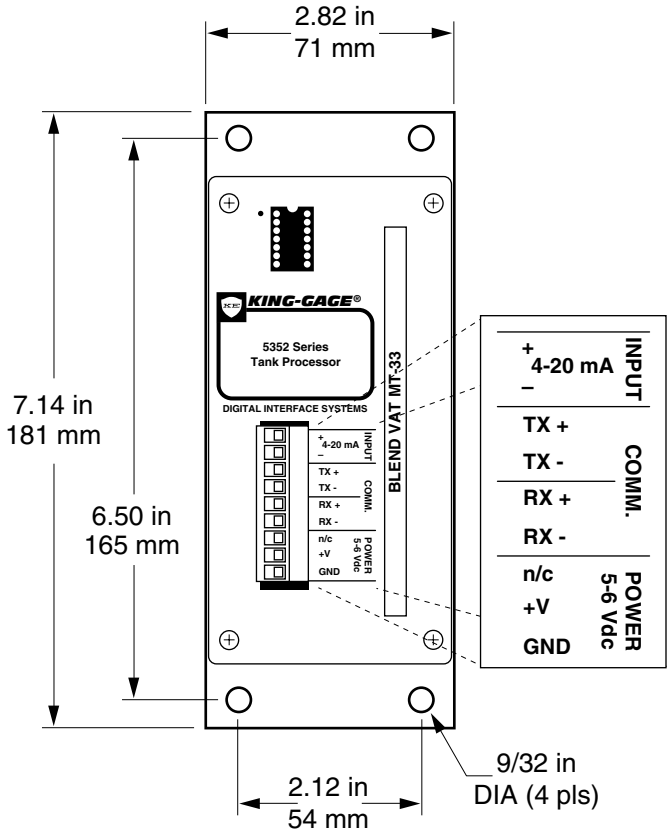
Memory (Non-Volatile)
Factory programmed PROM

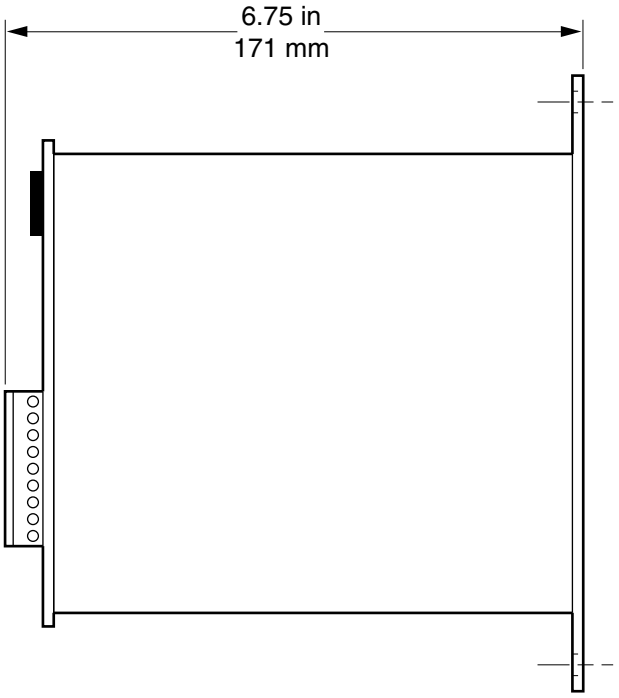
Digital Output
Serial ASCII communications via K.E.C. Communications Module 8050-2

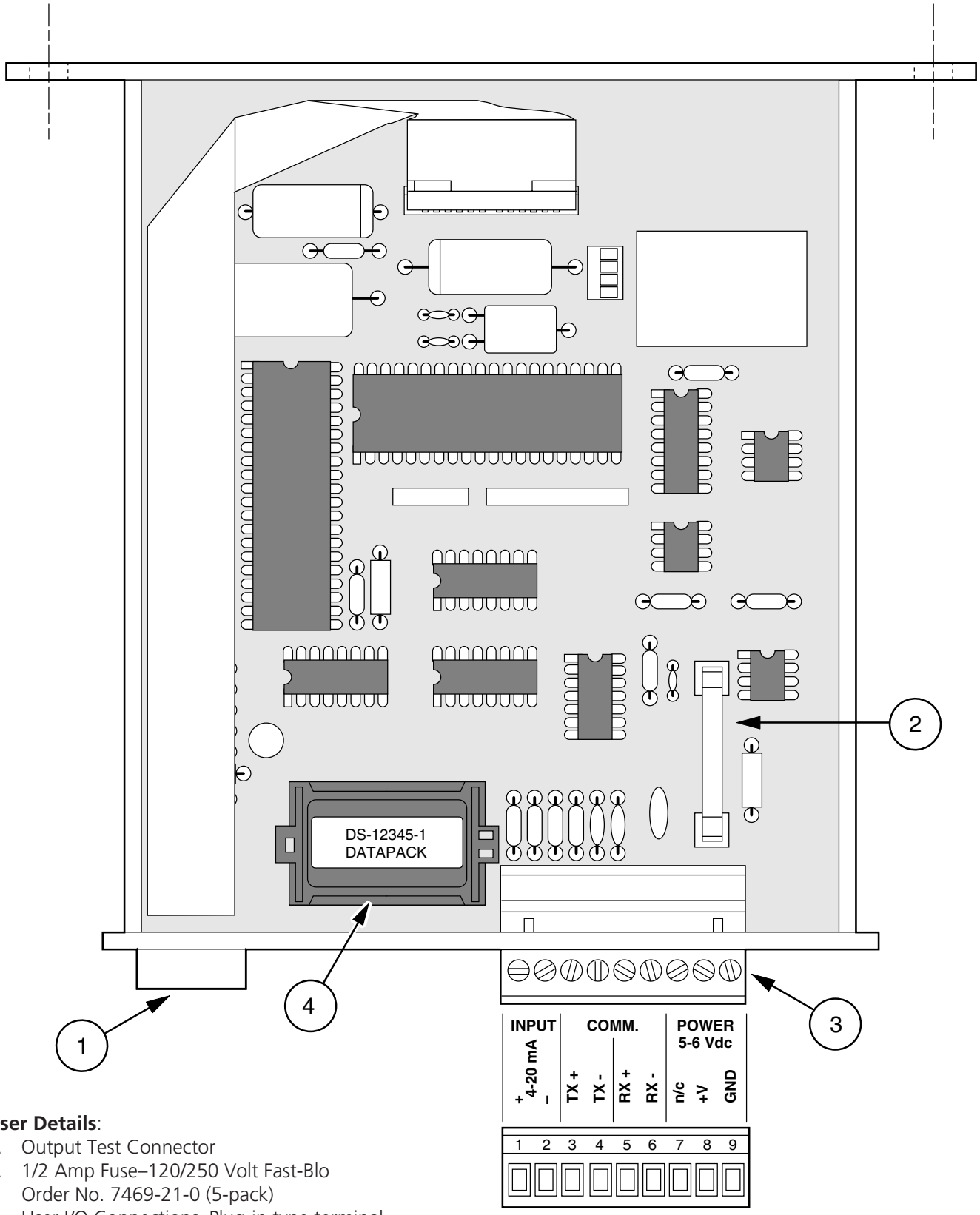
Accuracy
± 0.048% FS (± 0.024% FS, typical)

