

PICOSWARM

PIC Online System for Weather, Automation and Remote Monitoring

SYSTEM OVERVIEW

WIRELESS SENSORS AND WIRELESS RECEIVER & DISPLAY

Commercial off-the-shelf weather station - Oregon Scientific WMR918
Remote sensors report data every 45s (15s for wind sensor)
Current implementation uses:

- BTHR918 - indoor temperature, humidity and barometric pressure
- THGR918 - outdoor temperature and humidity
- PCR918 - rain gauge
- WGR918 - anemometer and wind vane
- THWR288 - floating water temperature sensor

Wireless receiver provides local display of current conditions as well as maximum, minimum and average historical values
Receiver includes RS-232 interface at 9600bps to connect to PC

RF PROTOCOL

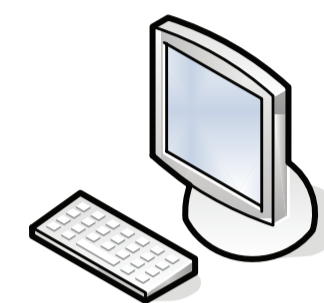
- 433MHz licence-free ISM band
- 2-ASK modulation
- Rate 1/2 'double' Manchester coding (one parity bit for each data bit)
 - 1 in data coded as 10; 0 as 01 (LSB first)
 - 1 in coded bitstream sent as high-low carrier level in bit period; 0 as low-high level
- 8-bit checksum appended
- Typical data packet for THGR918 at 28.3° and 35%:

1 A 3 D 1 0 E B 3 8 2 8 5 0 8 3 5 0 0 B

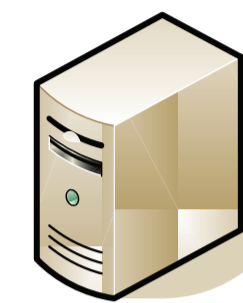
Sensor ID 1
Sensor ID 2
Channel number
Unique address
Temperature decimal
Battery status
Temperature 10s
Temperature 1s
Humidity 1s
-ve temperature
Humidity status
Humidity 10s
Checksum

FUTURE WORK

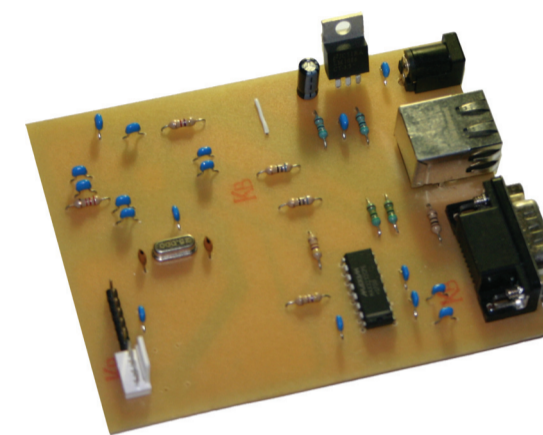
- Extend user-defined POST handler to allow control as well as monitoring for use with home automation systems, alarm systems, central heating controllers etc.
- Add Power-over-Ethernet to allow web interface to provide convenient IP connections for a wide range of legacy RS-232-controlled equipment
- Redesign interface board in surface-mount technology to improve space efficiency and assembly costs
- Implement remote firmware upgrade feature provided by TCP/IP stack to allow easy deployment of new software versions
- Use checksum from wireless receiver to confirm validity of data



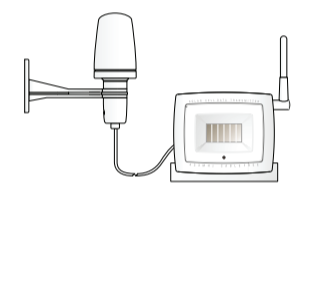
Client browser



Logging server



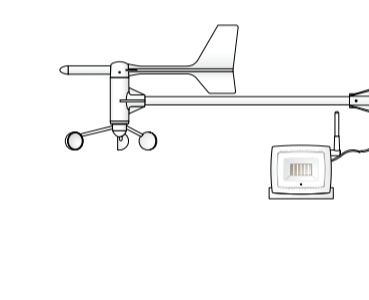
Web interface board



Wireless receiver & display



Wireless temperature, humidity, pressure, wind & rain sensors



WEB INTERFACE BOARD - SOFTWARE

- Uses Microchip's free TCP/IP stack
- Modular design allows unnecessary protocols to be excluded to optimize program memory space and runtime performance
- Nearly all popular TCP/IP suite protocols provided: ARP, DHCP, DNS, FTP, HTTP
- Cooperative multitasking
 - Each protocol has initialization routine and main processing routine
 - Software consists of infinite loop of calls to each processing routine in turn
 - Relies on behaviour of individual functions but provides simulated concurrency with much less overhead than preemptive multitasking
- Reception of data from wireless receiver driven by interrupt when character is received on serial port
- GET or POST web request from a client, or a placeholder encountered when serving a file, generates call to user-defined function to provide correct data

