Metro

Product Manual

Temporary

TRAFFIC GROUP SIGNALS

Contents

As of 2021, Traffic Group Signals have taken the decision to replace '**Slave**' with '**Signal**' within our terminology, which will be reflected across all controllers and supporting literature. This in no way affects the operation of our equipment and compatibility with previous generation equipment

Introduction

Metro from Traffic Group Signals

The Metro product range from Traffic Group Signals deliver highly modular temporary traffic signals, designed for Temporary Traffic Management applications where portable signals fall short of functional requirement or do not meet the relevant regulations or safety standards. The product is capable of combined vehicle and pedestrian control, and has been designed for compliance with the following TOPAS specifications: TOPAS 2502B, TOPAS 2503B, TOPAS 2537A and TOPAS 2538A.

This manual covers all aspects of the Metro product when operated using a Metro Master and Metro Signal controllers. This includes deployment, configuration, and operation of such systems.

A separate manual covers all aspects of the Metro product when operated using a Metro Pro as the Master controller. Scheme design using Signal Studio is covered in a separate manual.

Important

This system should be installed and operated only by fully trained and experienced personnel. The junction layout examples given in this document are for guidance only. Always consult your supervisor if you are in any doubt about correct procedures or if you are concerned about safety. Equipment must only be repaired by Traffic Group Signals Ltd or authorised repair agents.

Caution

Risk of explosion if battery is replaced by an incorrect type.

Dispose of used batteries according to the instructions.

Metro Series traffic signals are protected by one or more of the following granted patents; GB2534294, GB2554529 and GB2535320. Other patents and IP protection may apply.

System Overview

Portable or Temporary?

Metro is a temporary traffic signal system designed for high profile or complex sites where safety and efficiency is paramount. But what is the difference between portable and temporary systems and when should you opt for one over the other?

Portable Traffic Signals

'Portable' light signal control equipment uses light signals prescribed in Diagram 3000.1 of the UK statutory Instrument No.362 Traffic Signal Regulations and General Directions 2016 (TSRGD 2016) which are intended for the control of vehicular traffic and pedestrians for relatively short periods of time.

'Portable' light signals are normally mounted on a post fixed to a tripod or wheeled base unit and can be easily moved by one operative.

Temporary Traffic Signals

'Temporary' traffic signal control equipment uses full size light signals as prescribed in Diagram 3000 TSRGD 2016 and is capable of being used in any control configuration implemented by permanently installed light signals including signalised crossing facilities.

'Temporary' light signals are mounted on a post in a container that cannot be moved without the use of mechanical handling equipment.

Temporary signals should be considered for temporary traffic control applications where:

- Temporary signals better address the safety requirements of the application, such as; functionality, visibility etc.
- Temporary signals provide TSM Chapter 6 signalling functions which provide for the more efficient movement of traffic
- The duration or profile of the works is better suited to temporary signals

System Overview

Introducing Metro

Metro comprises a range of highly modular, visibly safer temporary traffic signals.

Metro is intended for the temporary traffic signal role and is designed to be robust and highly reliable, whilst minimising fleet management and inventory. It is quick and simple to deploy with wireless communications and interchangeable signal heads that are easily erected on site. Metro comes fitted with the AGD306 radar, which can be configured to perform Speed Extension, making the Metro product suitable for deployment on high-speed roads.

With it's wide range of signal head possibilities and sophisticated controller capabilities, Metro is designed to meet even the most challenging of scheme requirements, from standalone pedestrian and haul route crossings to complex junction reinstatements.

Metro unit consists of three main components which can be assembled on site as needed:

- Metro Series Controllers
- Metro Base Unit
- Metro Pole and Head Assembly

Metro Series Controllers

Metro Series controllers come in three different guises, the Metro Signal Controller, Metro Master Controller and Metro Pro Controller. The Metro Signal controller only operates as a signal controller and is combined with either Metro Master or Metro Pro depending on the signalling complexity required.

Metro Master is a phased based controller (similar to the Evo1® series) capable of 9 traffic phases and 8 pedestrian crossings. It is used as a system controller for less complex schemes, and most commonly used in Crossing mode to support either Haul Route or Standalone Pedestrian crossings.

Metro Pro is a staged based controller for more complex signalling requirements, configured using a scheme tool, capable of up to 16 stages with any of 9 traffic phases and 8 pedestrian crossings in 4 phases, permitting 'walk with traffic' schemes. Metro Pro is capable of operating in multi-phase AutoGreen® mode along with the ability to communicate with a central traffic signal control system operating UTC.

The Metro system is designed to integrate with TMdesk® for remote monitoring and management, with Metro Pro gaining access to the TMdesk Pro level of features.

All Metro products feature Active Channel Management (ACM®) delivering superior radio communication as well as the Endurance Power System delivering impressive battery runtimes.

Introducing Metro (cont.)

Metro Base Unit

The Metro Base Unit serves the following purposes:

- Securely houses up to six batteries and two Metro controllers, incorporating anti-theft measures in a tamperproof temporary pod.
- Convenient access via lockable flaps and panels to controllers and batteries.
- Delivers structural stability whilst ensuring good visibility for up to three signal heads in challenging environmental conditions including wind.

The design delivers fast and easy roadside deployment, with adjustable feet and quick-fit assembly featuring a hinge system to safely raise the signal head. The batteries can be hot swapped so operation is not interrupted and able to achieve run times of up to 6 weeks.

Metro Pole and Head Assembly

The lightweight pole and head assembly feature a distinctive design and reflective band, and are positioned at the same height as permanent light signals. A range of pole and head assemblies are available with a variety of signal combinations supported including traffic heads with or without substitute arrows and pedestrian heads with optional cycle aspects. Up to three signal heads can be installed on a single pole, and can be fitted with hoods or louvres as required by the site.

The possible combinations of signal heads are illustrated on the following page.

Introducing Metro (cont.)

Metro Ancillary Products

Finally, to support the deployment and management of Metro, we have designed a range of ancillary products.

Stillages are used to transport the batteries, poles, and head assemblies separately from the bases. This minimises inventory whilst maximising availability and simplifies fleet management.

We have designed a 'coaster' platform to support the Metro unit when deployed on soft or uneven ground, and are able to provide a dedicated charging system and additional batteries to support customers in maintaining active sites.

Signal Head Assembly Overview

The following head configurations provide simple single head signalling.

Traffic

Pedestrian

Cycle Lane

Offside Hybrid

Double Traffic

Crossing

Hybrid head configurations allow traffic and pedestrian head types to be employed on the same pole. This is useful where space is limited on site but does result in a reduction in runtime of approximately 50%.

Dual Substitution head configurations allow two directions of traffic to be signalled using substitute arrows on a single phase.

Traffic Dual Sub Left

Traffic Dual Sub Right

As with the hybrid head arrangements, these configurations also result in a reduction in runtime due to the operation of two signal heads and two controllers from a single set of up to 6 batteries.

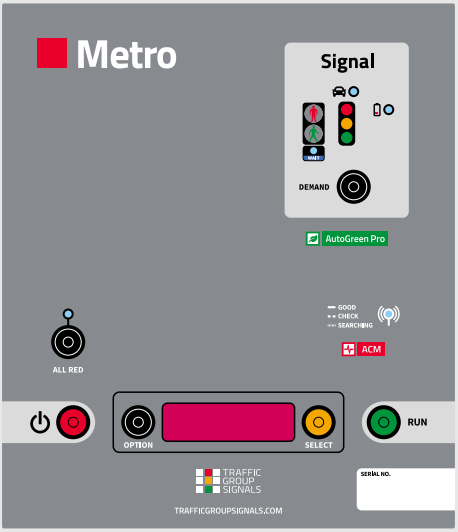
Where required, we are able to add **Hoods** and **Louvres** to improve driver perception on site.

Hoods and Louvres

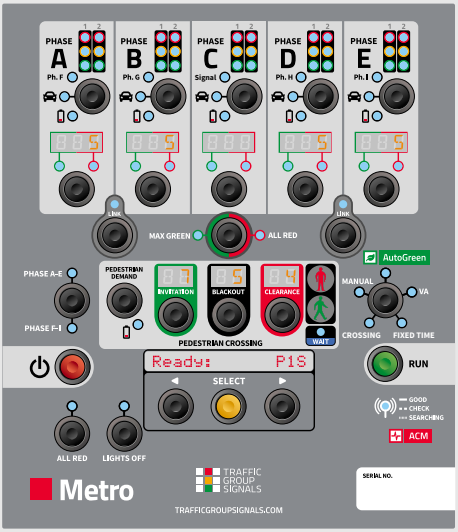
Regulatory Signs

Metro Series Controller Overview

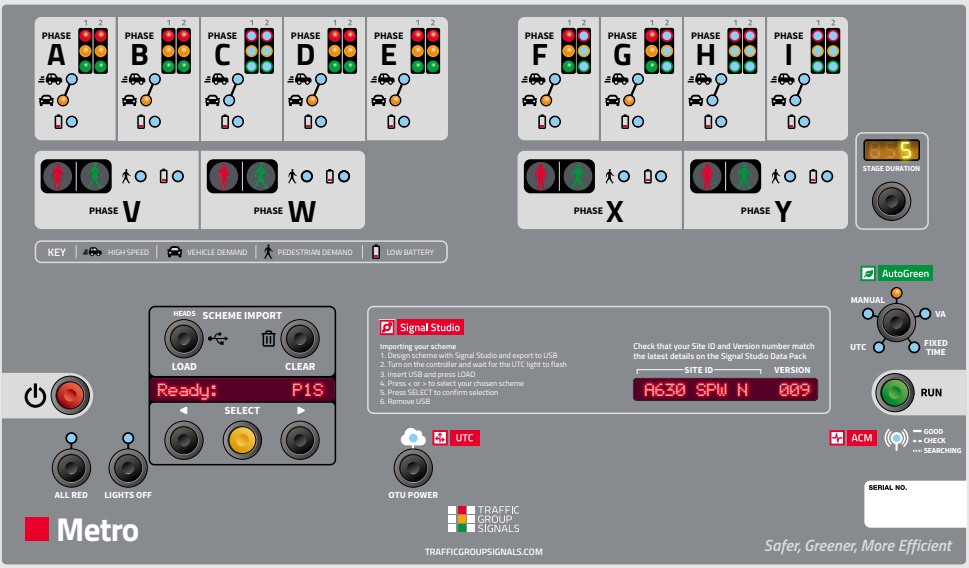
Metro Signal - controller only operates as a signal controller and is combined with either Metro Master or Metro Pro depending on the signalling complexity required.



Metro Master - is a phased based controller (similar to the Evo1® series) capable of 9 traffic phases and 8 pedestrian crossings. It is used as a system controller for less complex schemes, and most commonly used in Crossing mode to support either Haul Route or Standalone Pedestrian crossings.



Metro Pro - is a staged-based controller for more complex signalling requirements, configured using a scheme tool, capable of up to 16 stages with any of 9 traffic phases and 8 pedestrian crossings in 4 phases, permitting 'walk with traffic' schemes. Metro Pro is capable of operating in multi-phase AutoGreen® mode along with the ability to communicate with a central traffic signal control system operating UTC.



Metro Controller Overview

Metro Controllers

Controllers perform one of two possible functions:

Master Controller: Either a Metro standard or Metro Pro, this controller sends instructions out to the Signal Controllers in the scheme. It controls timings and operating modes and performs all system-wide functions including high-level safety monitoring functions.

System Controller: Usually a Metro Signal (although a Metro Master can operate in Signal mode) these controllers receive instructions from the Master Controller. They monitor their own operation and perform low level safety monitoring. They include limited user accessible functionality.

Any deployed scheme will employ one Master Controller and multiple Signal Controllers.

Metro Master Controller

The Metro Master is a phase-based master controller and is simple enough to be configured on site. It is well suited for use at shuttle working sites and most simple traffic and pedestrian schemes, especially standalone pedestrian crossings and standalone haul route crossings.

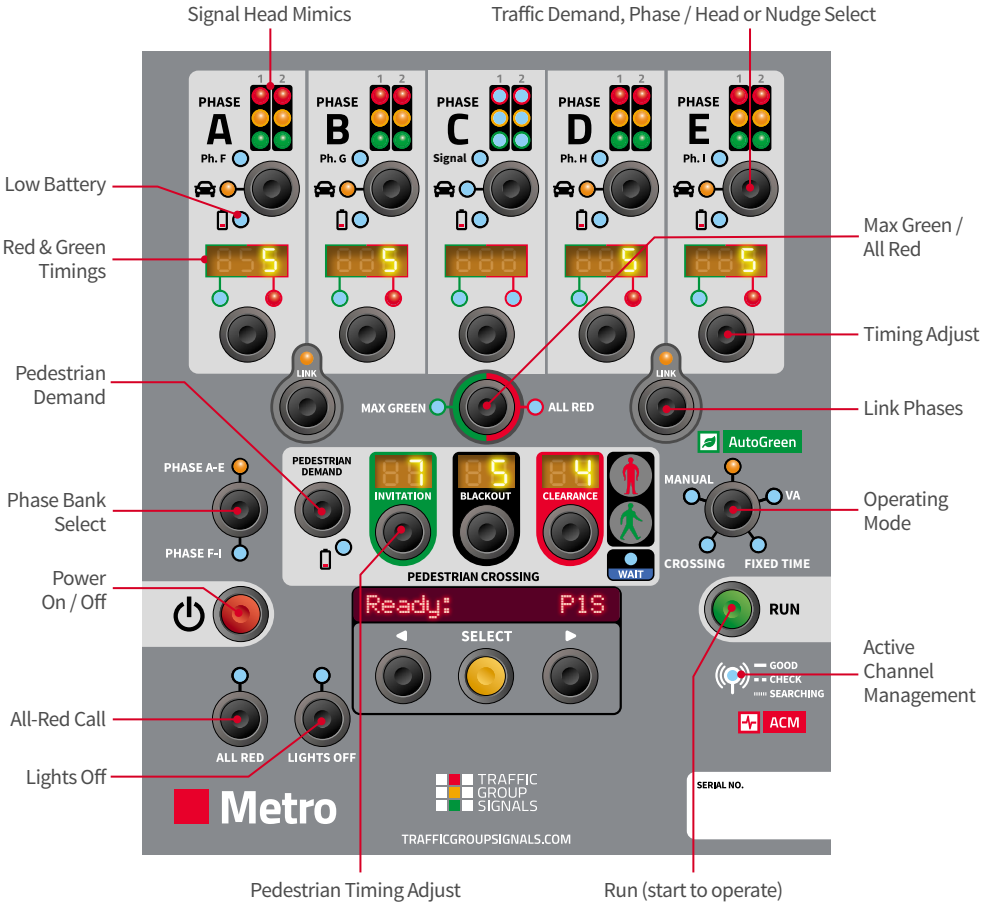
Phase based signalling is where either a single phase or a pair of linked phases can signal green at any point in time. By linking phases together opposing approaches can signal green at the same time providing they are non-conflicting. Up to 9 traffic approaches (either single or double heads) and 8 pedestrian crossings can be supported.

Metro Master benefits from AutoGreen 2-way as standard, which can also include a pedestrian crossing facility.

The Signal Studio can also be used to design Phased Based signalling schemes, and these can be exported in the form of a PDF data pack.

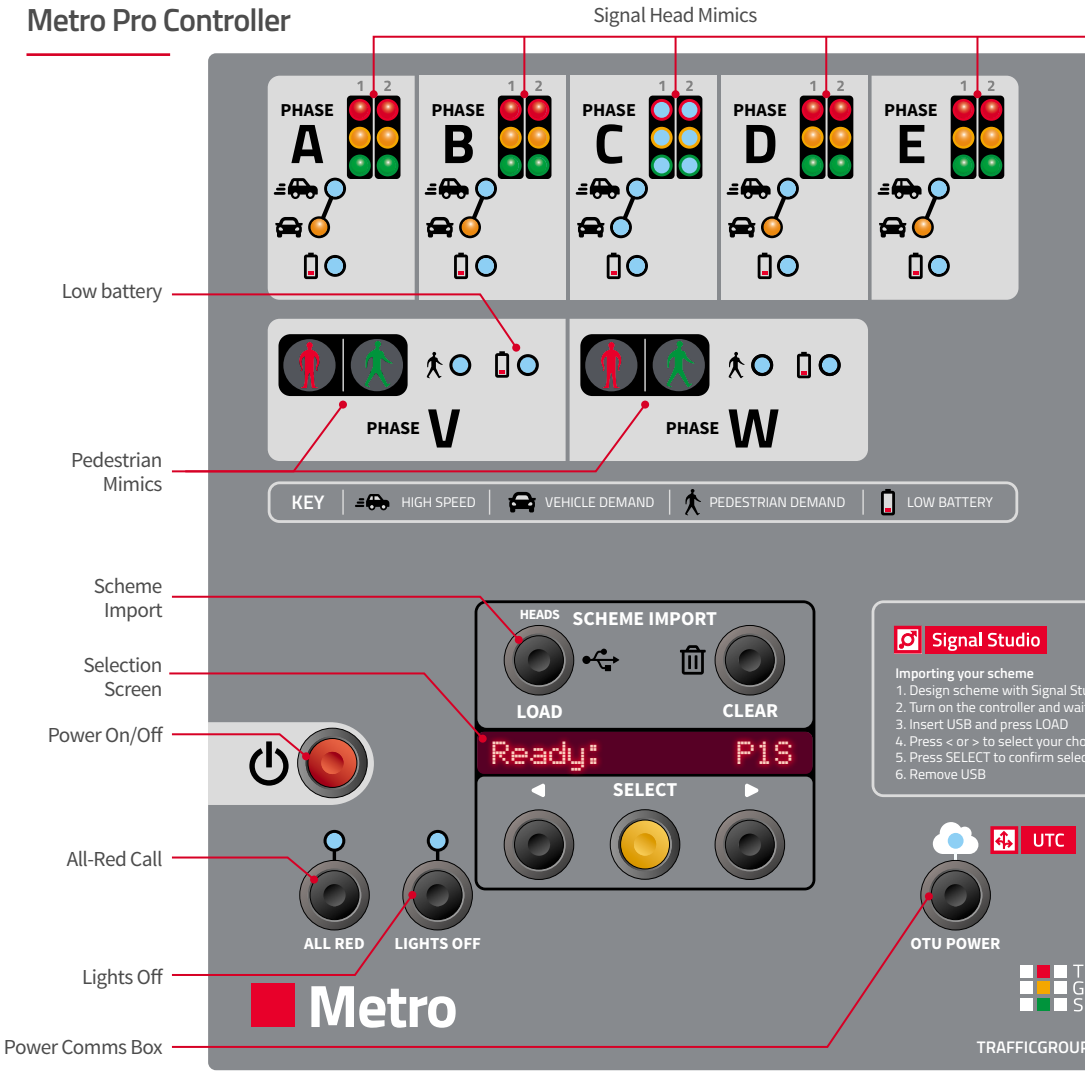
Metro Master employs datum point red times. These provide an improvement in efficiency over basic ‘clearance time’ timing found on many portable signals whilst remaining simple to specify and adjust on site if necessary.

