MetroCount®
Traffic Data Specialists

MC5712 Timing Analysis RSU

MC5700 Series RSUs

February 2009

MC5712 Timing Analysis RSU

Introducing the MC5712

MetroCount's MC5712 Roadside Unit introduces a new mode of analysis called *Timing Analysis*, which adds an extra dimension to vehicle classification.

The MC5712 is a two-channel RSU, where channel 0 is used to time-stamp vehicles using tubes, and channel 1 is used to synchronously time-stamp the RSU's fibre optic input. Timing events from the second channel form user-definable *Phases*, into which vehicles from the first channel are grouped. MCReport provides a range of new *Phase* reports for detailed analysis and statistics of vehicles grouped by phase, and of the timing source itself.

MetroCount 5712 Timing Analysis RSU

Timing Analysis is of particular use for traffic signals. Tubes are placed the intersection-side of a stop line, and timing is derived from one of the traffic signals facing the corresponding aspect. The resulting data can be used to examine:

- Driver behaviour, especially surrounding phase changes.
- Volume and Speed statistics for each phase.
- Individual vehicle transgressions.
- Performance statistics, such as average cycle times.
- Queuing and Capacity.

Example MC5712 installation

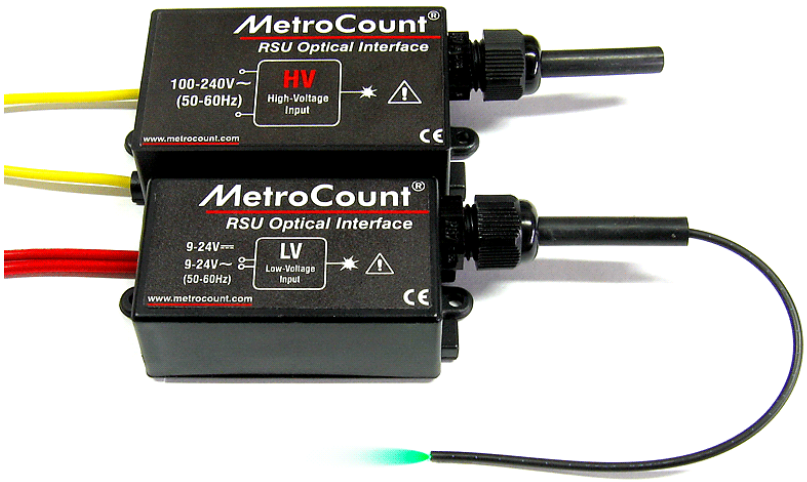
Timing Analysis is not limited to traffic signals. The MC5712 can be applied to controlled pedestrian or railway crossings. In fact, any application where there is a detectable timing parameter, can be investigated. For instance, traffic behaviour during icing conditions could be investigated with a simple on-road temperature sensor. Other environmental conditions such as rain or light level could also be used.

The MC5712's optical timing input is connected via a plastic fibre optic cable. This has several advantages:

- Complete electrical isolation of the fibre and RSU from the signal controller.
- No backward channel or possibility of damage to the signal controller.
- Immune from electrical interference.
- Rugged and easily terminated.

The MetroCount *RSU Optical Interface* is used to drive the MC5712's optical input. Optical Interfaces are small enough to be mounted directly in a traffic signal head, or can be installed in a controller cabinet, with up to 100 metres of fibre. Optical Interfaces are available in two versions:

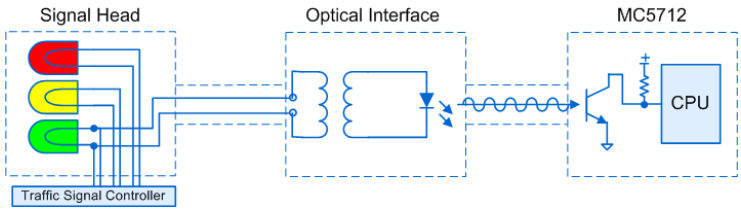
- Low Voltage - for 9-24VDC or 9-24VAC (50-60Hz)
- High Voltage - for 100-240VAC (50-60Hz)



