

R-Win Wireless Communication Management System

R-Win, *Wireless-Internet Networking*

A. General

R-Win is a smart communications adapter for management of wireless communications in a SCADA / Distributed Control System.

The R-Win system includes software installed in the SCADA / DCS control center and hardware-software units installed in remote stations in the field.

The software is an original development of AGM and is embedded in a microcontroller at a high industrial level.

The R-Win unit in the field transmits the PLC / RTU controller data via IP Radio-Modem or Cellular Router, or both, which broadcasts it to the network and manages the wireless communications of the distributed system.

The R-Win unit is capable of communicating with neighboring units through "lateral" communication without the mediation of the control center, and thus contributes to the system a number of unique and important capabilities, such as:

- Communication and Control Redundancy and Resilience.
- More effective communication network via Routing-Bridging-Store & Forward and Real Time or Near Real Time communication capabilities.
- Management of local, sub-system control processes without involving the control center.
- An additional level of information and communication security.

The combination of similar capabilities currently has a number of terms in the industry associated with it, such as – *MESH Networking* and *Wireless Networking System Redundancy*.

B. The R-Win/Server Control Center Software

- The R-Win/Server application is installed on a PC in the control center. In most cases this can be a Server-PC already connected to the Ethernet network in the center.
- R-Win/ Server manages communications with the remote units in the field to receive updated data.
- Initiating data transmission is a two-way capability of the system, from the center to the stations and vice versa.
- Data could be read & write from the same register, from a single operation screen.

- The control center software – R-Win/ Server, is an OPC-Server and allows for presentation of system data in real-time via a standard HMI supporting OPC application or through most OPC explorer software.
- R-Win/ Server receives write instructions from the HMI application and transmits them immediately to the end units.
- For remote monitoring, R-Win/ Server allows transmitting data to defined servers over the internet to obtain remote access capabilities.
- R-Win/ Server provides tools to monitor system activity for the purposes of communications maintenance of the distributed system.

