APPLICATION NOTE #31
iCLASS® RK40 / RWK400 KEYPAD READER

GENERAL
The *iCLASS* Keypad, RK40 (read-only) and RWK400 (read-write) Readers are compatible with any access control system using the SIA Wiegand interface.   Both keypad and card data are transmitted via the Wiegand outputs. The RWK400 can also be connected to a PC or microcontroller for read/write operation using the reader's serial port, which provides either an RS-232 or RS-485 interface (see *iCLASS* Protocol Document 6090-902.)   For general information on *iCLASS*, see HID Application Note # 28.

The *iCLASS* Keypad Reader is also capable of local PIN verification at the reader, when the PIN code is programmed into the *iCLASS* card at the factory or in the field, using the *iCLASS* Card Programmer.   This allows Card + PIN code to be used with panels without PIN capability, or with panels which only provide 2 of 7or 3x4 matrix keypad inputs.

FEATURE COMPARISON
As many HID customers are familiar with the HID ProxPro® with Keypad, a comparison chart between the *iCLASS* and ProxPro Readers is shown below:

Table 1 - *iCLASS* RK40 / RWK400 vs. ProxPro 5352 / 5355

Feature	ProxPro	*iCLASS*
Standard Model Numbers	5355AGK00 - Wiegand 5352AGK00 - Serial	6130AKT000000 - Wiegand 6131AKT000000 – Wiegand + Serial
Transmit Frequency	125 kHz	13.56 MHz
Dimensions	5.00" x 5.00" x 1.00" (12.7cm x 12.7cm x 2.54cm)	3.30" x 4.80" x 0.90" (8.38cm x 12.19cm x 2.28cm)
Power Requirements	10 - 28.5 VDC	10 - 16 VDC
Current Requirements	100/120 mA (avg/peak)	100/220 mA (avg/peak)
Tamper	Pressure switch with output	Embedded magnet for use with reed switch
Keycap Material	Rubber	Metallic
Backlit Keypad	None	Configurable for Continuous on/off, on Card Presentation, or on Key press
Keypress Beep	Switch selectable on or off.	Configurable on or off.
Hardware Options	Fixed Screw Terminal	Removable Screw Terminal or 18' Pigtail
Wiegand Output Options	Configurable to various panel manufacturer requirements	Same Options as ProxPro
Matrix Output Options	3 X 4 or 2 of 7	None
Serial Output Options	One-way RS-232 (5352 model only)	Bi-directional RS232/485 (6131 model only)
Invalid PIN Lockout	None	Configurable from 0 - 15
Invalid PIN Action	None	Open Collector Latch or Momentary from 0 - 255 sec.
Beeper/LED Options	Switch Selectable	Configurable – same options as ProxPro
Additional Features	Jumpers for metal mount and resistor pull up	Local Verification of PIN stored on the card.

WIRING INFORMATION

iCLASS Keypad Readers are designed for use with access control panels having a SIA standard Wiegand interface and a 12VDC power supply.   If you are currently using HID proximity readers, the wiring color codes for the Wiegand port are the same. If you are using existing wiring, make sure that it complies with minimum wire gauge and distance requirements stated in the Installation Guide. The RK40 is available with either removable screw terminals or wire pigtails. The RWK400 has screw terminals only.

Table 2 – Wiring Information				
Serial Port (Model RWK400 Only)		**Wiegand Port** (Models RK40, RWK400)		
8 Pin Terminal	Function	10 Pin Terminal	Color-coded Pigtail	Function
1	Ground	10	Violet	Open Collector[1]
2	Y / RS-232 TX[4, 5]	9	Blue	Hold[1]
3	Z[4]	8	Yellow	Speaker[1]
4	Ground	7	Drain	Shield Ground[2]
5	RS485B / RS-232 RX[4, 5]	6	Brown	Red LED[1]
6	RS-485A[4]	5	Orange	Green LED[1]
7	Ground	4	White	Data 1
8	DC+	3	Green	Data 0
		2	Black	Ground
		1	Red	+DC (10-16 VDC)[3]

[1] Optional Connections
[2] Drain wire can be used for data return line when a separate power supply is used.
[3] +DC, Return & Drain wires are common between the Wiegand and Serial Ports.
[4] In RS-485 mode, pin 2 must be connected to pin 6 and pin 3 must connected to pin 5 with jumpers at the connector.
5 In RS-485 mode, when cable distance exceeds 2000 feet, install a 120Ω resistor across pins 2 & 5 at the reader.

