ENGINEERING SUBMITTAL SPECIFICATIONS

MACE XCi System

SCOPE

This specification describes the requirements for a flow meter solution that uses continuous-wave Doppler ultrasonic sensors to measure flow in full pipes, partially-full pipes and open channels. This system shall allow for the connection of up to five (5) Doppler ultrasonic sensors to a single transmitter, thus enabling flow measurements in more than one pipe or channel. This specification covers the XCi System as manufactured by Measuring & Control Equipment (MACE), Sydney, Australia.

GENERAL

1. A flow meter shall consist of a remote electronics transmitter with local readout, on-board data logger, transmitting and controlling electronics; with submersible continuous-wave Doppler ultrasonic sensor/s connected by cable/s to the transmitter.
2. A maximum of five (5) sensors shall be able to be connected via add-on cards housed within the transmitter.
3. A flow meter shall be capable of powering and interfacing to a range of industry standard water quality and meteorological sensors via add-on card/s housed within the transmitter.
4. A flow meter shall be capable of uploading data to internet-based data servers via mobile telephone networks using 3G or GSM, via an add-on card housed within the transmitter.
5. A flow meter shall be powered by 12VDC internal battery with solar or mains powered trickle-charging. The solar regulating shall be onboard the transmitter.
6. A flow meter shall be configured & downloaded, using “point-n-click” PC software.

REMOTE TRANSMITTER

Transmitter Enclosure Specifications

1. The transmitter enclosure shall be made from UV stabilized polycarbonate plastic that can be directly mounted on a pole in outdoor locations without the need for further environmental protection.
2. The transmitter enclosure shall have a hinged door and be pad-lockable.
3. The transmitter enclosure shall have a UV stabilized decal on the front face, with a window for viewing the LCD
4. The transmitter enclosure shall have a rear scalloped section to provide the option to be easily mounted on a 2" O.D pole using U-bolts.
5. The transmitter enclosure shall be optionally able to be mounted on a flat surface
6. The enclosure shall be rated to IP 66 for ingress protection.
7. The transmitter shall have a 'punch-out' section to allow for optional cable access into the rear of the enclosure.
8. The transmitter shall have a 'punch-out' section to allow for optional cable access into the bottom face of the enclosure.

General Transmitter Specifications

1. The remote transmitter shall be the central processing unit of the system and include: 12VDC battery and five card slots allowing the user to install any of six optional add-on cards that control & monitor a variety of flow, water quality and meteorological sensors.
2. The transmitter shall perform all system control tasks including data logging, user interfaces, power management and sensor control.
3. The transmitter shall have a built-in data logger with sufficient capacity for 750,000 discreet data points.
4. The data log shall be cyclical and write over the oldest data first when the log is "full".
5. The data shall be stored in non-volatile memory.
6. On the front of the transmitter, a backlit 16-character, two-line alphanumeric liquid crystal display (LCD) allows the user an on-site readout of parameter values and status messages.
7. Pressing either membrane switch will turn on the LCD. The membrane switches can be used to scroll the display between the various parameters being measured.
8. Parameter units shall be user-definable.
9. The transmitter shall have a solar input capable of regulating up to 20W (@12VDC).
10. The transmitter shall be sufficiently charged by a 5W 12VDC solar panel in latitudes where four hours sunlight per day is available (configuration dependent).
11. The transmitter shall have sufficient battery capacity to run for at least four (4) weeks without any solar charge in the event of inclement weather (configuration dependent).
12. The transmitter shall have a DC power input of 16 - 30VDC @min. 2A.

REMOTE TRANSMITTER CARDS

Doppler Card

1. This card shall provide the input for connecting a single MACE Doppler ultrasonic sensor.
2. Each card shall allow for connection of sensors via a DB9 connector.
3. This card shall be compatible with any MACE Doppler ultrasonic sensor:
   a. MACE Doppler ultrasonic insert velocity sensor
   b. MACE Doppler ultrasonic area/velocity sensor
   c. MACE Doppler ultrasonic velocity sensor
4. The remote transmitter shall accept up to five (5) Doppler cards.

I/O Card

1. This card shall provide an interface (on screw terminals) for industry standard water quality & meteorological sensors.
2. Each card shall provide analog inputs:
   a. 2 x 4-20mA inputs, 12-bit resolution, accuracy 0.5% full scale
   b. 2 x Voltage inputs (0 - 2.5VDC or 0-30VDC)
3. Each card shall provide digital inputs:
   a. 2 x Frequency inputs, 16-bit resolution, range 0 - 65535Hz
   b. 2 x Counter inputs, range 0 - 10Hz
4. Each card shall provide analog outputs:
   a. 2 x 4-20mA outputs, 12-bit resolution, accuracy 0.5% full scale
5. Each card shall provide digital outputs:
   a. 2 x Digital/pulse outputs, open collector, referenced to GND, range 0 - 10Hz
6. Each card shall provide a 12VDC-switched power for powering sensors.
7. The remote transmitter shall accept up to five (5) I/O cards.