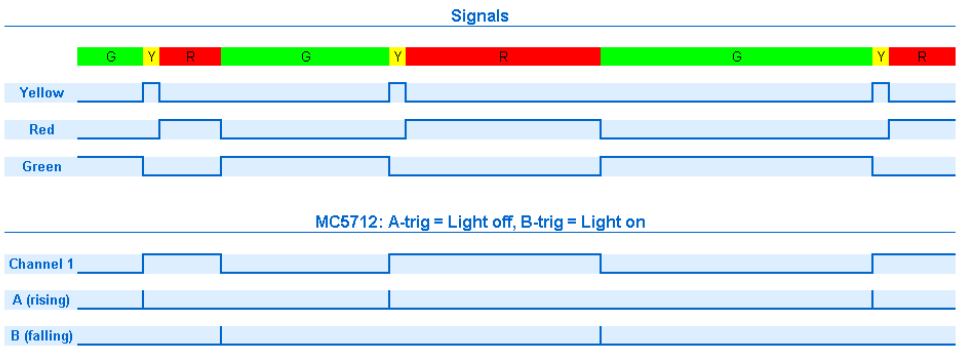
Optical Interfaces for MC5712

Consider the typical application of a straight-through aspect of a controlled intersection. The start and end of a complete cycle of the traffic signals can be derived entirely from the Green light. With the addition of fixed-length phases during analysis with MCReport, the varying length of the Red phase can be deduced.

The MC5712's timing channel (channel 1) time-stamps transitions on its optical input, called *Trigger* events. The unit's default configuration is for an Optical Interface connected to the Green signal. The Green light going off will generate an A-trigger, indicating the start of the Yellow. The Green light coming back on then generates a B-trigger, indicating the end of the Red.

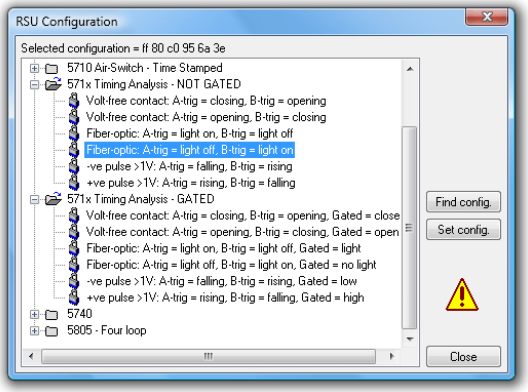


Optical Control Signal



Example signal timing

For other applications, the MC5712 can be reconfigured using MCSetup or MCSetLite. Several default configurations are provided to cover most scenarios, and new configurations can be easily created if nothing suitable exists.



Configuring a MC5712

For long-term analysis, the vehicle channel can be controlled by the timing channel. In this mode, known as *Gated* Timing Analysis, vehicles will only be logged when a configurable, static level (high or low) is present on the timing channel. Note that using this mode will result in some loss of information, especially vehicles leading up to and spanning the phase change, but provides much greater vehicle capacity.

Phase Signature Type

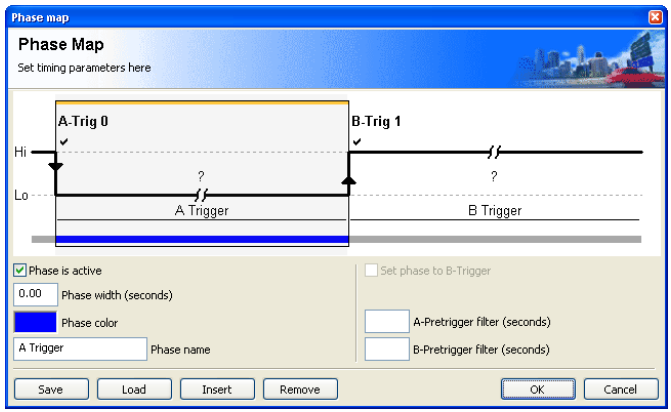
Timing Analysis introduces a new signature type called **Phase**, which provides access to MCReport's Timing Analysis reports, in addition to all the **Plus** reports.