Metro Controller Overview



Metro Controller Overview

Metro Pro Controller

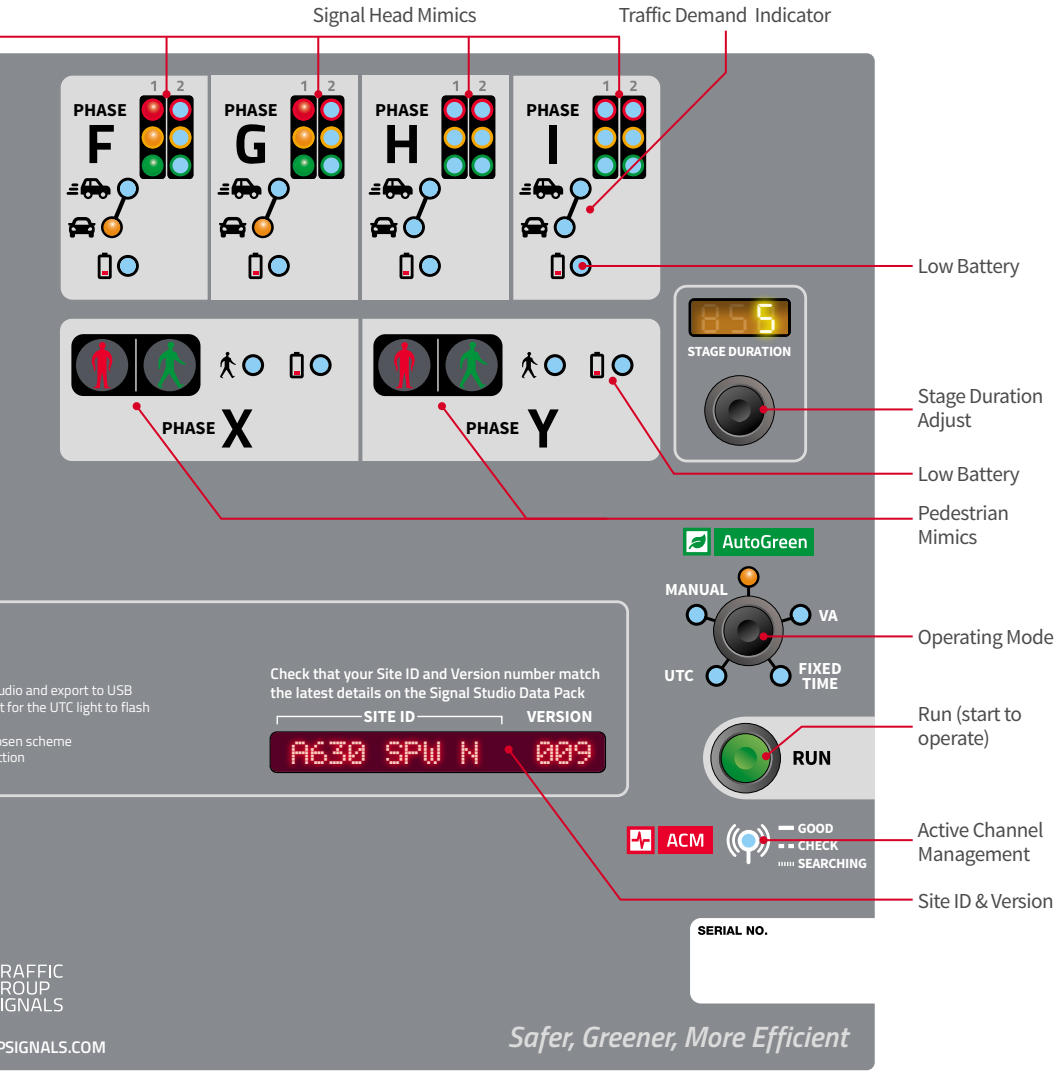


The Metro Pro is a stage-based master controller and is therefore capable of more complex signalling schemes for a wide range of junction signalling applications. It is especially well suited as a temporary replacement for permanent signals.

Stage based signalling is where phases can be grouped together into stages. A phase may be included in one or more stage. These controllers will signal one stage to green at any point in time, so that non-conflicting phases can signal green together for more efficient schemes. Thus 'walk with traffic' crossings can be supported as well as filter and indicative green arrows.

The Metro Pro controller employs a sophisticated Intergreen Matrix method of specifying red times.

Metro Controller Overview



This ensures maximum efficiency for signalling schemes, closely mirroring the configuration of permanent signals.

Metro Pro can be remotely monitored and managed, either as part of a UTC network or via TMdesk, including AutoGreen® mode operation.

Stage based schemes must be designed using the Signal Studio.

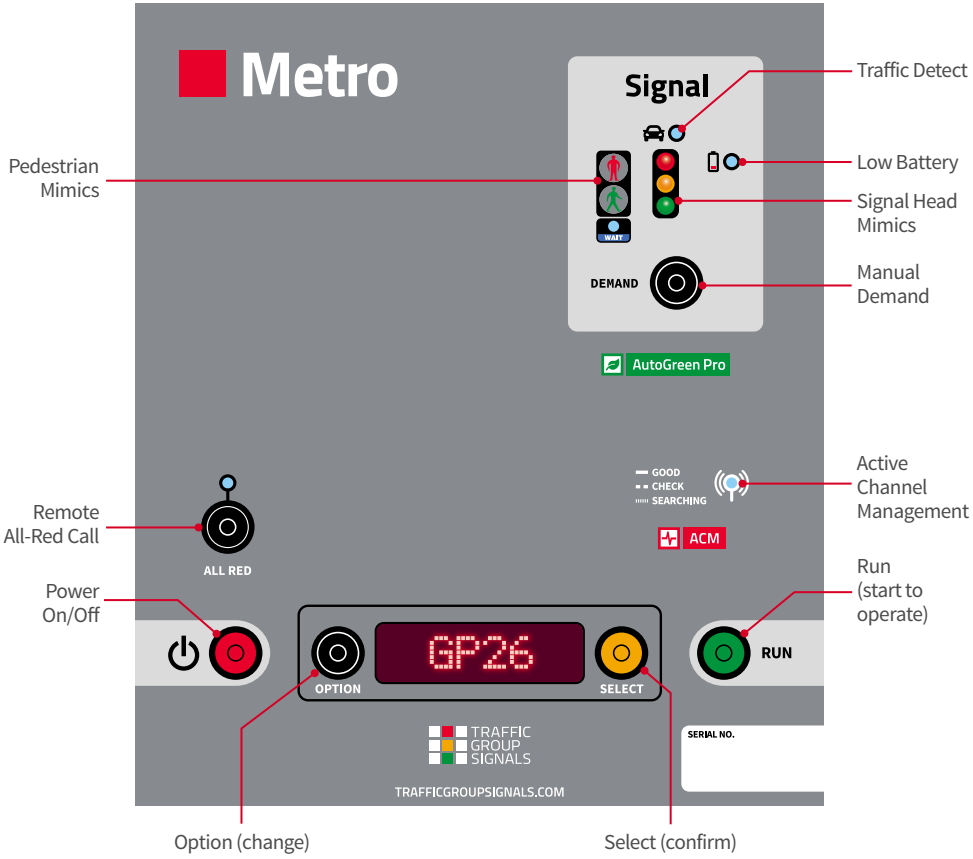
The configuration is exported and loaded into the controller via a USB flash drive. In addition, Metro Pro supports remote plan implementation, which can be synchonised from Signal Studio and manually activated at the press of a button by an on-site operative.

Metro Controller Overview

Metro Signal Controller

The Metro Signal controller only operates as a signal controller. It is not capable of operating as a master. It is compatible with either the Metro Pro or Metro Master operating as the Master Controller.

For details on how to set up and operate a Metro Signal as a signal controller see the **'Operating the Controller'** section on page 74.



Metro System Specification

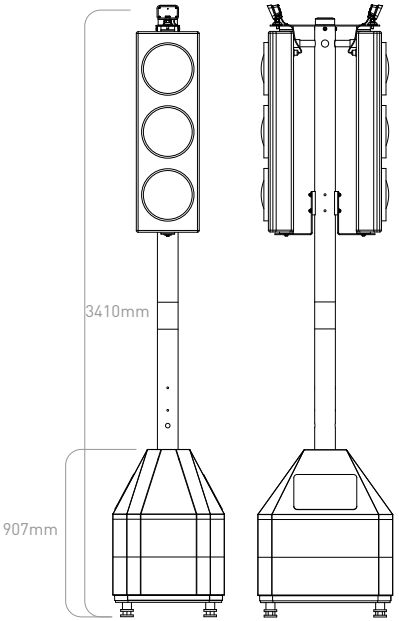
Specification			
Model	**Metro Signal**	**Metro Master**	**Metro Pro**
Description	Temporary Traffic Signal	Temporary Traffic Signal	Temporary Traffic System Controller
Compliance	TOPAS 2502, 2537, 2538	TOPAS 2502, 2537, 2538	TOPAS 2502, 2537, 2538
Led Signal	BS EN 12368:2015	BS EN 12368:2015	n/a
Red lamp monitoring	Yes	Yes	n/a
Signalling	Signal controller only	Phase-based	Stage-based inc. Walk with Traffic
Signal Studio	Signal controller only	Phase-based scheme design	Stage-based scheme design
Max Stages	Signal controller only	0	16
Clearance Time	Signal controller only	All-Red (Datum)	Intergreen Matrix
Max Traffic Phases	Signal controller only	9	9
Max Traffic Heads	Signal controller only	18	18
Max Ped Phases	Signal controller only	1	4
Max Ped Heads	Signal controller only	16	16
Max Ped Crossings	Signal controller only	8	8
Standalone Crossing	Signal controller only	Yes	Optional
Haul Route Crossing	Signal controller only	Yes	Optional
AutoGreen	Signal controller only	standard 2-way + Pedestrian	Multi-way up to 9 phases + Pedestrian
Remote Management	Signal controller only	TMdesk Basic	TMdesk Pro
UTC Support	Signal controller only	No	Yes – Fully Wireless
CLF Plans	Signal controller only	No	Yes
Controller Linking	Signal controller only	No	Yes
Phase Delay	Signal controller only	No	Yes
High Speed Roads	(>35mph) ToA Speed Extension with AGD306 Radar		
Communications	ACM Radio Technology		
Communications Range	500m subject to line-of-sight variations		
Communications Antenna	Helical Omni-directional	Helical Omni-directional	Virtual Quarter-wave
Detection	AGD306 Radar	AGD306 Radar	N/A
Power	12V Deep Cycle AGM Rechargeable		
Typical Run Time	Up to 6 weeks with single head	Up to 6 weeks with single head	3-4 weeks
Battery Payload	Up to 6 batteries	Up to 6 batteries	Up to 3 batteries
Battery Charger External	Metro Endurance Power Charger		

System Overview - Metro

Design Features

The key physical features of the Metro Product Range are as follows:

- Fast, easy roadside deployment, simple placement
- Modular, versatile, minimal inventory requirements
- Interchangeable signal heads, easily erected, quick-fit
- High visibility, compliant with TSRGD diagram 3000
- Poles and batteries conveniently transported in stillages
- Hot swappable batteries, charged at depot
- Long runtimes, battery capacity and health monitoring
- Reliable, robust, radio connection
- Stable static base able to withstand challenging wind conditions
- Secure tamper proof base with anti-theft measures



System Overview - Metro

New Technology and Features

The following sections describe the new technologies introduced into the Metro Product range.

Active Channel Management (ACM®)

The radio spectrum is filling up fast, meaning portable traffic signals must communicate with each other in an increasingly congested environment.

Active Channel Management, or ACM®, delivers reliable radio performance for portable and temporary traffic signals operating in challenging environments.

Traditional portable traffic signals operate using fixed channel radio communications between signals. The channel is selected by the operative at point of deployment, and manually entered into each signal in the set up. The choice of channel is often left to guesswork by the operative, or through using scanning functionality in the signal controller. The channel selection cannot be easily changed during operation.

ACM® constantly monitors all radio channels, both for signal quality and occupancy. ACM can automatically select and seamlessly change channels whenever necessary, as well as recover from temporary loss of communications. This agility avoids the system being affected by interference or causing interference to other equipment.

Enhanced Diagnostic Information

The operative can access diagnostic information, provided by ACM®, about the performance of the radio link to each signal through the controller front panel, helping to identify and resolve any radio communications issues.

Adaptive Channel Hopping

If there is some deterioration or occasional interference ACM® can quickly make a channel change to an available radio channel with a better signal quality. This occurs seamlessly as the Master signal can proactively inform all other signals in advance of the channel change.

Greater Resilience

ACM® generally maintains communications continuity with high reliability and minimal disruption. It learns which channels have the best signal quality and which to avoid. ACM also avoids causing interference by listening to all channels, including its own to determine whether the channel is in use by any other equipment[1].

In the vast majority of cases, any temporary loss of communications is tolerated and does not interfere with normal operation of the signals. Although ACM may choose to proactively change to a better channel, especially if it occurs more frequently.

[1] ACM incorporates the following standards: Dynamic Frequency Selection (DFS), Adaptive Frequency Agility (AFA) and Listen before Talk (LBT).

New Technology and Features

Active Channel Management (ACM®)

Automatic Channel Selection

ACM® selects the best channel at start-up or when recovering after a sudden or persistent loss of communications. This is based on an assessment of the best of the available channels.

The system will change channel whenever a more optimal channel is identified or in the rare event that communications loss with a Signal is persistent.

Only Signals configured with the same Group ID as the Master can connect with each other. The Master ensures that each Signal that connects matches one of the configured phases and that all are successfully connected before continuing. Usually this occurs on the first attempt. If not, the process is repeated with another channel until a successful connection is established.

What are the benefits of ACM®?

- ACM automatically selects the best available radio channel across all connected signals in the system without operator intervention.
- Only Signals configured with the same Group ID as the Master connect.
- ACM is adaptive, learning which channels have the best signal quality and which to avoid.
- ACM is resilient, maintaining communications continuity with high reliability and minimal disruption.
- ACM proactively changes channels seamlessly whenever necessary without impacting signal operation and without need of an operative to be present.
- ACM recovers from sudden or persistent loss of communications by reactively changing channel.
- ACM provides the user with detailed information about the performance of the radio link to each signal, helping identify and resolve any communications issues.

Endurance Power System

Endurance

The Endurance Power System manages power delivery in an intelligent, reliable, and efficient manner, whilst monitoring battery health and capacity. The system improves reliability and ensures a defective battery cannot drain power from the others in the set.

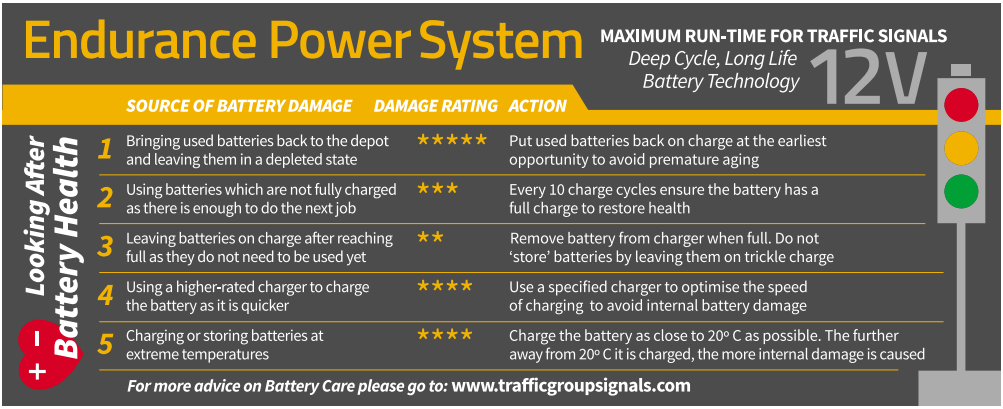
The system comprises of the following elements which should be employed together at all times.

1) A traffic signal whose controller, LED aspects and radar have all been engineered to consume as little power as possible.
2) High-performance professional grade batteries with power delivery characteristics that are matched to the operation of traffic signal.
3) Depot based performance chargers with rapid charge capability, whilst preserving and protecting battery chemistry (typically 80% in under 6 hours).

Using other makes, models or specifications of batteries or chargers is prohibited as this will impact system runtime, reliability, and performance. Additionally system indications including TMdesk battery alerts are all tuned to the supplied batteries and could be raised too late or too early where other batteries are employed.

The Endurance Power System achieves an un-rivalled level of runtime that can be relied upon for many years of use. This high level of performance requires a level of care and operational good practice.

For further detail please see the **'Battery Management'** section on page 90.



What are the benefits of Endurance Power?

- Un-rivalled level of battery runtime on a single charge.
- Intelligent rapid charger which preserves and protects battery chemistry.
- Professional grade batteries that reliably deliver power for their lifetime.
- Balanced and efficient power delivery.
- Monitors battery capacity and health.

New Technology and Features

Endurance Power System

Power Saving Mode

Some power saving in the controller is achieved by blanking the front panel during operation when no buttons have been pressed for more than 10 minutes. Only the ACM Comms LED remains illuminated to indicate that the controller is powered, connected, and operating. Any Low or Empty Battery indicators will also be shown.

Any button press will re-activate the front panel out of the power saving mode but otherwise has no effect.

AutoGreen®

AutoGreen® is an advanced form of scenario-based Vehicle Actuation (VA) designed to dynamically adjust signal control to create a safer, greener, more efficient, and less stressful roadworks environment.

AutoGreen® achieves this through a series of traffic scenarios, where signal performance is optimised according to prevailing traffic conditions, allowing the signal to incrementally adapt to an everchanging traffic environment.

Our extensive research into trends in driver behaviour at roadworks has enabled us to engineer AutoGreen® to enhance traffic flow and eliminate the need for manual intervention. It dynamically adapts to traffic flow and site topology. By shortening cycle times when possible and otherwise prioritising efficient traffic flow during peak times, it reduces driver frustration, keeps queuing to a minimum, lowers emissions and reduces exposure for on-site operatives. Now it is possible to include a pedestrian phase.

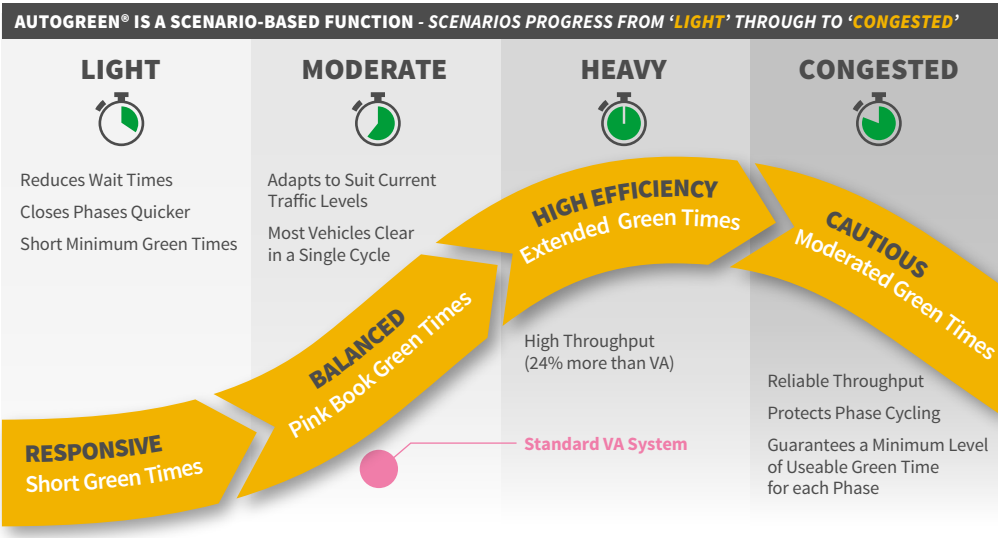
Multiway AutoGreen® is supported via the TMdesk® Pro system. TMdesk Pro can monitor and remotely manage a site to vary phase priorities as required or according to time of day and day of the week. TMdesk Pro is covered in separate product manual.

Traffic is typically managed at street works through a combination of Vehicle Actuation (VA) technology, and manual control. VA works well for low complexity sites. However, it can be inefficient in higher traffic volumes and fails to respond when congestion occurs. Manual control offers flexibility in high-volume sites but can be costly, unsafe, inconsistent, and difficult to deliver.

Traditional VA systems for portable signals use simple Doppler radars as the detection input for the signals. The radars used on the AutoGreen system are specially designed, low-power, FMCW radars which are capable of separately tracking each approaching vehicle with their associated range and speed. This data rich detection is used to optimise the operation of the signals.

AutoGreen®

As illustrated below, **AutoGreen®** automatically adjusts the operation of the signals according to the prevailing traffic conditions, using a sophisticated scenario-based software algorithm. AutoGreen is designed to protect the cycle and minimise the causes of congestion when traffic is heavy. Any congestion is automatically detected and recovery actions are deployed, all without operator intervention.



What are the benefits of AutoGreen®?

AutoGreen® maintains the cycle, shorting cycle times when possible, otherwise prioritising efficient traffic flow during peak times, thus keeping queues to a minimum.