Resolution
± 0.024% FS maximum (± 0.004 mA)

Mounting
Model No. 5352-2 surface mount housing (not environmentally sealed). Intended to meet NEMA 1, 2 for indoor locations affording minimum protection against falling water and/or dirt.







User Details:

1. Output Test Connector
2. 1/2 Amp Fuse–120/250 Volt Fast-Blo
   Order No. 7469-21-0 (5-pack)
3. User I/O Connections–Plug-in type terminal
   connections
4. Personality Datapack (PROM)

Specifications 5352-11 Digital Tank Processor (AC Powered Version)

Power Requirements
115 Vac/60 Hz (unregulated); fused @ 0.5 Amp

Temperature Range (Environmental)
30ºF to 120ºF / -1ºC to 49ºC operating

Signal Input
4-20 milliamperes (mAdc)

Current Limiting (Overload)
70 mAdc maximum; automatic trip/reset using PTC resistor (positive temperature coefficient) circuit

Power Output
24 Vdc nominal; fused @ 0.5 Amp

Input Impedance (Resistance)
120 ohm nominal (2.4 Vdc drop @ 20 mAdc)

Memory (Non-Volatile)
Factory programmed PROM

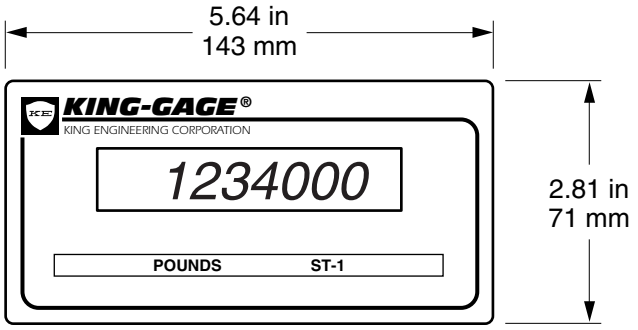
Digital Output
Serial ASCII communication via RS-232/RS-422 using K.E.C. Communications Module, 8050-2.

Accuracy
± 0.048% FS (± 0.024% FS, typical)

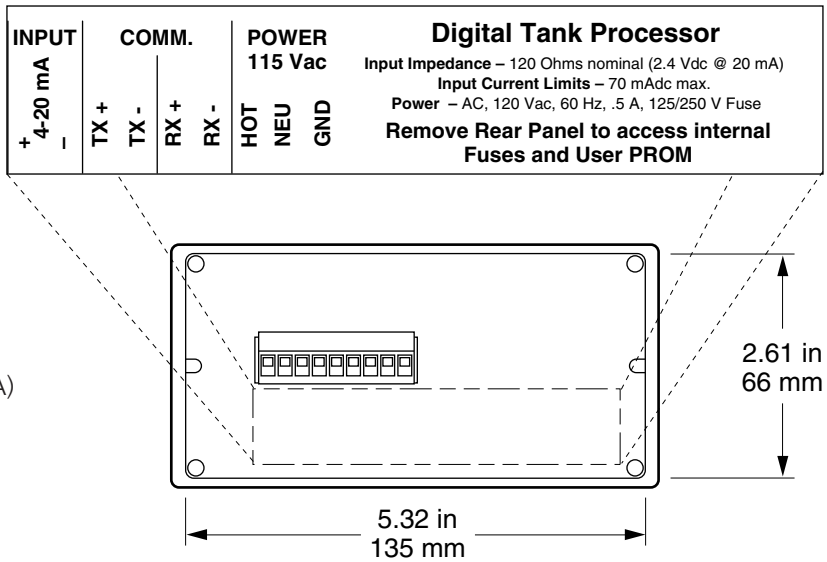
Resolution
± 0.024% FS maximum (± 0.004 mA)

Digital Readout
1/2 in. (12.7 mm) LCD; transflective type, with integral backlight, 7-digit (4 fully active), maximum 9999000 display value

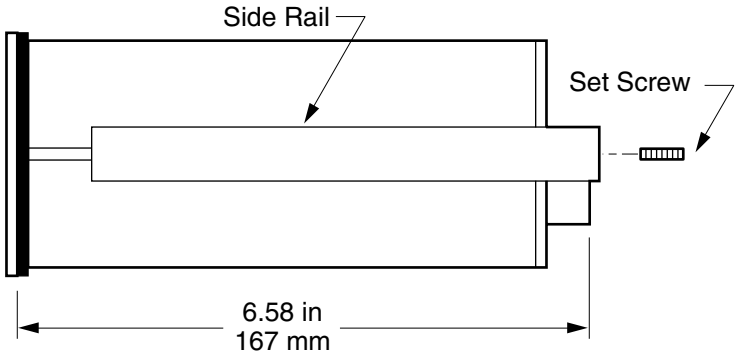
Mounting
Model No. 5352-11 flush mount housing assembly w/gasket sealed (water-resistant) front panel bezel. Intended to meet NEMA 4 for indoor/outdoor locations providing a degree of protection against windblown dust and rain, splashing water, and hose-directed water when properly installed.



