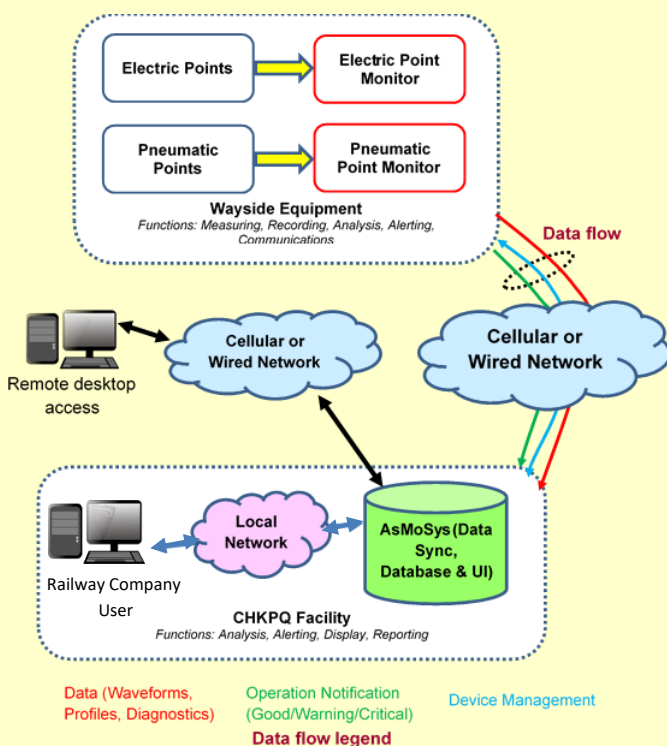


## Points Condition Monitoring

CHKPQ has developed a system that monitors the health of Pneumatic and Electric Points for railways. The system comprises hardware that monitors key mechanical and electrical metrics of Pneumatic and Electric Points, transmits data to a CHKPQ proprietary database and reporting tool called AsMoSys (Asset Monitoring System) that monitors operations, identifies maloperation and impending Point failures, and alerts railway network operators. Remedial actions can then be scheduled before a potentially catastrophic failure occurs. Refer to figure 1.



**Figure 1: Points Condition monitoring system**

### AsMoSys

The AsMoSys solution serves to:

- Communicate with the Point Condition Monitor (PCM), and display the views and reports.
- Set up the PCM training, approval and putting the PCM into operation.
- View, acknowledge and resolve alarms and alerts.
- View PCM operation graphs and save them to a catalogue. Users can create reports by selecting measurements to be displayed, time period etc.

### Citrus:

Citrus is the proprietary software that is used to communicate directly with the Miro PCM to download and view data, configure the PCMs, and upload firmware.

### Benefits

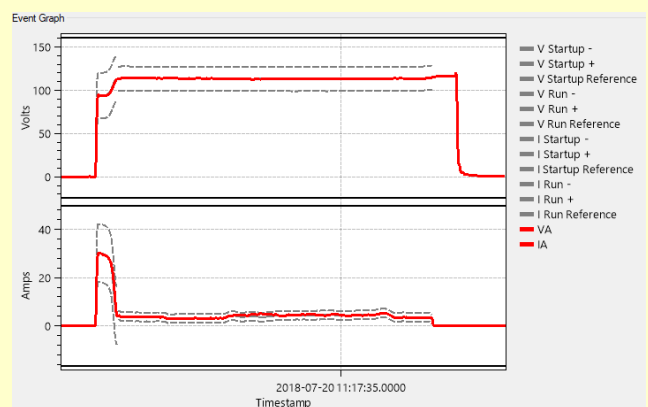
The PCM allows railway operators to track point operation trends and optimise maintenance intervals. Trends include point operation duration, load current and flow rate changes between maintenance periods.

The benefits of PCMs and the data it provides include:

- Improved operational statistics, thereby optimising maintenance intervals (thereby minimising costs).
- Transition from periodic maintenance to a condition-based maintenance regime (thereby minimising costs).
- Reduced train delays (minimise or eliminate downtime and costs).
- Increased intangible benefits, e.g. customer goodwill.
- Enhanced key performance indicators, e.g. high train service availability.