The following paragraphs provide additional detail about each input.

DC Voltage (+ = Pin 1 or Red, - = Pin 2 or Black)
- The *iCLASS* Keypad Reader requires 100/220mA avg/peak @ 10-16VDC. Existing wire runs are usually adequate, but you may need to reconnect the + voltage conductor to a 12VDC source at the panel. Consult the panel manufacturer for the location of a suitable 12VDC output.
- Older access control panels frequently provide only 5VDC at the reader output. However, some have a jumper allowing this output to be changed to 12VDC – check with the panel manufacturer.
- If no 12VDC source is available from the panel, install a 12VDC linear supply at the panel or door location, whichever is most convenient, and use the drain wire as a data return line for the Wiegand signal (connect to signal ground at the panel.)

Wiegand Data (Data 0 = Pin 3 or Green   Data 1 = Pin 4 or White)
Normally, there are two Wiegand data lines, Data 0 and Data 1, referenced to DC Ground. Some older Cardkey Wiegand readers combine Data 0 and Data 1 into a single output line. Converters are available from the Cardkey division of Johnson Controls to adapt the two-line Wiegand output from the *iCLASS* reader into the Cardkey single line interface. Contact HID technical support for more information.

LED Control Lines (Green LED = Pin 5 or Orange, Red LED = Pin 6 or Brown)
iCLASS Keypad Readers feature separate red and green LED inputs. These lines are usually held at a logic "high" level, and when an input is "asserted" or pulled to a logic low level, the appropriate LED will light. Amber can be created by simultaneously asserting both lines, or rapidly toggling the line corresponding to one color while the other color is lit.

Because there is no industry standard for LED operation, the *iCLASS* reader is available from the factory in several LED configurations (see the *iCLASS* How to Order Guide). LED configurations

can also be configured in the field, using a command card. Consult the panel manufacturer for additional information.

Beeper Control Line (PIN 8 or Yellow)
Not all existing readers have a beeper control line. When this line is asserted, the speaker in the *iCLASS* reader sounds a 1000Hz steady tone. Other tones or tone sequences can be logically linked to operation of the Green or Red inputs. Call HID technical support for details.

Hold Control Line (PIN 9 or Blue)
Not all existing readers have or use the Hold control line. The Hold Input is a control line which can operate in one of two modes (configurable with a command card). In one mode, when this line is asserted, the reader's RF transceiver circuit will turn off, until the line is released. This input can be connected to the contact or logic output of a vehicle loop detector, so that the card reader will not accept a card unless a vehicle is detected. In the second mode, when this line is asserted, the reader will buffer one card read (ignoring subsequent reads) until the line is released.

Drain Wire (Pin 7 or unshielded wire)
This wire can be used as a data return line if power is not supplied directly from the access control panel.

Open Collector (Pin 10 or Violet)
This logic output is unique to *iCLASS*. It does not connect to the panel, but rather allows the reader to control local devices in response to successful Local PIN Verification, PIN Retry alarms, or serial commands. This output is configurable via a command card.

Serial Port Wiring (RWK400 only)
To connect an RS-232 device, using the 8-pin terminal, connect Power (8), Ground (7), RX (5) to TX on the device, and TX (2) to RX on the device. There are no handshaking or control lines.

To connect an RS-485 device, using the 8-pin terminal, connect Power (8) to 12VDC, Ground (7) to DC Supply Ground, RS-485 A (6) to A on the device and RS-485 B (5) to B on the device. The reader provides bi-directional, 2-wire RS-485 communications.

When RS-485 cable distances exceed 2000 feet (up to 4000 feet), a termination resistor must be installed at the reader. Connect a 120Ω resistor across pins 2 and 5 on the connector.

KEYPAD OUTPUT CONFIGURATION

To simplify ordering, *iCLASS* keypads are available with the same keypad output configurations offered on the ProxPro. These are indicated by the last two digits in the model number.

