Compact High-Resolution Position Sensing Transmission Ionization Chamber

Features

- 64 mm x 64 mm sensitive area
- Ionization chamber with 32 by 32 strip readout for position and shape monitoring
- Minimum scattering due to thin films of low-Z material
- Small beamline length (32 mm)
- Small electrode gaps for low recombination
- Polyimide film electrode substrates for radiation hardness
- Electrode patterns laser-cut for high geometric precision
- Operable with atmospheric pressure air chamber gas or flow-through gas
- Integrated temperature, pressure and humidity sensing
- Integrated desiccant for fill gas
- HV loopback
- Compatible with I3200 or I6400 readout electronics

Applications	• Particle therapy beam monitoring • On-line beam trajectory monitoring • General high energy ion beam diagnostics
Options	• Non-multiplexed environmental sensor readout

Specifications

Beam compatibility	
Species	Protons, deuterons, fully-stripped carbon
Energy range	30 MeV/nucleon to 500 MeV / nucleon
Beam current density range	Up to 20 nA cm^{-2} (particle current)

Sensor	
Type	Parallel plate dual ionization chamber with multi-strip cathodes
High voltage	500-1000 V nominal (1660 to 3330 V cm^{-1}); maximum 1500 V
Sensitive area	64 mm by 64 mm

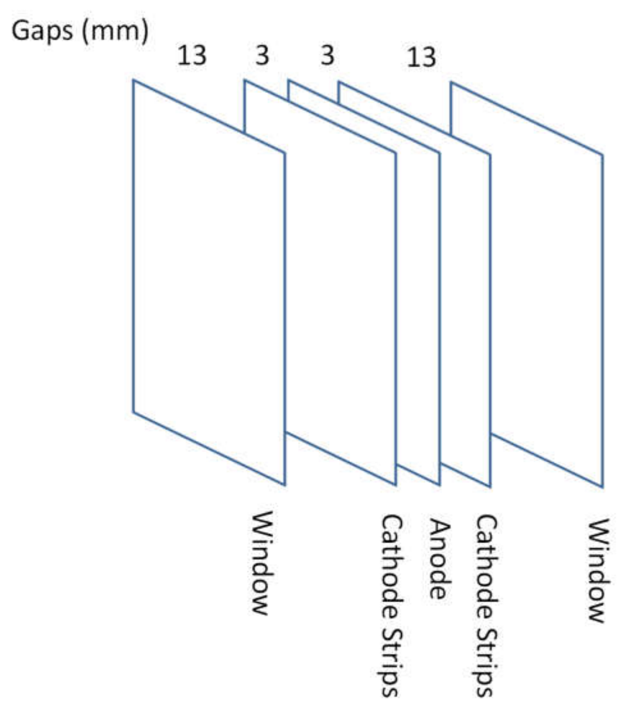
Sensor (cont)	
Sensitive volume	Active volume 1: Strip cathode 1 to anode. 3mm spacing. Active volume 2: Anode to strip cathode 2. 3mm spacing.
Strip geometry	32 strips 2.00 mm pitch (50 µm inter-strip gaps typical)
Gain uniformity	Better than +/-2% for beams within the sensitive area.
Position accuracy	Integral linearity better than 50 µm maximum deviation relative over the sen-
Position resolution	Depends on signal to noise ratio; 10’s of µm achievable provided beam co-vers more than one strip.
Fiducials	Electrode strips tolerance build-up relative to fiducial features on body +/- 0.3 mm nominal, < +/- 0.1 mm typical .

Chamber gas	
Operating gas	Dry atmospheric air, or flow of any clean ionization chamber gas (Ar/CO_2, N_2 etc)
Flow gas connections	To suit 1/8” tube push fit
Desiccant	For use when chamber is closed to atmosphere. Silca gel sachet. Sachet can be changed with chamber in situ.

