Remote Terminal Unit® 1.0

Summary

The RTU system is comprises of various electronic cards would be used as part of an automation system. A CPU would communicate with these cards for data exchange over an RS485 based communication bus.

The system is comprises of 4 cards viz.

- Analog Input
- Analog Output
- Digital Input
- Digital Output

These cards are mounted on 32 slots backplane (*4U standard*). Backplane supplies power to each card.

Features

1. All rack-mounted cards are hot-swappable.
2. Current consumption per card is in the range 100-150mA @ 5VDC.
3. Card status can be easily determined by following LEDs.

LED	Function
PWR	Power OK
CB1	Communication Bus 1 Error
CB2	Communication Bus 2 Error
FLT	Fault

4. All cards are communicating to CPU through a proprietary protocol. The card cannot communicate the status of I/O unless it has interrogated all its channels after initialization to avoid any spurious status that might affect the functioning of the system.
5. A unique ID for each card helps preventing interference with other card's data on the communication bus to the CPU. This card ID also utilized to sense the card types currently placed in the rack.
6. All the inputs and outputs are being optically isolated. RS485 bus is also optically isolated.
7. All the cards have surge protection for all I/Os through MOV's.
8. To provide power to various components, miniature DC-DC converters are used on each board which will generate +/-5V and +3.3V.
9. Minimal slew-rate limited components to limit EMI noise.
10. The speed of the RS485 bus could be up to 1Mbps. In case of daisy-chaining of the RTUs' repeaters will be provided on backplane for RS485 bus if required.
11. All the boards will be multilayer boards (4 layer or more).
12. The backplane have a per-slot adjustable mechanism for 'keying' the type of card that can be inserted in a slot. All cards have a unique fixed 'key' for mating with the key in the backplane. This is to avoid insertion of wrong card in a slot for which wiring has been done as per some other card.
13. Mechanical Dimensions: 3U standard size (160mm x 100mm x 2mm).

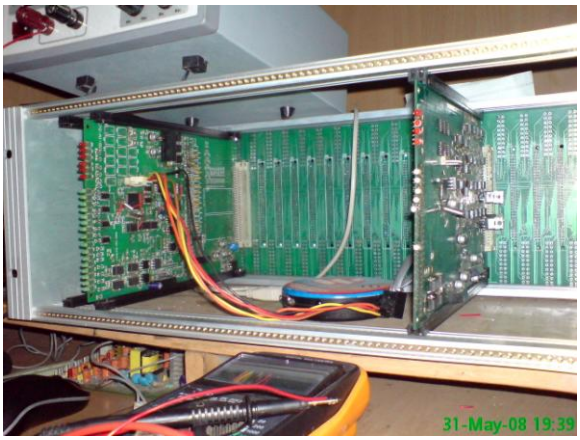

Fig 1: RTU Assembly

Analog Input (AI) Card

This card is used to sense analog parameters, e.g., Pressure, temperature etc. A transducer installed in the field converts the process parameter into electrical signal. The electrical signal is then converted to digital form using A/D converter and the digital value communicated to the CPU.

Specifications

The card is a specialty card which performs many functions:

1. Provides measurement of AC voltage in the range 0 –150V. The value of the AC voltage is transferred to CPU through backplane communication.
2. For each channel, input voltage is compared with a preset value. If the input is less than preset value then internally a value '0' is to be stored for that channel (This is known as voltage failure), else a value 1 is to be stored for that channel. This transition from 0 to 1 or 1 to 0 must be time stamped and transferred to CPU like a digital input. The preset value for each channel is separately adjustable through a POT.
3. Voltage failure for each channel is to be shown as green LEDs which are lit if input voltage is normal, and OFF if input voltage is less than preset value.