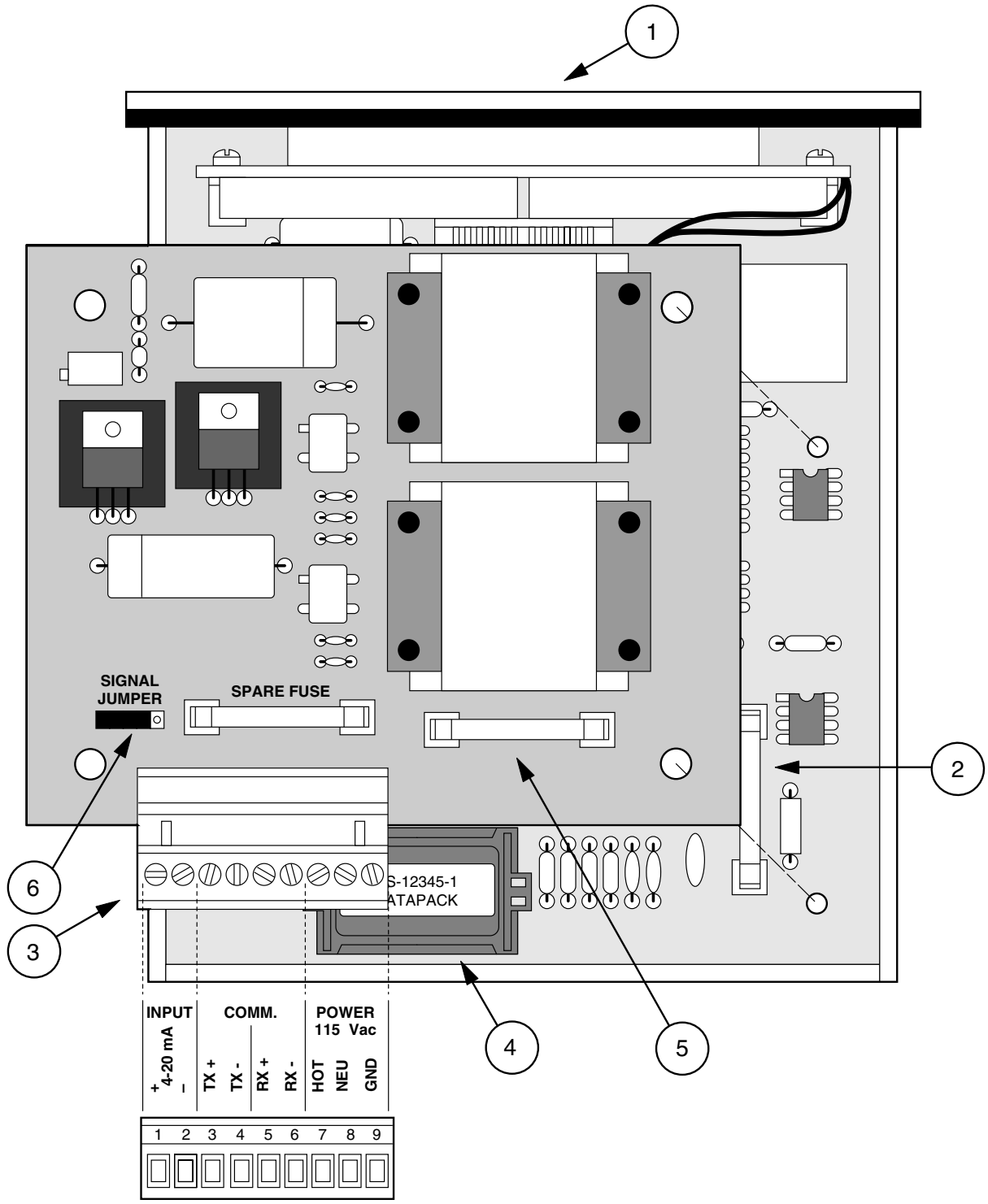
Front View



Rear View



Right Side View



User Details:

1. LCD Readout
2. 1/2 Amp Fuse–120/250 Volt Fast-Blo, Order No. 7469-21-0 (5-pack)
3. User I/O Connections–Plug-in type terminal connections
4. Personality Datapack (PROM)
5. 1/2 Amp Fuse–120/250 Volt Fast-Blo, Order No. 7469-21-1 (5-pack)
6. Signal Jumper

Principle of Operation

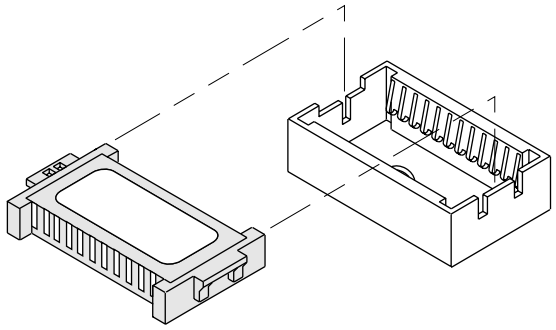
The KING-GAGE Digital Tank Processor works as an intelligent signal conditioner and data processor. It accepts the 4-20 mAdc two-wire output signal from a pressure-based level sensor which is directly proportional to liquid depth. Initially, the input current signal is digitized for analysis by the internal microprocessor. Utilizing a tank capacity listing (pressure vs capacity) preprogrammed into a PROM memory chip, the microprocessor correlates signal levels to actual volume of liquid in the tank.

Pressure-based level sensing actually measures product mass (pressure = weight = mass). The density of material is of critical import when calculating level and utimately, its corresponding volume of liquid occupying the tank. The King-Gage Tank Processor factors in the liquid density (specific gravity) either as a downloaded variable from the host or, in its absence, as a preprogrammed default stored in the PROM.

Conversion factors are used to translate the final volume data into the desired engineering unit desired for output (i.e., pounds, gallons, liters, % full). This output is realized as a ASCII character string transmitted via RS-232/RS-422 serial interface to host.

Tank Capacity Data

All specific application data is preprogrammed into a non-volatile PROM memory chip. The PROM and its internal data file is referred to as the PERSONALITY DATAPACK. Information must be provided when ordering so that a tank capacity listing can be calculated and programmed into the Personality Datapack (PROM).



Personality Datapack (PROM)

- Tank Capacity Listing
- Engineering Units Selection (lbs, gal, etc.)
- ASCII # Address Code
- Transmission Speed Selection
- Density Value (default)

(Figure 1-1)

The data required includes dimensional information describing tank shape/size (or an accurate strapping table), specific gravity of the liquid and what type of readout unit (weight, volume or depth) to be used. Unless this information is made available, the Personality Datapack cannot be made. Without this specific application programming, the 5352 Series Tank Processor cannot calculate the actual amount of product present within the tank. (Figure 1-1).

Tank Processor Address Code

Each of the individual Tank Processors in the system are constantly monitoring the communications loop. However, a Tank Processor will only respond when its unique polling location number (two-digit ASCII address code) is received. This address code is programmed into the Personality Datapack (PROM) used by the processor.