Mechanical	
Insertion length	32 mm window to window, 37 mm housing face to face.
Overall size	190 mm by 190 mm by 37 mm approx (see figures)
Weight	1.3 kg (2.8 lb) excluding any added mounting brackets.
Operating environment	Clean and dust-free, 0 to 35 C (15 to 25 C recommended , < 70% humidity, non-condensing, vibration < 0.1g all axes (1 to 50 Hz) Temperature and pressure compensation of chamber gain must be per-formed.
Shipping and storage environment	-10 to 50 C, < 80% humidity, non-condensing, vibration < 1g all axes, 1 to 20 Hz

Beam scattering	
Layers in beam path	

1	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (window)
2	13 mm	Fill gas (non-active gap)
3a	0.1 µm	Aluminization (ground plane)
3b	25 µm	Polyimide foil
3c	0.1 µm	Aluminization (strip cathode)
4	3 mm	Fill gas (active gap)
5	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (anode)
6	3 mm	Fill gas (active gap)
7a	0.1 µm	Aluminization (strip cathode)
7b	25 µm	Polyimide foil
7c	0.1 µm	Aluminization (ground plane)
8	13 mm	Fill gas (non-active gap)
9	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (window)



Total effective thickness < 150 µm water equivalent.

CAUTION	Do not expose the device to ionizing radiation beams unless all connections to readout electronics and bias supplies are made, or otherwise grounded. Charge build-up and subsequent arcing damage can occur.

Connectors	
Strip readout	DSub male high density 44 pin. Two identical connectors (one per axis, 32 strips per axis)

1	Strip 29	16	Strip 31	31	Strip 32
2	Strip 28	17	Strip 30	32	Screen
3	Strip 26	18	Strip 27	33	AGnd / KGnd
4	Strip 24	19	Strip 25	34	AGnd / KGnd
5	Strip 22	20	Strip 23	35	AGnd / KGnd
6	Strip 20	21	Strip 21	36	AGnd / KGnd
7	Strip 18	22	Strip 19	37	AGnd / KGnd
8	Strip 16	23	Strip 17	38	AGnd / KGnd
9	Strip 14	24	Strip 15	39	AGnd / KGnd
10	Strip 12	25	Strip 13	40	AGnd / KGnd
11	Strip 10	26	Strip 11	41	AGnd / KGnd
12	Strip 8	27	Strip 9	42	AGnd / KGnd
13	Strip 6	28	Strip 7	43	Screen
14	Strip 4	29	Strip 5	44	Strip 3
15	Strip 2	30	Strip 1	-	-

Connector shell is common with cable screen 1.

The pin arrangement is compatible with a pin to pin (M-F) 44-way cable connection to an I6400 electrometer. One axis will read out on I6400 channels 1-32, the other on channels 33-64.

HV in	SHV
HV out	SHV
Monitor (default option)	DSub male 9-pin

1	Chassis	6	Analog out +
2	Analog out -	7	Signal select bit 0
3	Signal select bit 1	8	Device ID2
4	Device ID1	9	+5V in
5	DGnd		

DGnd is isolated from AGnd.

AGnd and KGnd are equivalent (the I6400 and I3200 electronics use the name AGnd, the I128 electronics uses KGnd)