AI card – Type A

Part No	E08-AIA-001
Card ID	0301
Input signal range	0-150VAC
POT settable range for each channel	50V to 90V, with 10V hysteresis, i.e., if set value is 60V, then voltage failure is declared at 60V and voltage normal is declared only at 60+10 = 70V. Default value = 66V
Number of AI channels	12
Visual indications	Power supply OK – Green LED Voltage failure LEDs: 12 Green LEDs, with numbering.
A/D converter resolution	16 bit
Accuracy	0.1% or better Overload Capacity - 750V continuous 1000V 10 seconds 1200V 3 seconds Burden - < 0.04VA
Isolation	User input to the channel : 2000V
Protection	Surge protection through MOV per channel. Current limiting to be provided, Resettable fuses for each channel for overload protection.
Terminal usage	For each AI, there would be 2 terminals : one for phase, the other for neutral AI 01: A1: PH, A2: Neutral AI 01: A3: PH, A4: Neutral AI 03: A5: PH, A6: Neutral AI 04: A7: PH, A8: Neutral AI 05: A9: PH, A10: Neutral AI 06: A11: PH, A12: Neutral AI 07: B1: PH, B2: Neutral

	AI 08: B3: PH, B4: Neutral AI 09: B5: PH, B6: Neutral AI 10: B7: PH, B8: Neutral AI 11: B9: PH, B110 Neutral AI 12: B11: PH, B12: Neutral
Diagnostics	Channel fault for each channel

AI Card – Type B

Part No	E08-AIB-001
Card ID	0302
Input signal range (settable through jumpers, per channel)	4-20mA / 0-10mA/-10mA to +10mA 0-5V 0– 10V -10 to +10 VDC (Settable)
Field Power	To be generated internally
Number of AI channels	8
A/D converter resolution	12/16 bit
Accuracy	0.1% or better
Input impedance	<= 250 Ohms for 4-20mA signals
Visual Indications	Power supply OK – Green LED Field Power FLT – Red LED on loss of internally generated field power Channel Fault LED: A common channel fault LED. This should be lit if any of the 4-20mA signals falls below 4mA, or higher than 21 mA.
Functionality	Normal and totaling threshold mode Averaging with variable amount of samplings Filtering and Suppression of162/3 Hz, 50 Hz, 60 Hz Zero-Suppression Live Zero Monitoring: 4-20mA signal would be monitored for availability of at least 4mA on the channel. Channel fault LED to be lit if value falls below 4mA. This state should also be available to the CPU over communication bus. Provision to declare a signal “not connected” (either through communication bus or through a jumper/DIP switch) so that live-zero monitoring can be disabled on a spare (i.e., not in-use) channel. Gradient threshold or rate of change monitoring. This would be settable for each channel in terms of raw counts per unit time. With and without time tag including time of threshold violation
Protection	Surge protection per channel, should protect from (but not limited to) voltage spikes and residual currents at 50Hz, 0.1mA (peak to peak). Overload of 50% of the input should not cause any failure. From wrong wiring of inputs, i.e., when wiring has been done as per some other range which has not been selected by mistake.
Isolation	User input to the channel : 2000V All channels to be individually isolated
Terminal usage	AI1: V1 : A1, I1:A2, Return (common) : A3

	AI2: V2 : A4, I2:A5, Return (common) : A6 AI3: V3 : A1, I3:A2, Return (common) : A9 AI4: V4 : A1, I4:A2, Return (common) : A12 AI5: V5 : B1, I5:B2, Return (common) : B3 AI6: V6 : B4, I6:B5, Return (common) : B6 AI7: V7 : B7, I7:B8, Return (common) : B9 AI8: V8 : B10, I8:B11, Return (common) : B12
Jumpers/DIP switches required on the card	For choice of input signal range. Choice of signal that would get selected by particular jumpering action should be clearly printed on the AI card itself so that such settings could be done even without the documentation.
Diagnostics	Channel fault for each channel

Analog Output (AO) Card

This card is used to output analog data in form of electrical signals. The CPU communicates 12/16 bit digital values per AO channel to the AO card. The AO card then outputs these values as electrical signals after conversion using D/A converter.