Phase Reports

MCReport's Timing Analysis reports include:

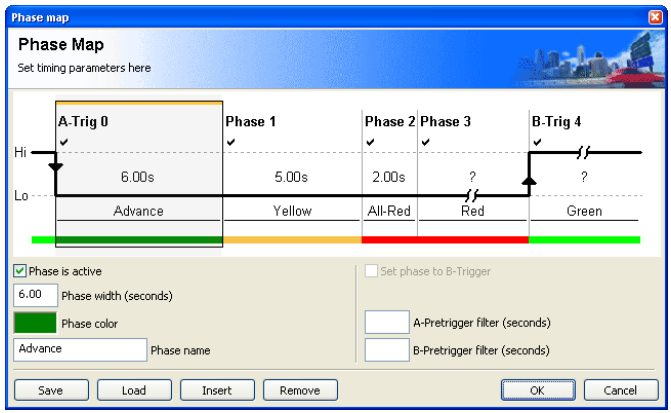
- **Data Phase Report** - individual vehicles ordered by phase.
- **Phase Statistics** - timing statistics for each phase.
- **Custom List Report** - standard Custom List report, filtered by phase.
- **Phase Flow Chart** - plot of vehicle volume versus phase.
- **Phase Speed Chart** - plot of average vehicle speed versus phase
- **Phase Spectrum** - distribution of phase timing.
- **Phase Cycle** - average phase length versus time.

Interpretation of the timing channel data is defined using MCReport's **Phase Map**, which is displayed as part of the Report Wizard for Phase reports. Initially, MCReport constructs a simple two-phase map for the A and B triggers from the timing channel.



Phase Map

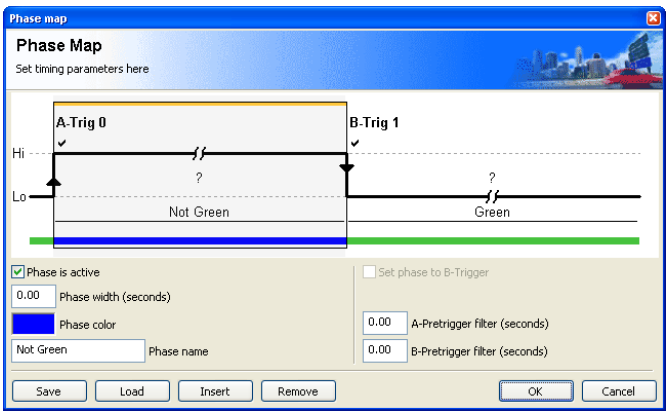
From here, more complex Phase Maps can be constructed by adding phases with fixed lengths, and assigning names and colours to each phase. Phases can be enabled and disabled to examine driver behaviour under combinations of phases, such as only the Yellow and Red phases for traffic signals.



Example Phase Map for traffic signal timing

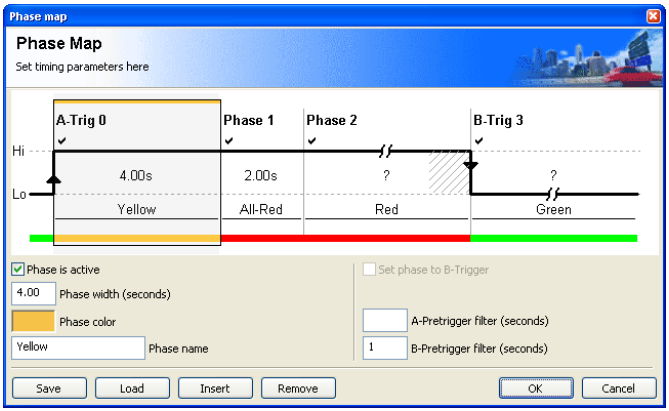
Signal Timing Example

Consider the typical signal timing application described previously. A MC5712 was connected to a pair of tubes, spaced one metre apart, and approximately 200mm on the junction side of a stop line. An Optical Interface was connected by signal technicians to the Green light on the signal pole adjacent to the stop line being monitored. The MC5712's timing channel was configured to detect a rising-edge as the A trigger (light off), and a falling-edge as the B trigger (light on). In it's simplest form, this is represented by the following Phase Map.