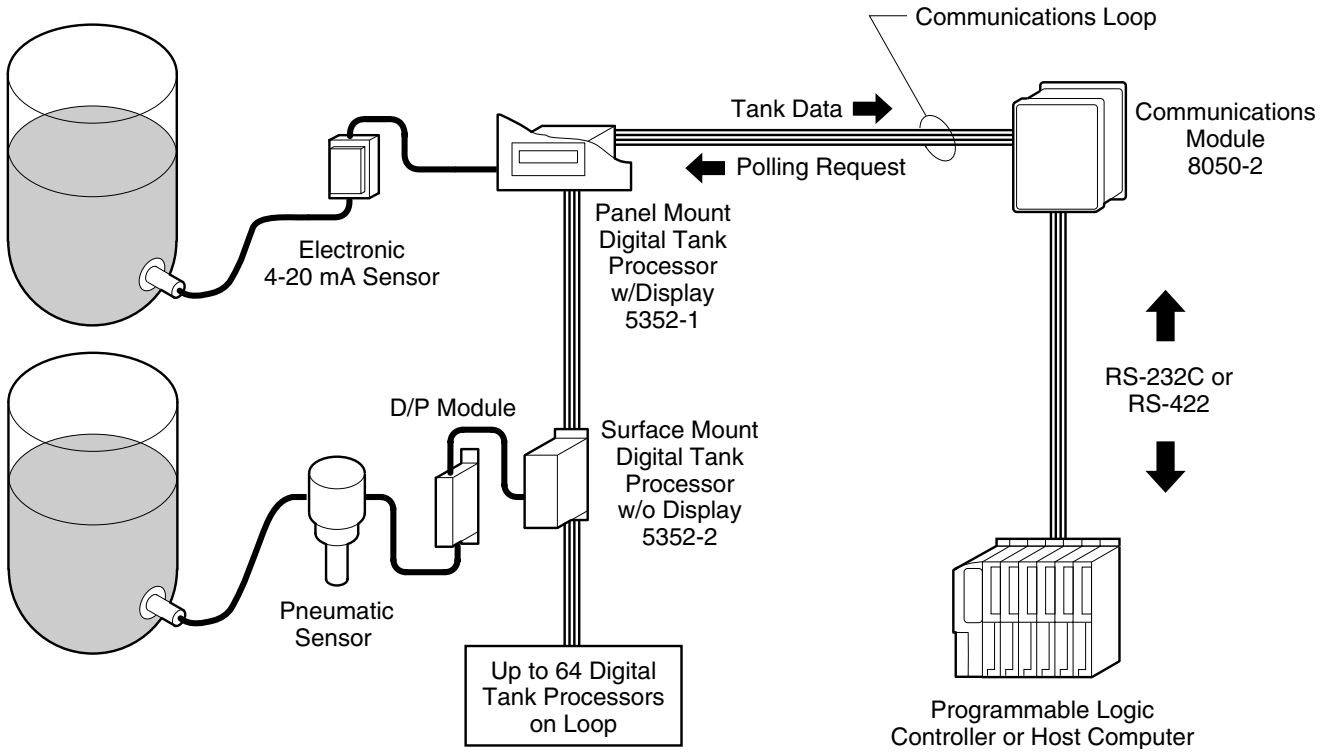
Default Density Value

5352 Series Digital Tank Processors will accept downloading of product density values (i.e., specific gravity). These values are used in the calculation from pressure to volume or mass (weight). However, if the host device will not be providing density values, a default programmed into the Personality Datapack (PROM) is used. This default value is also employed should loss of RAM occur due to power interruption or failure. The default value is factory programmed and selected upon the range of product density(s) expected to be encountered in the gauging application.

Communication Transmission Speed

The Digital Interface System supports two (2) transmission speeds: 1200 baud or 9600 baud. Whichever speed setting is chosen must be programmed into the Personality Datapack (PROM) of the Digital Tank Processor. Transmissions at higher or lower speeds will not be acknowledged by the Tank Processors.

NOTE: Transmission speed from host must match settings (1200 or 9600) programmed into each Tank Processor datapack.



(Figure 1-2) - Digital Pulse Communications Loop

Digital Pulse Communications Loop

The 5352 Series Digital Tank Processors communicate over a 4-conductor digital pulsed serial/parallel current loop to the 8050-2 Communications Module. The serial side of the communications loop is tied to the Vdc output from the Communications Module used to drive a continuous current. Downloaded values from the host device are transmitted from the Communications Module through the serial loop. Individual tank processors respond by using a digital pulsed current over the parallel side of the communications loop. (Figure 1-2).

Communications Module Model 8050-2

The Digital Interface System employs the 8050-2 Communications Module as a pulsed-current-to-voltage converter. Its basic function is to permit direct communications to the individual Tank Processors using a standard RS-422 (or RS-232) serial interface from a host device.

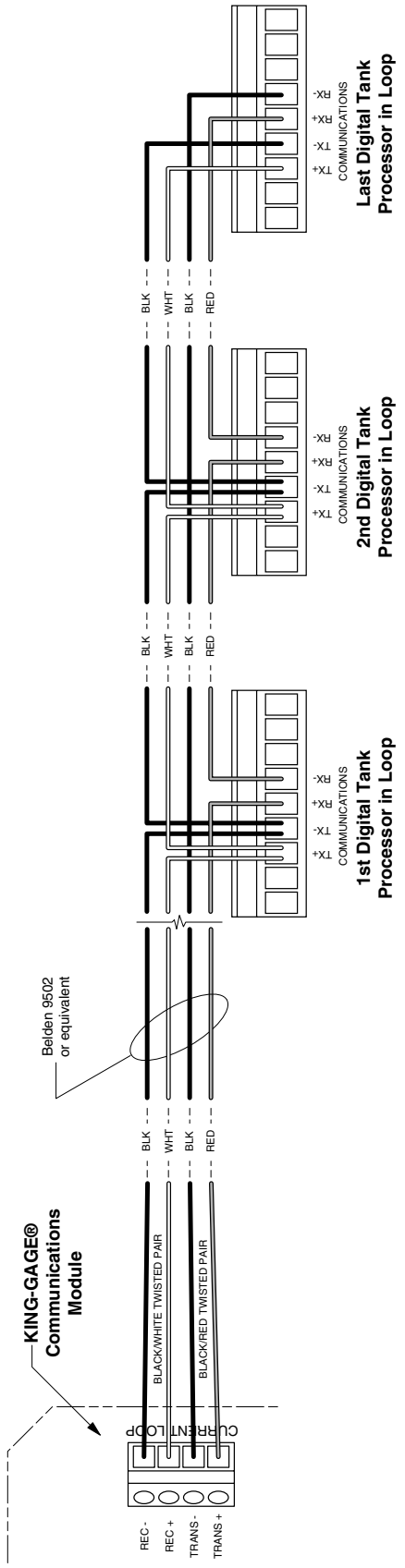
Tank Processor Communications Connections

It is critical that each Tank Processor be correctly connected into the communications loop. Reversing connections at even one location may result in total communications failure of the entire system. Please note, however, that it is possible to remove (or bypass) an individual Tank Processor if desired. (Figure 1-3).