Here is the standard "00" configuration:

- No Local PIN Processing – all PIN data and card data transmitted in real time and actual order of entry
- No PIN Buffering – individual key presses transmitted in standard data format (4-bit BCD)
- No Parity Added to PIN Data
- Clear (*) key transmits HEX 0x0A; Enter (#) key transmits HEX 0x0B
- Backlighting Always On - blinks off with each keypress
- Keypress Beep is On
- Latch on PIN / Invalid Pin Lockout (IPL) is Off
- IPL is 30 seconds
- No Append Enter Key

Config No	Description/Functionality
	Table 3 – Custom Keypad Data Output Configurations
08	Buffer four keys and output in PCSC format
09	"Buffer one key" and add compliment – 8-bit message (Dorado, Cardkey). */# = A/B
10	Buffer 6 keys and add parity
11	"Buffer one key" and add parity (Edicon, AMSD, Apollo)
12	Not used
13	Not used
14	Galaxy (26 bit)
15	6 key, no parity, * = clear buffer; # = transmit data
16	6 key, no parity, * and # transmit data
17	Not used
18	Not used
19	4 key with parity output option (#/* = E/F)
20	"Single key buffering" for keypad operation (use with CASI-RUSCO adapter)
21	Not used
22	Local PIN Verify (requires PIN programmed into card) Card programming determines PIN length

Note: "Buffer one key" and "single key buffering" reflects terminology used in ProxPro Keypad literature – data is actually sent real time after each individual key press, formatted as described above.

CUSTOM KEYPAD CONFIGURATIONS

Custom configurations will require a custom part number suffix. Contact HID technical support for more information. Configurable parameters and options are described below:

Keypad/Card Event Sequencing Options
> 1**- Decoupled** – Default; card "read" is transmitted immediately; key presses transmitted immediately; Host/Panel does all Keypad and card processing
> 2- **No Preference** – applies to Local PIN Verify; will accept either PIN or Card First
> 3- **Enter PIN First** – applies to Local PIN Verify; will only accept PIN First
> 4- **Enter Card First** – applies to Local PIN Verify; will only accept Card First

> In modes 3 and 4, the reader ignores the wrong item if it is input first.

Keypad Mode Options
> 1- **Single Key Entry** – no buffering (works with Decoupled Keypad/Card Sequencing)
> 2- **Buffered Key Entry**
> 3- **Verify PIN Locally** – works with Keypad/Card Sequencing modes 2, 3, 4 above; if card and keypad PIN match, then Wiegand Card Data only is sent

Maximum Number of PIN Digits
> Range: 0 - 16
> Only valid if Keypad Mode is set to Buffered Key Entry. The reader sends the buffered key presses to the host automatically, once the maximum number of keys is pressed.

Backlighting Operation Options
  1- Continuously on
  2- Triggered by card read
  3- Triggered by keypress
  4- Continuously off

Backlighting will blink off momentarily with each keypress in modes 1 – 3, and blinks on momentarily in mode 4.

Clear and Enter values
  1- * (clear) / # (enter) = 0x0A / 0x0B
  2- * (clear) / # (enter) = 0x0E / 0x0F

Append Enter (ASCII CR) to keypad data
This option only applies if Keypad Mode is set to Buffered Key Entry
  1- Do not append Enter
  2- Append Enter

Include Parity in Bit Stream
Add beginning/ending parity bits to each key press
  1- No parity
  2- Parity

Keypad Data format
  1- Standard (4bit)
  2- Dorado (8 bit burst)
  3- PCSC (proprietary)
  4- Galaxy (26 bit)

  The "Galaxy" format sends buffered key presses to the host in a SIA 26-bit card data format. The key presses are sent as the card ID portion, and 000 is sent as the default facility code (also configurable, see below). The PIN may be variable length, with a range of 0 – 65535, and should be terminated by the # key (enter) or deleted by the * key (clear).

Facility Code
  Range 0-254. This 8 bit value represents the facility code used in the Galaxy (26 bit) Data Format. 255 is not a legal value for this format. (Presentation of a "Galaxy" configuration card with facility code 255 sets the reader into a mode allowing the desired facility code to be entered via the reader keypad.) Contact Technical Support for help with this procedure.

Keypad Beep
If this feature is enabled, a beep is triggered by each keypress.
  1 - Keypad Beep On (default)
  2 - Keypad Beep Off

LOCAL PIN VERIFICATION

Local PIN Verification **requires** that the User PIN be programmed into the *iCLASS* card, using the *iCLASS* Card Programmer. When this mode is enabled, the cardholder presents a card and enters a PIN into the keypad. The reader compares the manually entered PIN with the PIN stored on the card, and if they match, the Wiegand card data is transmitted immediately. PIN data is not sent to the host. Card and PIN may be presented in any order; however, there is no visual feedback if the PIN is entered first.