Fundamental Phase Map, without fixed phases

For the intersection in question, several fixed-length phases are known. The Yellow phase is always four seconds, followed by a two-second phase where all aspects of the intersection are Red. These phases can be easily added, so that they may be analysed in detail.



Expanded Phase Map, with fixed phases added

The optional *pretrigger filter* removes vehicles for a specified window prior to a trigger event. This feature is useful for traffic signals for removing vehicles at the end of a phase that may be *jumping* the phase transition.

The following sample reports give an insight into the types of information that can be derived from Timing Analysis data.

Phase Statistics

The Phase Statistics report displays MCReport's standard speed statistics block for each phase in the Phase Map, and for all phases combined. A summary block of statistics from the timing channel is also included.

Vehicle Statistics

Phase = [Yellow + All-Red + Red + Green]
Vehicles = 116638 (100.00%)
Posted speed limit = 60 km/h, Exceeding = 22135 (18.98%), Mean Exceeding = 67.06 km/h
Maximum = 199.1 km/h, **Minimum** = 0.9 km/h, **Mean** = 36.4 km/h
85% Speed = 61.6 km/h, **95% Speed** = 68.4 km/h, **Median** = 29.9 km/h
20 km/h Pace = 10 - 30, **Number in Pace** = 50717 (43.48%)
Variance = 437.74, **Standard Deviation** = 20.92 km/h

Phase = Yellow
Vehicles = 8990 (7.71%)
Posted speed limit = 60 km/h, Exceeding = 4184 (46.54%), Mean Exceeding = 66.69 km/h
Maximum = 120.1 km/h, **Minimum** = 9.6 km/h, **Mean** = 54.8 km/h
85% Speed = 67.7 km/h, **95% Speed** = 73.4 km/h, **Median** = 59.0 km/h
20 km/h Pace = 52 - 72, **Number in Pace** = 5822 (64.76%)
Variance = 230.73, **Standard Deviation** = 15.19 km/h

Phase = All-Red
Vehicles = 468 (0.40%)
Posted speed limit = 60 km/h, Exceeding = 280 (59.83%), Mean Exceeding = 72.56 km/h
Maximum = 112.5 km/h, **Minimum** = 6.7 km/h, **Mean** = 57.8 km/h
85% Speed = 77.4 km/h, **95% Speed** = 85.7 km/h, **Median** = 64.1 km/h
20 km/h Pace = 60 - 80, **Number in Pace** = 230 (49.15%)
Variance = 417.56, **Standard Deviation** = 20.43 km/h

Phase = Red
Vehicles = 119 (0.10%)
Posted speed limit = 60 km/h, Exceeding = 9 (7.56%), Mean Exceeding = 74.92 km/h
Maximum = 97.2 km/h, **Minimum** = 0.9 km/h, **Mean** = 18.6 km/h
85% Speed = 33.8 km/h, **95% Speed** = 64.1 km/h, **Median** = 8.3 km/h
20 km/h Pace = 0 - 20, **Number in Pace** = 78 (65.55%)
Variance = 448.97, **Standard Deviation** = 21.19 km/h

Phase = Green
Vehicles = 107061 (91.79%)
Posted speed limit = 60 km/h, Exceeding = 17662 (16.50%), Mean Exceeding = 67.06 km/h
Maximum = 199.1 km/h, **Minimum** = 1.0 km/h, **Mean** = 34.8 km/h
85% Speed = 60.5 km/h, **95% Speed** = 67.3 km/h, **Median** = 28.4 km/h
20 km/h Pace = 9 - 29, **Number in Pace** = 49809 (46.52%)
Variance = 421.92, **Standard Deviation** = 20.54 km/h

Timing Statistics

A Trigger = 19212
Yellow = 76848.0 sec (5.6%)
All-Red = 38424.0 sec (2.8%)
Red = 385726.4 sec (28.1%)

B Trigger = 19214
Green = 854938.6 sec (62.2%)

A-A [Yellow-Yellow] Maximum = 34573.999, **Minimum** = 0.998, **Mean** = 71.575
A-B [Yellow-Green] Maximum = 34545.328, **Minimum** = 0.539, **Mean** = 26.077
B-B [Green-Green] Maximum = 34825.021, **Minimum** = 0.999, **Mean** = 71.569
B-A [Green-Yellow] Maximum = 3306.411, **Minimum** = 0.457, **Mean** = 45.496

Phase Statistics report for each phase, and combined phases

Data Phase Report

The Data Phase report displays individual vehicles, interspersed with phase timing. Phases can be disabled in the Phase Map to show only vehicles in phases of interest. The **Gap** column is the time since the last phase transition.