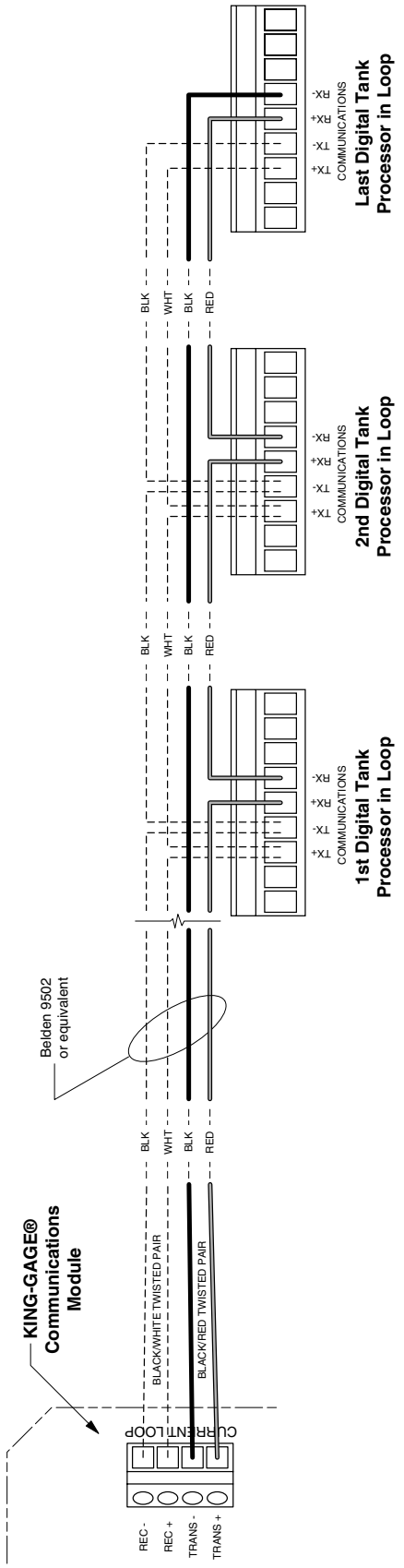
Serial Loop

+Vdc is transmitted from the TRANS+ terminal of the Communications Module to the RX+ terminal of the tank processor. This voltage is connected in series through each tank processor, exiting from the RX- terminal of one to the RX+ terminal of the next.

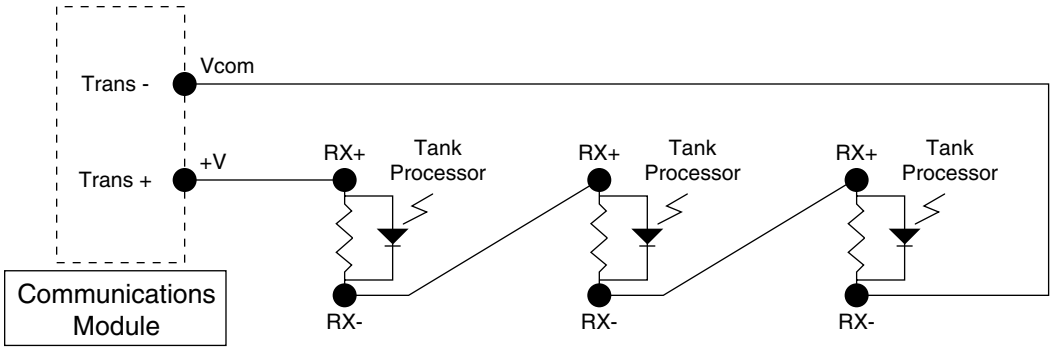
The tank processor incorporates optically coupled isolators across the input voltage (+V) at the RX+/RX- terminals. In this manner, the tank processor electronics are not directly connected to the power output from the Communications Module. (Figure 1-4 & 1-5).



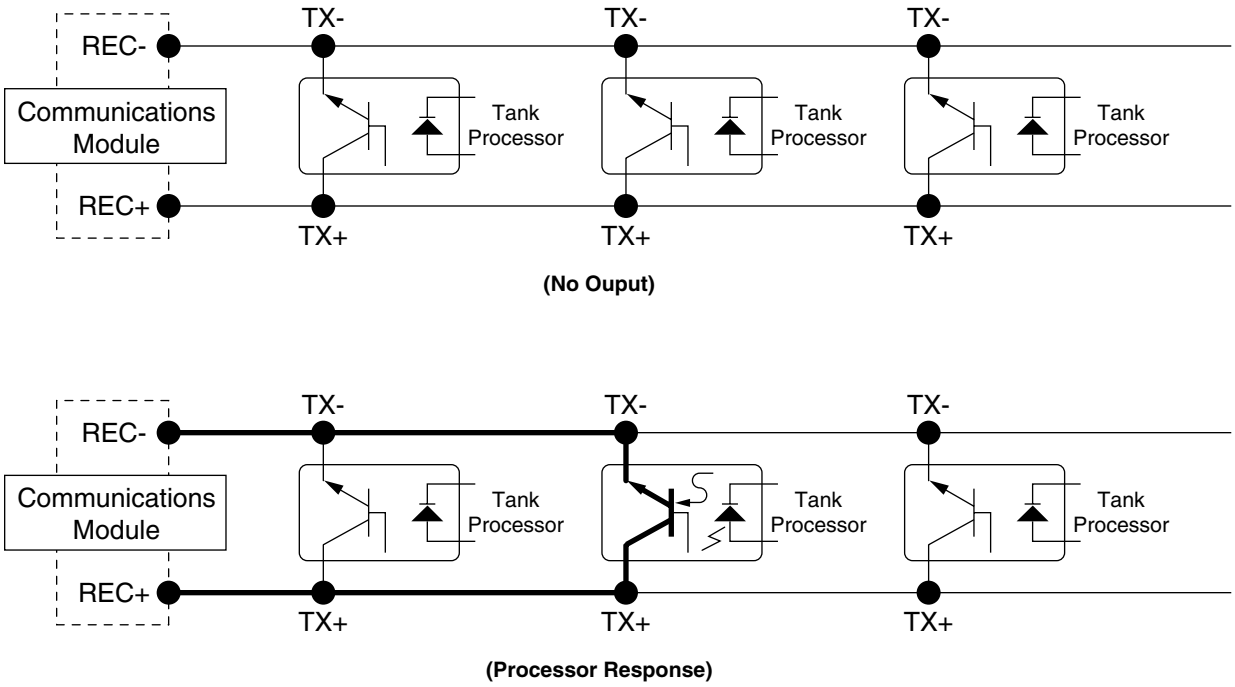
(Figure 1-3) Tank Processor Communications Connection