Table-1 R-Win/Server screen tracking communications on the control center

R-Win Trace	
2011-05-15 16:02:25 - /rwin1 connect IP: 192.168.1.19	
2011-05-15 16:02:25 - /rwin1 - Recv: <01,/rwin1,1,>	
2011-05-15 16:02:25 - /rwin1 - Send: <01,/rwin1,1,>	
2011-05-15 16:02:26 - /rwin1 - Recv: <06,/rwin1,2,>	
2011-05-15 16:02:26 - /rwin1 - Send: <06,server,2,1305475346,>	
2011-05-15 16:02:26 - /rwin1 - Recv: <03,/rwin1,3,/r0,35,1,1,;/r1,2015,1,1,;/r2,28,1,1,;/r3,38,1,1,;/r4,48,1,1,;/r5,58,1,1,;/r6,68,1,1,;/r10,55,1,1,;/r11,1501,1,1,;>	
2011-05-15 16:02:26 - /rwin1 - Send: <03,/rwin1,3,>	
2011-05-15 16:02:32 - /rwin1 - Recv: <03,/rwin1,4,/r10,41,1,1,;/r11,1502,1,1,;/r12,3,1,1,;/r13,13,1,1,;/r14,23,1,1,;/r15,33,1,1,;/r16,43,1,1,;/r1501,1,1,1,;/r1502,1,1,1,;>	
2011-05-15 16:02:32 - /rwin1 - Send: <03,/rwin1,4,>	
2011-05-15 16:03:26 - /rwin1 - Recv: <03,/rwin1,5,/r11,1503,1,1,;/r12,4,1,1,;/r13,14,1,1,;/r14,24,1,1,;/r15,34,1,1,;/r16,44,1,1,;/r1503,3,1,1,;>	
2011-05-15 16:03:26 - /rwin1 - Send: <03,/rwin1,5,>	
2011-05-15 16:04:26 - /rwin1 - Recv: <03,/rwin1,6,/r11,1504,1,1,;/r12,5,1,1,;/r13,15,1,1,;/r14,25,1,1,;/r15,35,1,1,;/r16,45,1,1,;/r1503,4,1,1,;>	
2011-05-15 16:04:26 - /rwin1 - Send: <03,/rwin1,6,>	
15/05/2011 16:05:26 - /rwin1 - Recv: <03,/rwin1,7,/r11,1505,1,1,;/r12,6,1,1,;/r13,16,1,1,;/r14,26,1,1,;/r15,36,1,1,;/r16,46,1,1,;/r1503,5,1,1,;>	
15/05/2011 16:05:26 - /rwin1 - Send: <03,/rwin1,7,>	
15/05/2011 16:06:26 - /rwin1 - Recv: <03,/rwin1,8,/r11,1506,1,1,;/r12,7,1,1,;/r13,17,1,1,;/r14,27,1,1,;/r15,37,1,1,;/r16,47,1,1,;/r1503,6,1,1,;>	
15/05/2011 16:06:26 - /rwin1 - Send: <03,/rwin1,8,>	
15/05/2011 16:07:32 - /rwin1 - Recv: <03,/rwin1,9,/r11,1507,1,1,;/r12,8,1,1,;/r13,18,1,1,;/r14,28,1,1,;/r15,38,1,1,;/r16,48,1,1,;/r1503,7,1,1,;>	
15/05/2011 16:07:32 - /rwin1 - Send: <03,/rwin1,9,>	
15/05/2011 16:08:26 - /rwin1 - Recv: <03,/rwin1,10,/r11,1508,1,1,;/r12,9,1,1,;/r13,19,1,1,;/r14,29,1,1,;/r15,39,1,1,;/r16,49,1,1,;/r1503,8,1,1,;>	
15/05/2011 16:08:26 - /rwin1 - Send: <03,/rwin1,10,>	
15/05/2011 16:09:26 - /rwin1 - Recv: <03,/rwin1,11,/r11,1509,1,1,;/r12,10,1,1,;/r13,20,1,1,;/r14,30,1,1,;/r15,40,1,1,;/r16,50,1,1,;/r1503,9,1,1,;>	

Table-2 This table depicts control of variable values and communications quality in the system:

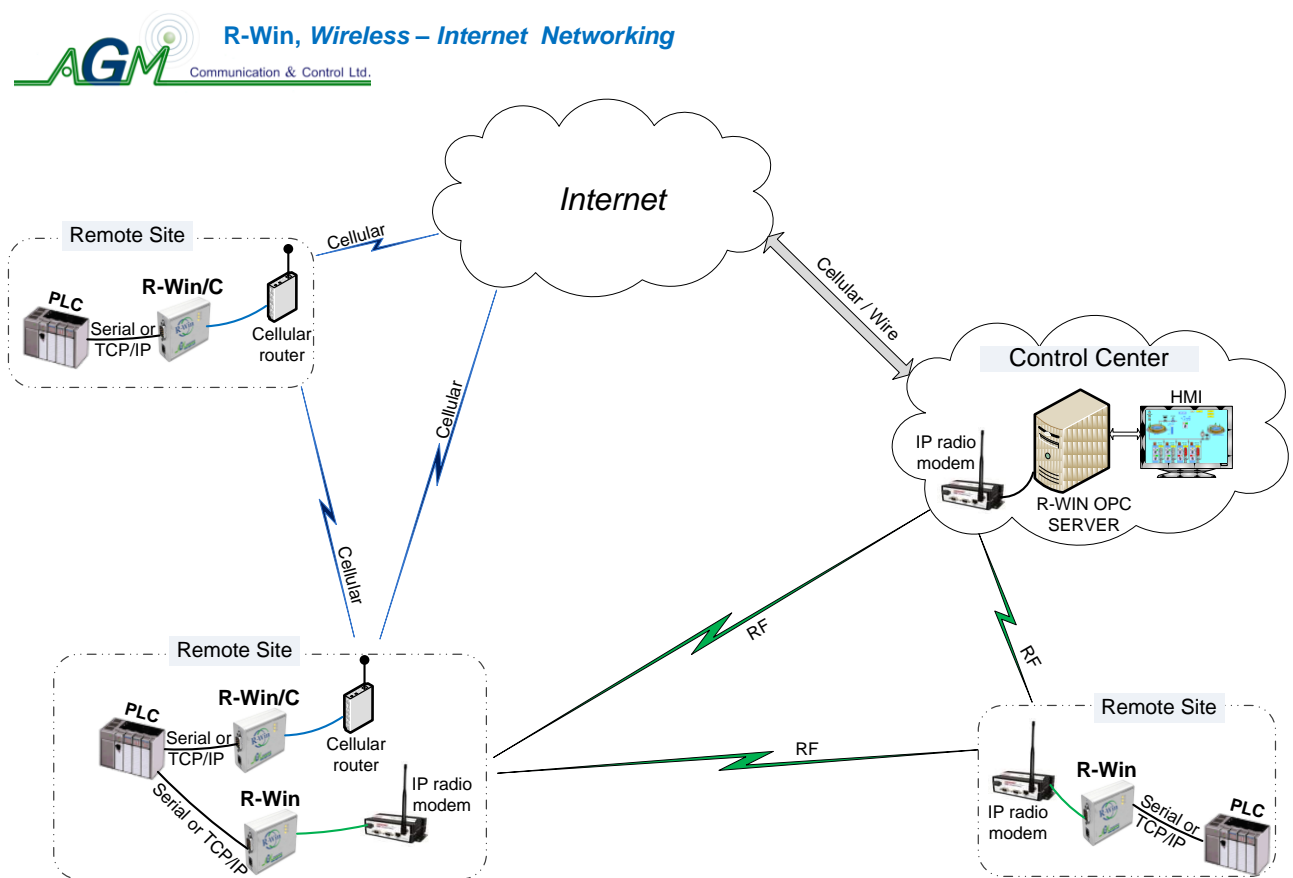
Item ID	Access Path	Status	Value	TimeStamp	Quality
site7/r4		Active	0	12/12/2011 15:34:38	Good, non-specific
site7/r40		Active	300	12/12/2011 15:34:38	Good, non-specific
site7/r41		Active	300	12/12/2011 15:34:38	Good, non-specific
site7/r42		Active	2	12/12/2011 15:34:38	Good, non-specific
site7/r43		Active	2	12/12/2011 15:34:38	Good, non-specific
site7/r44		Active	1200	12/12/2011 15:34:38	Good, non-specific
site7/r45		Active	1500	12/12/2011 15:34:38	Good, non-specific
site7/r46		Active	200	12/12/2011 15:34:38	Good, non-specific
site7/r47		Active	3000	12/12/2011 15:34:38	Good, non-specific
site7/r48		Active	200	12/12/2011 15:34:38	Good, non-specific
site7/r49		Active	1800	12/12/2011 15:34:38	Good, non-specific
site7/r5		Active	0	12/12/2011 15:34:38	Good, non-specific
site7/r50		Active	800	12/12/2011 15:34:38	Good, non-specific

R-Win End Unit

The R-Win software is installed in a compact, secure package at the end unit, between the data originator, a PLC/RTU and the wireless device; R-Win to IP radio-modem, R-Win/C to a Cellular router.

In order to facilitate this document, when the two R-Win description is identical, we refer to it as "R-Win", without the repetition for R-Win, and R-Win/C.

Drawing-1 "Lateral" wireless communication, multi-point signal handling, communication redundancy



- R-Win manages the communications between the station and the control center, updates the control center with the station data and receives operating instruction from the control center HMI.
- R-Win performs initial update of the control center when the station boots-up, then only updates data changes in accordance with scan and filter time / the defined operation range of each datum.
- R-Win sends "I am alive" messages in predefined time periods if no other data needs to be transmitted.

- R-Win allows for transmitting and receiving of data from a number of other end stations, directly without intermediation of the control center. This "lateral communication" enables the updating of distant controllers in other network stations and creating local command and control processes, without the control center's involvement.
- R-Win supports the following communication protocols:

Modbus TCP/IP	Ge_SNPX
Modbus RTU serial	TI
AB-DF1	CTI

Compatibility with other protocols can be created.