### Commissioning (training)

Once installed, every PCM is trained (monitors and characterises the normal operation of the Point). Once trained, the PCM then monitors every Point operation and determines if the operation is within allowable limits, i.e. 'normal'.



**Figure 2: Typical Electric Point operation showing 'normal operation'**

Figure 2 shows:

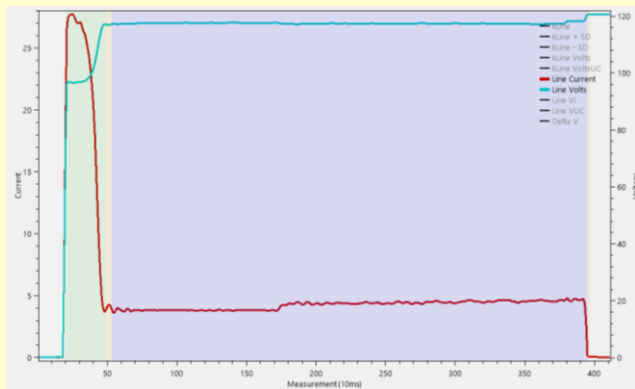
- limit envelopes (dashed lines) from the training data;
- voltage and current curves for each Points Operation.

## Detection and classification of Points operation

Point operations are segmented into three phases:

- Start-up (green region);
- Transition (yellow region); and
- Run (blue region).

Key metrics are calculated including Start-up duration, Run-duration, and Peak-values. Two classifications of operations exist 'Critical' (defined by Run-duration) and 'Possible' (other) by testing metrics against limits.



**Figure 3: Point operation showing three characteristic regions**

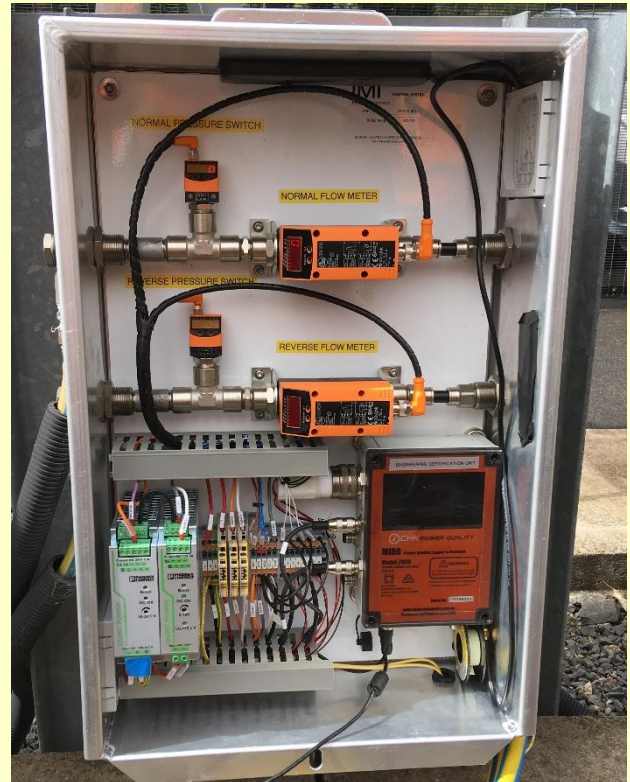
## Alarms

If thresholds are exceeded, alarms are raised and notifications sent to relevant staff. Email notifications include a graphic representation of the operation and staff can quickly identify specific abnormalities, deploying field staff with necessary spares to quickly rectify the problem.

## Hardware models

Two PCM models are currently available:

- **1ARL-Elect:** PCM for electrically driven Point machines. Inputs for this version include points operating voltages and currents.
- **1ARL-Pneu:** PCM for pneumatically driven point machines is shown in Figure 4. Inputs for this version include pressure and flow rates.