(Figure 1-4) Serial Loop



(Fiqure 1-5) Serial Communication Loop (Host Response)



(Fiqure 1-6) Parallel Communication Loop

Parallel Loop

This circuit changes state when one of the Tank Processors responds. As the processor responds, it completes the circuit loop, whereby +Vdc creates a current flow. This current is digitally pulsed by the Tank Processor to encode its data over the circuit to the Communications Module. (Figures 1-6a & 1-6b)

Optically coupled isolators are also used at the TX+/TX- inputs of the tank processor. Each current pulse is actuated by a photodiode triggering the respective phototransitor. Voltage (+V) is not directly connected to the internal electronics of the processor.

NOTE: Optically coupled isolators can be destroyed in the event extremely high voltage is applied through the communications cabling. The internal logic and micro-processor will not be affected, although communications functions will be inoperative.

Digitally Encoded Output

The output format of the Digital Tank Processor is a pulsed current loop. Transmission is comprised of a combination of ASCII character designators and binary values corresponding to the calculated tank inventory. (Communications Module is required to provide RS-422/ RS-232 interface). See EX-1595-8 for details.

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Input Requirements

Processor Models (5352-1 & 5352-2)

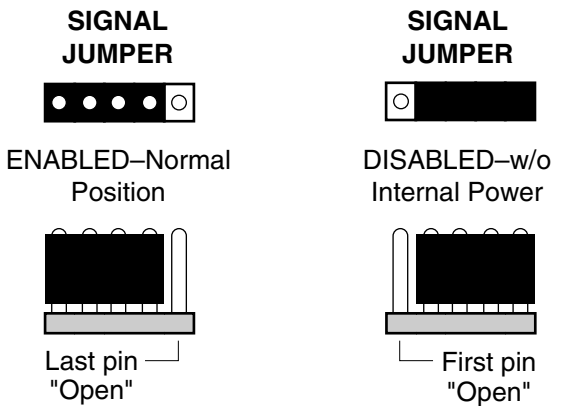
An external power supply will be required to drive the signal loop when using either the 5352-1 or 5352-2 Digital Tank Processors. A separate power supply is required to provide 5-6 Vdc to power the Digital Tank Processor's internal logic components. (Figure 1-7)

Processor Models (5352-11)

The 5352-11 Tank Processor incorporates an internal 24 Vdc supply that can be used to power the signal loop. If the circuit load requires a power supply in excess of 24 Vdc, a separate external power supply will be required and the internal power source must be disabled (see "Enabling/Disabling" below). The 5352-11 Tank Processor requires nominal 115 Vac/60 Hz. power for operation. (Figures 1-8a & 1-8b)

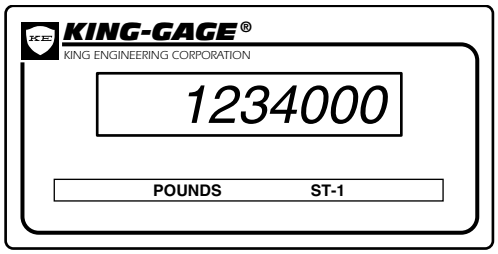
Transmitter Signal Loop – Typical transmitter provides a 4-20 mA output over a DC-powered two wire current loop circuit. This normally requires at least a 24 Vdc power source to provide excitation voltage to the transmitter. The power requirements should be calculated to accommodate the total resistive load residing on the circuit (e.g., cable impedance, additional receivers, etc.). Refer to the specific load capacity specifications for the pressure sensor of transmitter.

Enabling/Disabling 24 Vdc (5352-11 only) – A signal jumper is used to enable/disable voltage across the signal input terminals. The unit is shipped from the factory with the jumper installed in the ENABLED position to supply 24 Vdc power across signal input terminals no. 1 and no. 2. If an external DC power supply will be used, move the jumper to the DISABLED position. For location, see page 9, item 6.

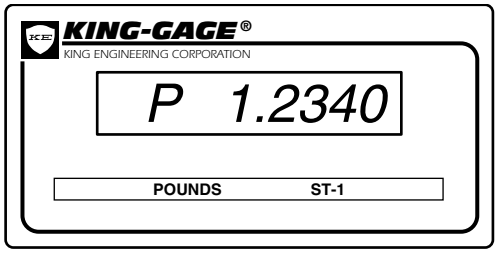


Model 5352-1/11 LCD Readout Panel for Tank Level Indication

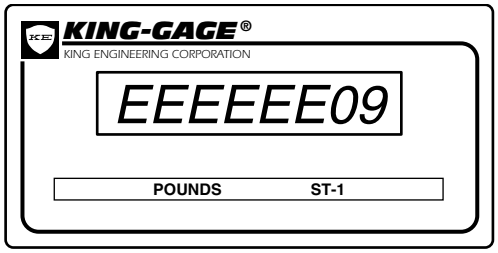
Tank Level Display - A LCD readout is provided on this unit for use as a local level display indicator. This readout is identical to the transmitted output of the Tank Processor and can be used to verify tank levels by plant operations personnel.