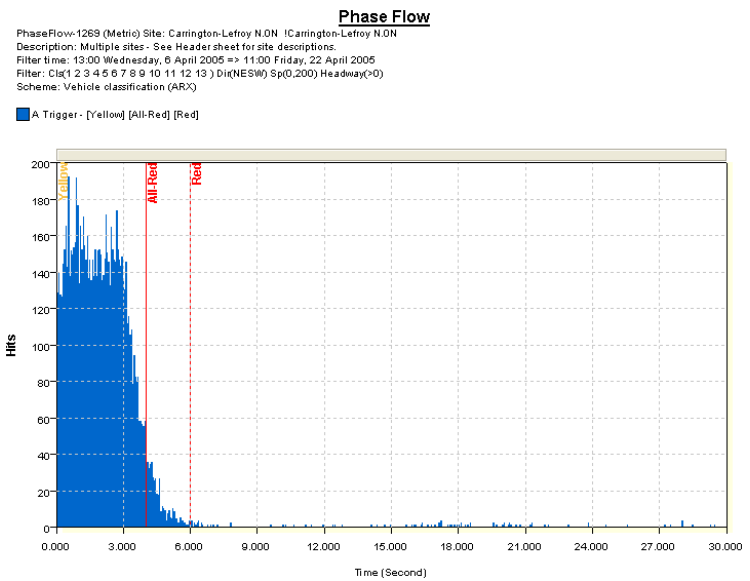
DS	Axle	Num	Ht	YYYY-MM-DD	hh:mm:ss.000	Dr	Speed		Wb	Hdwy	Gap	Ax	Gp	Rho	Cl	Nm	Vehicle	
03	00000a2e	01		2005-07-08	16:14:50.357	BT	-----	-----		52.8	0.0	--	--	----	--	10000000	Ph3 Green	
02	00022784	04		2005-07-08	16:15:41.137	AB	82.6	2.4	2.1	50.8	2	2	1.00	2	00000020	SV o o		
02	00022788	04		2005-07-08	16:15:42.089	AB	78.1	2.7	1.0	51.7	2	2	1.00	2	00000020	SV o o		
02	0002278c	04		2005-07-08	16:15:44.201	AB	79.3	2.5	2.1	53.8	2	2	1.00	2	00000024	SV o o		
02	00022790	04		2005-07-08	16:15:44.644	AB	80.0	2.5	0.4	54.3	2	2	1.00	2	00000020	SV o o		
02	00022794	04		2005-07-08	16:15:47.370	AB	74.3	2.8	2.7	57.0	2	2	1.00	2	00000020	SV o o		
02	00022798	04		2005-07-08	16:15:50.455	AB	75.4	2.4	3.1	60.1	2	2	1.00	2	00000020	SV o o		
02	0002279c	06		2005-07-08	16:15:53.792	AB	71.5	5.5	3.3	63.4	3	3	1.00	3	00000020	SVT o o	o	
02	000227a2	04		2005-07-08	16:15:55.163	AB	72.2	2.6	1.4	64.8	2	2	1.00	2	00000020	SV o o		
02	000227a6	04		2005-07-08	16:15:56.071	AB	75.2	3.2	0.9	65.7	2	2	1.00	2	00000020	SV o	o	
03	00000a2f	01		2005-07-08	16:15:56.668	AT	-----	-----		66.3	0.0	--	--	----	--	10000000	Ph0 Yellow	
02	000227aa	04		2005-07-08	16:15:57.318	AB	70.1	2.8	1.2	0.7	2	2	1.00	2	00020042	SV o o		
02	000227ae	04		2005-07-08	16:15:58.037	AB	73.1	2.8	0.7	1.4	2	2	1.00	2	00020042	SV o o		
02	000227b2	04		2005-07-08	16:15:58.635	AB	72.8	2.6	0.6	2.0	2	2	1.00	2	00000020	SV o o		
02	000227b6	04		2005-07-08	16:15:59.839	AB	73.4	2.4	1.2	3.2	2	2	1.00	2	00000020	SV o o		
03	00000a2f	01		2005-07-08	16:16:00.668	AT	-----	-----		4.0	0.0	--	--	----	--	10000000	Ph1 All-Red	
02	000227ba	04		2005-07-08	16:16:01.165	AB	83.0	3.0	1.3	0.5	2	2	1.00	2	00020042	SV o o		
02	000227be	04		2005-07-08	16:16:01.763	AB	82.1	2.3	0.6	1.1	2	2	1.00	2	00000020	SV o o		
03	00000a2f	01		2005-07-08	16:16:02.668	AT	-----	-----		2.0	0.0	--	--	----	--	10000000	Ph2 Red	
02	000227c2	12		2005-07-08	16:16:03.066	AB	73.9	15.2	1.3	0.4	6	3	1.00	10	00000010	ART6 o	oo	ooo