**Figure 4: Shows 1ARL-Pneu in a Pneumatic control cabinet**

The 1ARL-Elect is normally installed in a Rail Location Cabinet (LOC) and not necessarily located close to the Electric Point whilst the control cabinet containing the 1ARL-Pneu is installed on a metallic frame located close to the Pneumatic Point.

## Key features of the Miro instrument

### Electric

- Support for multiple point machine types/setups
  - Single ended machine.
  - Double-ended machine.
  - Two independent single machines ("dual single").
- Detection of non-operational failures
  - Voltage still present after end of operation.
  - Lack of operation despite presence of voltage.
  - Ends operating out of sync.
  - Multiple operations in the same direction.

### Pneumatic

- Pressure and Flow measurements
  - 4-20mA inputs.
  - 20ms measurements for points operation detection and classification.

## Get more Work from your Power

- 200ms measurements aggregated to 10-min (configurable) periodic logged min/avg/max for diagnostic purposes.
- Support for 'single machine' setup.
- Detection of non-operational failure
  - Multiple operations in the same direction.

### Common features

- PCM training process
  - Sets 'normal' operation trace.
  - Provides suggested values for metric limits.
- Maintenance mode
  - Operations and non-operational failures are flagged as 'maintenance' and are excluded from trend data.
- LCD
  - Real time display of voltage/current or pressure/flow.
  - Displays graph of most recent operation.
  - User interface for initiating training and maintenance modes.
- Local communication by USB
  - Device configuration and firmware upgrade using Citrus software.
  - Live monitoring of captured events and other data.
  - On site data download in case of loss of remote communications.
- Remote communications
  - 3G/4G cellular option.
  - 10/100 Ethernet option.
  - Secure Socket Shell (SSH) for authenticated and encrypted communications.
  - Device configuration and firmware upgrade using Citrus.
  - 'Real time' data update.
  - Network Time Protocol (NTP) time synchronisation.

### Key features of AsMoSys

#### General features

- Retrieval of data from Miro devices in real time.
- Storage of all data in the database.
- Associating of Miro devices with a hierarchy, e.g. 'Asset', 'Location', 'Region' etc.
- Alert/Alarm generation based on event data
  - Alert/Alarm listing, filtered according to network, location or individual asset.
  - Acknowledgement and actioning of alerts/alarms.
- Asset and Location alarms/alerts shown in order of most-severe to least severe Alert/Alarm status.
- Event listing for an Asset or Miro device
  - Event view based on Citrus software.
  - Filtering by event type.

- Pop-out graphs and tables for Points metrics.
- Exporting of graphs.
- Metric trends for points operations
  - Average flow/current.
  - Run duration.
- Different level User accounts
  - 'Engineer' level that can action alerts/alarms.
  - 'Analyst' level for viewing only.
  - Secure username/password login.

### The AsMoSys dashboard



Figure 5: AsMoSys dashboard

The AsMoSys dashboard has multiple functions, including:

- Setting up and maintaining user logins and access levels.
- Setting up, training and commissioning new points.
- Viewing the overall railway network, point locations and state of the points (Normal, Alarm, Alert).
- Drilling down to individual points to see how a point is performing and view operation trends.
- Creating and maintaining event catalogues that users can refer to when trying to identify and understand point operation behaviour, faults and peculiarities.
- Creating multilevel reports (e.g. individual point, group of points or network wide), including operation trends and maintenance intervals.

### The AsMoSys Point Status window

The AsMoSys Point Status window utilises the 'traffic light' system to show the status of each Point installed in the network:

- Red blinking dot - Unacknowledged alarm.
- Red dot - Acknowledged alarm.
- Yellow blinking dot - Unacknowledged alert.
- Yellow dot - Acknowledged alert.
- Green dot - Resolved Alert/Alarm.