Specifications

Part No	70-AOA-001
Card ID	401
Output signal range, per cannel	4-20mA or 0-5VDC or -10 to +10 VDC (Settable)
Number of AO channels	8
D/A converter resolution	12 bit
Accuracy	0.1% or better
Visual Indications	Power supply OK – Green LED Field Power FLT – Red LED on loss of internally generated field power Channel Fault LED: A common channel fault LED.
Protection	From wrong wiring of outputs, i.e., when wiring has been done as per some other range which has not been selected by mistake.
Isolation User input to the channel	2000V All channels to be individually isolated.
Terminal usage	AO1: V1+ : A1, V1-:A2, I1+: A3, I1-: A4 AO2: V2+ : A5, V2-:A6, I2+: A7, I1-: A8 AO3: V3+ : A9, V3-:A10, I3+: A11, I1-: A12 AO4: V4+ : A13, V4-:A14, I4+: A15, I1-: A16 AO5: V5+ : B1, V5-:B2, I5+: B3, I5-: B4 AO6: V6+ : B5, V6-:B6, I6+: B7, I6-: B8 AO7: V7+ : B9, V7-:B10, I7+: B11, I7-: B12 AO8: V8+ : B13, V8-:B14, I8+: B15, I8-: B16
Diagnostics	Channel fault for each channel

Digital Input (DI) Card

This card is used to sense status (ON/OFF) of a contact. DC Voltage through an external source is applied at one end of the contact and sensed at the other. If the voltage is available at the other end then the switch is ON (corresponding digital state = 1), else it is OFF (corresponding digital state = 0).

Specifications

Part No	E08-DIA-001
Card ID	0101
Voltage sensing range	5-110VDC Pickup voltage levels shall be settable per group via on-board DIP switches (5, 24, 48, 110 VDC). Also, provision should be made for sensing the Digital inputs correctly if the +ive side of the DC is grounded.
Number of DI channels	32 (In groups of 8, i.e., for each set of 8 channels a common 0V could be used for sensing +ive voltage at the channel). Therefore no. of process connection pins = 32+32/8 = 36.
Scanning period	0.5 ms or faster
Visual Indications	Power supply OK – Green LED ON status LED for each channel – Green LEDs with numbering
Optical Isolation	User input to the channel : 2000V Group To Group : 2000V
Protection	Surge protection through MOV per channel. Resettable fuses for each channel for overload protection.
Current consumption per channel	< 12mA
Time stamping of events	Each change of state from 0 to 1, or 1 to 0 for a channel should be time stamped (with 1 ms accuracy) and transferred to the CPU over communication bus. For this the DI card should have an RTC which would be synchronized by the CPU.
Time Synchronization	For purpose of accuracy, the times of RTCs of all DI cards must be synchronized with the CPU clock.
Filter time	Configurable between 0-100ms in steps of 1ms. Default should be 1ms. Care shall be taken that if any input channel is chattering it shall be suppressed (not reported to CPU) for a preset amount of time. Also, a status is required per channel, indicating whether the channel is chattering or not. Chattering is defined as follows – If a channel changes its state more than a preset limit within a given time, then the channel is said to be chattering. All limits shall be programmable via the communication bus from the CPU.
Input impedance	10Kohm
Terminal usage	DI 1-8: Terminal no. A1-A8 Common 0V for the above terminal No. A17 Common 0V for the above terminal No. A18 DI 9-16: Terminal no. A9-A16 DI 17-24 Terminal no. B1-B8 Common 0V for the above terminal No. B17

	DI 25-32 Terminal no. B9-B16 Common 0V for the above terminal No. B18
Diagnostics	Input channel faulty. In case even a single input channel is faulty, a CHN FLT LED on the card should glow in Red color. Diagnostic information also to be transferred to the CPU over communication bus. Exact method to be elaborated as part of communication protocol. Diagnostic information transferred to CPU would be per channel.
High Speed Pulse inputs	Possibility to configure 8 of the DIs as high speed pulse inputs with maximum frequency of 5 KHz. Acceptable pulse amplitude is 3V – 30V. Functionality of high speed pulse inputs is explained in section 3.2