Data Phase report - individual vehicles with phase timing

Phase Flow Chart

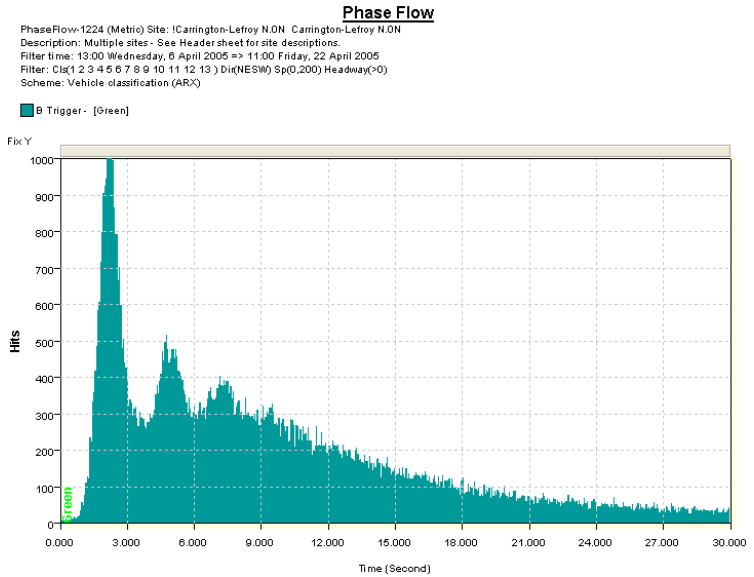
The Phase Flow report represents average vehicle volume versus time from the start of a Phase Map cycle. Each phase is indicated by a vertical line on the chart.

This report is particularly useful for examining driver behaviour, and characterising a given site. For instance, this site shows a definite tail of vehicle flow into the All-Red phase.



Phase Flow report, demonstrating a tail into the All-Red phase

Behaviour at the end of a cycle (start of the Green) can also be examined.

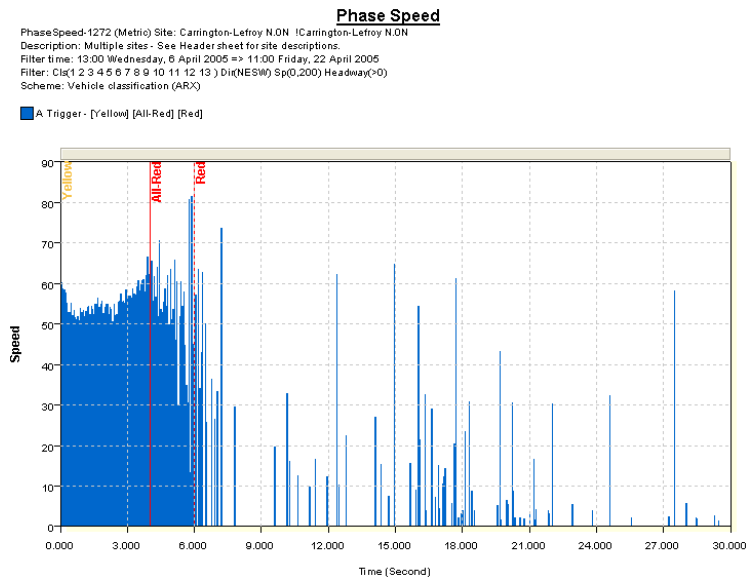


Phase Flow report, showing driver behaviour at the beginning of the green phase

Phase Speed Chart

The Phase Speed report shows average vehicle speed versus time from the start of a Phase Map cycle. For sporadic events, the average speed may be just a single vehicle.