- The system adjusts in response to traffic variations throughout the day and to unexpected peaks in demand whenever these occur.
- Avoids the causes of congestion and recovers from congestion when it occurs unexpectedly.
- Removes the need for Manual Control on those sites where traffic density is suitable for AutoGreen control.
- Reduces driver frustration and protects onsite operatives from abuse.
- There are no user settings required other than red time for each phase.
- Green times vary automatically and can extend above and below 'Pink Book' times where appropriate.
- Adjustments cover much more than just green time and are based on extensive trials and observation of real-world performance.
- Unaffected by adverse weather conditions or proximity to high tension power lines.

For a standard 2-phase system on a 50m length of roadworks AutoGreen can improve journey times by up to 50% compared to traditional VA based systems based on the **'Pink Book'** recommendations.

Please also see **'AutoGreen®'** in the Operating Modes section on page 39.

Crossings Mode

Metro Master features a new **Crossings mode** that provides support for a Standalone Pedestrian Crossing or a Standalone Haul Route Crossing. A Haul Route Crossing is a vehicle crossing, typically used for vehicle access to a construction site.

Crossings Mode is used where there is a public highway which rests at green until there is a call from the crossing.

Note that in Crossings Mode the radars on the public highway operate differently. The radars do not need to call the phase as it rests at green. Instead the radars are only used to extend the phase until there is a suitable gap in the approaching traffic on the highway to bring it safely to red, before servicing the call for the crossing.

To comply with regulatory requirements, each approach must have double heads. The public highway must always be configured for Phase A and linked to Phase B for opposing approaches.

The public highway may also be a high-speed road, requiring the radars to be reconfigured for ToA (Time of Arrival) speed extension.

For further information see **'Crossing Mode'** in the Operating Modes section on page 42.

Metro Master supports both vehicular and pedestrian type crossings. The type of crossing determines how the crossing functions:

- Pedestrians: Standalone Pedestrian Crossing
- Haul Route Vehicles: Standalone Haul Route Crossing

Standalone Pedestrian Crossing

A standalone crossing is a pedestrian crossing that is independent of any junction. It can also be for use by cyclists, or equestrians. It operates as a single traffic phase, comprised of either a pair of linked phases for two approaches or a single phase for one approach (for example on a one-way street). Each approach must have two heads, located on the nearside and offside.

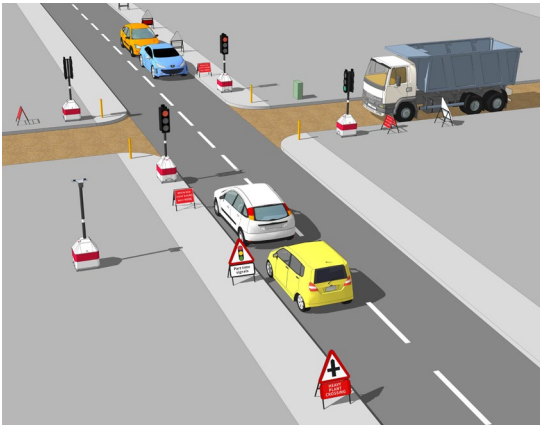
The crossing user makes a request to cross by pressing a button and receives a wait indication until the invitation to cross (green man) period commences. Provided that the public highway has been at green for more than the standard Min Green period (12 seconds), it is brought to red when there is a suitable gap in the traffic or at any time after the Max Green setting has expired. Whilst the crossing is not in use, the public highway returns to and rests at green.

Crossings Mode

Standalone Haul Route Crossing

A Haul Route Crossing is a vehicular crossing, typically used for vehicle access to a construction site.

Chapter 8 of the DfT Traffic Signs Manual (TSM) defines a Haul Route as follows:



"It may be necessary to provide traffic signal control when contractors' vehicles, site equipment or materials need to be moved across a public highway between sites or within a site. The haul route traffic should approach the public highway in a defined line and on a level gradient. Priority should be given to the public highway, not to the haul route."

TSM provides guidance on the preferred traffic signal configuration, method of operation, traffic priorities and safe signalling, particularly when operating with higher speed traffic.

Metro Master supports simple configurations of Haul Route Crossing that is independent of any pedestrian crossing, additional junction or shuttle works. Hence known as a Standalone Haul Route Crossing. This configuration comprises a pair of linked traffic phases in the case of a two-way road or a single traffic phase in the case of a one way road. Each approach must have two heads located on the near side and offside.

Whilst the crossing is not in use, the public highway returns to and rests at green.

Metro Master provides two modes of operation for Haul Route Crossing Applications. These are:

- Automatic Haul Route Crossing mode
- Manual Haul Route Crossing mode

When operating in Automatic Haul Route Crossing mode, radars mounted on the traffic signal heads for the crossing detect haul route vehicles automatically and enter a call for the haul route crossing to be serviced. There is a configurable 'Hold Off Period' that acts to limit the frequency with which the haul-route will be serviced. This helps highway authorities and contractors identify and deliver a level of haul-route crossing activity that balances the needs of both parties. It avoids the need for an operative on site and avoids variations in timing that a manually controlled haul-route would deliver.

When servicing the haul-route, the public highway is brought to red within 60 seconds, or sooner when there is a suitable gap in the traffic.

When operating in Manual Haul Route Crossing mode, an operative decides when to request service of the haul route by pressing a demand button. The demand button may be on the controller panel or external. Provided that the public highway has been at green for more than the Min Green (12 seconds) period, the system transitions to red within 60 seconds of the demand or sooner when there is a suitable gap in the traffic.

Support for High-Speed Roads

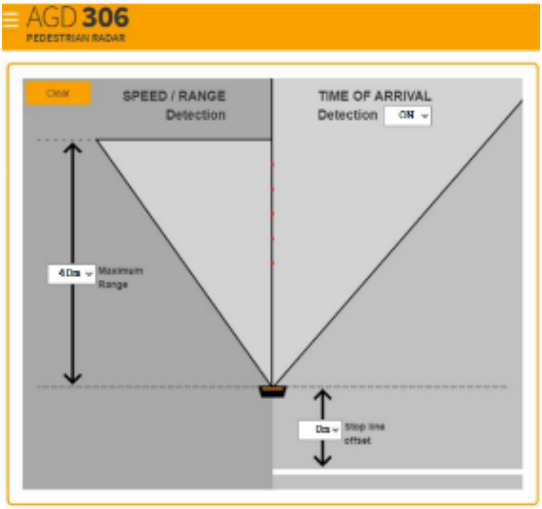
High-speed approaches require temporary signals, as they are more visible with taller poles, so less likely to be obscured. For the purposes of traffic signals, a high-speed road is where vehicles often approach at speeds of 35mph or more, at times when traffic is free flowing.

Metro supports high-speed roads using speed extension and is therefore fitted with the AGD306 radar with Time of Arrival detection capability.

High-Speed Approaches

When traffic signals transition from green to red on a phase, there is a possibility that one or more vehicles will pass the signal at red. Extensive research has been performed in this area by the permanent traffic signal industry. This has determined over many studies that the following factors affect whether a vehicle will stop:

- Location and speed of the vehicle in relation to the traffic signals
- Weather conditions
- Type of vehicle (e.g. car or HGV)
- Human reaction times
- Vehicle braking system capability
- Driver Psychology



Research also shows that if a system can precisely detect the position and speed of each vehicle then it is possible to make a good estimation of the likelihood that such a vehicle will stop, given the wide variability in the other relevant factors such as weather and psychology.

The Metro system employs precisely this method to determine a suitably safe point in time at which to transition signals to red on a high-speed approach. Until this is reached, the signals remain safely on green. This is called Time of Arrival (ToA) speed extension and is implemented in Metro by the AGD306 FMCW radar that is fitted to all Metro traffic heads.

Vehicles which are least likely to stop are those within the so-called **'dilemma zone'** where it can be difficult to decide whether to brake for a red signal or continue to pass through on amber.

In order for this protection to be effective, it is important that the driver can see the traffic signals before entering the dilemma zone. Also that the signals can detect the speed and distance of approaching vehicles in the dilemma zone.

Note: that speed extension does not extend the Max Green period. Therefore the operative must also extend the red time by 2 seconds to minimise any conflict between a vehicle failing to stop and the opposing phase.

Support for High-Speed Roads

To comply with regulatory requirements for temporary signals:

1. When operating on high-speed roads the Red Time setting (as recommended in the 'Pink Book') must be extended with an additional 2 seconds.
2. Pedestrian crossings must not be operated on roads with speeds above 50mph and serious consideration must be given to speed reduction where possible.

It is recommended that the Time of Arrival speed extension is only enabled in the AGD306 radar when used with a high-speed approach. This is essential for road speeds of 50mph or above.

Note: also that the AutoGreen mode of operation is designed for use on low speed roads only. Use of AutoGreen on high-speed roads may result in excessive extension of green times.

To operate effectively, the AGD306 radar requires unobscured visibility as set out below. If visibility is restricted, such as by a bend in the road, an additional Metro unit can be deployed as an upstream detector.

Road Speed	Time of Arrival	Extended Red Time	Radar visibility required
Up to 30mph	Disabled	None	Better than 40m
Up to 40mph	Disabled	+ 3 sec	Better than 40m
	Enabled	+ 2 sec	Better than 110m
Up to 50mph	Enabled	+ 2 sec	Better than 130m
Up to 60mph	Enabled	+ 2 sec	Better than 160m

Other New Features and Improvements

The preceding section described some new technology and features introduced into the Metro Product range. In addition the Metro Products have benefitted from some simplifications and usability improvements as well as additional new features.

The following is a summary of some of the other changes, which are explained further in other sections:

Signalling and Timing:

- Datum Red Time settings are now used for all Traffic phases (instead of Clearance Red Time).
- Changes to the servicing of phases for schemes containing pedestrian facilities in order to maximise pedestrian safety.

Battery Management:

- Improved battery alerting for low battery and early warning for battery fail (part of the Endurance Power System).
- Now displays “Sys Batt Fail” (rather than “Comms Fail”) on critical battery failure at a signal.

Communications:

- Improved indication for Comms loss and ACM status.
- New Comms performance diagnostic information feature.

Fault Management:

- Display more meaningful messages for status, warnings faults and errors.
- CAT1 fails to Lights-Out with Auto Recovery.
- New Cat4 failure for sustained loss of comms.

User Interface and Operator Function:

- Remote All-Red call can now be remotely cleared from any Signal.
- New start up at All-Red feature in addition to start up at Lights Out.
- Phase Bank Selection to permit additional phases to be displayed / configured.
- Simplified selection for configuring single or double heads.
- Removal of need for user to choose between two heads opposing **(↔)** and two heads non-opposing **(↑↑)** when configuring schemes.
- Permit shorter red times, as low as 1s for traffic phases.
- Permit shorter green times, between 6s and 14s for traffic phases.
- Nudging of traffic phases can be deselected in the controller.
- Change method for selecting Master or Signal controller.
- Change method for selecting the number of pedestrian crossings.
- Auto-increment time settings with button hold.

Features of the Metro Controller

The following sections describe the main features of the Metro Controller.

Phases and Heads

This section describes the concepts of phases and heads as employed in Metro products. These differ subtly from their use in portable traffic signals.

Traffic Phases and Heads

Metro uses a system of letters for identifying phases, crossings and signal heads that is more closely aligned with permanent traffic signal schemes.

Metro requires a phase to be configured as requiring single or double heads. For reasons of simplicity and safety it is no longer possible to specify that double heads are deployed to opposing approaches. Double heads are now always considered to be signalling the same approach.

SAFETY NOTE: Never deploy double heads from the same phase on opposing approaches.

In the event that two approaches are required to be signalled together, this should now always be achieved using linked phases.

WARNING: Deploying the two heads from the same phase onto different approaches whilst able to signal traffic as required, disables important safety protections within the product. It can result in an approach left running with no working red aspect. Always use linked phases for dual approaches!

Traffic phases are lettered from **A to I**, split into two phase banks **A** to **E** and **F** to **I**.
There is a button to select which phase bank is active on the front panel.

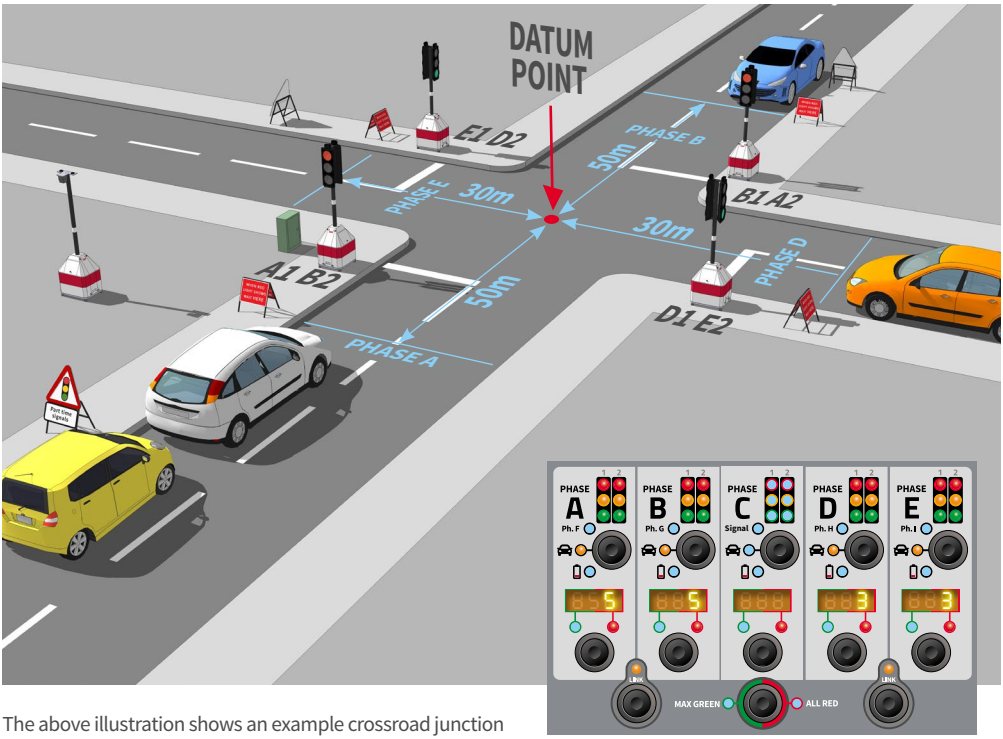
Each phase may have a single head **(e.g. A1)** or double head **(e.g. A1 and A2)**.

	Normal Phase Bank					Alternate Phase Bank			
Phases:	A	B	C	D	E	F	G	H	I
Head:	A1, A2	B1, B2	C1, C2	D1, D2	E1, E2	F1, F2	G1, G2	H1, H2	I1, I2

Linked phases should be used when opposing approaches need to be signalled to green together. Although linked phases share the same green time, each may have a different datum red time.

Phases and Heads

The following pairs of phases can be linked, so that they operate together as one phase: **A&B, D&E, F&G, H&I**.



The above illustration shows an example crossroad junction operating as a 2-way, with linked phases A and B operating together, then linked phases D and E operating together. Note the use of double traffic heads to provide secondary signals across the junction.

Pedestrian Phases, Crossings and Heads

Pedestrian phases are now lettered from V to Y, with two pairs of heads per phase. Each pair of heads must be placed either side of a crossing.

Crossing:	1	2	3	4	5	5	7	8
Head:	V1, V2	V3, V4	W1, W2	W3, W4	X1, X2	X3, X4	Y1, Y2	Y3, Y4

Phases and Heads

Operating Pedestrian Phases Safely with Traffic Phases

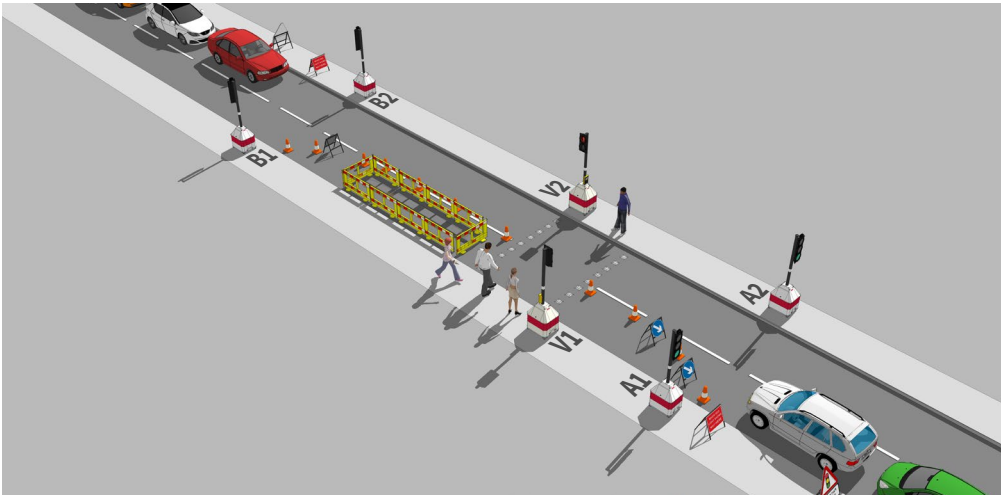
For Metro Master, all Pedestrian crossings are serviced together as a Full Pedestrian phase (sometimes known as an 'All-round Pedestrian' phase). This pedestrian phase is normally serviced no more than once per cycle with all traffic phases at red. This may however be varied in the case where site priorities are being specified using AutoGreen with TMdesk Pro.

Metro Master now applies a scheme for pedestrian crossings known as Ped Guard. This ensures maximum pedestrian safety, particularly for a stand-alone pedestrian crossing or for a shuttle works with two traffic phases.

Ped Guard

Ped Guard is simple safety enhancement for temporary traffic signals. It requires that the pedestrian crossing in a shuttle working site should be located directly next to the phase A traffic head(s).

Ped Guard ensures that the Full Pedestrian stage always follows traffic phase A, other than the case where the signals are resting at all-red with no vehicular demands.



This helps to ensure that vehicles that are delayed in their journey through the shuttle are not then travelling through the pedestrian crossing when the green man becomes illuminated. Such delays through the work can occur as a result of general congestion or when a works vehicle, bus or refuse lorry disrupts traffic flow.

SAFETY NOTE: In a shuttle working site any pedestrian crossing should be located directly next to the phase A traffic head(s) in order to receive Ped Guard protection. The use of double heads on the approaches either side of the crossing is also strongly recommended

Importantly, be aware that Ped Guard does not offer any safety improvement in the case of vehicles emerging within the signal controlled space itself (e.g. driveways, works vehicles etc) in such a case consider increasing the red time for Phase A by a few seconds..

Setting Timings

This section provides an overview to signal timings, red and green times for traffic and pedestrian phases. These differ subtly from their use in portable traffic signals.

Setting Timings for the Full Pedestrian Phase

The timings for the Full Pedestrian phase are controlled by the following three settings. These are displayed on the front panel when configured for at least one pedestrian crossing. Each can be changed using the button beneath the displays.

Invitation The Invitation to Cross period represents a fixed period during which the pedestrian green is displayed on pedestrian aspects, instructing pedestrians that they are invited to begin crossing the road. This should be set to 7s unless otherwise instructed / required.

Blackout The Blackout period represents a fixed period following the Invitation to Cross period during which all pedestrian aspects are extinguished. This period should be long enough to allow the majority of pedestrians to complete walking across the crossing.

Clearance Finally, the Clearance period provides a safety margin to allow pedestrians to complete crossing safely before traffic is signalled to move.

The following Pedestrian timings are supported:

Pedestrian Timings	Range
Invitation to Cross period:	6s to 9s
Blackout period:	3s to 15s
Clearance period:	2s to 9s

All times are adjustable in 1 second increments.

Guidance on how to select the most appropriate pedestrian crossing timings can be found in the Traffic Signs Manual published by the UK Department for Transport. The pedestrian timings generally assume a walking speed of either 1.2 m/s or in some cases 1.0 m/s at the time of publication of this document.

Setting Red Times for Traffic Phases

Red time settings in traffic signals are set so as to reflect the geometry, scale and road gradients at the deployment site.

The Metro Master controller employs Datum Red times. Datum Red times are more efficient than clearance red times used historically in many portable traffic signal products. Please read the remainder of this section below, to ensure that the concept of datum timings is well understood before setting the red times.