High speed pulse inputs

These could be configured as 8 single pulse inputs (Form A), or any two channels could be combined to accept dual pulse input. In case of dual pulse, the expected phase shift (90, 180, 270 degrees etc.) between the two pulses would be configurable (Form C). Output expected for each single or dual pulse input is as follows:

A retentive 32 bit integer for pulse counting. This should roll over to 0 on reaching its maximum value.
Pulse rate as 16 bit integer which counts actual pulses received per second.
Pulse error LED to be lit in case of dual pulse, if actual phase shift is not matching with the configuration). This error should also be transferable to the CPU over communication channel.

Pulse input channels of all cards should also be resettable through a single command sent from communication channel. Each pulse channel shall have a separate freeze register, which shall store the current counter value, when a freeze command is received from the CPU. This register can be cleared on first read, or on receipt of a specific command.

The accumulated pulses should have on-board non-volatile storage.

Digital Output (DO) Card

This card is used to drive external machinery. Typically the card receives the state (1 or 0 corresponding to ON or OFF state) of the DO channel from CPU. Based on this state the DO channel is triggered ON or OFF. Each DO channel is either a relay or a transistor.

Specifications

Part No	E08-DOA-001
Card ID	0201
Output Voltage	Transistor based 5-48V DC. (Output voltage to be decided by the common voltage supplied to each group) with back-EMF protection.
Current Rating per Channel	500mA
Number of DO channels	16 (In groups of 8, i.e., for each set of 8 channels a common source could be provided for output on the DO channels).
Visual Indications	Power supply OK – Green LED

	ON status LED for each channel – Green LEDs with numbering Channel Fault LED A common channel fault LED. SELECT status yellow/orange LED per group. i.e., 2 LEDs, indicating whether a channel is selected in that group or not.
Select Before Execute Support	Each DO card to support select before execute functionality as described below: The card is sent a command SELECT from CPU. The card then arms the channel and senses if the correct channel has been armed. It then sends a POSITIVE reply to CPU and starts a 30 second timer. Within 30 seconds the CPU must send EXECUTE command on the same channel, otherwise the channel would be DESELECTED. When CPU sends EXECUTE command then the channel is actually operated. Note that de-energization of the channel does not require SELECT; it would always be done through DIRECT EXECUTE command as explained below.
Direct Execute support	The card also should support DIRECT EXECUTE functionality as explained below; If a CPU sends DIRECT EXECUTE command to the channel then the channel is immediately energized or de-energized. Option for generating pulsed/continuous outputs. Three types are required – Latched Outputs – CPU will inform the card to make a channel ON permanently. A separate OFF command will de-energize the channel. Pulsed Outputs – CPU will inform the card to make a channel ON for a specified duration (in milliseconds), after which the card will automatically de-energize the channel. Pulse-Train Outputs – CPU will inform the card to generate pulses of a specific duration (separate durations for high and low cycles), 'n' number of times. With each new message from CPU, a new pulse should begin and if the previous pulse was already in progress then that pulse would be overlapped by the new pulse. The card will then generate pulses accordingly. A CANCEL command, any other command on this channel, expiry of pulse duration shall cancel the pulse-train.
Isolation	User input to the channel : 2000V Group To Group : 2000V
Protection	No false output should get generated during Power ON/hot swapping
Terminal usage	DO 1-8: Terminal no. A1-A8 Common voltage for the above terminal No. A9 DO 9-16: Terminal no. B1-B8 Common voltage for the above terminal No. B9
Diagnostics	Output channel faulty. In case even a single output channel is faulty, a CHN FLT LED on the card should glow in Red color. Diagnostic information also to be transferred to the CPU over communication bus. Exact method to be elaborated as part of communication protocol. Diagnostic information transferred to CPU would be per channel and would consist of channel fault

	conditions as bare minimum. Security checks – Cyclical loop check, loop check before command activation, (resistance, short circuit, open loop), loop check during command activation [Please check if such a functionality can also be achieved.]