# QProx™ E2SR

Charge Transfer ('QT') Development Sensor

The QProx™ E2SR is designed specifically for development and experimentation; accordingly it incorporates a large variety of user-definable QT modes and processing options. In addition, the unit can be employed as a programming device for QProx™ modules and IC's by acting as a "cloning" source of setup data.

QT technology uniquely allows virtually any object or surface to be made proximity sensitive. Simply connecting the sensor to a conductive, isolated material will make it proximity or contact sensitive. Nonmetallic objects can be made sensitive by attaching a metal foil, wire, or sheet to the object. The sense field easily penetrates great thicknesses of material including glass, plastics, wood etc. The sense field can also be shaped by the use of nearby grounded metal surfaces. Additionally the QT effect has the unique capability of performing material analysis, for example to examine moisture content, by taking advantage of signal versus pulsewidth dependencies.
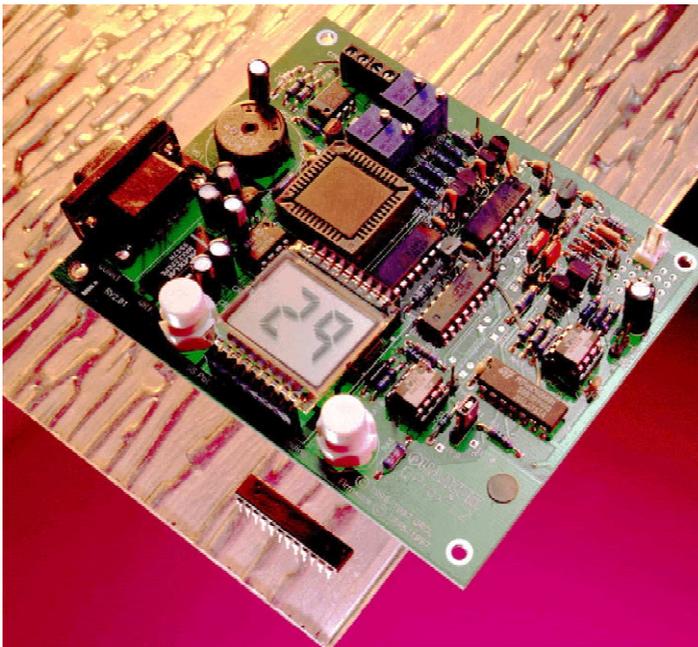
FEATURES

- Burst mode charge transfer capacitance sensor
- Sensitivity to 5 femtofarads (0.005pF)
- Up to 2,500pF load capacity
- Response time settable from 200μs to 100ms
- Variable charge-transfer times from 50ns to 1μs
- Automatic self-calibration
- Automatic drift compensation
- Median and averaging digital filters built in
- Programmable sensitivity, burst timing, filtering, gain
- Post detection processing including event filtering
- Displays signals in real time on LCD
- Buffered analog output
- Open drain detection output
- Ratio mode for material analysis
- RS232 port for external control and data extraction
- Critical parts socketed for easy experimentation
- Cloning port to transfer setups to ICs and modules

Offering an effective 96dB operating range using an innovative acquisition method, the QProx™ E2SR can easily detect femtofarads of change within a background level of hundreds of picofarads. The E2SR also allows thousands of processing feature combinations via its unique Setups interface.

In addition to the QT effect's natural noise immunity, the E2SR contains two types of signal filters plus a unique post detection event filter, any of which can be enabled or disabled. A psuedo-random burst spacing mode allows the sensor to 'skip around' repetitive impulse noise, which, when combined with the internal median filter can act to drastically reduce the noise effects.

The E2SR also has a serial port which can be monitored with included QTWinView™ software to assist in the understanding of QProx™ technology.

User Setups

The E2SR employs an LCD plus two buttons to allow configuration of the many possible operating modes and parameters. The LCD acts like a menu-driven interface; one button scrolls through a list of items, the other can alter the selection. The E2SR has 20 user definable parameters to allow a high degree of flexibility. All functions can be enabled or disabled, or changed for the degree of the function's effect.

After the Setup procedure is complete the sensor can be made to self-calibrate and run. During operation the LCD will show the actual signals in real time.

The E2SR may also be programmed over its RS232 serial port from virtually any PC using a simple ASCII command set, or via included QTWinView™ software.