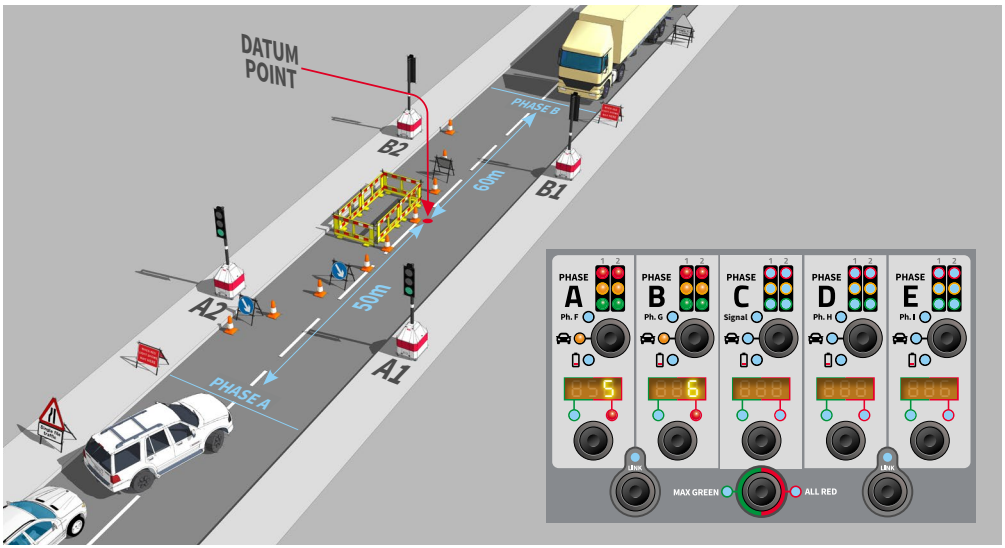
IMPORTANT: Remember that Datum Red times are used for all traffic phases and all configurations both 2-way and multiway. Entering an incorrect red time is likely to compromise safety.

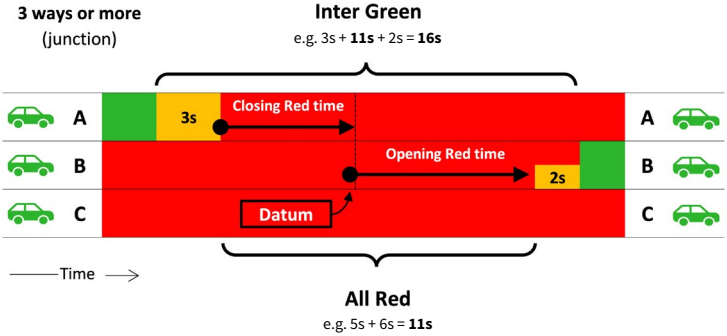
Setting Timings

Datum Red Time

The Datum Red time for a phase is the time required for a vehicle to travel between the WAIT board for the phase and a notional Datum Point at the centre of the junction.

The All Red period between any two traffic phases is calculated by the controller as the sum of the Datum Red time for the closing phase plus the datum red time for the next phase to open at green.





In this example, the closing Phase A has a Datum Red time setting of 5 seconds, whilst the opening Phase B is set 6 seconds.

Added together an All Red time of 11 seconds is run between the two phases.

Adding on the amber times this gives an inter green time of 16 seconds.

This ensures that the vehicles from the closing phase can clear the full distance between WAIT boards at both ends, so that there is no conflict with vehicles from the next phase to open at green. It also ensures that an efficient All Red period is always applied.

Setting Timings

The choice of where to position the datum point is down to the scheme designer to identify. For the vast majority of sites there is no unsafe location to place the datum point. There are however, positions for the datum point that will result in more efficient signalling. As a rule it is best to select a location for the Datum point that is central within the junction.

The one exception to the above guidance is the case of a pedestrian crossing located on a one-way street. In this case, the datum point should be located on the pedestrian crossing in order to ensure that red times for the transition from the traffic phase to the pedestrian phase are correctly calculated.

The following Datum Red time settings for Traffic phases are supported:

Time	Range
Datum Red Times:	0s to 30s

All times are adjustable in 1 second increments.

Guidance on how to select the most appropriate red timings for temporary traffic signals can be found in the **'Pink Book'** published by the UK Department for Transport. This generally recommends allowing 1 second for every 10m distance between WAIT boards.

Please also refer to the **'Site Deployment'** section on page 46.

Note: Whilst it is possible to enter a datum time of 0s for each phase, the system ensures during operation that the All Red period is never less than a minimum value as defined below:

- For schemes that include a pedestrian crossing: 3s
- For schemes containing only traffic phases: 1s

Understanding Inter Green Times

When discussing timings for a site, the traffic management industry has historically referred to **'All-Red'** periods. This is a period of time when all phases are at red between phases at green.

The Inter Green period includes the All-Red period plus the amber times and pedestrian blackout period where applicable.

By designing a scheme using Signal Studio, it is possible to have the full inter green matrix automatically calculated which reflects the above logic. This can be useful when using Metro Master in a UTC environment where a permanent traffic signal engineer requires a knowledge of the inter green matrix for the site in order to configure their UTC system.

Setting Timings

Setting Green Times for Traffic Phases

Green time settings in traffic signals are set based on the required levels of traffic flow through the junction.

The following Traffic Phase Green timings are supported:

Time	Range
Max Green times:	15s to 60s
Hidden Max Green times:	6s to 14s

Access is hidden – see below for details.
Not applicable to AutoGreen mode

All times are adjustable in 1 second increments.

Guidance on how to select the most appropriate Max Green timings for temporary traffic signals can be found in the **'Pink Book'** published by the UK Department for Transport.

Please also refer to the **'Site Deployment'** section on page 46.

Hidden Max Green Times

In specific circumstances (such as in inner city locations), with prior agreement from the appropriate Highway Authority, the product supports very short Max Green times in the range 6 to 14 seconds (except in AutoGreen mode).

Such short green times can have significant adverse effects if mis-used. They have been **'hidden'** in the sense that they require specific knowledge in order to access them. This is intended to ensure that only users who are fully familiar with the product can employ them.

Understanding Min Green Times

Generally in any operating mode a phase must remain at green not less than a period of **'Min Green'**, which is normally 12 seconds. This is to allow stationary vehicles time to get going when the signals turn to green, particularly heavy goods vehicles.

However, shorter Min Green times are applied when setting Hidden Max Green times (between 6 and 14 seconds) as follows:

Max Green	Min Green
6 to 8 seconds	Same as Max Green
9 or 10 seconds	8 seconds
11 or 12 seconds	9 seconds
13 seconds	10 seconds
14 seconds	11 seconds
15 to 60 seconds	12 seconds

Note: that when the controller is under UTC control (force bits are being actively sent to it by a UTC server), the controller automatically switches to using a 6 second minimum green time. This provides maximum flexibility for the UTC system.

Note: that AutoGreen can apply varying Min Green times depending upon prevailing traffic conditions under the control of TMdesk Pro.

Setting Timings

Understanding Max Green Times

The signal can remain at green indefinitely if there is continued demand for the phase or until there is a demand to service another phase or it can return to red after Min Green if there is no further demand.

How and when to extend the current green phase or end it or change to another phase very much depends upon the selected operating mode, the demands, and Max Green setting.

Demands may either come from radar detection of approaching vehicles at the signal at green or another approach at red. Alternatively it may be a manual demand, a UTC demand or a fixed time that expires.

The Max Green setting applies to VA, AutoGreen, Crossing and Fixed Time modes. It limits how long the green phase can be extended after Min Green whilst there is demand for the current phase at green and starts a point of demand for another phase.

Max Green in Crossing Mode

In Crossing mode the public highway rests at green when the crossing is not active. The Max Green setting for the public highway (Phase A) is therefore used to specify the **'Hold Off Period'**.

Please see **'Crossing Mode'** in the Operating Mode section on page 42.

Nudging of Traffic phases

In VA and AutoGreen modes demand for a phase is normally driven by the radar detecting an approaching vehicle within 40m of the signal.

In some legacy products, the radar would generate a nudge demand when there had been no detection within the last 150 secs. This ensures the phase is always serviced occasionally.

However in some cases it is desirable to disable this feature for specific phases so that for example, a little used side road does is not regularly interrupt the cycle and waste valuable green time when there is nothing waiting.

Intelligent Nudging

In Metro the radar no longer generates any nudge demand. Instead nudge demands are now generated when required in the controller in VA and AutoGreen modes.

This allows nudges to be configured and controlled by the controller more intelligently. Nudges can now be timed from when the phase last ended green.

In VA mode, nudging is enabled by default. The operative can selectively disable or enable nudging for any of the phases.

Nudges are automatically disabled when UTC takes control or when in Crossing mode.

Setting Timings

Start-Up Sequence

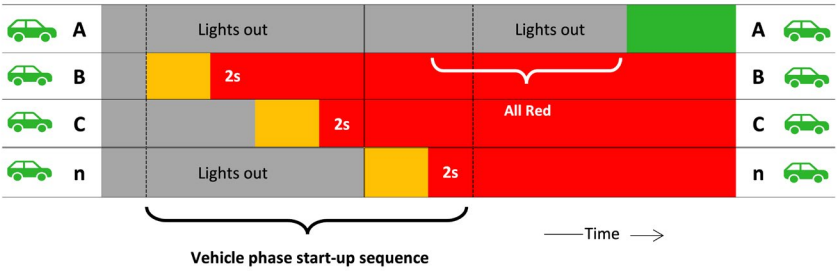
The start-up sequence has a few variations as described below.

Unless there is a pedestrian phase configured in the system, the start-up sequence normally proceeds as follows.

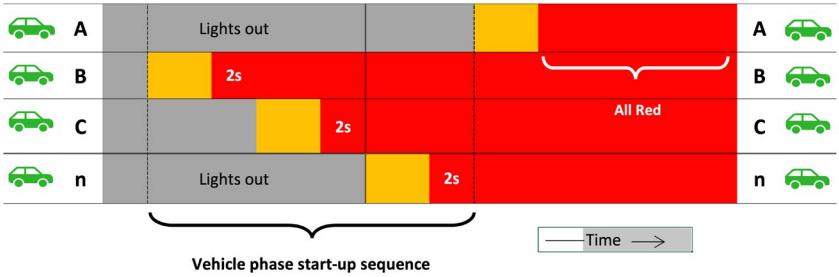
Normal Start-Up Sequence (for Traffic phases)

Starting from Lights Off, each traffic phase in turn signals amber for 3 seconds then red for 2 seconds, starting with the phase following Phase A. When the last traffic phase signals red, there is an All Red period long enough to ensure any conflicting vehicle movements are cleared.

a) Normally Phase A immediately starts at green



b) However Phase A starts at red when starting in Manual Mode or All Red



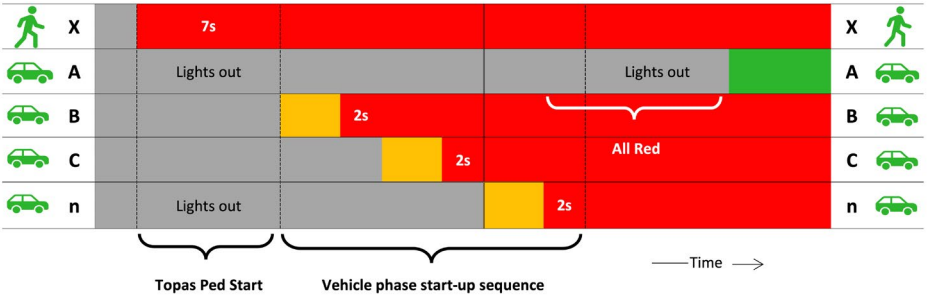
Note: that the start-up sequence when using the UTC mode of operation can be either of the above sequences depending on which phase it being requested (forced) by the UTC server whilst start-up is occurring.

Setting Timings

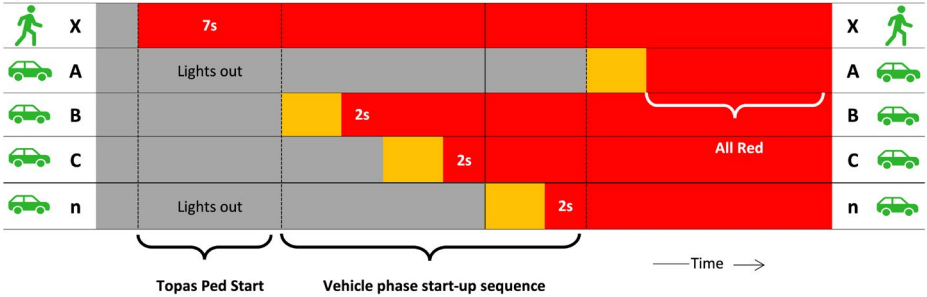
Start-Up Sequence with Pedestrian Stage

However, when the system includes a pedestrian phase then either of the above start-up sequences are preceded with pedestrian phase at red for 7 seconds as follows.

c) Normally Phase A immediately starts at green



d) However Phase A starts at red when starting in Manual Mode or All Red



Once again, a system under UTC control may use either of these start-up sequences.

All Red Timing at the end of the Start-Up Sequence

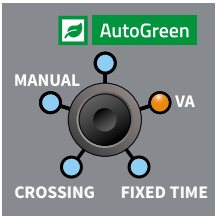
The All Red period within the start-up sequence is the sum of the two longest Red Time settings. This ensures all traffic has cleared the site before a phase is signalled to green.

Operating Modes

One of the following operating mode can be selected during configuration or operation using the Operating Mode button. Each time the button is pressed the selection advances around the mode wheel.

- **VA** – Vehicle Actuation: responds to radar detection
- **AutoGreen** – varies behaviour to suit traffic conditions
- **Manual** – for manual control
- **Fixed Time** – cycles through phases with fixed time share
- **Crossing** – for haul route or standalone pedestrian crossings

Vehicle Actuation



VA has historically been the most commonly used operating mode for signals at temporary works however is increasingly being replaced by the use of AutoGreen and UTC systems.

Under VA, an approaching vehicle is detected by the radar when it is within 40m. This sets a demand to call the phase when it is at red or can extend the duration of a phase when it is at green.

Demanded phases are serviced in numerical order, skipping over any phase that has not been demanded. With a pedestrian crossing a Full Pedestrian phase is inserted into the cycle when called. Pedestrian service will generally occur straight after service of phase A, in accordance with the Ped Guard provisions discussed on page 28.

Green Timing for VA

A demanded phase goes to green when it is serviced. The phase remains at green for at least the Min Green period. After this, the phase remains at green until either there is no further demand for the phase or the Max Green period expires. The Max Green period starts upon the detection of a vehicle at any opposing phase at red. It is therefore possible for the phase to remain at green for a longer period than Max Green whilst there is demand for the phase and none at any opposing phase.

Quiescent Red and Red Reversion

When there are no demands for any other phase or to extend the current phase then the signals return to All Red and rest at red. This state is known as Quiescent Red.

When the current phase at green closes and returns to Quiescent Red, then a new demand from the same phase can be serviced again immediately after only 2 seconds at red. This is known as Red Reversion.

Operating in VA Mode

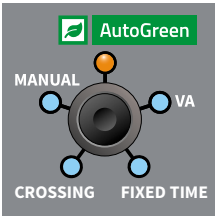
It is recommended that the operation of the system is observed for at least 20 minutes after starting and at various periods during the day. Make any adjustments to red and green times as needed to optimise the performance for the conditions at the site.

If congestion occurs it may be necessary to change to Manual mode to resolve the situation.

Use the **ALL RED** button at any time if you need to briefly stop the traffic for site access. Then press **ALL RED** again to continue the mode.

Operating Modes

AutoGreen®



AutoGreen® is an advanced form of scenario-based Vehicle Actuation (VA). AutoGreen® automatically selects a suitable operating scenario throughout the day in response to traffic variations (e.g. tidal flow) and unexpected peaks in demand whenever these occur.

In many cases, AutoGreen® removes the need for Manual Control. By shortening cycle times when possible and otherwise prioritising efficient traffic flow during peak times.

Two-way AutoGreen is suitable for a shuttle or crossroads (when using linked phases). A Full Pedestrian phase can also be included when required. There are no user settings required other than red time for each phase (same settings as for VA).

Multiway AutoGreen is supported and operates in conjunction with TMdesk Pro. Please refer to the TMdesk Pro Product Manual.

For more information please see **'AutoGreen®'** in the New Technology and New Features section on page 21.

Phase Service for AutoGreen®

AutoGreen applies the same principles as VA for servicing phases.

However AutoGreen tracks the traffic conditions over several cycles and automatically adjusts to prevailing traffic conditions during operation.

Initially it is a good idea to set Max Green as for the VA mode in case the mode is changed during operation.

Operating in AutoGreen Mode

When AutoGreen mode is running just leave the signals to make the necessary adjustments. If congestion occurs the signals automatically recover the situation at most after one or two cycles.

Use the ALL RED button at any time if you need to briefly stop the traffic for site access. Then press All Red again to continue the mode.

Suitable Sites for Deploying AutoGreen®

AutoGreen® is suitable for the majority of 2-way applications, such as shuttle working and may include a pedestrian crossing.

However, we would advise to consider the following factors before deploying AutoGreen:

- Proximity and interactions with nearby junctions and pedestrian crossings.
- Any requirement to keep specific junctions or facilities free of queues, such as motorway slip roads and hospital entrances.
- Average Annualised Daily Flow (AADF) of traffic that is greater than 22,000 vehicles (see following page).

Operating Modes

AutoGreen® Continued

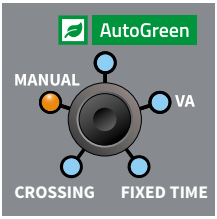
These factors may call for stricter control measures, such as our UTC connected system or manual control.

The table below can be used as a guide to assess site suitability by Average Annualised Daily Flow, and you may find the figure for your site via the DfT website: **https://roadtraffic.dft.gov.uk**

	Minimum Proximity to	
AADF	Nearest Junction	Major Junction
10,000	80m	120m
12,000	100m	150m
14,000	120m	200m
16,000	150m	250m
18,000	200m	300m
20,000	250m	350m
22,000	300m	UTC or Manual
24,000	UTC or Manual	UTC or Manual

Operating Modes

Manual Mode



In **Manual mode** the operative manually controls the servicing of phases.

Press the demand button for a phase to manually demand the phase to go to green next. The phase remains at green until another phase is demanded or press the demand button for the phase at green to clear all demand and end the green phase. The signals remain at All Red until a phase is demanded.

Manual control requires the operative to be trained, competent and remain alert. It does expose the operative to operational hazards and therefore should be employed only where absolutely necessary. Consideration should instead be given to the deployment of AutoGreen or UTC based systems.

Phase Timings for Manual

For safe operation Manual mode ensures that the configured red times are maintained regardless of operator input. Therefore the red time should be set as it would be for VA.

The Max Green time is not applicable to Manual mode, although the green phase cannot be shorter than Min Green.

Operating in Manual Mode

At start-up, Manual mode first starts with all phases held at red.

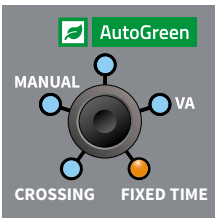
Whilst operating in another mode the Master can be changed to Manual mode. In most cases Manual mode will take over and hold the signals in their current state.

The signals are then controlled manually by the operative.

The operating mode can be changed to another mode at any point. The mode changes occur seamlessly after any phase at green transitions to red.

Switching to Manual mode can be useful for responding and taking control of situations, such as when there is congestion. Although the **ALL RED** button is recommended as it is often a better initial response. From All Red it is then possible to switch to Manual mode if manual control is needed.

Fixed Time



Fixed Time mode simply sequences each phase in numerical order, giving each approach in turn a predetermined period of green time. This strategy controls the flow of traffic in a deterministic manner, although it generally is not efficient. So it is mainly used in specific circumstances or times of day often with stipulated timings as instructed.

Operating Modes

Crossing Mode

Crossing mode consists of a public highway which rests at green until there is a call from the crossing.