- R-Win configuration is done by preparing configuration files and uploading them into the unit through Client-FTP. This operation can be performed via local and remote communication.
- R-Win provides tools for monitoring communications with the control center and other units through Client-Telnet. This operation can be performed via local and remote communication.

C. Communication Management Operations in the R-Win Network

- Communications options in the R-Win network are;
Radio TCP/IP, R-Win
Cellular Router, R-Win/C
Each R-Win has single identification by a unique name and IP address;
R-Win unit on a remote site is a LAN member, identified by a subnet IP address.
R-Win/C unit is a WAN member, identified by a global IP address.
- Each R-Win unit on the network can be designated and operated as a single unit operating vis-à-vis the control center and also as a member of additional sub-group/s, designation derived from the application the station is partner to. Therefore, the architecture of the R-Win network is a Point to Point *and* Point to Multi Point communication and not a Star Configuration as is usual in "classic" SCADA systems (example of implementation is provided later on).
- Additional "non classic" R-Win feature is it's efficient communication operation; R-Win is not Polling, but check the data status on the PLC/RTU, analyze it and sends the relevant changes only.

Operation Method

- Each R-Win end unit contains list files of all relevant data in the controller, with instructions on how to sample them:

Table-3 Database configuration screen: (Path = controller identification in the station and registers value in the controller)

Path	Description	SampleRate	Deadband	WriteAble
/rwin1	rwin1	60		<input checked="" type="checkbox"/> True
/rwin1/r0	1-0	60		<input checked="" type="checkbox"/> True
/rwin1/r1	1-1	60		<input checked="" type="checkbox"/> True
/rwin1/r10	1-10	60		<input checked="" type="checkbox"/> True
/rwin1/r11	1-11	60		<input checked="" type="checkbox"/> True
/rwin1/r12	1-12	60		<input checked="" type="checkbox"/> True
/rwin1/r13	1-13	60		<input checked="" type="checkbox"/> True
/rwin1/r14	1-14	60		<input checked="" type="checkbox"/> True
/rwin1/r15	1-15	60		<input checked="" type="checkbox"/> True
/rwin1/r1501	1-1501	60		<input checked="" type="checkbox"/> True
/rwin1/r1502	1-1502	60		<input checked="" type="checkbox"/> True
/rwin1/r1503	1-1503	60		<input checked="" type="checkbox"/> True
/rwin1/r1504	1-1504	60		<input checked="" type="checkbox"/> True
/rwin1/r1505	1-1505	60		<input checked="" type="checkbox"/> True
/rwin1/r16	1-16	60		<input checked="" type="checkbox"/> True
/rwin1/r2	1-2	60		<input checked="" type="checkbox"/> True
/rwin1/r3	1-3	60		<input checked="" type="checkbox"/> True
/rwin1/r4	1-4	60		<input checked="" type="checkbox"/> True
/rwin1/r5	1-5	60		<input checked="" type="checkbox"/> True
/rwin1/r6	1-6	60		<input checked="" type="checkbox"/> True
/rwin2	rwin2	60		<input checked="" type="checkbox"/> True
/rwin2/r0	2-0	60		<input checked="" type="checkbox"/> True
/rwin2/r1	2-1	60		<input checked="" type="checkbox"/> True
/rwin2/r2	2-2	60		<input checked="" type="checkbox"/> True
/rwin2/r3	2-3	60		<input checked="" type="checkbox"/> True
/rwin2/r4	2-4	60		<input checked="" type="checkbox"/> True
/rwin2/r5	2-5	60		<input checked="" type="checkbox"/> True
/rwin2/r6	2-6	60		<input checked="" type="checkbox"/> True

- Communication start up operation is carried out by R-Win, which initiates the connection to the control center or to other units which it is partnered with for an embedded process, to which it attempts to transmit data and attempts to send connection messages.
- Following a successful connection, R-Win sends an initial update of data to the control center or other units, and then continues to scan the units (PLCs) attached to it, updating the control center and other units according to existing time/filter configuration.
- The unit constantly listens to R-Win/Server in the control center and to all units designated as partners in the process, and is ready to report and receive write instructions to operate elements and change data.
- "Network neighbors", nearby stations serve as an alternative route when communications fail on the primary route, and are also receptive to each other, depending on configuration.