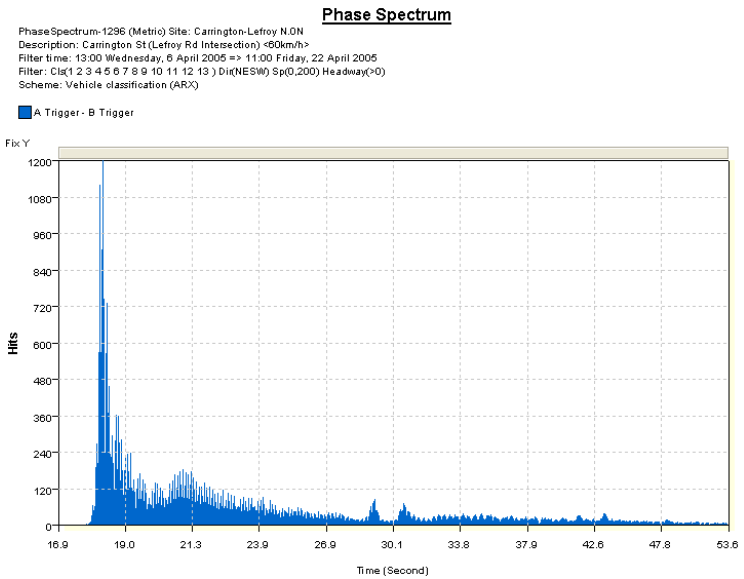
Like the Phase Flow report, this report highlights driver behaviour. In this case, there is an increase in average speed approaching the Red phases.



Phase Speed report, showing an increasing speed trend approaching the red phases

Phase Spectrum Report

The Phase Spectrum report is useful for examining the distribution of time between trigger events. For example, the A-to-B distribution represents the variable cycle length.

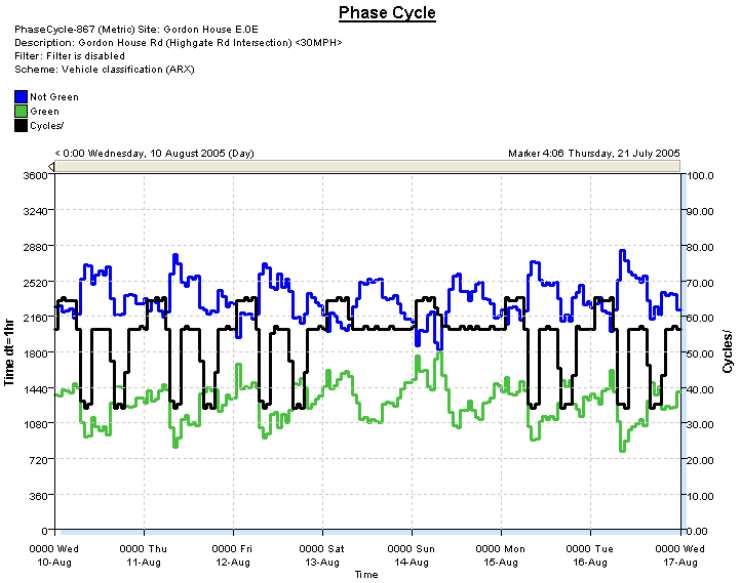


Phase Spectrum showing distribution of cycle length

Phase Cycle

The Phase Cycle report plots average phase length (between trigger events) versus time, highlighting the change in behaviour of the timing signal at varying times of the day and week. The total number of cycles can optionally be plotted on the same report.

The following example demonstrates a traffic signal flipping between a demand-driven cycle, and a simple fixed-timed cycle.