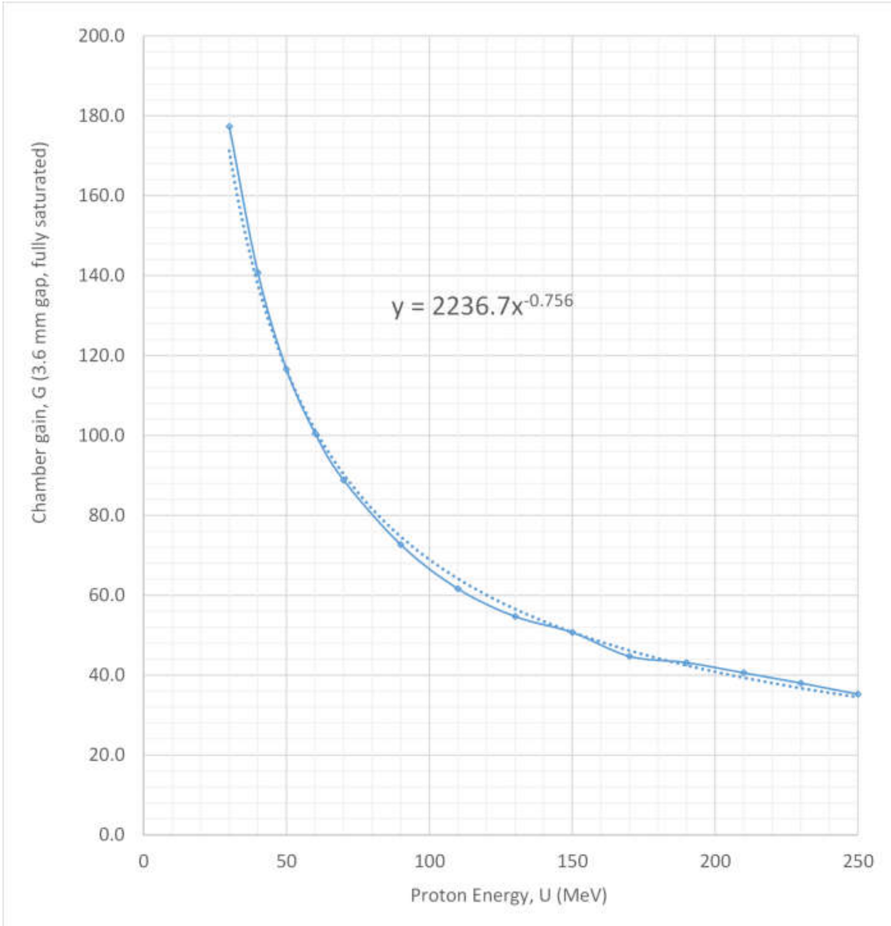
Calibration (cont)	
Readout MUX	Digital bit pattern (TTL levels(to select analog sensor voltage that is switched to pins 6, 2 of monitor connector. *Bit 1* / *Bit 0* / *Selected sensor*: 0 / 0 / Temperature (V_{measT}) 0 / 1 / Pressure (V_{measP}) 1 / 0 / Relative humidity (V_{measH}) 1 / 1 / Reference voltage (V_{ref})
Monitor (-NMX option)	DSub male 9-pin 1 Chassis; 2 Pressure (V_{measP}); 3 Temperature (V_{measT}); 4 Device ID1; 5 DGnd; 6 Relative humidity (V_{measH}); 7 +5 V in; 8 Device ID2; 9 +5 V in -NMX purchase option; direct signals, no multiplex
Temperature	Temperature(centigrade) = 100*V_{measT} Temperature(Kelvin) = Temperature(centigrade) + 273.2
Pressure	Pressure(psi) = 18.75 * (V_{measP} / V_{ref} - 0.1) Pressure(mbar) = Pressure(psi) * 68.95 Pressure(Pa) = Pressure(psi) * 6895
Humidity	Relative humidity (%) = 157 * (V_{measH} / V_{ref}) - 23.8
Gain correction	Nominal gain at standard ambient temperature and pressure ($Temperature_{SATP}$ = 298.15 K, $Pressure_{SATP}$ = 100000 Pa), must be corrected for measured temperature and pressure: Gain = $Gain_{SATP}$ / [($Pressure_{SATP}$ / Pressure(Pa)) * (Temperature(Kelvin) / $Temperature_{SATP}$)] For nominal gains established at other reference temperature and pressure, substitute the appropriate reference values in the equation.

Readout MUX bit pattern:

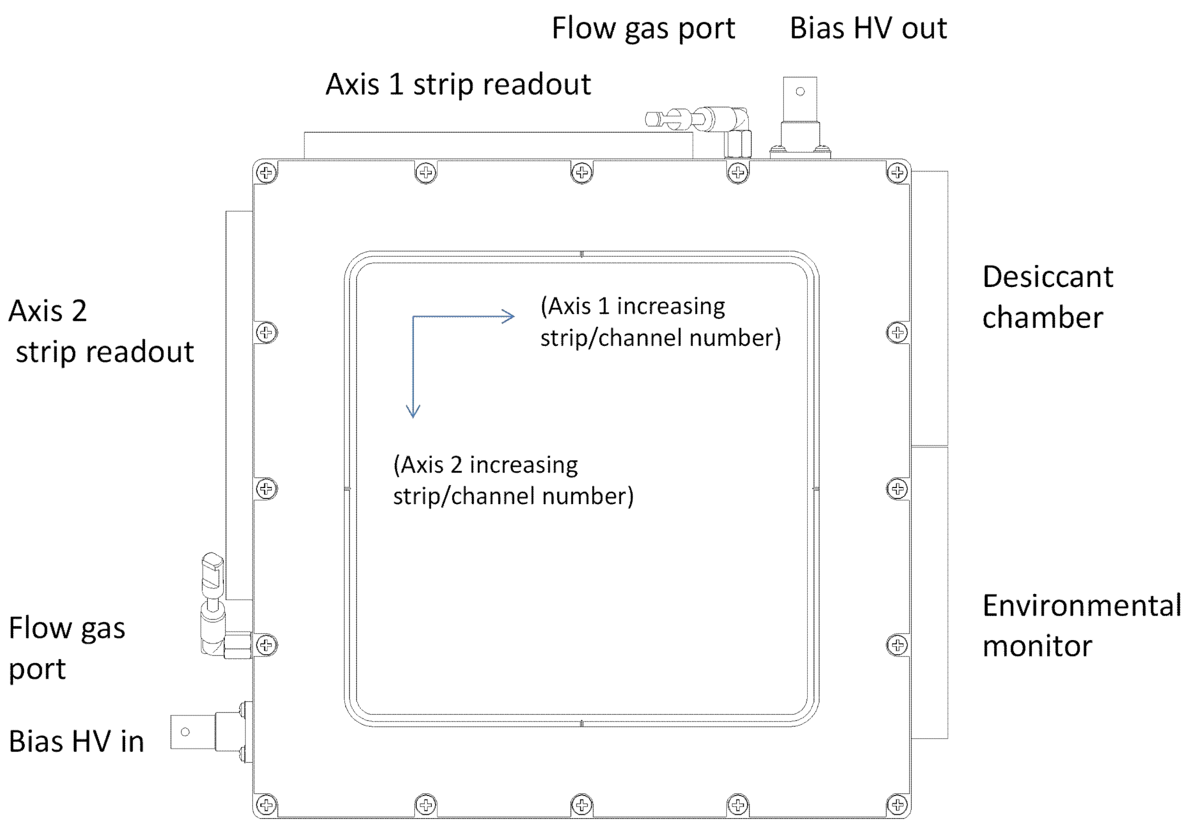
Bit 1	*Bit 0*	*Selected sensor*
0	0	Temperature (V_{measT})
0	1	Pressure (V_{measP})
1	0	Relative humidity (V_{measH})
1	1	Reference voltage (V_{ref})

Monitor pinout:

1	Chassis	6	Relative humidity (V_{measH})
2	Pressure (V_{measP})	7	+5 V in
3	Temperature (V_{measT})	8	Device ID2
4	Device ID1	9	+5 V in
5	DGnd		

Calibration	
Gain curves	Approximate gain curves for air at standard ambient temperature and pressure for protons calculated by Geant4. The fitting curve is approximate.  **Note:** Critical dosimetry measurements must use accurate gain values referenced to traceable standards, and regularly validated.