- Should no data transmission between a station and the control center prove necessary for more than a minute (time period can be configured), R-Win will broadcast an “I am alive message”. The control center will reply with a confirmation message.
- Communication procedure with the stations is identical to the procedure vis-à-vis the control center. In R-Win network architecture, all stations default to an equal status.
- Should the station need to receive updated data from other stations for a local control process (such as a reservoir vis-à-vis a number of distant pumping stations), R-Win maintains an open connection with the partner stations in the process, acting as ad-hoc control center towards the updating unit.
- In R-Win network architecture, any station designation options are:
 - Data Consumer
 - Data Producer
 - Data Consumer *and* Producer

One station can serve as a Producer in one process and as a Consumer in a second process, simultaneously. Therefore, the station R-Win has the configurations of the partners to each local process which is taking place via "lateral" communication – both the updating stations and the stations being updated. These configurations are application dependent. This configuration cover also a two stations scenario, in which station A is a Producer for station B for one process, and a Consumer for another process between A & B, in the same time.
- Should any communication malfunction occur, up to 5 communication attempts will be made, with a varying, growing interlude between each. After five failed attempts, the station will switch to "communication malfunction" mode and initiate reboot/connection procedure.

R-Win and R-Win/C main features comparison table:

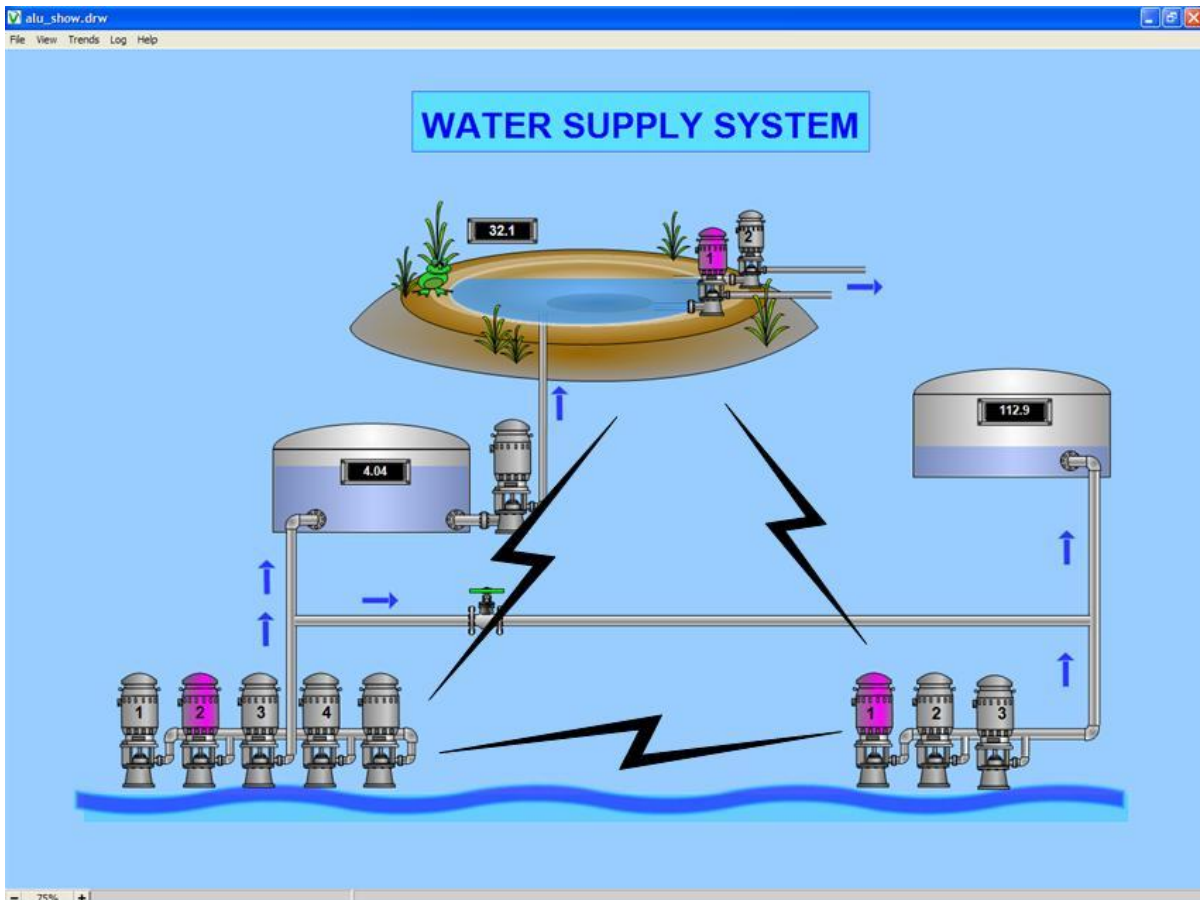
<i>Feature</i>	<i>R-Win</i>	<i>R-Win/C</i>
Comm media	Radio	Cellular
Hardware interfaces	Off-the-shelf PLC & IP radio-modem	Off-the-shelf PLC & cellular router
Protocols	Standards	Standards
Running costs	Country dependent, usually just the annual Radio license fee	Cellular provider