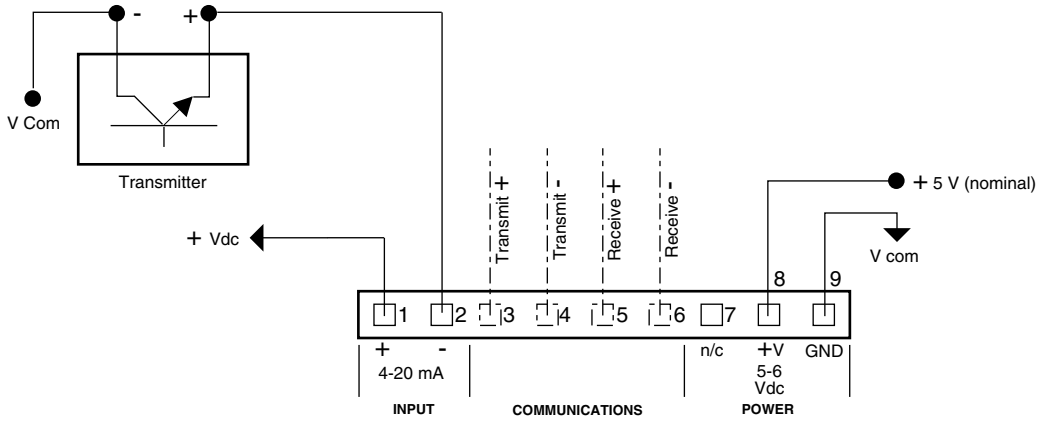


Density Display Mode -This readout also features a periodic display of the density value (specific gravity) associated with the tank level. At 15-second intervals, a 5-digit representation of the specific gravity currently being used is displayed for approximately 5-6 seconds. This display is indicated by a "P" designation.

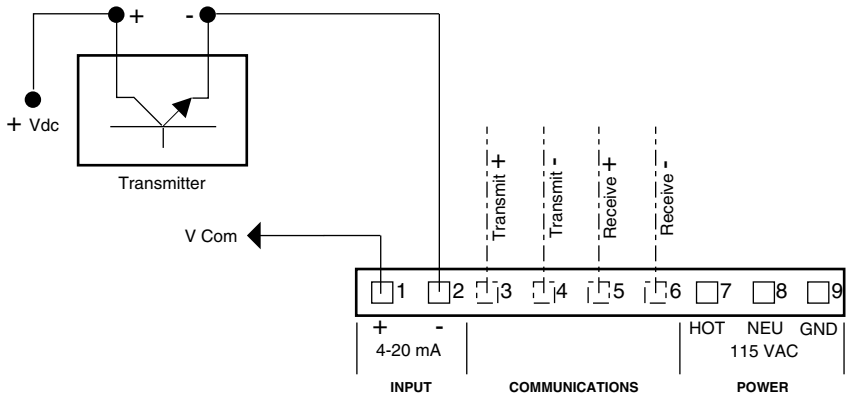


Overrange Error Display - Should the transmitter input exceed 20.01 mAdc, the Tank Processor will interpret this value as an overrange input. Overrange is designated by an error message on the readout ("EEEEEE09").

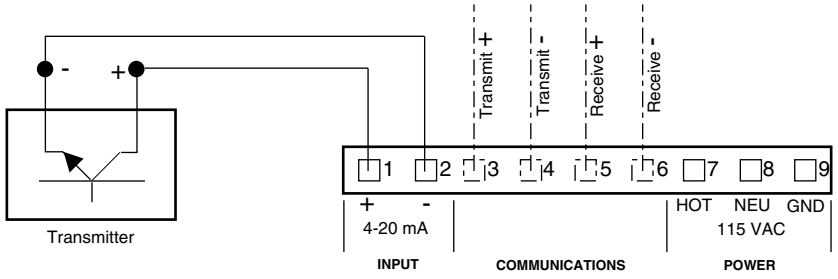




(Figure 1-7) Transmitter Signal Loop (5352-1 & 2)



(Figure 1-8a) Transmitter Signal Loop – External Power
5352-11 w/External Vdc Power Supply



(Figure 1-8b) Transmitter Signal Loop – Internal Power
5352-11 w/Onboard 24 Vdc Output Enabled

Troubleshooting Checklist

Certain problems experienced during initial system installation and start-up may result from incomplete connections (i.e., DC power, serial and parallel communication circuits). Optimal performance will occur when power and cabling recommendations are followed during installation of the complete Digital Interface System.

Refer to KEC publication EX-1595-8 "Software Protocol" for Digital Interface Systems regarding programming requirements and proper syntax for system communications.

No Output
Unit does not appear to be functioning (no communications response)

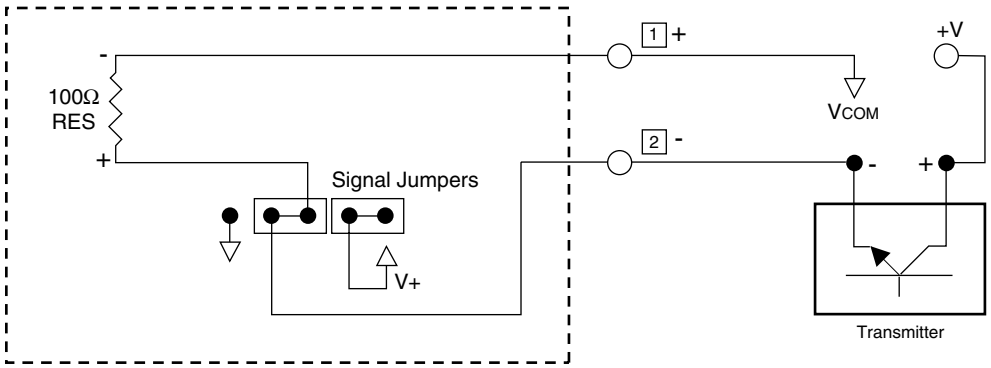
- Make certain that Tank Processor is connected to a power source providing nominal 5 Vdc.
- Check fuses and replace if necessary.

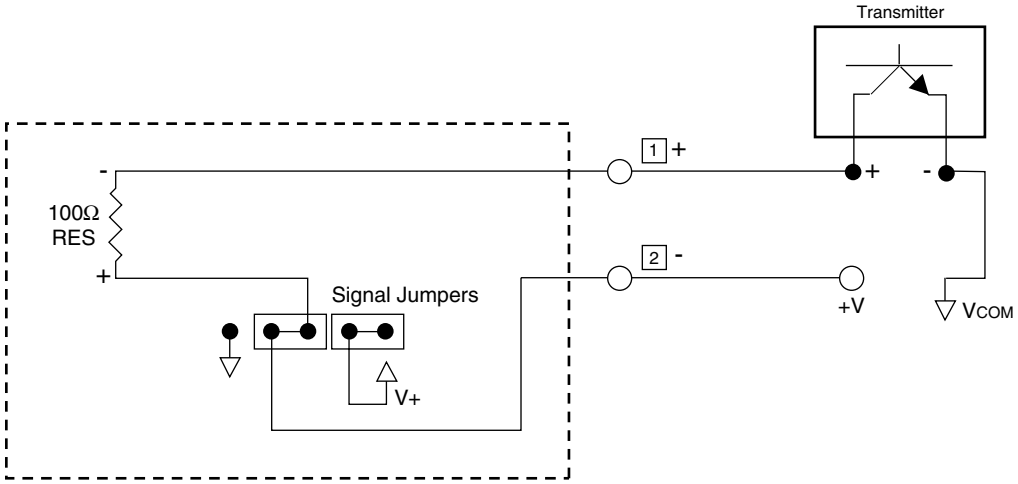
Output Value Too Low
Calculated tank value is inaccurately low, or does not change -