For further information see '**Crossings Mode'** in the New Technology and Features section on page 23.

Configuring and Setting Up Crossing Mode

Use of the Crossing mode requires that the scheme comprises of a specific combination of phases and heads. Crossing mode cannot be run or selected during operation unless the applicable configuration has been set as explained below.

Metro Master supports both vehicular and pedestrian type crossings. The type of crossing determines how the crossing functions:

- Pedestrian phase: Standalone Crossing
- Traffic phase: Haul Route Crossing

Configuring a Standalone Pedestrian Crossing

A standalone crossing is a pedestrian crossing that is independent of any junction.

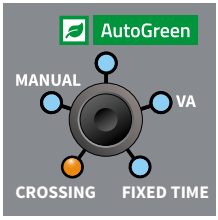
Therefore it is only supported when a pedestrian crossing is configured with the public highway operating as a single traffic stage. This may be either a pair of linked phases (usually Phases A and B) for two approaches or a single phase for one approach, such as a one-way road. Each approach must have two heads for safety and regulatory compliance. There must be a pedestrian phase but no additional traffic phases configured.

SAFETY NOTE: It is important to correctly set the vehicle red time and pedestrian crossing times. Remember that Datum Red times are used for traffic phases. Also for a high-speed approach on the highway, 2 seconds should be added to the vehicle red time and to enable Time of Arrival detection in the AGD 306 radar.

See **'Datum Red Time'** in the Setting Timings section on page 32.

Also see the **'High-Speed Approaches'** section on page 25.

Using a Standalone Crossing Mode



In **Crossing mode** the public highway rests at green until the pedestrian presses the request button as normal, which enters a call for the crossing to be serviced.

After Min Green and following any demand for the crossing, the public highway transitions to red as soon as the radar detects a suitable gap in the approaching traffic. If no gap in radar detection occurs, the system will service the pedestrian crossing when the Max Green duration is reached on Phase A.

When the AGD306 radar is configured for Time of Arrival then gap timings will be adjusted for the speed and distance of any approaching vehicles.

Operating Modes

Configuring a Standalone Haul Route Crossing

A Haul Route Crossing is a vehicular crossing, typically used by construction vehicles to cross a public highway. Metro Master supports a **'standalone'** configuration of Haul Route Crossing, that is a simple crossing that does not require pedestrian facilities or shuttle operation.

For further information see **'Standalone Haul Route Crossing'** in the New Features section on page 24.

Therefore it is only supported when the crossing is configured as a single traffic stage, in addition to the public highway operating as a single traffic stage.

The public highway stage may be either a pair of linked phases (linked Phases A and B) for two approaches or a single phase (Phase A) for one approach, say on a one-way road. The crossing stage may be configured as either a pair of linked phases for two approaches (Phases D and E) or a single phase for one approach. Each approach must have two heads. There must be no pedestrian phase or any additional traffic phases configured.

SAFETY NOTE: It is important to correctly set the vehicle red time. Remember that Datum Red times are used for traffic phases. Also for a high-speed approach on the highway, 2 seconds should be added to the vehicle red time and to enable Time of Arrival detection in the AGD 306 radar.

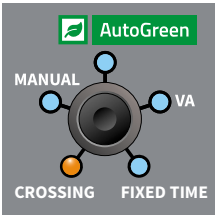
See **'Datum Red Time'** in the Setting Timings section on page 32.

Also see **'High-Speed Approaches'** section on page 25.

Metro Master provides two operating modes for Haul Route Crossings:

- Automatic Haul Route Crossing mode
- Manual Haul Route Crossing mode

Using Automated Crossing Mode



In **Automated Crossing mode**, the radars mounted on the traffic signal heads automatically detect haul route vehicles arriving at the crossing, entering a call for the crossing to be serviced.

The Max Green setting for phase A is used to configure a **'Hold Off Period'** in the range 20 – 600 seconds. This ensures that the public highway is protected from a follow-on call for the crossing occurring too soon after it returns to green and thus limits the service interval for the crossing. This provides a method of balancing the needs of the Haul Route Crossing traffic versus those of the public highway.

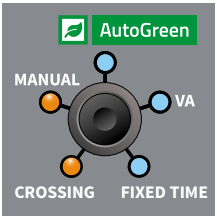
Before the Hold Off Period has expired any call for the crossing is queued ready to be serviced after the hold-off period has expired. After the Hold Off Period expires, the public highway services a crossing call by transitioning to red after 60 seconds or sooner provided the radars on the public highway detect a suitable gap in the approaching traffic.

When the AGD306 radar is configured for Time of Arrival then gap timings will be adjusted for the speed and distance of any approaching vehicles.

Features of the Metro Controller

Operating Modes

Using Manual Crossing Mode



In Manual Haul Route Crossing mode, the operative manually enters a call for the crossing, and thereby controls the frequency of service of the crossing. To enter this mode, press the operating mode button until both the **CROSSING** and **MANUAL LEDs** are illuminated.

The operative enters the call for the crossing by pressing the demand button for the crossing (usually phase D). The demand is not serviced unless the public highway has been green for at least the Min Green (12 seconds) period. Otherwise the public highway transitions to red within 60 seconds of the demand or sooner provided the radars on the public highway detect a suitable gap in the approaching traffic.

When the AGD306 radar is configured for Time of Arrival then gap timings will be adjusted for the speed and distance of any approaching vehicles.

IMPORTANT: Manual Crossing Mode should not be confused with Manual Mode. The use of the latter for haul route applications is highly discouraged as it provides no Speed Extension functionality. With a high-speed approach this can result in traffic being signalled to red whilst it is in the **'dilemma zone',** which is unnerving for motorists and can have adverse safety implications.

All Red Function

The **ALL RED** button operates on all signal controllers as well as the master controller in any mode to bring all signals to red to stop the traffic, such as for site access.

All Red can now be cleared by pressing **ALL RED** again on any controller.

All Red Call When Operating

When the **ALL RED** button is pressed the current mode is interrupted sending all signals to red as soon as possible, after the minimum green period has concluded on the phase (usually 12 seconds at the start of green).

The All Red LED is illuminated on all signal controllers when **ALL RED** has been pressed. Pressing the **ALL RED** button again at any controller then cancels the All Red call and the interrupted mode resumes.

Use the **ALL RED** button at any time if you need to briefly stop the traffic, such as for site access. Then press **ALL RED** again to clear the All Red call and continue the mode.

Whilst in All Red it is possible to change to another mode before clearing the All Red call. For example to continue in Manual mode.

Start-up with All Signals at Red

The system can be started at All Red by pressing the **ALL RED** button at the master controller before **RUN** or during the amber to red start-up sequence. This can be useful to complete deployment on the road before operating the signals normally.

Features of the Metro Controller

Operating Modes

Lights Off Function

The **LIGHTS OFF** button only operates at the master controller in any mode, including All Red, to bring all signals in the system to a Lights Out state a controlled manner simultaneously, such as prior to power-off.

The system can now also be started at Lights Out by pressing the **LIGHTS OFF** button at the master controller before **RUN**. Together with **ALL RED**, **LIGHTS OFF** is useful for hand over between two sets of signals, including with permanent signals.

It is strongly recommended that **LIGHTS OFF** be used prior to power off, perhaps at the end of a shift on a part-time system or at end of work prior to return to depot. It can be used in conjunction with **ALL RED** to bring the signals to All Red prior to Lights Out.

IMPORTANT: Powering off any controller whilst the system is operating live without using **LIGHTS OFF** or **ALL RED** will result in uncontrolled system shut down with potential safety consequences.

Lights Off when Operating

Whilst the lights are operating, pressing the **LIGHTS OFF** button interrupts the current mode and sends all signals to Lights-Out as soon as possible, after the minimum green period has concluded on the phase (usually 12 seconds).

The associated Lights Off LED is illuminated on the master controller when the **LIGHTS OFF** button has been pressed. Pressing the **LIGHTS OFF** button again first runs the amber to red start-up sequence before the interrupted mode resumes.

Whilst at Lights Out it is possible to change to another mode before pressing the **LIGHTS OFF** button again to run the amber to red start-up. For example to start up in Manual mode.

Start-up with Lights Off

The system can be started at Lights Out by pressing the **LIGHTS OFF** button at the master controller before **RUN**. This is recommended after placing the pods to check that the system is correctly configured, connects OK and is operating fault free prior to live operation. The quality of communications and battery voltages can be monitored from the master controller with the system at Lights Out. The radars can also be set-up and configured.

This approach is highly recommended, especially where a transfer from permanent signals to temporary signals will be required. These preparations remove the possibility of any issue that might impact a smooth handover of signalling.

Hand-over between Two Sets of Signals

LIGHTS OFF and **ALL RED** can be used together and are recommended for hand over between two sets of signals, including with permanent signals.

Tip: Pressing **ALL RED** during the amber to red start up sequence before phase A goes green will start-up with all phases held at red. Press **ALL RED** again to clear and start normal operation. This can be done after the other set are at Lights Out.

Site Deployment

It is important that the system is set-up properly by a competent operator according to best practices as advised in the Department for Transport (DfT) publications as set out below:

- An Introduction to the Use of Portable Vehicular Signals (the 'Pink Book')
- Safety at Street Works and Road Works – A Code of Practice (the 'Red Book')
- Traffic Signs Manual, Chapter 6 (known as "Chapter 6"): "Traffic Control".
- Traffic Signs Manual, Chapter 8 (known as "Chapter 8"), parts 2 and 3: "Operations" and "Update 2020".

As of end 2019 / start 2020 the DfT have published an update to Chapter 8 of the Traffic Signs Manual (Part 3, "Update 2020") and a new Chapter 6 of the Traffic Signs Manual, "Traffic Control". Chapter 6 specifically advises on traffic signals for junctions and crossings on roads with a speed limit of 40 mph and under. Note that Chapter 6 now supersedes most Traffic Advisory Leaflets, in particular:

- Traffic Advisory Leaflet 2/11: Portable Traffic Signals for the Control of Vehicular Traffic
- Traffic Advisory Leaflet 3/11: Signal-controlled Pedestrian Facilities at Portable Traffic Signals

IMPORTANT: The responsibility lies with the organisation setting up and managing the temporary signals to carry out the necessary risk assessment. To plan and design a scheme that complies with all the road traffic regulations and satisfies the appropriate highways authority. As well as correctly set-up and ensure that the scheme is operated safely.

Planning

Careful consideration of the delivery of the Metro system should take place early on in the planning phase. This should include understanding the ground on which the signals will be placed, along with assigning a safe unloading location for the stillages and Metro equipment. This would normally be conducted using online map software or visiting the site. An understanding of the contractor work being performed at site and which machinery will be operating would also be beneficial from a deployment and maintenance perspective.

Any site specific imagery and notes can be recorded in Signal Studio and incorporated into the Data Pack to facilitate HA approvals and roadside deployment.

Site Deployment

Deployment at the Roadside

Position the required signage, cones, barriers, etc. in accordance with the Traffic Signs Manual Chapter 8.

Position the Signal Pods with the heads needed in the required positions according to scheme design in the Data Pack.

Before switching on, we recommend measuring the distances from the WAIT signs (or stop line) to the designated Datum Point. Check that these match the scheme design in the Data Pack and make any adjustments needed. In particular check that the specified Datum Red Times are suitable.

Switch on each Signal controller first and configure as needed, then press RUN.

Lastly switch on the Master controller and configure as per the scheme design in the Data Pack. In particular check that the phases and heads are configured to match the set-up on site, that the Datum Red Times are configured appropriately, and make any adjustments needed.

We recommend initially starting up in Lights Out to check that all Signals can connect and are free of any faults before operating.

Observe the site operating over various periods, particularly at peak times. Make any adjustments needed to ensure the site continues to operate reliably in an effective manner and is as efficient as possible.

Site Deployment

Metro System Deliverys

Delivery by 18t Truck

Unloading performed by loader crane or compact forklift.

Stillages

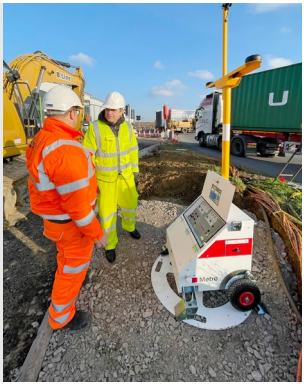
For safe transportation of batteries and other equipment, Metro arrives in a series of transport stillages.

Placement

Signal placement is performed using a load crane, forklift or telehandler or using a rugged pallet truck. ‘Coasters’ or ‘Elephant Feet’ may be required on soft or uneven ground.

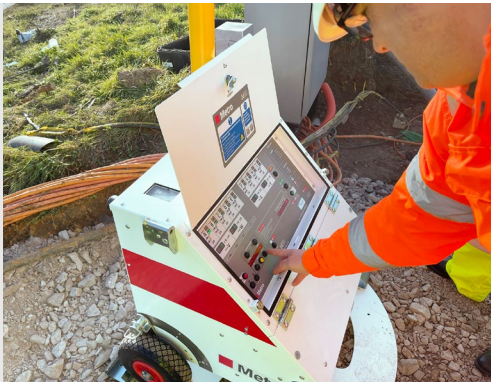
Collaboration

Onsite collaboration is vital to ensure HA, contractors and TM providers understand their role in safely deploying a Metro system.



Maintenance

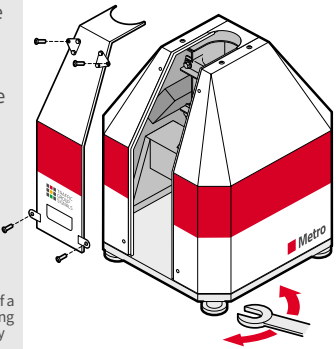
Site maintenance involves ensuring Metro batteries are replaced in a timely manner, and signalling configuration suits the needs of a site. It may be necessary to update timing plans if equipment or road layout changes throughout the project. The use of TMdesk can support battery changes and general monitoring of the site.



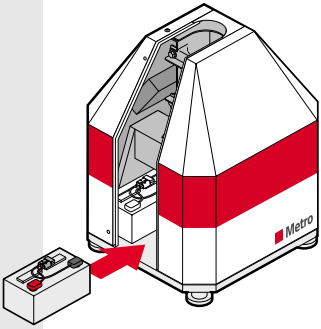
Installing Metro at the roadsides

1. Position the base at the roadside location, level it using the adjustable feet and a 25mm spanner, and the open the covers using a 5mm security torx key.

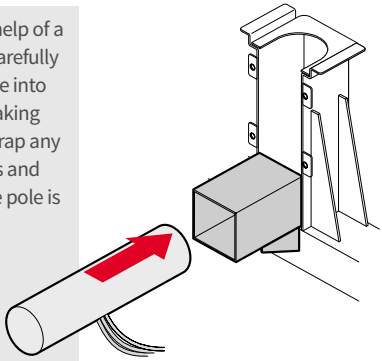
NOTE: base units must be used only on hard, level surfaces. Relocating, use of a ground coaster or improving the surface conditions may be required.



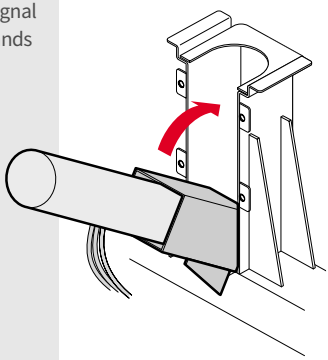
2. Insert and connect the batteries



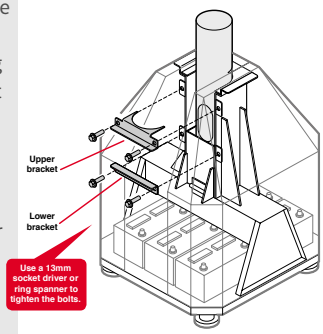
3. With the help of a colleague, carefully slide the pole into the footer, taking care not to trap any of the cables and ensuring the pole is fully seated.



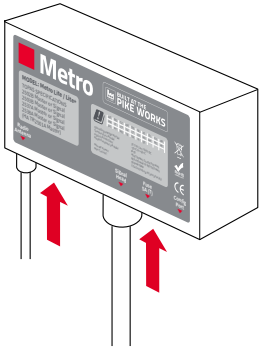
4. Tilt up the signal pole until it stands vertically.



While your colleague supports the pole to prevent it tipping forward, attach first the upper bracket and then the lower bracket. Tighten all bolts fully using a 13mm socket driver or ring spanner.



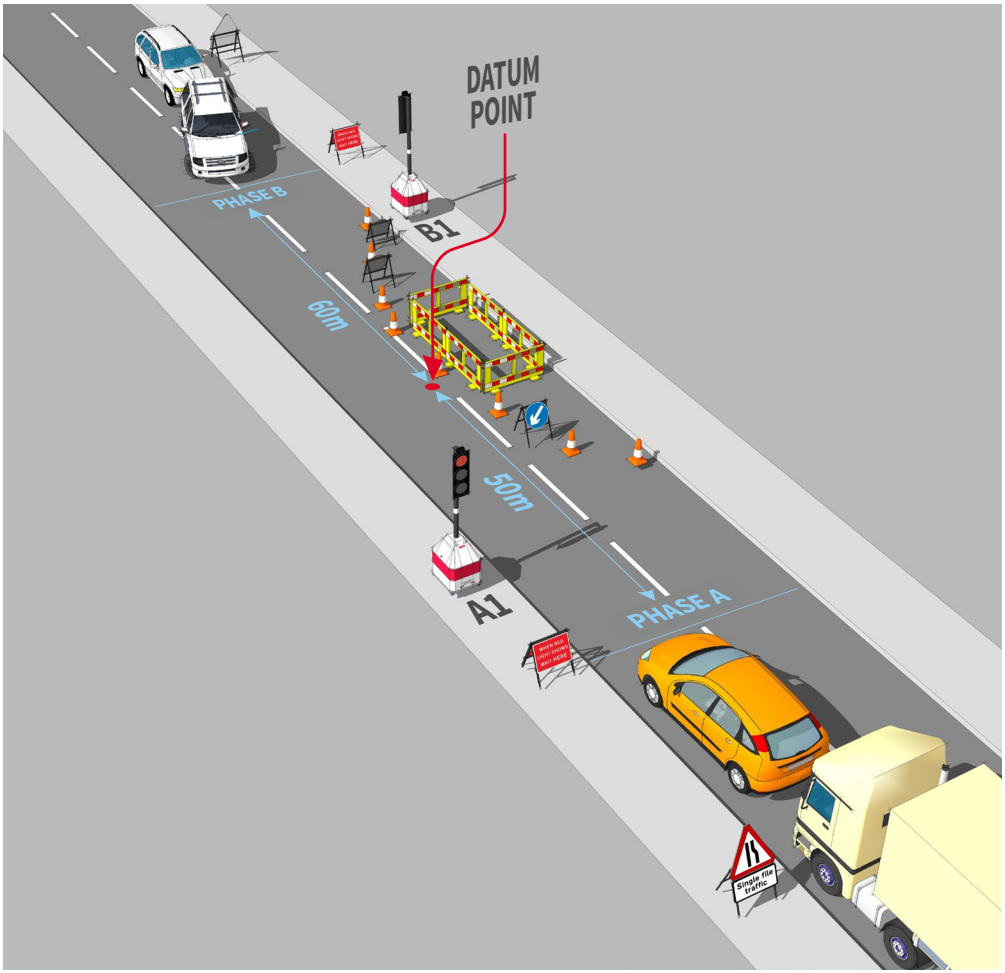
Finally, connect the coded antenna cable, signal cable(s) and power to the respective controller(s) then power up the system.



Signal timings - Vehicle only deployment

Deployment Example 1: Basic shuttle working

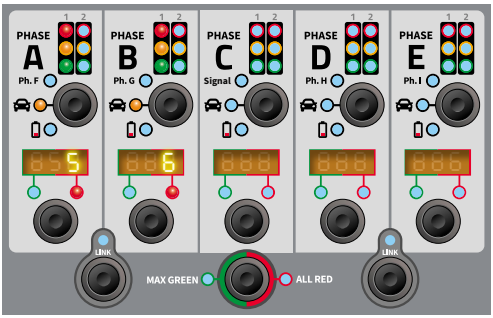
This example shows a carriageway controlled by two single-approach phases, each with one signal head possibly operating in 2-Way AutoGreen or in VA mode.