- R-Win System Implementation Example:

Two Pumping Stations Discharging to an Operating Reservoir

- An embedded process is configured between the three main partners to the implementation: a reservoir and two pumping stations. Data such as water level, pump status, piping status and command/control equipment is transmitted in lateral communication between the reservoir and the pumps, as well as between each station, maintaining all the necessary communication for a controlled "autonomous" process.
- When functioning correctly, the SCADA control center will be an "observer" or "partner" according to application and system configuration. The control center receives ongoing reports and intervenes or not depending on its configuration.
- Should a communication malfunction occur between process partners or between a partner and the control center, the R-Win network will activate the alternate communication route, system operation will not halt, data will not be lost and the process will continue to function.

Drawing-2 Sample application: a reservoir and two pumping stations



D. Control Center Communication Management Operation

- The R-Win/Server software is installed in the center and operated on a PC communicating with the end units in the field via an IP radio-modem or the line/cellular/Wi-Fi internet.
- R-Win/ Server software is an OPC Server and allows any standard HMI supporting OPC software to connect and receive data in real time. Connection is also possible through other OPC Client software.
- R-Win/ Server software can connect to an authorized internet server, transmit and receive selected data and enable remote access to authorized users.

E. R-Win Information Security

The IP radio-modem system currently in use supports the advanced data and security encryption standard AES 128-bit, which conforms to the FIPS 140-2 Standard requirements.

The R-Win microcontroller is equipped with information security protocols - Security protocol SSL, SSH and IPsec.

Security capabilities can be expanded by making use of the programming options of the microcontroller, including adding encryption software.