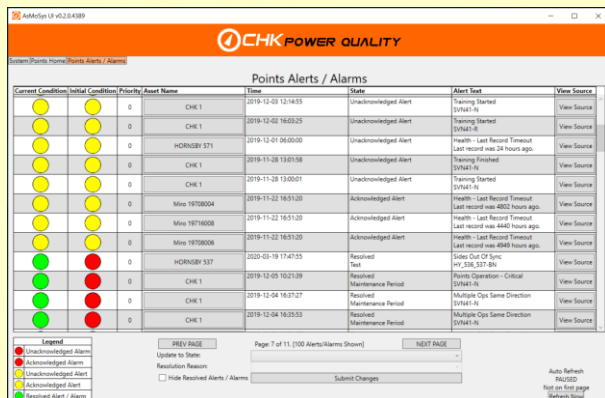


Figure 6: AsMoSys Point Status window

The above system allows users to very quickly ascertain the status of the Points, e.g. are there any unresolved alarms and alerts.

## Reports

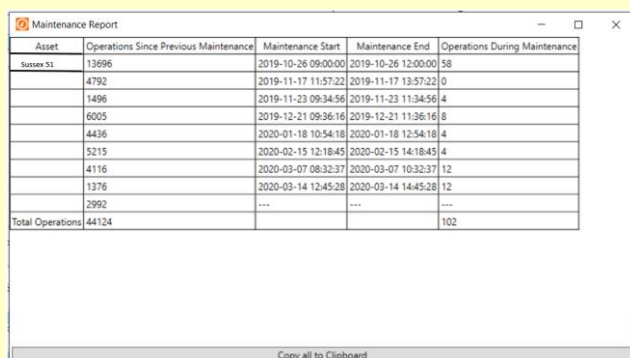


Figure 7: AsMoSys Maintenance report

Table in Figure 7 shows operations between Point maintenance and during point maintenance. This allows rail operators:

- to optimise maintenance programs by determining the number of operations that the point can undergo, before maintenance is required.
- determine the number of operations that was carried out during the maintenance period. These operations can be ignored when generating reports and therefore reflect accurate data.

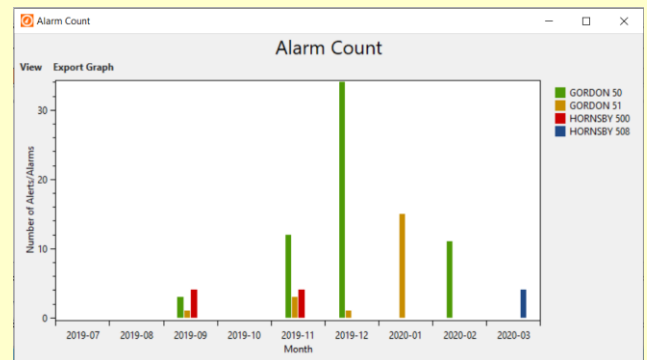


Figure 8: AsMoSys Alarm Count

Figure 8 shows the Alarm and Alert counts for various Point machines. This allows users to:

- quickly determine which Points are prone to failure, identify the causes and take remedial action.
- drill down to correlate alarms and alerts and identify failure trends e.g. insufficient lubrication during maintenance.

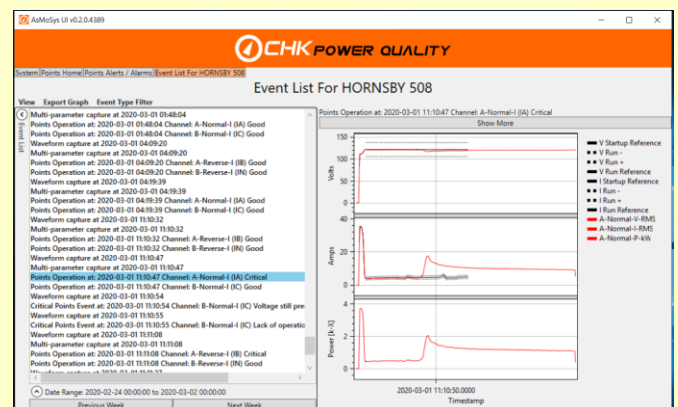


Figure 9: AsMoSys Event List

The Event List shows traces for a critical alarm. This allows users to:

- recognise and identify probable cause of failure and advise field staff and thereby minimise downtime.
- Use the traces as a learning tool where information can be added to the trace and saved to the event catalogue and made available to other users.