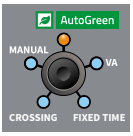


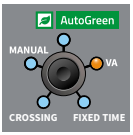
Signal timings - Vehicle only deployment

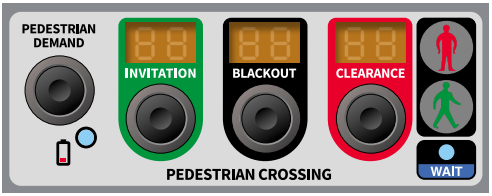
Deployment Example 1: Basic shuttle working

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.









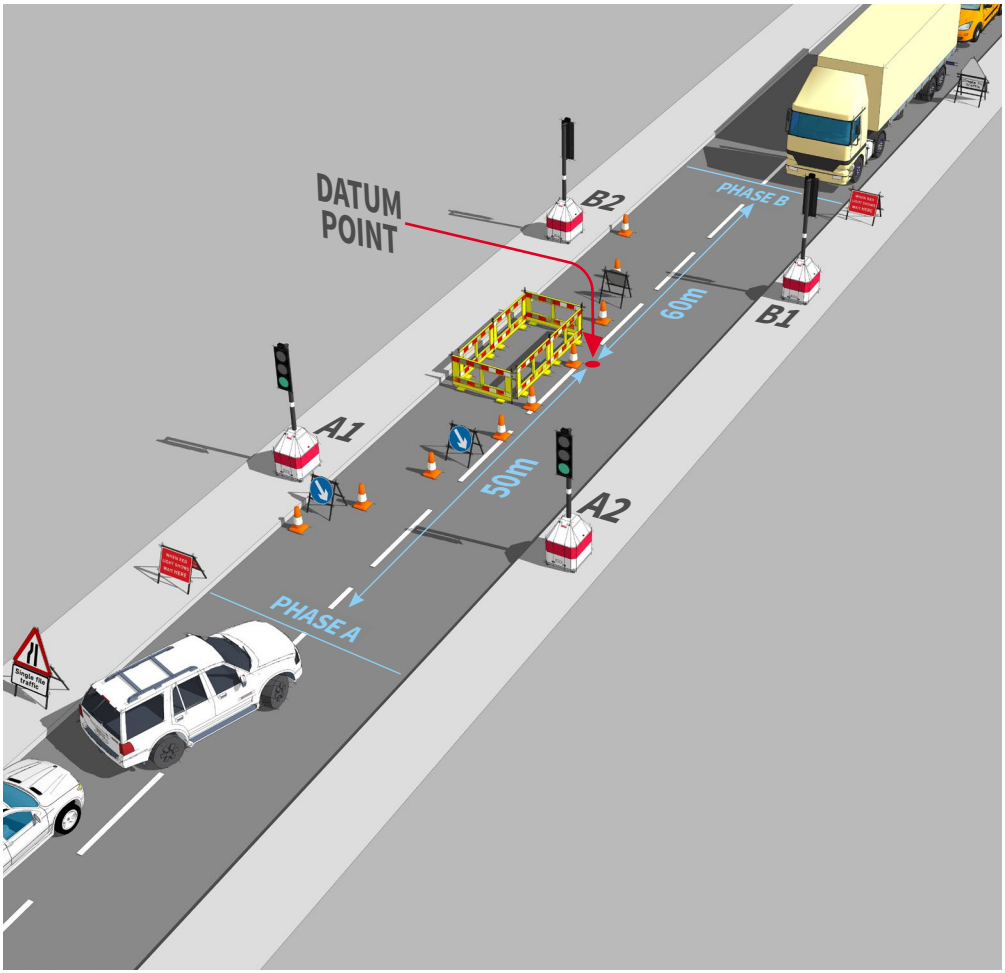
The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

Red time matrix	To	
From	**Stage 1 Phase A**	**Stage 2 Phase B**
Stage 1 Phase A	-	5 + 6 = 11
Stage 2 Phase B	6 + 5 = 11	-

Signal timings - Vehicle only deployment

Deployment Example 2: Dual head shuttle working

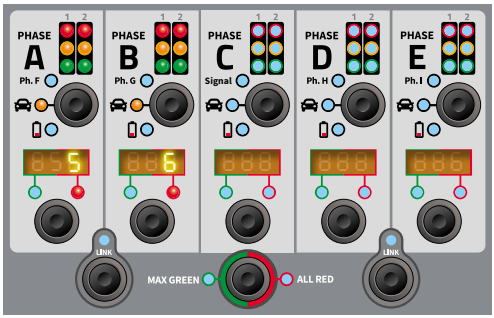
This example shows a carriageway controlled by two single-approach phases, each with dual signal heads possibly operating in 2-Way AutoGreen or in VA mode.

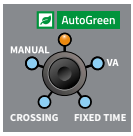


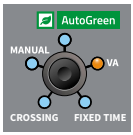
Signal timings - Vehicle only deployment

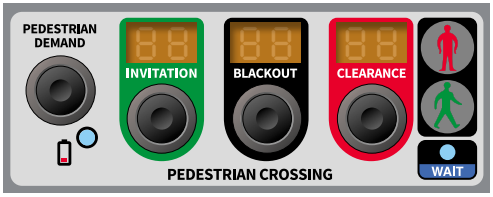
Deployment Example 2: Dual head shuttle working

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.









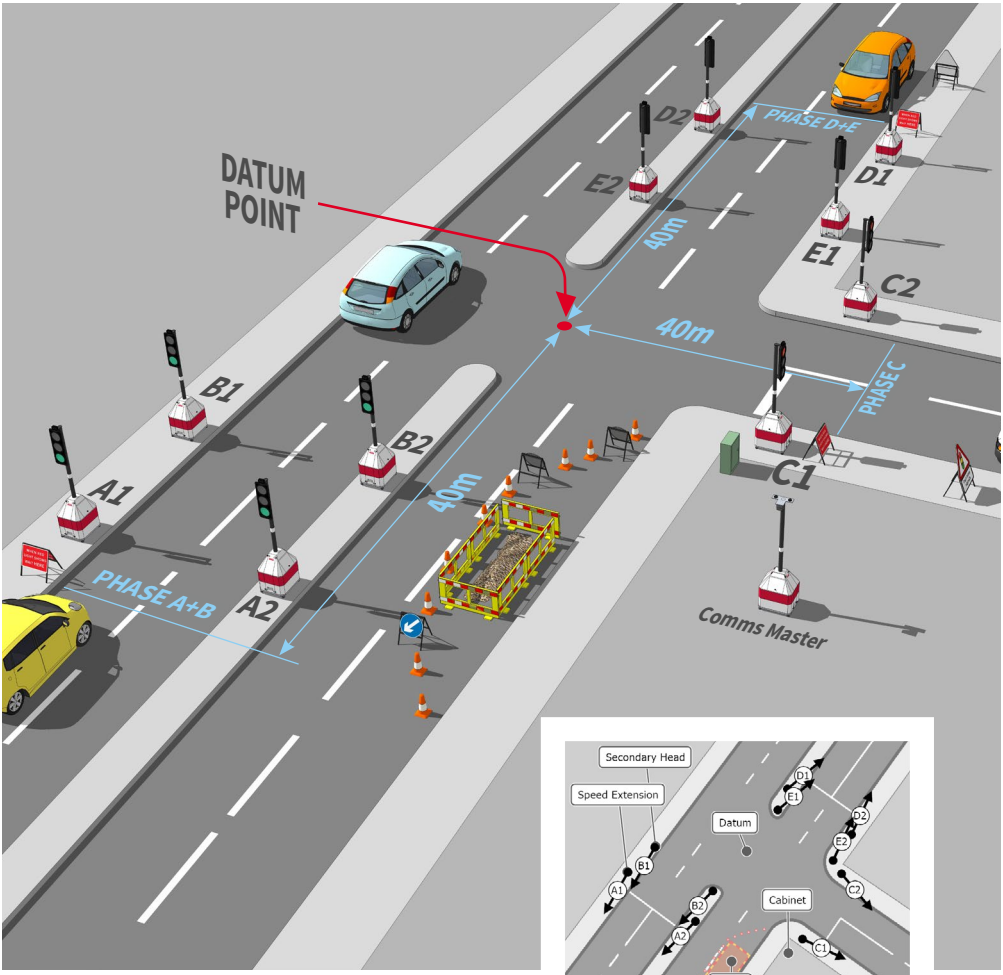
The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

Red time matrix	To	
From	**Stage 1 Phase A**	**Stage 2 Phase B**
Stage 1 Phase A	-	5 + 6 = 11
Stage 2 Phase B	6 + 5 = 11	-

Signal timings - Vehicle only deployment

Deployment Example 3: Fast carriageway with side road

This example shows the control of a three way junction on a fast dual carriage way. The minor road is phase C, and may have nudges disabled. The fast carriageway uses secondary heads in addition to nearside and offside primaries, using linked phases A and B for the north bound approach and linked phases D and E for the south bound approach. Possibly operating in Multi-Way AutoGreen with a connection to TMdesk Pro or alternatively VA or UTC with a network connection.

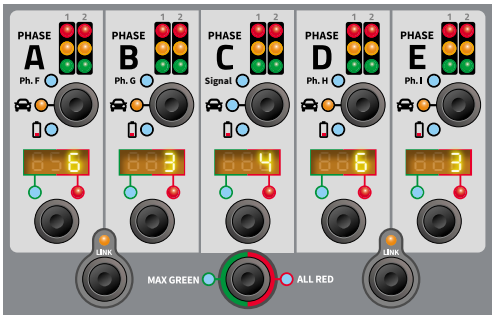


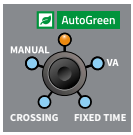
Excerpt from Signal Studio

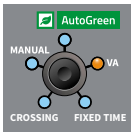
Signal timings - Vehicle only deployment

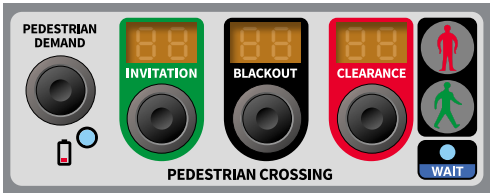
Deployment Example 3: Fast carriageway with side road

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.









The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

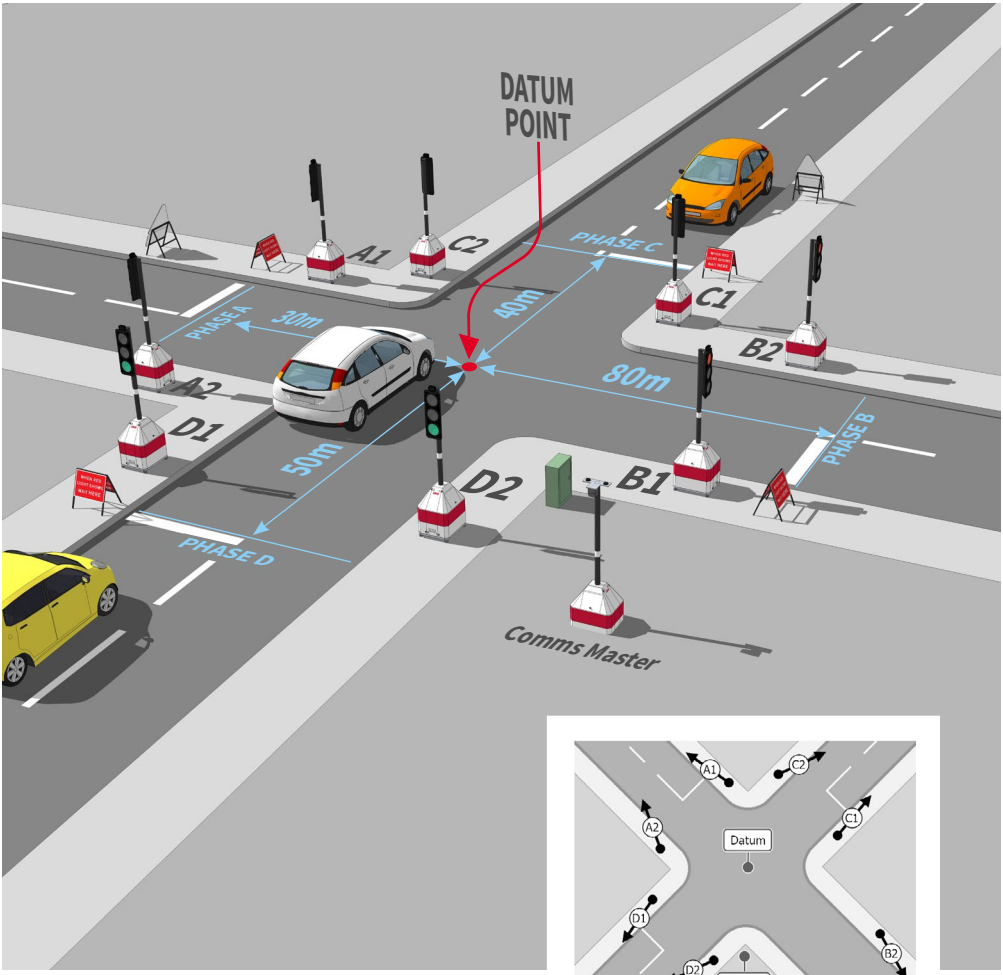
Red time matrix	To		
From	Stage 1 A+B	Stage 2 C	Stage 3 D+E
Stage 1 A+B	-	6 + 4 = 10	6 + 6 = 12
Stage 2 C	4 + 6 = 10	-	4 + 6 = 10
Stage 3 D+E	6 + 6 = 12	6 + 4 = 10	-

Note: *Only the largest datum red time setting from any pair of linked phases is applied to the timing of a transition between stages.*

Signal timings - Vehicle only deployment

Deployment Example 4: Four-way crossroad

This example shows a crossroad controlled by four vehicle phases, with dual heads in three stages. Minor approaches phase A and B can be serviced together as one stage and so are linked, possibly with nudges disabled. Main road approaches phase C and D are serviced as separate stages. Possibly operating in VA or controlled by UTC with a network connection or Multi-Way AutoGreen with a TMdesk Pro subscription.

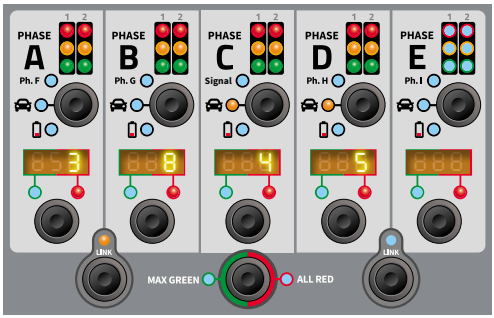


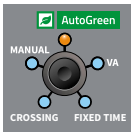
Excerpt from Signal Studio

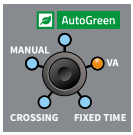
Signal timings - Vehicle only deployment

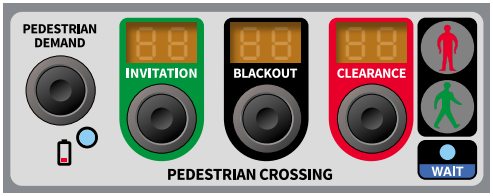
Deployment Example 4: Four-way crossroad

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.









The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

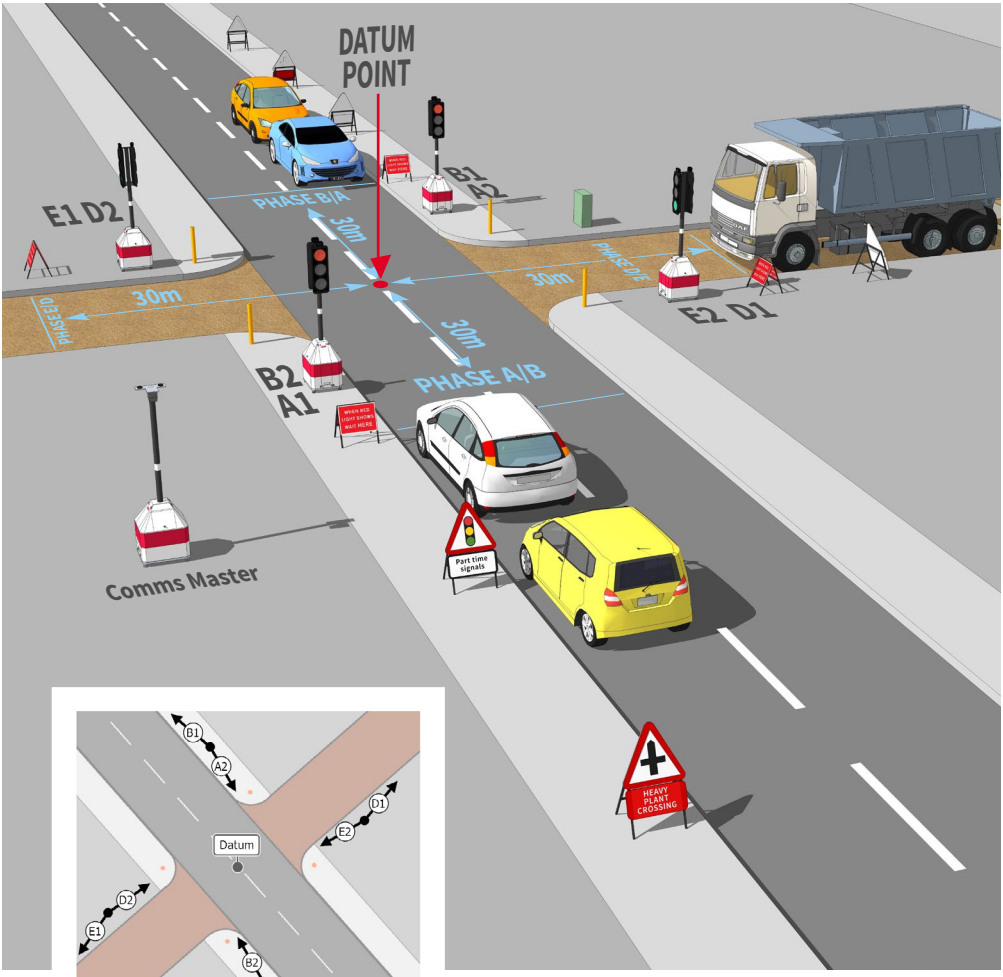
Red time matrix	To		
From	Stage 1 A+B	Stage 2 C	Stage 3 D
Stage 1 A+B	-	8 + 4 = 12	8 + 5 = 13
Stage 2 C	8 + 4 = 12	-	4 + 5 = 9
Stage 3 D	5 + 8 = 13	5 + 4 = 9	-

Note: *Only the largest datum red time setting from any pair of linked phases is applied to the timing of a transition between stages.*

Signal timings - Vehicle only deployment

Deployment Example 5: Standalone Haul Route Crossing

This example shows a standalone haul route crossing that might cross a fast main road. Using a pair of controllers with double heads mounted on each battery pod enhances visibility providing a secondary head across the junction. The system operates using **CROSSING** mode so that the linked phases A and B rest at green for the main carriageway until there is demand for the crossing. ***Don't forget for high speed approaches the datum red times should be increased by 2 seconds and the radars reconfigured for Time of Arrival speed extension.***

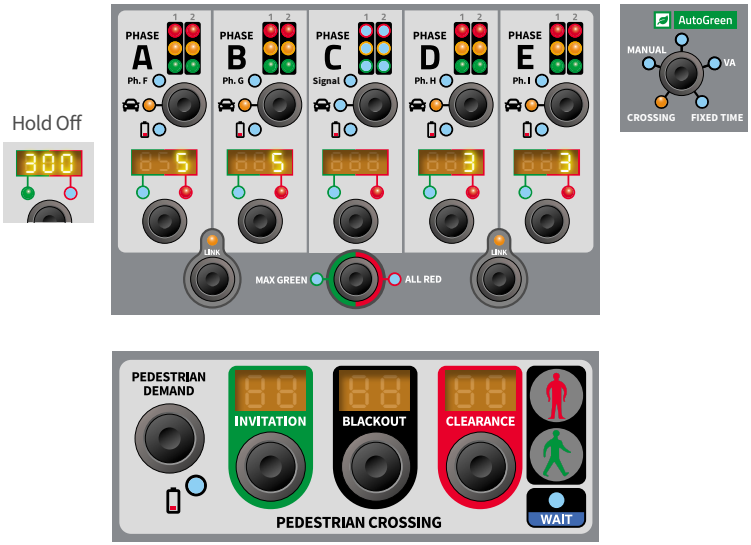


Excerpt from Signal Studio

Signal timings - Vehicle only deployment

Deployment Example 5: Standalone Haul Route Crossing

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.
Note: In CROSSING mode the Max Green time for Phase A sets the 'Hold Off' time for the crossing. The crossing cannot operate again any earlier than this hold off time.