Pulse I/O Card

1. This card shall provide a single pulse input for “pulsing” flow meters and a single pulse output (on screw terminals).
2. This card shall provide alternatively 5VDC or 12VDC for powering sensors.
3. Each card shall provide a single digital input:
   a. 1 x Frequency input, range 0 - 1000Hz, accuracy 0.5Hz
4. Each card shall provide a single digital output:
   a. 1 x Voltage-free contact, max. output 10Hz
5. Each card shall provide switched sensor power:
   a. +5VDC (50mA limit, source impedance 30Ω) or +12VDC (1A limit)
6. The remote transmitter shall accept up to five (5) Pulse I/O cards.

SDI-12 Master Card

1. This card shall provide an input for interfacing (on screw terminals) industry standard sensors that communicate via the SDI-12 sensor communications protocol.
2. This card shall be SDI-12 Version 1.3 Compliant
3. This card shall provide 12VDC sensor power
4. The remote transmitter shall accept up to five (5) SDI-12 Master cards.

FloSI Card

1. This card shall provide an interface (on screw terminals) to SCADA, radio networks or data loggers.
2. This card shall provide:
   a. A ModBus RTU slave interface over RS232 or RS485
   b. An SDI-12 Version 1.3 compliant output
   c. An ASCII output over RS232
3. The remote transmitter shall accept one (1) FloSI card.

WebComm Card

1. This card shall provide the remote transmitter with the ability to automatically upload data to a web-based data server via cellphone networks.
2. No polling of the remote transmitter shall be necessary for data to be uploaded.
3. This card shall utilize mobile telephony to access the internet through GSM or 3G networks.
4. Data shall be uploaded and stored in un-encrypted plain text format.
5. All logged data in the remote transmitter shall be uploaded
6. Uploads shall be user-scheduled from a maximum of every 5 minutes to a minimum of every 4 weeks.
7. The data server shall store a maximum of 500Mb of data per site.
8. The data server shall store the data for a minimum of 12 months after which time it will be deleted.
9. Site data shall be accessible via a simple web-interface.
10. The card shall upload data via a simple HTTP protocol directly to other data servers
11. The data server shall provide an HTTP download protocol for access to data via industry standard software packages
12. The web interface shall:
    a. Be password protected
    b. Provide simple site “setup” and maintenance
    c. Provide the ability to “view” and “download” site data
    d. Provide multiple “site access” for a primary user and secondary users
    e. Provide SMS/Email alerts for user configured alarm conditions based on uploaded data
13. The remote transmitter shall accept one (1) WebComm card.

DOPPLER ULTRASONIC SENSORS

Doppler Ultrasonic Insert Sensor

1. The sensor shall be a wetted type, of single piece construction, with both receiver and transmitter housed in a sensor body that is inserted into the fluid flow.
2. The sensor shall have US Patent No. D544,803 and AUS Patent No. AU 301464 S
3. The sensor shall have wetted materials of nickel-plated marine brass and epoxy.
4. The sensor shall be rated to IP68 for ingress protection and capable of being buried and submerged.
5. The sensor shall be capable of being installed through a 2” (BSP or NPT) ball valve.
6. The Doppler ultrasonic insert sensor shall measure fluid velocity in full pipes when there is access to the outside wall of the pipe in which the sensor is to be mounted.
7. The sensor shall use 1MHz continuous-wave Doppler ultrasonic signal processing, to calculate fluid average velocity.
8. The sensor shall measure fluid velocities from ±0.025 to ±4 m/s where the fluid contains 100ppm of suspended acoustically reflective particles that are greater than 75µm in size.
9. Velocity resolution shall be 1mm at 1.0 m/s.
10. Velocity accuracy shall be ±1% (up to 3 m/s).
11. The sensor shall be designed so that the same sensor can be installed in any pipes with a diameter range of 100mm to 2540mm (4” to 100”).
12. Sensor shall be designed as obstruction-less in debris laden flow with an intrusion area no greater than 11.25cm^2.
13. Sensor cables shall be urethane, have a potted bond to the sensor body and be fixed lengths of 10m, 20m, 30m or 50m.
14. Sensor cables shall terminate with a DB9 connector suitable for connecting to a MACE FloSeries3 Doppler card.

Doppler Ultrasonic Area/Velocity Sensor

1. The sensor shall be a wetted type, of single piece construction, with both velocity transducers and depth sensing element housed in a sensor body that is installed into the fluid flow. Access to the monitoring point shall be required for installation and maintenance
2. Sensor body shall have wetted materials of PVC, alumina ceramic and epoxy.
3. The sensor shall be rated to IP68 for ingress protection and capable of being buried and submerged.
4. The Doppler ultrasonic area/velocity sensor shall measure fluid velocity in partially-full pipes and open-channels using 1MHz continuous-wave Doppler ultrasonic signal processing, to calculate fluid average velocity.
5. The sensor shall measure fluid velocities from ±0.025 to ±4 m/s where the fluid contains 100ppm of suspended acoustically reflective particles that are greater than 75µm in size.
6. Velocity resolution shall be 1mm at 1.0 m/s.
7. Velocity accuracy shall be ±1% (up to 3 m/s).
8. The Doppler ultrasonic area/velocity sensor shall measure fluid depth using a ceramic capacitive pressure diaphragm referenced to atmosphere.