## Specifications - Point Condition Monitor (Electric and Pneumatic)

PARAMETER	DESCRIPTION
<b>Technical</b>	
Power Quality Parameters	To IEC 61000-4-30, Class A (PCM-Electric only)
Class A declared/nominal input	230V 50Hz
A to D Conversion	16 bits
Samples per Cycle	384 @ 50 Hz
Sampling Rate	Nominal: 19.2kHz synchronised to mains.
Max. Voltage Input	600V AC RMS, 6kV transient (PCM-E only)
Power Supply	12VDC, 15W, via external DC supply. 1 x DC Supply input, M8, 3 Way Female Connector with 5m, 2 core V90 Cable.
Backup Battery	LiFePO4 3.2V 2.65Ahr
Backup Duration	5 min.
Timing RTC	Typical $\pm 3$ ppm from -15 to 60C. Drift <1 second per week.
Current Accuracy (PCM-E)	$\pm 0.2\%$ of full scale (Instrument only). System accuracy depends on sensors.
4-20mA Accuracy (PCM-P)	$\pm 0.2\%$ of full scale.
Voltage Accuracy	$\pm 0.1\%$ of nominal value. (Nominal = 230V AC RMS)
Memory	7.5GB available for logging.
<b>Mechanical</b>	
Display	Colour graphic LCD (4.3" 480x272 graphic TFT LCD). Dimensions: (97 x 56) mm.
Dimensions	(180 x 180 x 60) mm.
Weight	1.0kg (Instrument only).
Mounting	Custom Location Cabinet (LOC) case mounting bracket for PCM-E, Magnetic mounting feet for PCM-P.
<b>Environmental</b>	
Operating Temperature	-20°C to +65°C.
Relative Humidity	95% Relative Humidity. IEC 60068-2-30
Dust and Water Resistance	IP40
Installation Condition	For internal/indoor use only.
Vibration	IEC 60068-2-6
Shock	IEC 60068-2-27
Salt Mist	IEC 60068-2-11
<b>Sensors &amp; Interfaces</b>	
PCM-E Voltage Input	4 x Isolated channels. Isolation voltage-6kV Channels A Normal, A Reverse, B Normal, B Reverse 8 Way 7.62mm pluggable terminal block header and plug.
PCM-E Current Inputs	4 x Current Channels, 4 x 2 Way 5.08mm pluggable terminal block header and plug.
Current Transformer	CT open circuit protection- built in 12V bidirectional TVS provided. See page 3 for details.
PCM-P Pressure Input	2 x 4-20mA interface. Channels A Normal, A Reverse. 4 Way 7.62mm pluggable terminal block header and plug. See page 3 for further details.
PCM-P Flow Input	2 x 4-20mA, Channels A Normal, A Reverse interface 2 x 2 Way 5.08mm pluggable terminal block header and plug. See page 4 for further details.
Cellular antenna port	SMA Female