The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

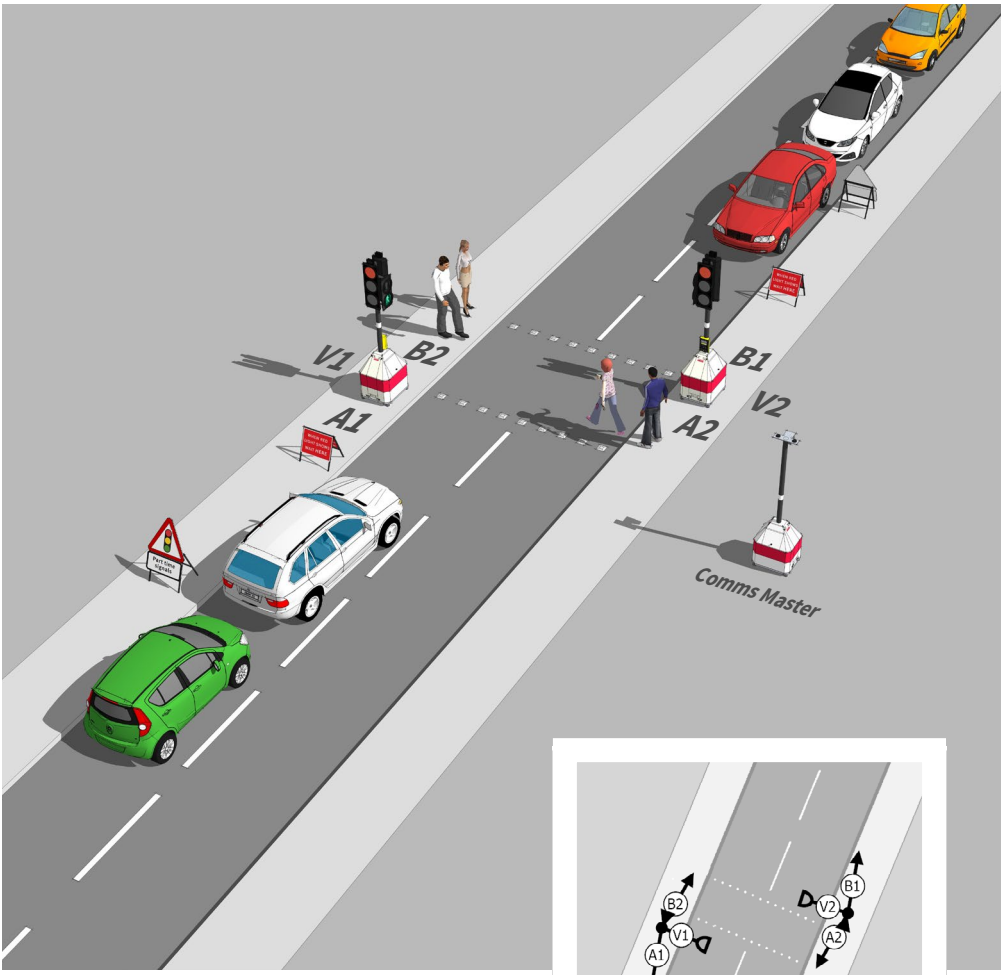
Red time matrix	To	
From	**Stage 1 Phase A+B**	**Stage 2 Phase D+E**
Stage 1 Phase A+B	-	5 + 3 = 8
Stage 2 Phase D+E	3 + 5 = 8	-

Note: *Only the largest datum red time setting from any pair of linked phases is applied to the timing of a transition between stages.*

Signal timings - Pedestrian crossing deployment

Deployment Example 6: Standalone pedestrian crossing with 2 vehicle heads per approach

This example shows a standalone pedestrian crossing that might be used on a faster road using crossing heads. These combine a pedestrian crossing with double back to back traffic for added visibility. Phases A and B are linked, so that they operate together. In **CROSSING** mode the linked traffic phase A+B rests at green when the crossing is not in use.

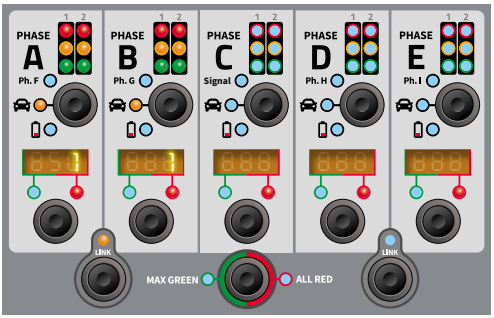


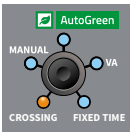
Excerpt from Signal Studio

Signal timings - Pedestrian crossing deployment

Deployment Example 6: Standalone pedestrian crossing with 2 vehicle heads per approach

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.





The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

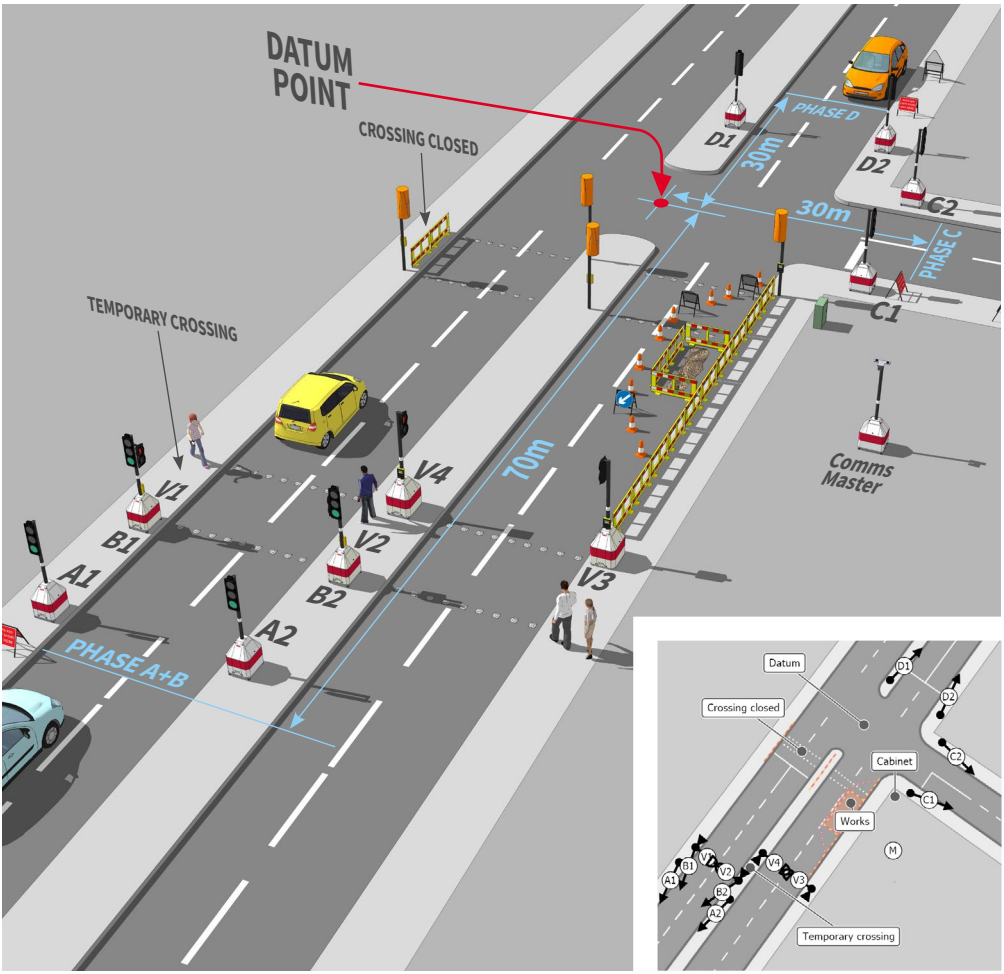
Red time matrix	To	
From	Stage 1 Phase A+B	Stage 2 Phase V
Stage 1 Phase A+B	-	3
Stage 2 Phase V	3	-

Note: *The controller ensures a minimum red time of 3 seconds is applied prior to any pedestrian phase.*

Signal timings - Pedestrian crossing deployment

Deployment Example 7: Dual carriageway plus temporary pedestrian crossing

This example shows a three way junction on a fast dual carriage way with a re-positioned temporary Pedestrian crossing due to road works. The site operates in 4 stages in VA or under UTC control or Multi-way AutoGreen with a TMdesk Pro connection for remote supervision. Phases A and B are linked and operate together as stage 1. A full pedestrian only phase follows at stage 2 when called. The phase A heads are located 10m before the crossing to protect it from a high speed approach, and operates together with Phase B to provide secondary traffic heads. Combined pedestrian and traffic heads are used for B1/V1 and B2/V2. V3 and V4 are pedestrian only heads. Phases C and D are at red long before this part of the crossing operates, so no further protection is necessary. Both phases A and D should be configured for speed extension by enabling Time of Arrival in the radars and an additional 2 seconds on the datum red times.

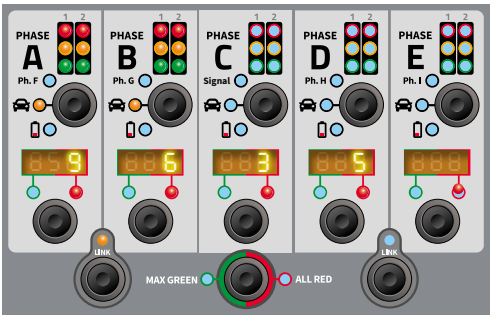


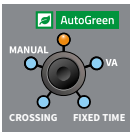
Excerpt from Signal Studio

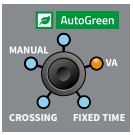
Signal timings - Pedestrian crossing deployment

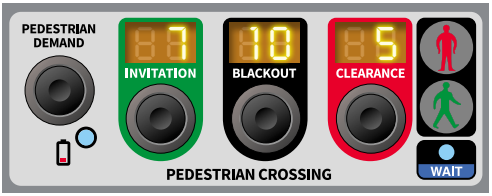
Deployment Example 7: Dual carriageway plus temporary pedestrian crossing

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.









The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

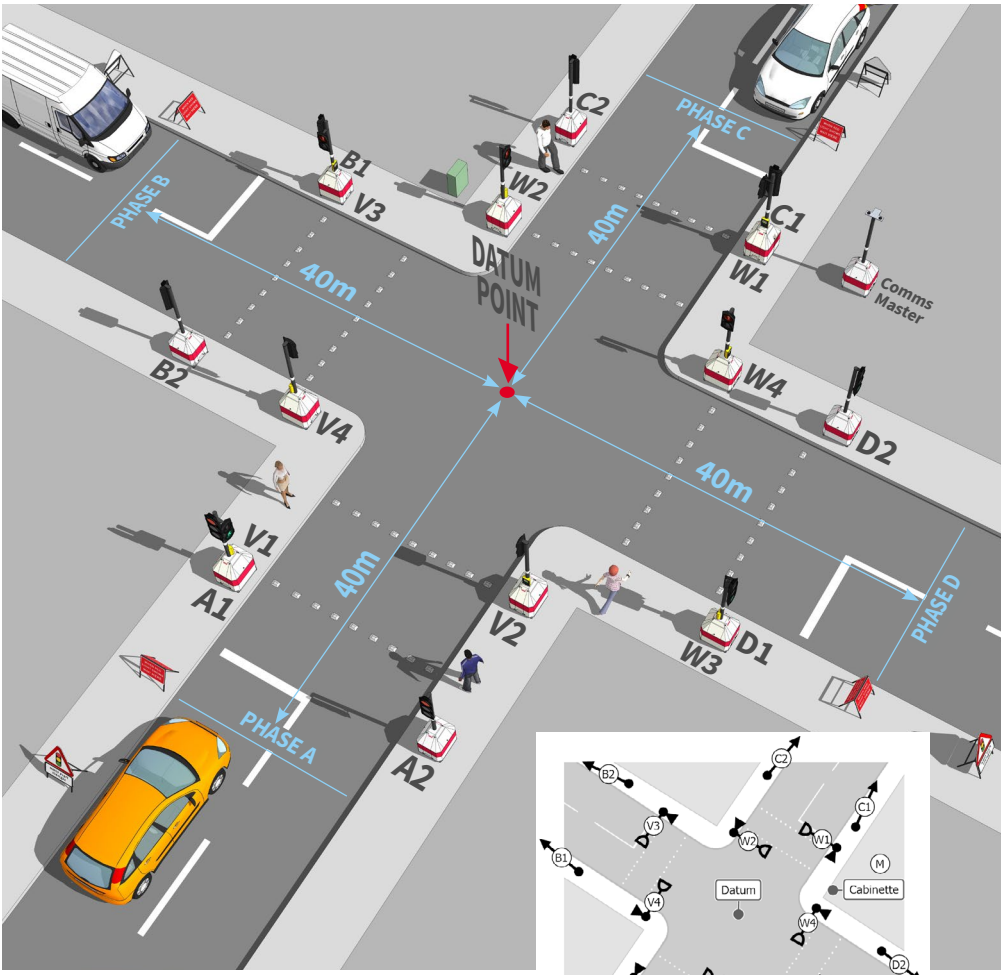
Red time matrix	To			
From	Stage 1 A+B	Stage 2 V	Stage 3 C	Stage 4 D
Stage 1 A+B	-	9 + 7 = 14	9 + 3 = 12	9 + 5 = 14
Stage 2 V	5	-	5	5
Stage 3 C	3 + 9 = 12	3 + 9 = 11	-	3 + 5 = 8
Stage 4 D	5 + 9 = 14	5 + 9 = 14	5 + 73 = 8	-

Note: *The controller ensures a minimum red time of 3 seconds is applied prior to any pedestrian phase."*

Signal timings - Pedestrian and Vehicle deployment

Deployment Example 8: Four-way crossroad plus pedestrian crossings

This example shows a crossroad with dual vehicle heads on each approach and is controlled by four vehicle phases. It also has four pedestrian crossings, one on each approach. When demanded the full pedestrian stage 2 follows phase A in stage 1. This site has 4 combined hybrid pedestrian and traffic heads for pods marked A1/V1, B1/V3, C1/W1 and D1/W3.

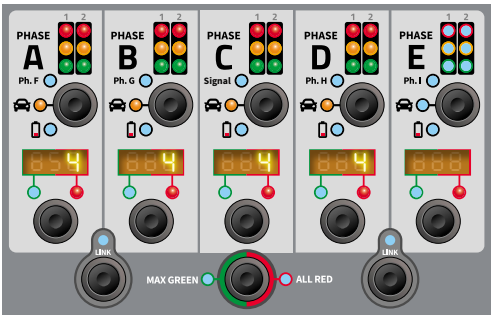


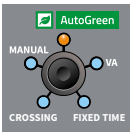
Excerpt from Signal Studio

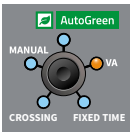
Signal timings - Pedestrian and Vehicle deployment

Deployment Example 8: Four-way crossroad plus pedestrian crossings

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.







The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

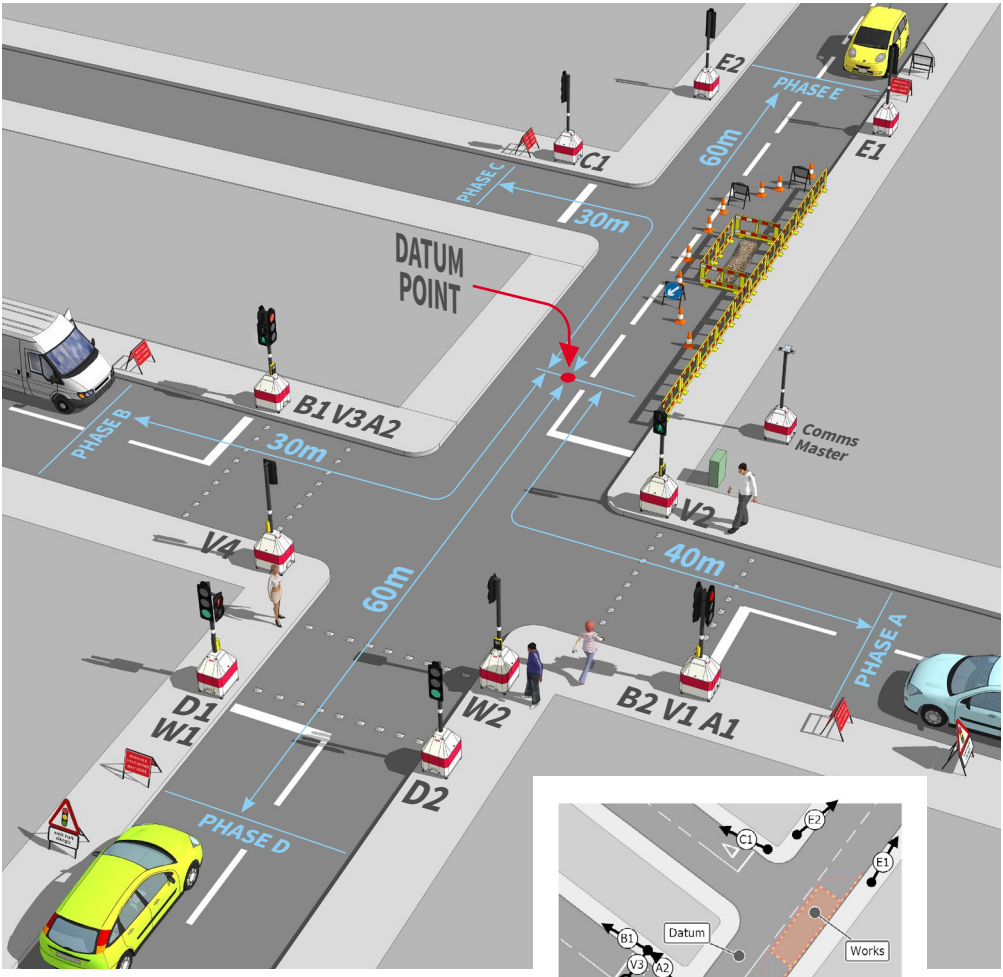
Red time matrix	To				
From	**Stage 1 A**	**Stage 2 V+W**	**Stage 3 B**	**Stage 4 C**	**Stage 5 D**
Stage 1 Phase A	-	4 + 4 = 8	4 + 4 = 8	4 + 4 = 8	4 + 4 = 8
Stage 2 Phase V+W	5	-	5	5	5
Stage 3 Phase B	4 + 4 = 8	4 + 4 = 8	-	4 + 4 = 8	4 + 4 = 8
Stage 4 Phase C	4 + 4 = 8	4 + 4 = 8	4 + 4 = 8	-	4 + 4 = 8
Stage 5 Phase D	4 + 4 = 8	4 + 4 = 8	4 + 4 = 8	4 + 4 = 8	-

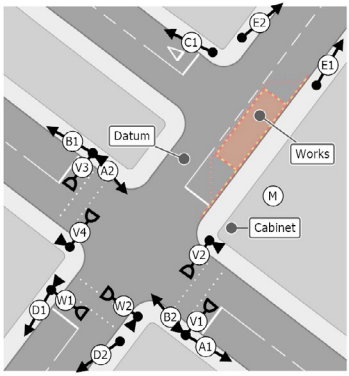
Note: *The red time prior to the Pedestrian phase is the sum of the datum red time settings for Phase A plus the longest of any other vehicle phase. The red time following the pedestrian phase is the Pedestrian clearance time setting.*

Signal timings - Pedestrian and Vehicle deployment

Deployment Example 9: Five-way staggered junction plus pedestrian crossings

This example shows a major junction controlled using five vehicle phases as well as three pedestrian crossings operating in 5 stages in VA or under UTC control or Multi-way AutoGreen with a TMdesk Pro connection for remote supervision.