9. The depth sensor shall measure depth over the range 0 to 4m.
10. Depth accuracy shall be 0.2% of full scale at constant temperature in a static stream. One percent of full scale over a stream temperature range 5 to 50 Celsius.
11. Depth resolution shall be 1mm
12. Integral depth sensor shall withstand over-range depths up to 60 meters (192 feet) without damage
13. The sensor shall be designed so that the same sensor can be installed in any pipe with a diameter range of 150mm to 2540mm (6” to 100”) or any open channel with a maximum width or depth of 2.54m (100”).
14. Sensor shall be designed as obstruction-less in debris laden flow.
15. Sensor shall be mounted to a polypropylene mounting plate or strap and then installed within the pipe or channel.
16. Sensor cables shall be urethane, have a potted bond to the sensor body and be fixed lengths of 10m, 20m, 30m or 50m.
17. Sensor cables shall terminate with a DB9 connector suitable for connecting to a MACE FloSeries3 Doppler card.

Doppler Ultrasonic Velocity Sensor

1. The sensor shall be a wetted type, of single piece construction, with velocity transducers housed in a sensor body that is installed into the fluid flow. Access to the monitoring point shall be required for installation and maintenance
2. The sensor body shall have wetted materials of PVC, epoxy.
3. The sensor shall be rated to IP68 for ingress protection and capable of being buried and submerged.
4. The Doppler ultrasonic velocity sensor shall measure fluid velocity in full-pipes, partially-full pipes and open-channels (when used in conjunction with a depth sensor) using 1MHz continuous-wave Doppler ultrasonic signal processing, to calculate fluid average velocity.
5. The sensor shall measure fluid velocities from ±0.025 to ±4 m/s where the fluid contains 100ppm of suspended acoustically reflective particles that are greater than 75µm in size.
6. Velocity resolution shall be 1mm at 1.0 m/s.
7. Velocity accuracy shall be ±1% (up to 3 m/s).
8. The sensor shall be designed so that the same sensor can be installed in any pipe with a diameter range of 150mm to 2540mm (6” to 100”) or any open channel with a maximum width or depth of 2.54m (100”).
9. Sensor shall be designed as obstruction-less in debris laden flow.
10. Sensor shall be mounted to a polypropylene mounting plate or strap and then installed within the pipe or channel.
11. Sensor cables shall be urethane, have a potted bond to the sensor body and be fixed lengths of 10m, 20m, 30m or 50m.
12. Sensor cables shall terminate with a DB9 connector suitable for connecting to a MACE FloSeries3 Doppler card.

SOFTWARE

1. The flow meter shall be configured using software designed to be run on a PC with minimum system requirements of Windows XP and 4Mb available hard drive space.
2. Shall be “point-n-click” interface with no proprietary coding knowledge required
3. Shall allow site configuration, LCD configuration, data downloads and site diagnostics.
4. Shall allow user the ability to configure the time interval between measurement cycles.
5. Shall provide logging of system channels and status messages pertinent to the site.
6. Shall allow for “real-time” viewing and capturing of velocity profiles in full pipes, partially-full pipes and open channels.
7. Shall provide dual password protection, a “Super” level password to access transmitter configuration, and a “Download” level password for access to logged data.
8. Shall allow the user to enter 16-character alphanumeric “Names” to parameter channels for display on the LCD and/or data log file.
9. Shall allow for multiple “flow rate” parameter channels to be totalised as a single total parameter channel.
10. Shall have both resettable and permanent totalisers.
11. Shall allow for simple calibration of connected sensors (where applicable).
12. Shall provide configuration of open channels, closed channels, full or not full: circle, custom, ellipse, flat bottom-vee, ovoid, square, distance vs. depth, depth vs. width, and CAD designer.
13. Shall calculate 5th-order polynomial co-efficients for open-channel cross-sectional area configurations.
14. Shall provide a simple text interface for viewing logged data files.
15. Shall have built-in equations for calculating flow through/over a weir or flume.
16. Shall have a 35-point look-up table of depth Vs flow rate for rated structures.

WARRANTY

1. 24 months (2 years) parts and labour guarantee.

MANUFACTURER

Flow meter system shall be:

1. MACE FloPro XCi for wastewater, stormwater and industrial flows

2. MACE AgriFlo XCi for agricultural water and wastewater flows

3. MACE HydroMace XCi for monitoring environmental sensors without Doppler ultrasonic sensors.