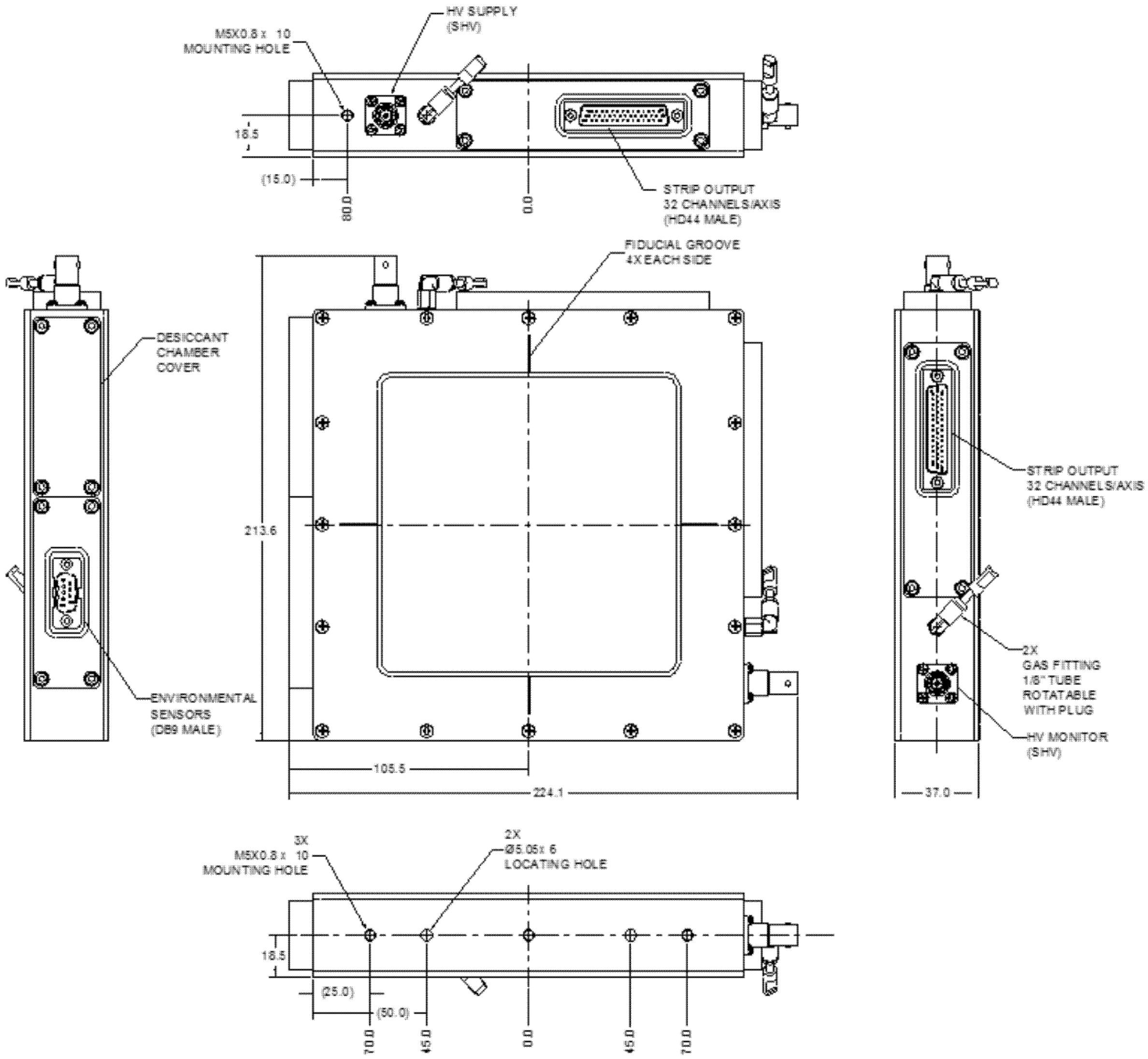
Layout



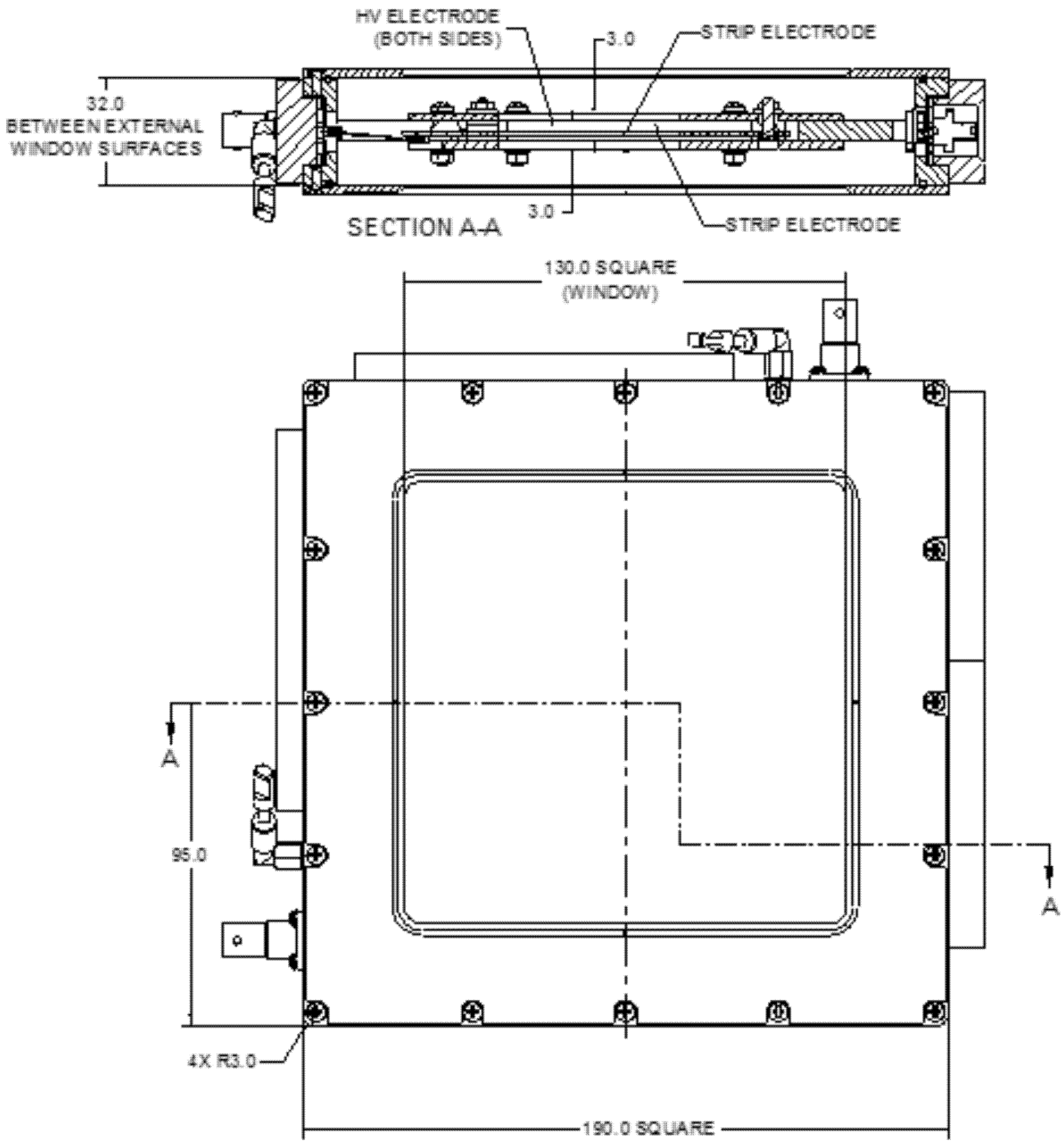
The IC32-6 has no preferred beam entrance side—it is symmetric along the beam path. Designation of axes as X /Y, or horizontal / vertical is arbitrary, as it depends upon the orientation of the IC with respect to the beamline, and of the beamline relative to any other reference coordinate system.

Strips/channel numbering is shown assuming that the axes are connected to I6400 readout electronics with pin to pin cables.

Assuming that the chamber is standing vertically on the mounting face as shown, a beam entering into the page on the figure passes first through the horizontal sensing gap (axis 1, strips running up and down the page), and second through the vertical sensing gap (axis 2, strips running across the page).


HV SUPPLY
(SHV)
M5X0.8 x 10
MOUNTING HOLE
18.5
(15.0)
80.0
0.0
STRIP OUTPUT
32 CHANNELS/AXIS
(HD44 MALE)
FIDUCIAL GROOVE
4X EACH SIDE
DESICCANT
CHAMBER
COVER
213.6
STRIP OUTPUT
32 CHANNELS/AXIS
(HD44 MALE)
2X
GAS FITTING
1/8" TUBE
ROTATABLE
WITH PLUG
ENVIRONMENTAL
SENSORS
(DB9 MALE)
HV MONITOR
(SHV)
105.5
224.1
37.0
3X
M5X0.8 x 10
MOUNTING HOLE
2X
Ø5.05 x 6
LOCATING HOLE
18.5
(25.0)
(50.0)
70.0
45.0
0.0
45.0
70.0

Dims mm



Dims mm

Ordering information

IC32-6	Thin film ionization chamber with 6.4 by 6.4 cm sensitive area, 32 by 32 strip cathode readout.
- NMX	Option—environmental sensor signals not multiplexed (default is multi-plexed signals)

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