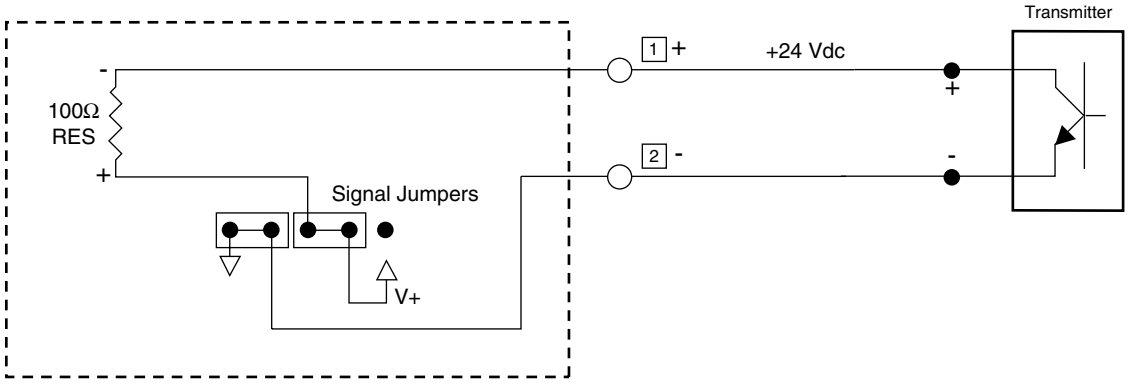
- Check sensor/transmitter output. (Check sensor zero/span.)
- Possible reversed connections @ sensor or indicator signal input terminals (refer to figures on page 15-17).

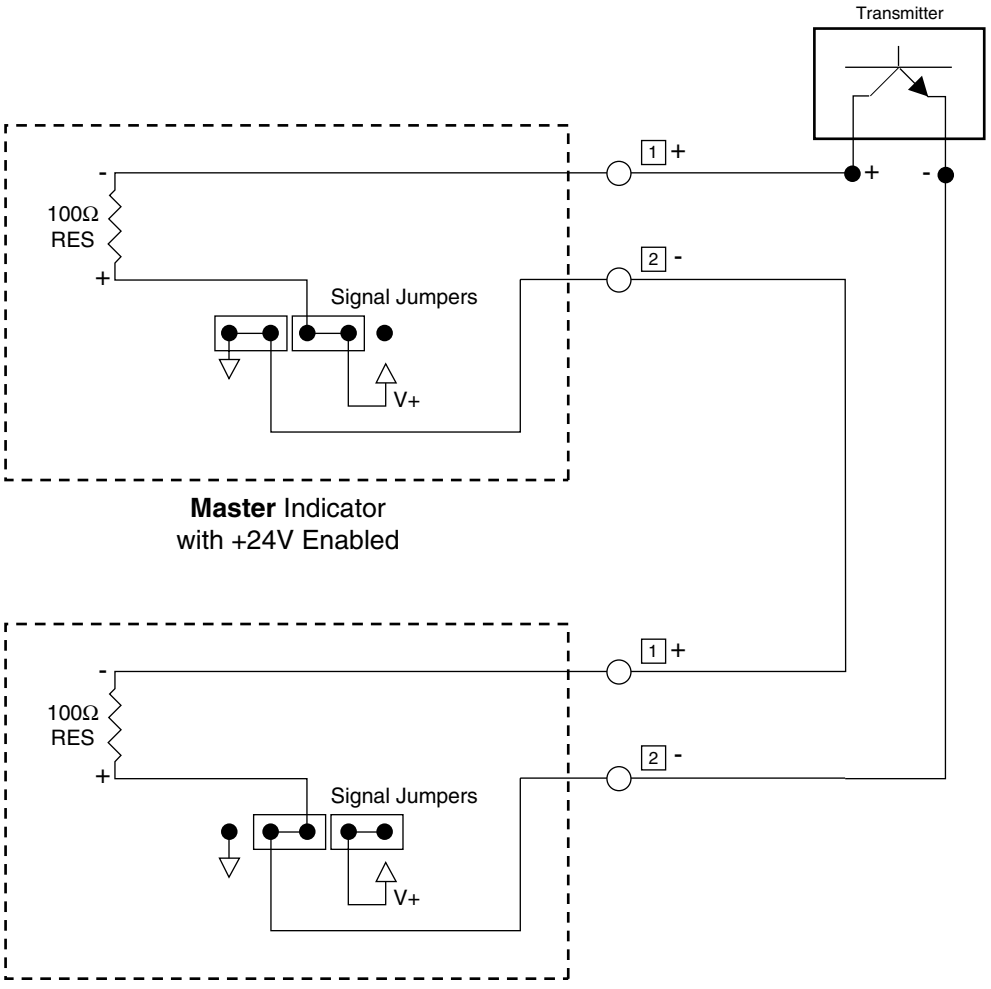
No Response
Unit appears to be functioning, however no data response from selected Tank Processor when requested -

- Check for proper communications (interface) connections at user I/O terminals.
- Determine whether proper ASCII address code was used.
- Make certain that Datapack (PROM) is installed.
- Transmission speed (baud rate) differs from programmed setting in Processor datapack.
- Excessive EFI/RFI noise levels on communications lines.
- Capacitance rating of cabling (between conductors) does not meet required specifications.


1 +
2 -
100Ω
RES
Signal Jumpers
V+
+V
VCOM
Transmitter


Transmitter
1 +
2 -
100Ω
RES
Signal Jumpers
V+
+V
VCOM


Transmitter
1 +
2 -
+24 Vdc
100Ω
RES
Signal Jumpers
V+


Transmitter
+
-
1 +
2 -
100Ω
RES
-
+
Signal Jumpers
V+
Master Indicator
with +24V Enabled
1 +
2 -
100Ω
RES
-
+
Signal Jumpers
V+
Receiver (Slave)
with Power Supply Disabled