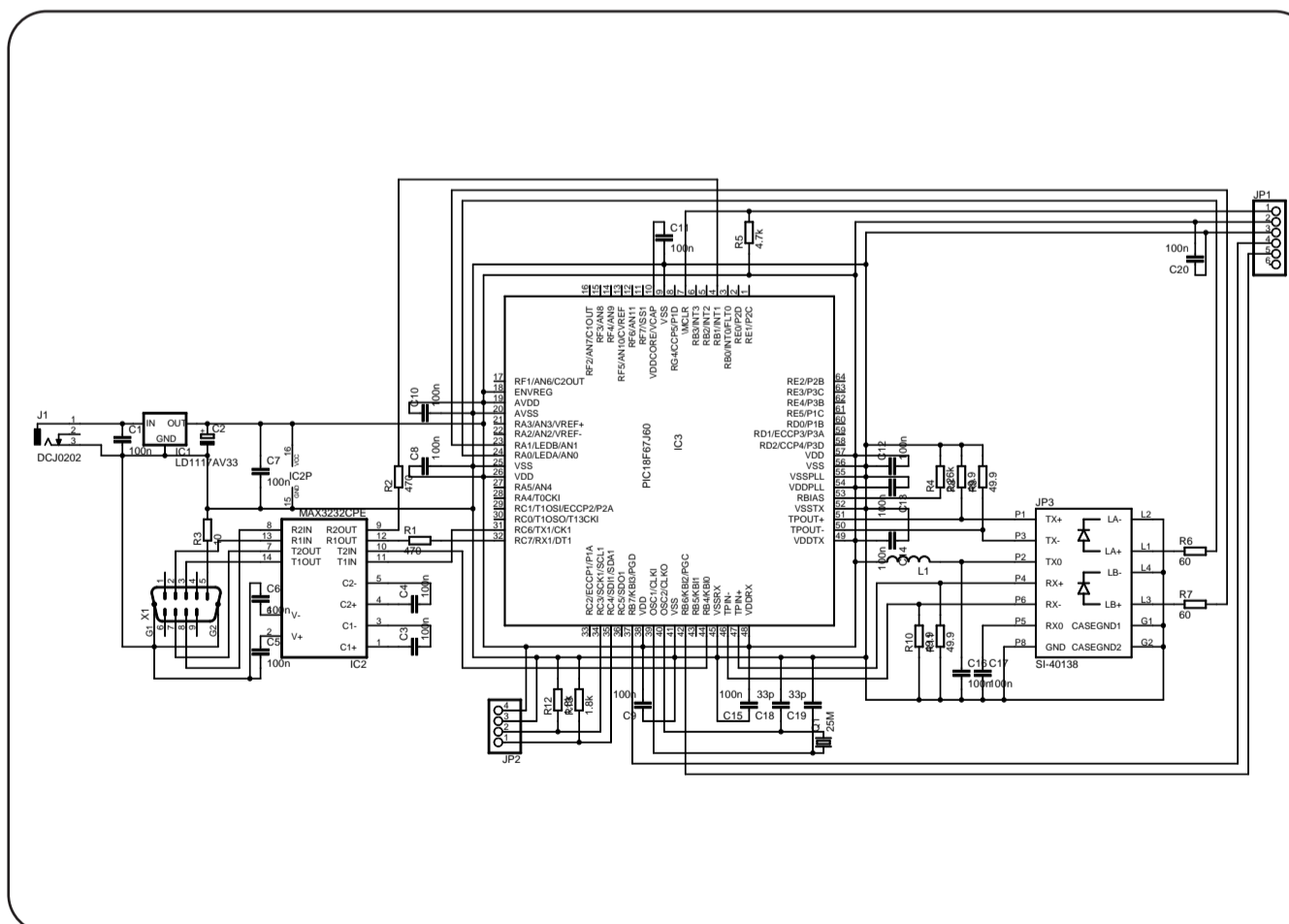
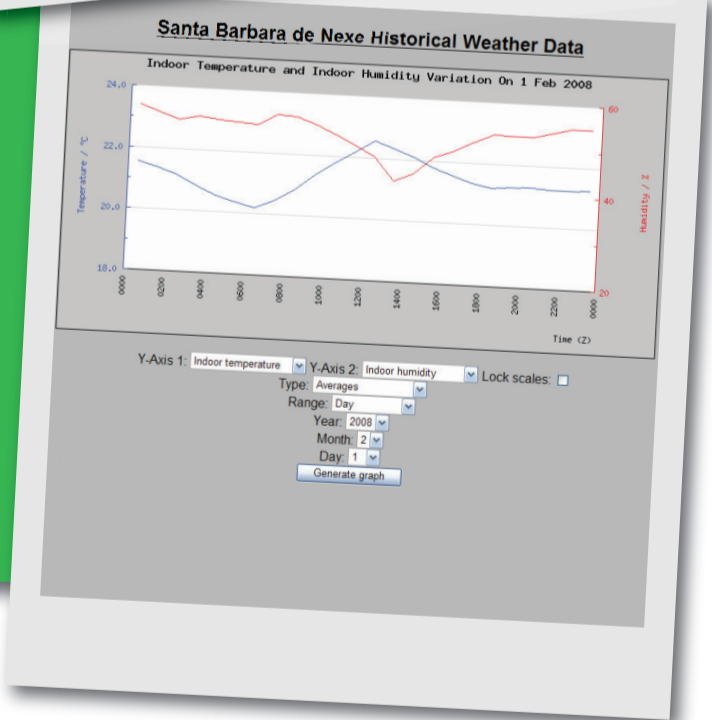
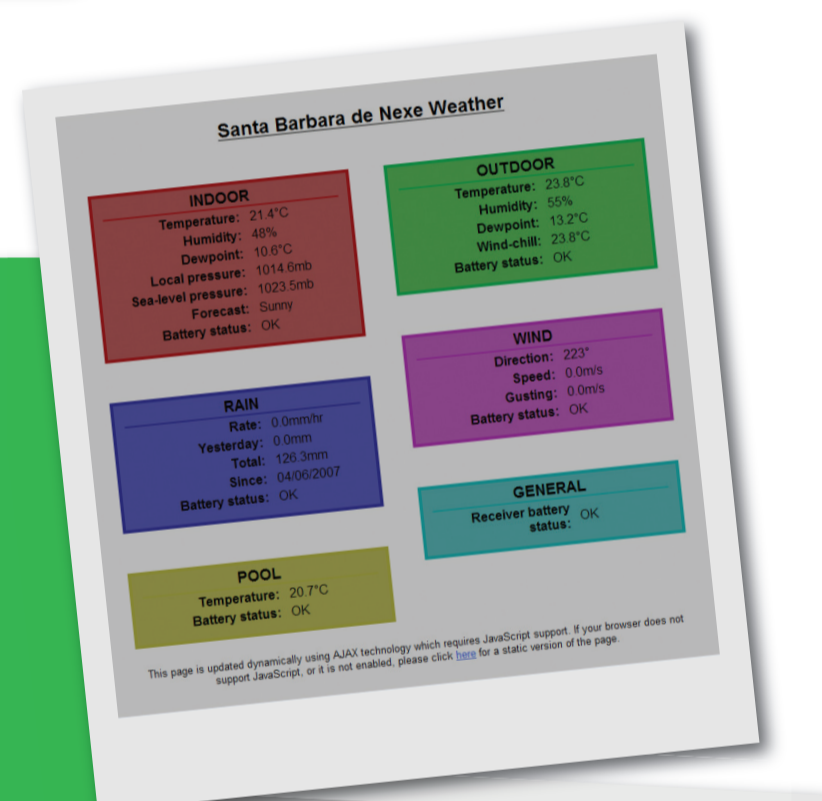
```
void main(void)
{
    Initialize();
    TickInit();
    MPFSInit();
    StackInit();
    HTTPInit();

    while(1)
    {
        StackTask();
        HTTPServer();
    }
}
```