QUANTUM

Auto-Learn Modes

The E2SR can automatically learn the required signal for a detection trip point by simply presenting the object to be detected to the sense element and pushing a button. The unit can permanently remember the signal strength
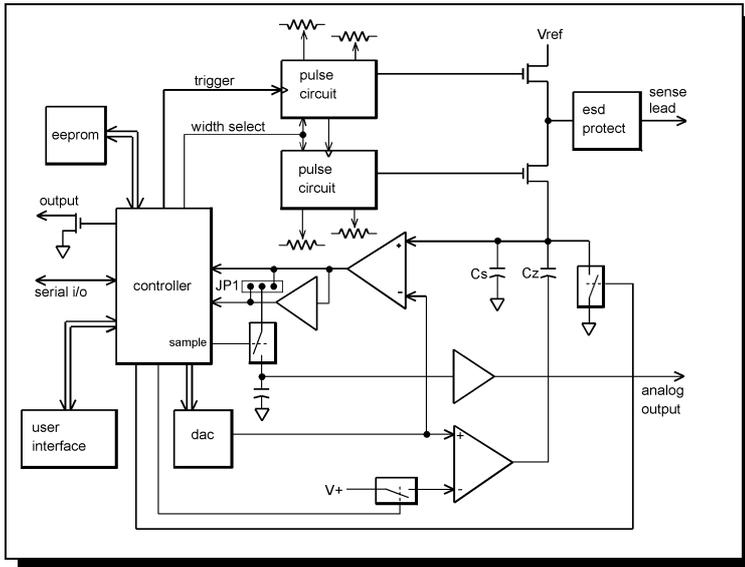
required to create a prox 'trip' for the object presented; this feature eliminates the need for sensitivity potentiometers. There are three different calibration modes to select from.

The E2SR can also be set to track slow changes in the background signal level and thus alter the detection trip point over time as the environment changes. This 'drift compensation' feature is user-programmable.

Gain and Offset Controls

The QT method allows for gain changing by altering the number of pulses in a burst; the E2SR can be set to burst lengths from 4 to 64 pulses long. Gain can also be altered by changing the value of the sample capacitor Cs.

Using a subranging technique, the E2SR processes an arbitrary 8-bit subrange within a 16 bit signal space. Subranging is accomplished by using a DAC to control charge cancellation and amplifier offset. During each burst, charge cancellation at Cs reduces the buildup of voltage and creates, in effect, a virtual summing junction. Additional offset performed at the amplifier positions the signal at a specific point in the ADC's range. Using these methods, high loads can be connected without affecting sensitivity.

Signal Processing

The E2SR contains two cascadable digital filters. The first is a median filter designed for the efficient removal of impulse noise. The second is a finite impulse response signal averager that can be set from 2 to 64 averages.

Cascaded together, the filters are efficient at suppressing all types of signal noise.

The E2SR can also process signals to create an output when a specified event criteria is met. Criteria can include exceeding positive or negative signal thresholds, exceeding a rate of change of the signal, or sensing a detection for a minimum duration of time.

If a detection occurs for longer than a user-specified duration the unit can be made to auto-recalibrate. This is useful to clear a 'stuck sensor' condition caused by a foreign object or debris around the sense element; auto-recalibrate causes the unit to take the current signal as its new reference, effectively nulling out the signals caused by the foreign object.

The E2SR's burst rate can be set to occur every 200μs, resulting in a 5kHz update rate. The sensor can be intentionally slowed down by slowing the burst rate and/or increasing the amount of pre- or post-detection filtering. Lengthening the interval between bursts reduces average RF emissions and power draw.

Data Outputs and Interfaces

The unit provides a real-time LCD display of signal level, raw analog output, and a bidirectional RS232 interface that can transfer a data stream in real time to a PC, all in addition to the open-drain detect output.