If the card has no programmed PIN, the reader will time out, and not transmit Wiegand data.

This mode also includes a PIN Retry Alarm function. This function provides important protection against an unauthorized person who obtains a card and attempts to guess the PIN by making repeated entries.

Here is the sequence of events for Local PIN Verification:

Cardholder presents card
- Short beep/green LED indicates that the card has been read
- Reader toggles LED alternating from red to green at 1Hz (a 15 second timer starts)

Cardholder enters the correct PIN
- Short beep/green LED indicates correct PIN
- Wiegand card data is transmitted to host
- Open Collector activates momentarily, if so configured

If the Cardholder fails to enters a PIN
- Reader toggles red/green LED until timer expires – returns to normal state

If the Cardholder enters the wrong PIN
- Reader beeps/flashes LED red three times rapidly, ending the transaction.
- Reader counts the number of successive wrong PIN entries
- The count increases with each error until Invalid Pin Lockout (IPL) threshold is met

   IPL threshold met invokes any/all of the following actions (each configurable, lockout time also configurable):
   - Beeper sounds "error tone," alternating high/low
   - PIN keypad is disabled for a configurable time
   - Open Collector latches (if so configured – connect to an alarm input)

   To reset the IPL count - remove/restore power or wait for timeout
   To cancel an active IPL condition - present a different valid card + PIN

   IPL threshold may be set from 1-16 wrong PIN entries
   IPL time may be set in five second intervals: 1-255

The objective for the IPL is to create a delay, preventing use of trial-and-error to gain entry. The IPL also brings attention to the intrusion attempt with the audio warning and with a contact closure, which could be connected to the access control or alarm system.

OPEN COLLECTOR OUTPUT

This output is a normally open logic output controlled by a serial command via the RS-232 or TTL input. This solid-state switch provides a means of controlling any device or logic input that can be operated by a switch closure, and is useful for non-access control applications, where a relay may not be available at the reader location. The output can be latched, unlatched, or momentarily latched for 1 – 255 seconds.

The open collector output can switch up to 50mA at 12VDC (13.8VDC max). For larger loads, an interposing relay must be used. A surge suppressor (MOV) should be installed across any inductive load attached to this output, to prevent transient pulses from damaging the reader.

The open collector output can control an external device (13.8VDC, 40mA, source – 1mA). It can operate an interposing relay to control a larger load, or it can be used as a logic input.

When a serial command is sent, the open collector can:
- latch indefinitely
- unlatch
- latch momentary (0 - 255 seconds)

The commands for each option are detailed in the *iCLASS* Serial Protocol, 6090-902.

The reader can also be configured to operate the open collector when in Wiegand mode:
- When Local PIN Verify mode is selected, and a valid Card + PIN is entered
- When Local PIN Verify mode is selected and a PIN Retry Alarm condition occurs.

SERIAL COMMUNICATIONS

The RWK 400 includes a serial transceiver which can be connected for either RS-485 or RS-232 operation. This port allows the reader to be connected to a PC or other microcontroller.

See Table 2 for wiring information. Two jumpers must be installed on the connector at the reader for RS-485 operation. The reader power and ground inputs are duplicated on the Wiegand and Serial connectors, so that only one connector needs to be wired for either Wiegand or Serial operation.

The *iCLASS* Serial Protocol must be used to communicate with the reader. This protocol allows a host device to control all reader functions, as well as to read and write to *iCLASS* cards. See Protocol Document 6090-902 for information

MIFARE® OPERATION

The *iCLASS* Keypad Reader has the same capabilities for reading MIFARE as the other *iCLASS* readers (see Application Note 28), but it also has additional capabilities to read the CSN (card serial numbers) from newer types of MIFARE cards, such as MIFARE 4K, MIFARE DESFire, and MIFARE Ultralight

The MIFARE 4K CSN length and output options are the same as for MIFARE 1K. The Ultralight and DESFire cards have a 56-bit CSN, and allow two additional output configurations

> Configuration 5 – Transmit the 37 LSB (truncate from 56 bits) MSB First
> Configuration 6 – Transmit the entire 56 bit CSN, MSB First

Note that if configurations 5 and 6 are used with MIFARE standard cards (with 32 bit CSNs), the reader will still transmit 37 and 56 bits respectively, by padding the 32 bit number with 0's to total the desired number of bits.