Web interface board main routine

WEB INTERFACE BOARD - OVERVIEW

- Powered by Microchip PIC18F67J60 microcontroller
 - 41.67MHz clock
 - 128kB flash program memory
 - 39 I/O pins
 - 11-input 10-bit A/D converter
 - Built-in ethernet MAC and PHY interface
- Allows client browsers and logging server to observe real-time conditions reported by wireless receiver
- Ethernet socket for internet connection and DB9 socket for serial connection; headers for expansion and programming in-circuit
- Serves dynamic HTML pages, JavaScript and stylesheets to clients
- Web interface uses AJAX technology to update continually, without needing to refresh the browser
- Serves machine-readable XML data to logging server
- Program memory software re-writable allowing remote firmware upgrade



Web interface board schematic

LOGGING SERVER

- Computer on internet with php script to connect to web interface board and download XML data every two minutes
- Script is run as a 'cron' job and saves data to MySQL database
- Second script allows queries on data from web interface and graphs to be drawn using JpGraph library

WEB INTERFACE BOARD - CONSTRUCTION

- PCB constructed using 'Press-n-Peel' transfer film
 - Positive image printed onto film using laser printer
 - Film applied to copper-clad board and ironed to adhere toner to copper
 - Board quenched to produce sharp image
 - PCB etched in sodium persulfate
- Minimum track width of 0.25mm achieved
- All components through-hole mounting except microcontroller
- 64-pin TQFP package PIC hand-soldered using 'flooding' technique, applying solder across all pins and removing bridges using copper braid