QTWinView™ Setups Screen

		0	1	2	3	4	5	6	7	8	9
0	Detect Threshold, Counts	62	40	32	25	19	14	11	8	6	4
1	Hysteresis, % of Threshold	50	25	12.5	0						
2	Reference Offset	16	32	64	96	112	128	160	192	224	240
3	Amplifier Gain	Low	High								
4	Pulse Width Pots Select		Pair 1	Pair 2				Ratio			
5	Burst Length, pulses/burst	4	8	16	24	32	40	48	56	64	
6	Burst Spacing	200us	500us	1ms	2ms	5ms	10ms	20ms	50ms	100ms	
7	Burst Randomization, %	off	12.5%	25%	50%						
8	Drift Comp Rate, secs/bit	off	100	50	20	10	5	2	1	0.5	0.2
9	Median Filter	off	on								
A	Boxcar Average, length	off	2	4	8	16	32	64			
B	Detect Integrator, counts	off	1	2	5	10	20	50	100	200	
C	Max On-Duration, secs	infinite	100	50	20	10	5	2	1	0.5	0.2
D	Detection Mode	P+	P+D	P+/-	P+/-D	PN+/-	PN+/-D	N+/-	N+/-D	N-	N-D
E	Beeper Mode	off	soft	med	loud						
F	Serial/Motion Modes	off	9600V	19.2V	9600P	19.2P					motion
G	Buttons Mode	norm	bg/obj								
H	Cal Store and Lock	off	store	lock							
J	LCD Display Default	Sig	Sig - Ref	Ref		FineOff	CrsOff	DI Ctr			
L	Ratio coeff. 100's	0	100	200	300	400	500	600	700	800	900
N	Ratio coeff. 10's	0	10	20	30	40	50	60	70	80	90
P	Ratio coeff. 1's	0	1	2	3	4	5	6	7	8	9
U	reserved										

The QT9701B2 QProx™ IC uses the same communications protocol as the E2SR, allowing host software to be used with these ICs as well.

The E2SR can communicate the signal levels, reference and offset values, status, and detection state over the serial link. In addition, all setup functions of the E2SR can be remotely interrogated and if desired, reprogrammed.

This includes all gain-setting parameters, digital filtering options, and post-processing features.

The serial mode can be configured to either a 'polled mode' or a 'verbose mode'. Polled mode allows the host device to request any data element from the E2SR by sending a single ASCII character command. Verbose mode makes the E2SR send a particular data element continuously.

Baud rates of 9600 and 19200 are supported.

QTWinView™ Software

Included QTWinView™ software displays signals in real time along with other pertinent data such as offsets and post-processing status. This software package includes a strip-chart recorder and a disk logging feature that is compatible with most spreadsheet packages. A separate events window can record time and date stamped events if desired.

User setups can be saved and recalled; it is even possible to create numerous radio buttons that set the unit to user-defined settings.

QTWinView™ also permits remote programming for full control of the E2SR.

This invaluable software package yields a rapid understanding of the QT principle, the E2SR's internal workings, and its interaction with sensed objects. Free software updates are available on Quantum's web site.

Cloning to QProx™ ICs and Modules

The onboard serial e²prom is used to store all user setup parameters and certain calibration data, ensuring that these will not vanish when power is interrupted. Setups may be transferred to QProx™ modules or circuits by using the included cloning cable. The e²prom setup data is extracted over the cable and copied to the module or IC.

It is also possible to clone setup information by removing the socketed e²prom from the E2SR and temporarily mating it to the QProx™ module or circuit via the included adapter. The target circuit will absorb the e²prom's contents into its own permanent memory. The e²prom can then be removed and placed back into the E2SR when done.

QProx™ IC's can be programmed in quantity by simply copying the inexpensive, readily available e²prom in a commercial duplicator.

The QT9701B2 IC can clone data like QProx™ modules; its clone port requires no extra components and thus is
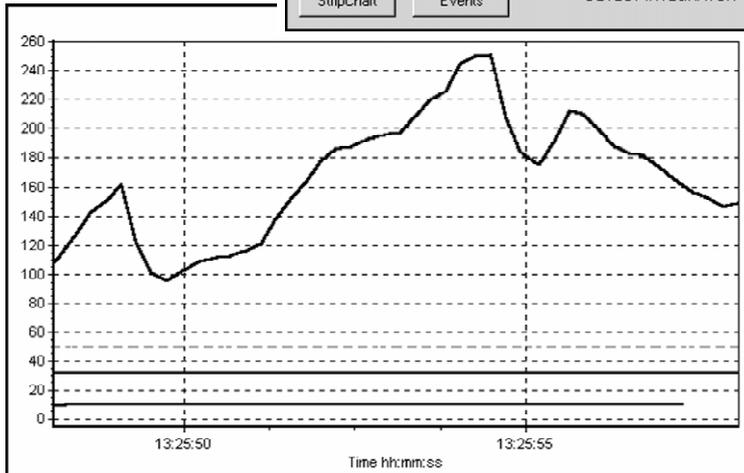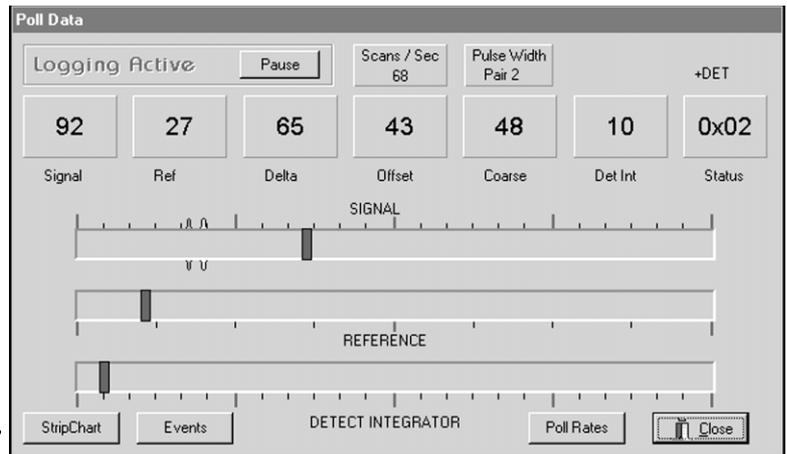
extremely easy to design into a circuit. The only pcb area required is for 6 pins of empty pads to act as a mating strip for the cloning adaptor's 'pogo' pins.