F. Use of Protocols and Frequencies in IP-Radio Communication

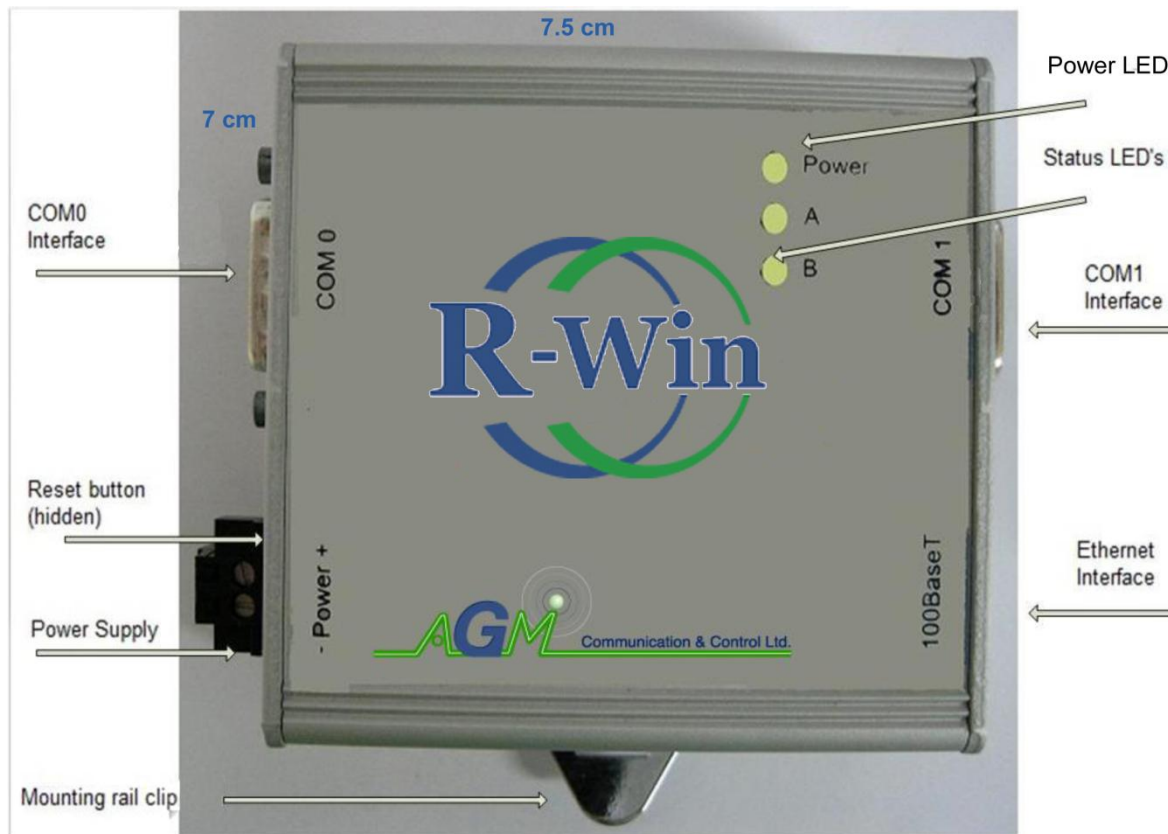
R-Win uses standardized Radio-IP products that include their communication protocols and operation frequencies.

R-Win improves the use of free-public radio bandwidth.

G. R-Win Hardware

H.1. Package and connectors

Picture 1 R-Win hardware and connectors



Package dimensions mm: 70 x 75 x 25

Package dimensions Inches: 2.75 x 2.95 x 0.98

Connectors:

1 TCP-IP port	Connecting the unit directly to the radio-modem, or to a switch to which the controller, the radio-modem and a PC are connected for local management and updating of unit configurations.
1 Serial port	Connect to the controller (which supports a serial connection).
1 Serial port	RS-232 and RS-485 connections.

H.2. Microcontroller Features

- Embedded Web-Controller with powerful 96 MHz processor
- Memory capacity with up to 8 MB RAM and up to 2 MB Flash
- 2 x Ethernet (1x10/100 BaseT Phy , 1xMII)
- CAN 2.0
- USB host and device
- 34 GPIOs
- Simple expansion
- RTOS Real-time multi-tasking Operating System with TCP/IP, web-server and security protocols
- Programming in C++
- Operating voltage 3.3V
- Heat dissipation typ. 1 Watt
- Operating Temp. range -25 to 85 °C
- Standards: EC , UL

H.3. Additional Technical data

IEC Safety Specifications.

Protection type (IEC 60529): IP 20
Protection class (IEC 61140): III
Isolation measurement: EN 60950

Electrical Data.

Input voltage: 24V (10V-30V DC)
Power Consumption: Typically 1.5W

Picture 2 R-Win Installation



AGM Communication & Control Ltd. Mitzpa, Lower Galilee 15276, Israel
+972-544-284221 agm@agm.co.il www.agm.co.il