Phase Cycle graph, showing average phase length versus time

Phase Custom List Report

A special version of the Custom List report also supports Timing Analysis. Any of the Custom List's features can be applied to selected vehicles using the Phase Map. For instance, complete speed statistics can be calculated for vehicles in the first two seconds of the green, and so on.

*** Virtual Day (7)** [Yellow + Red]

Time	-/n	Total	Cls 1	Cls 2	Cls 3	Cls 4	Cls 5	Cls 6	Cls 7	Cls 8	Cls 9	Cls 10	Cls 11	Cls 12
0000	7	1	0	1	0	0	0	0	0	0	0	0	0	0
0100	7	0	0	0	0	0	0	0	0	0	0	0	0	0
0200	7	0	0	0	0	0	0	0	0	0	0	0	0	0
0300	7	0	0	0	0	0	0	0	0	0	0	0	0	0
0400	7	1	0	1	0	0	0	0	0	0	0	0	0	0
0500	7	4	0	4	0	0	0	0	0	0	0	0	0	0
0600	7	18	0	17	0	0	0	0	0	0	0	0	0	0
0700	7	42	0	39	1	1	0	0	0	0	0	0	0	0
0800	7	47	0	44	1	1	0	0	0	0	0	0	0	0
0900	7	52	0	49	1	2	0	0	0	0	0	0	0	0
1000	7	42	0	39	0	2	0	0	0	0	0	0	0	0
1100	7	46	0	43	0	2	0	0	0	0	0	0	0	0
1200	7	45	0	43	0	1	0	0	0	0	0	0	0	0
1300	7	42	0	39	1	1	0	0	0	0	0	0	0	0
1400	7	45	1	42	1	2	0	0	0	0	0	0	0	0
1500	7	50	0	46	1	2	0	0	0	0	0	0	0	0
1600	7	47	0	45	0	1	0	0	0	0	0	0	0	0
1700	7	42	0	40	1	1	0	0	0	0	0	0	0	0
1800	7	38	0	36	0	1	0	0	0	0	0	0	0	0
1900	7	28	0	28	0	0	0	0	0	0	0	0	0	0
2000	7	12	0	12	0	0	0	0	0	0	0	0	0	0
2100	7	10	0	10	0	0	0	0	0	0	0	0	0	0
2200	7	7	0	7	0	0	0	0	0	0	0	0	0	0
2300	7	3	0	3	0	0	0	0	0	0	0	0	0	0
07-19	**7**	**538**	**4**	**503**	**7**	**18**	**1**	**1**	**1**	**2**	**0**	**1**	**0**	**0**
06-22	**7**	**607**	**5**	**570**	**8**	**18**	**1**	**1**	**1**	**2**	**0**	**1**	**0**	**0**
06-00	**7**	**616**	**5**	**579**	**8**	**18**	**1**	**1**	**1**	**2**	**0**	**1**	**0**	**0**
00-00	**7**	**622**	**5**	**585**	**8**	**18**	**1**	**1**	**1**	**2**	**0**	**1**	**0**	**0**

*** Virtual Week (1)** [Yellow + Red]

Time	-/n	Total	Cls 1	Cls 2	Cls 3	Cls 4	Cls 5	Cls 6	Cls 7	Cls 8	Cls 9	Cls 10	Cls 11	Cls 12
Mon	1	587	7	538	11	24	2	1	2	1	1	0	0	0
Tue	1	644	5	594	11	26	0	0	3	3	0	2	0	0
Wed	1	671	4	629	10	21	1	0	0	4	0	1	0	1
Thu	1	646	4	613	5	18	2	1	0	2	0	1	0	0
Fri	1	706	3	666	8	20	3	2	0	1	2	1	0	0
Sat	1	608	7	578	9	11	0	0	0	3	0	0	0	0
Sun	1	495	5	477	2	8	1	0	0	2	0	0	0	0
--	**1**	**4357**	**35**	**4095**	**56**	**128**	**9**	**4**	**5**	**16**	**3**	**5**	**0**	**1**

Phase Custom List report, showing virtual day and week for yellow and red phases

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