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Ethernet Connector	1 X RJ45 connector provided. *1
Mini Expansion Port	1 X M8 4 way male port provided.
USB Data Port Input	1 X USB port provided.
USB Data Cable	USB cable, 2m length.
Push Button	2 x push button switches for accessing local menu.
<b>Measurements</b>	
	Event Triggers: points operation
	Event Captures: waveform, RMS, multi-capture parameters.
	Logging Interval: adjustable Interval, 1 sec to 1 hour.
	Points operation event capture.
<b>Communications</b>	
USB	USB 2.0
Cellular	Sierra Wireless HL7650 4G communications module fitted as standard.
Ethernet	Optional
<b>Protocols</b>	
Citrus Protocol	CHK Proprietary protocol for device configuration, firmware updates and data downloading. Citrus data retrieval (CiDR) service compatible.
AsMoSys Server	Real-time device syncing.
FTP	Device configuration, firmware updates and data uploading.
<b>Security</b>	
SSH Encryption & Authentication	For Citrus/ AsMoSys interface, private key required.
FTPES	FTP with explicit security.
<b>Device Access</b>	
Device configuration	Available via USB and remote interface. Device configuration via remote interface can be disabled if required, for security reasons.
<b>Software</b>	
AsMoSys	Asset Monitoring System with database interface.
Citrus	Configuration, data download, viewing and analysis. Citrus over WiFi is supported.
Miro App	Available for iOS and Android devices (WiFi Only)
<b>EMC</b>	
EMC General	EN 61326
Radiated and Conducted Emissions	AS/NZS CISPR 11:2011 (Group 1 Class A)
Immunity – ESD	IEC 61000-4-2
Immunity – RF	IEC 61000-4-3
Immunity – Burst	IEC 61000-4-4
Immunity – Surge	IEC 61000-4-5
Immunity – RF Conducted	IEC 61000-4-6
Immunity – Power Frequency Magnetic Field	IEC 61000-4-8
Immunity – Voltage Dips	IEC 61000-4-11

## Specifications - Current Sensor

Manufacturer	CHK Power Quality
Part Number	CHK PQ CT TA24Y11-50A-0.44V
<b>Technical</b>	
Rated Primary Current	50A
Linearity Range	5%In-120%In
Nominal Secondary Burden	26.37 Ohms
Accuracy	Class 0.1
Ratio Error at rated primary input	$\leq \pm 0.1\%$
Working Frequency	50Hz—2000Hz
Temperature Drift	20ppm/°C
Insulation Resistance	1000MΩ@500VDC,1min
Power Frequency Withstand Voltage	2500V, 1min
<b>Product Structure</b>	
Primary Input	P1-P2 pass through core
Window size	9.0mm diameter
<b>Environmental Protection</b>	
ROHS compliant	Yes
Case Material	UL 94-V0 flame retardant material
Cable temperature rating	V90
Encapsulation Type	Epoxy resin
Secondary Output	Lead Wire AWM2547 24AWG black jacketed cable, core wire red/black.
Cable length	7m±0.05m, end stripped and tinned 5-8mm.
<b>Working Environment</b>	
Operating temperatures	-40°C~+85°C
Storage Temperature	-40°C~+85°C
Relative Humidity	≤95%
Atmospheric Pressure	80-110kPa

## Specifications - Pressure Sensor<sup>\*4</sup>

Manufacturer	IMI Norgren
Part No.	34D-V110G-DA1-AA
Pressure Range for analogue output	0 to 10 bar
Operating Voltage	18 to 32 V DC
Total Accuracy	+/- 0.5% of Full Scale
Linearity	+/- 0.25% + 1 display step size
Repeatability	< +/- 0.1 % of span
Long Term Stability (6 months)	< +/- 0.05% of Span
Temperature Coefficient Span	0.2 % of the span / 10 K
Response Time	< 2.5 ms
Analogue Output	4-20 mA

**Specifications - Flow Rate Sensor<sup>\*4</sup>**

Manufacturer	IFM Electronic
Part No.	SD6020
Flow Range	4...1250 l/min
Operating Voltage	18.. 30 V DC
Total Accuracy	+/- 15% MW <sup>*2</sup> + 1.5% MEW <sup>*3</sup>
Repeatability	+/- 1.5% of the measured value
Response Time	0.1s (dAP = 0)
Analogue Output	4-20 mA

<sup>\*1</sup> Units are provided with remote cellular module as standard. Optional Ethernet communications module required for Ethernet communications.

<sup>\*2</sup> MW = Measured Value

<sup>\*3</sup> MEW = Final value of the measuring range

<sup>\*4</sup> The PCM-Pneumatic is compatible with the listed pressure and flow sensors. These sensors are to be supplied and installed by the user. Please contact CHK PQ for using the PCM-Pneumatic with alternative sensors.