The cloning method of setup transfer permits IC's and modules to be programmed with highly sophisticated processing options that are unimaginable with any other technology.

Circuit Flexibility

The QProx™ E2SR has been designed for maximum flexibility. Critical sensor parts are socketed including the amplifiers, charge detector and cancellation capacitors, FETs, and amp gain resistor. This facilitates easy experimentation with the QT effect via part substitution. For example, the unit can be made much more sensitive by simply replacing the socketed capacitors with smaller values.

The E2SR features numerous test points to allow probing with an oscilloscope in conjunction with the schematic.

Ratio Mode

The E2SR's ratio mode allows the user to determine certain material properties like moisture content, while largely ignoring the mass of the object itself.

This mode works by taking the ratio of signals measured at two different QT pulse widths, thus looking at the frequency dependence of materials from a time-domain perspective.

Both sets of pulse times, for charge and transfer, are controlled by a set of potentiometers which may be varied from 50ns to 1,000ns.

QUANTUM

E2SR Specifications

Recommended Operating Conditions	min	typ	max	units
Recommended Supply Voltage	7.5		12	VDC
Load Capacitance	0		2,500	pF
Operating Temperature	0		40	°C

Absolute Maximum Ratings	min	typ	max	units
Supply Voltage	-0.5		15	VDC
Output transistor voltage	-0.5		11	VDC Note 1
Output transistor current			100	|mA|
Sense signal lead voltage	-0.5		5	VDC
Sense signal lead current			50	|mA|
Analog output voltage	-0.5		5.0	VDC
Analog output current			10	|mA|

Operating Specifications	min	typ	max	units
Capacitance load range	0		2,500	pF
Resolution @ 2000 pF load	35	30		femtofarads (fF)
Resolution @ 1000 pF load	25	15		fF
Resolution @ 400 pF load	10	8		fF Note 2
Resolution @ 200 pF load	6	4		fF Note 2
Differential linearity		1	1.5	lsb
Response time	200			µs
Burst spacing	200µs		0.1s	s
Burst randomization	0		50	% of burst spacing Note 3
Burst length	4		64	QT cycles / burst Note 4
Gate drive pulse width, min, charge or transfer		50		ns
Gate drive pulse width, max., charge or transfer	1,000	1,200		ns
Supply current		35		mA

Signal Processing

	min	typ	max	units
Median filter sample length			5	samples
Boxcar filter sample length	2		64	samples Note 5
Drift compensation rate	100		0.2	secs/bit
Post-detection integrator length	1		200	counts Note 6
Post-detection recalibration timer duration	0.2		100	seconds Note 6

Outputs

	min	typ	max	units
Output transistor on-resistance @ 10 mA			20	ohms
Analog frequency response			2.5	kHz Note 7
Analog output impedance @ 1 kHz			50	ohms
Analog output range, unloaded	0.05		4.0	volts

Note 1: Output is zener clamped to 12 volts
Note 2: Change in charge detector parts required (socketed)
Note 3: Randomized in steps of 12.5, 25, 50% of spacing
Note 4: In steps of 4, 8, 16, 24, 32….

Note 5: Intervals of 2, 4, 8, 16, 32, 64
Note 6: In 1-2-5 sequence
Note 7: Burst rate dependent
All features and specifications subject to change

ORDER INFORMATION

QProx™ Development Sensor . . . . **E2SR**   Includes board, theory and operation manual, adhesive copper foil strip, coaxial signal cable, PC serial cable, QTWinView™ software