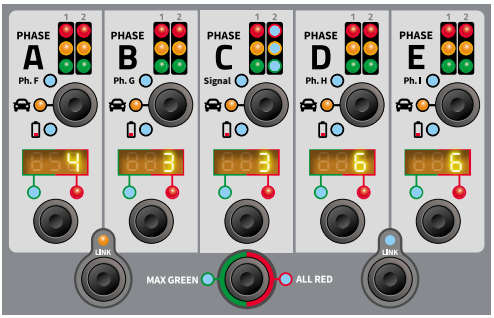


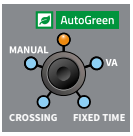
Excerpt from Signal Studio

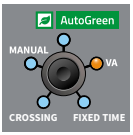
Signal timings - Pedestrian and Vehicle deployment

Deployment Example 9: Five-way staggered junction plus pedestrian crossings

After configuring the master controller for this deployment example, the front panel may show the settings illustrated below.







The following Red Time Matrix shows how the datum red time settings for each phase are combined for a transition between stages.

Red time matrix	To				
From	**Stage 1 A+B**	**Stage 2 V+W**	**Stage 3 C**	**Stage 4 D**	**Stage 5 E**
Stage 1 Phase A+B	-	4 + 6 = 10	4 + 3 = 7	4 + 6 = 10	4 + 6 = 10
Stage 2 Phase V+W	4	-	4	4	4
Stage 3 Phase C	4 + 4 = 8	3 + 6 = 9	-	3 + 6 = 9	3 + 6 = 9
Stage 4 Phase D	6 + 4 = 10	4 + 6 = 10	6 + 3 = 9	-	6 + 6 = 12
Stage 5 Phase E	6 + 4 = 10	4 + 6 = 10	6 + 3 = 9	6 + 6 = 12	-

Note: *The red time prior to the Pedestrian phase is the sum of the datum red time settings for Phase A plus the longest of any other vehicle phase. The red time following the pedestrian phase is the Pedestrian clearance time setting.*

Operating the Controller

This section describes how to configure and operate the Metro Controllers.

Operating a Metro Master Controller as a Master

Setting up and operating a controller as the master is a two-stage process. Initially the Configure stage starts immediately after turning the controller on. This is completed when the **RUN** button is pressed, and the controller starts to operate. The system remembers the last configuration successfully run and presents these previous selections as the initial choice unless it is no longer appropriate. Any changes made are not saved until the controller starts to operate successfully after pressing **RUN**.

Configuring and Setting Up

Press the Power button to turn on the controller.

Stage 1: Configure the controller:

During configuration changes can be made to the following:

Cannot be changed after RUN at Stage 2

1. Select Master or Signal Controller
2. Select a Group ID (between 1 and 64)
3. Select the number of pedestrian crossings
4. Choose the traffic phases with single or double heads
5. Optionally disable nudging as required
6. Optionally link pairs of phases as required
7. Set initial vehicle red and green timings
8. Set initial pedestrian invitation, blackout, and clearance timings
9. Set operating mode
10. Select the required mode and if required press either of the following:
    - **LIGHTS OFF** – to start with lights off
    - **ALL RED** – to start and hold all phases at red following start-up
11. Ensure a signal controller is configured to match each head for all traffic and pedestrian phases

Press the **RUN** button on the Signal controllers first, then the Master controller.

Stage 2: Operate the controller:

During operation, the following can be done in any order at any time:

- Adjust vehicle or pedestrian timings.
- Change operating mode.
- Call or clear All Red.
- Call or clear Lights-Out mode.
- Using Manual mode for manual control.
- Set phase demands manually, in Manual, VA, AutoGreen and Crossings modes.
- Monitor battery voltages.
- Monitor comms performance.

Note: *Care should be taken during the configuration stage as some choices made in steps 1 to 6 cannot be varied whilst operating without power cycling the master controller resulting in a lights-out condition.*

IMPORTANT: *Remember that Datum Red times are used for all traffic phases. Entering an incorrect red time is likely to compromise safety. See* **'Datum Red Time'** *in the Setting Timings section on page 34.*

For guidance please also refer to the **'Site Deployment'** section on page 46.

Operating a Metro Master Controller as a Master

Configure Metro Master as a Master Controller

After turning on, the controller prompts for the following selections when set to Master Mode:

1. Select Master Mode
2. Select a Group ID (between 1 and 64)
3. Select the Number of Pedestrian Crossings

The above can only be done during the Configure stage after turning the controller on and before pressing **RUN** and not when the system is operating.

Selecting Master Mode:

Use the ◀ ▶ keys to change between Master Mode or Signal Mode

Choose Master Mode to operate a Metro Master controller as a Master Controller then press **SELECT**

Selecting Group ID:

Use the ◀ ▶ keys to change the Group ID between 1 and 64 then press **SELECT**

Only controllers operating on the same Group ID communicate with each other as a system. Therefore, the same Group ID must also be entered into the Signal Controllers for them to connect with the Master at a site.

Note that the choice of Group ID has no bearing on the radio channel that the system will choose to use. Choose a unique Group ID for the set of controllers at a site to ensure there is no conflict with any other controllers nearby.

Selecting the Number of Pedestrian Crossings (Vehicle Only):

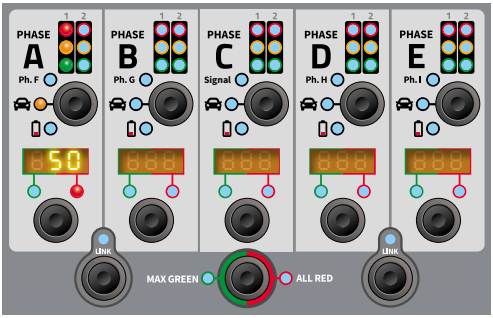
Use the ◀ ▶ keys to change the Ped Crossings between 0 and 8 then press **SELECT**

This selects the number of pedestrian crossings to be included in the signalling scheme. Each crossing requires two pedestrian signal heads. Select **'0'** for a scheme with no pedestrian crossings, traffic phases only. For any other setting refer to the section: 'Adding Pedestrian Crossings' below.

Choosing the Traffic Phases and Heads:

Use the Traffic Phase Demand button for each phase to include the phase as a single or double head approach or exclude the phase from the scheme.

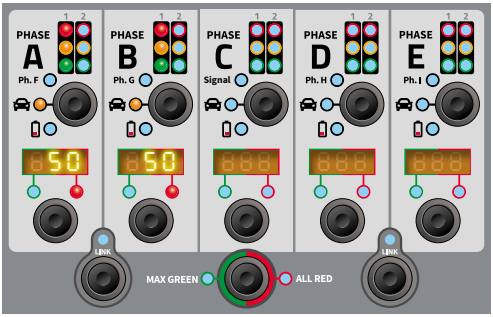
Note: *Changes to the phase and head selection must be done during the Configure stage after turning the controller on and before pressing RUN.*



In the above example, pressing the demand button once on phase A adds a single head **'A1'** on that phase to the scheme.

Operating a Metro Master Controller as a Master

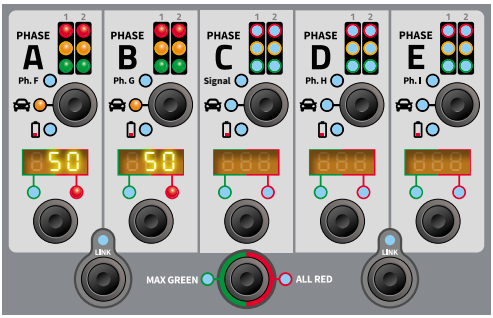
Similarly, by pressing the demand button once on phase B, a single head 'B1' on that phase is also included.



This is a two-way scheme with single heads on each approach.

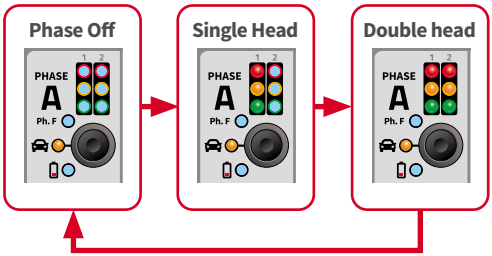
Further presses of the demand buttons on phases A and B includes each of them as a double headed approach. The heads will be labelled: A1, A2, B1, B2.

IMPORTANT: *Both heads on a phase must signal the same approach. Failure to do so undermines safety provisions within the product (e.g. red lamp monitoring).*



A third press of the demand button would remove the phase from the scheme.

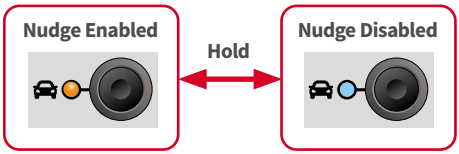
Thus during configuration each press of the demand button cycles through the following simplified sequence to select the head type, as indicated by the signal head mimics on the front panel:



Disabling or Enabling Nudging:

A press and hold the Traffic Phase Demand button for 3 or more seconds to toggle the demand LED for the phase, indicating whether nudges are disabled or enabled.

The setting is indicated by the demand LED as follows:

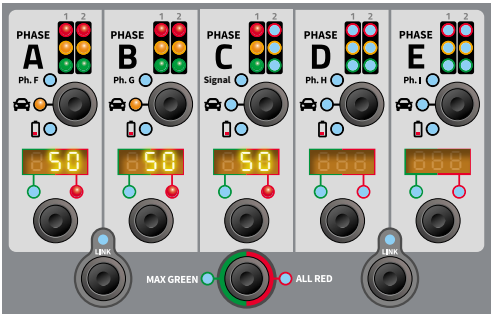


See **'Nudging of Traffic phases'** in the Setting Timings section on page 35.

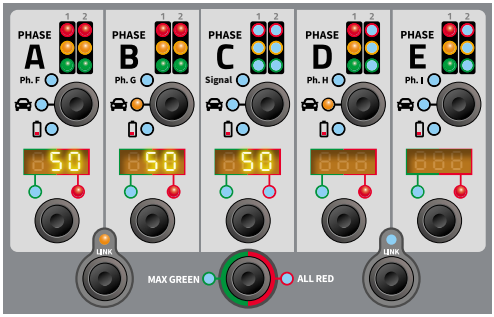
Note: *Nudging can only be disabled or enabled on a phase during the Configure stage after turning the controller on and before pressing RUN (not when the system is operating).*

Operating a Metro Master Controller as a Master

In the example below, a three-way scheme has been configured with double heads on phase A and B and single head with nudging disabled on phase C (hence phase C demand LED is not illuminated).



The remaining Phase C is not linked and nudges have been disabled.



Linking Phases

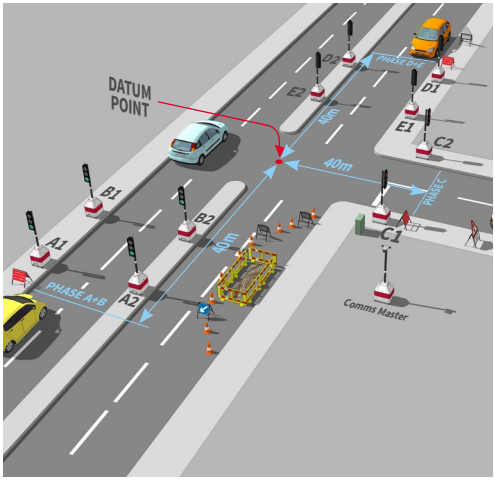
In some circumstances, a scheme may require that more than one approach be signalled with the same phase. Such as opposing approaches for a main road. Opposing approaches should have a pair of heads on the near and far sides. So at least one of the linked phases must be configured to have a pair of heads.

The system allows the following pairs of phases to be linked: A&B, D&E, F&G, H&I.

To achieve this, configure the heads that are required in the scheme then press the LINK button to join the associated pair of phases together.

Note: *Phases can only be linked during the configure stage after turning the controller on and before pressing* **RUN** *(not when the system is operating).*

The scheme below is a three-way configuration. Phases A and B are linked north bound, D and E are also linked south bound. Each of the linked phases operate together, with double primary and secondary heads, that share the same green time. Although different datum red times can be specified for each phase. However a linked phase will operate using the largest datum red time.



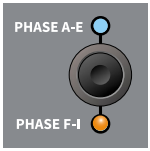
Operating a Metro Master Controller as a Master

Accessing Alternate Phase Bank

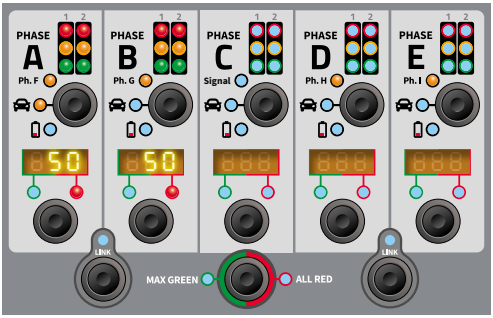
Metro Master includes additional phases as follows:

- A, B, C, D, E
- F, G, H, I

The Phase Bank Selection button toggles the display between the two phase banks above. The additional phases can then be configured in the same manner and included into same scheme.



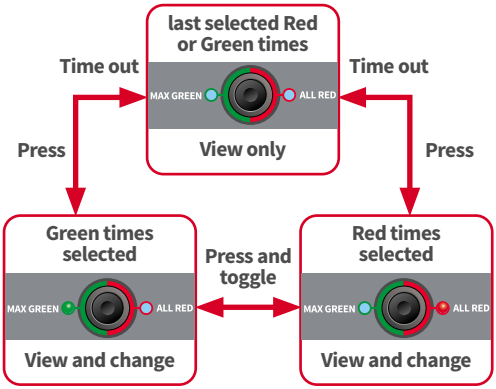
In the example below phases F and G have both been added to the scheme. Each employ a single head but only F has nudge enabled. Notice that the phases F and G LEDs are illuminated for each as a reminder of which phases are being configured (F and G, not A and B).



Viewing and Changing Red and Green Times

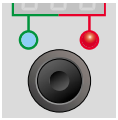
The numeric displays for each phase display either the Traffic Phase Red or Green timings in seconds as indicated by the red or green LED beneath each numeric display.

Use the **MAX GREEN** / **ALL RED** button to toggle the displays between red and green times. The Max Green LED and All Red LED to the left and right of this button indicate when these values can be changed.

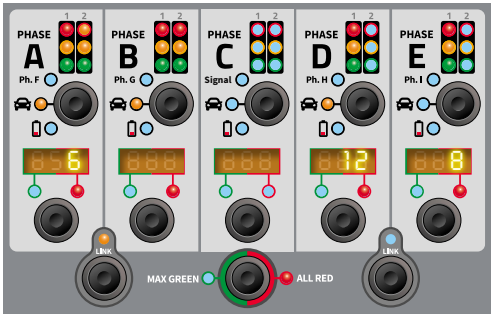


The values can only be changed for a while after the **MAX GREEN** / **ALL RED** button is pressed and times out when no buttons are pressed.

Traffic Phase Red / Green times are then modified by pressing the Timing Adjust button beneath the display for the appropriate phase.



Timings increment for each button press. Holding the Timing Adjust button down will cause times to auto increment until released.



Operating a Metro Master Controller as a Master

The following Traffic Phase Red / Green timings are supported:

Time	Range	
Datum Red times:	0s to 30s	See note below.
Max Green times:	15s to 60s	Access is hidden. Not applicable to AutoGreen mode or Haul Route
Hidden Max Green times:	6s to 14s	

All times are adjustable in 1 second increments.

For further details see the **'Setting Timings'** section on page 31.

Note: *Datum Red times are used for traffic phases. When configured with pedestrian crossings the system ensures that the All Red period is never less than 3 seconds when the Datum Red times are combined.*

Access to the Hidden Max Green times is achieved as follows:

1. Set the Max Green time to 60s for the phase in question and release the Timing Adjust button.
2. Count slowly to 3 (or a bit longer if needed).
3. Press the Timing Adjust button once. The lowest Max Green time of 6s will now appear on the display.
4. Press the Timing Adjust button again to adjust from 6s as required.

Adding Pedestrian Crossings

Note: *that the choice of whether to include pedestrian facilities in a scheme must be made when the master controller is first powered up.*

Selecting the Number of Pedestrian Crossings:

Use the ◀ ▶ keys to change the Ped Crossings between 0 and 8 then press **SELECT**

This selects the number of pedestrian crossings to be included in the signalling scheme.

Note that each Ped Crossing employs two pedestrian heads. Thus, in the above illustration selecting 4 crossings will therefore require 8 pedestrian crossing heads to be present.

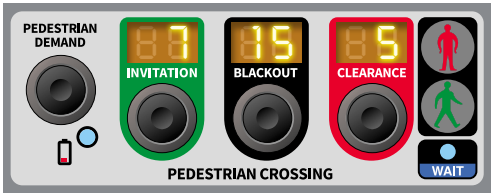
According to the number of crossings configured, the system will expect to see Signal units configured for the following crossing phase and head names:

Crossing:	1	2	3	4	5	5	7	8
Head:	V1, V2	V3, V4	W1, W2	W3, W4	X1, X2	X3, X4	Y1, Y2	Y3, Y4

Setting Pedestrian Times

Adjustment of pedestrian times does not require a specific timing editing mode to be entered. Times may be adjusted during operation.

Simply press the Invitation, Blackout or Clearance button in the **'Pedestrian Crossing'** area on the front panel of the controller.



The following Pedestrian timings are supported:

	Range
Invitation to Cross period:	6s – 9s
Blackout period:	3s – 15s
Clearance period:	2s – 9s

All times are adjustable in 1 second increments.

For further details see the **'Setting Timings'** section on page 31.

Operating a Metro Master Controller as a Master

Bringing into Operation

Having configured the traffic phases and heads, the number of pedestrian crossings, and all timings then the system is nearly ready to start operating.

Ready to Start Operating

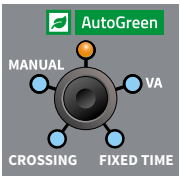
At this point the Signal Controller will display **"Ready"**, indicating it is ready to start.

Pressing the **SELECT** button followed by the ◀ ▶ keys to cycle around a series of additional information displays. The **SELECT** button can be pressed at any time to exit (or when no button is pressed for a time) then it returns to displaying "Ready".

- Local battery voltage
- Controller serial number
- Software versions ("MB V" for main board, "FP V" for front panel, "RB V" for radio board)
- Configuration file CRC

Setting the Operating Mode

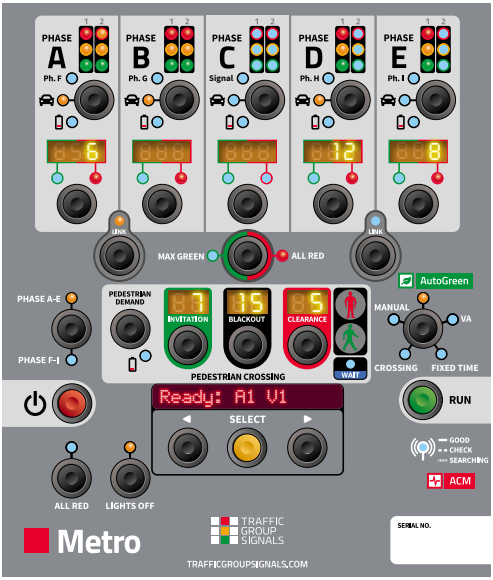
The final task is to select the operating mode using the Operating Mode button. Each time the button is pressed the selection advances around the mode wheel. Choose the required operating mode from one of the following:



- AutoGreen – varies behaviour to suit traffic conditions
- VA – Vehicle Actuation: responds to radar detection
- Fixed Time – cycles through phases with fixed time share
- Crossing – for haul route or standalone crossings
- Manual – for manual control

For details please see the **'Operating Modes'** section on page 38.

The controller may now look something like this:



This controller is configured to use the AutoGreen operating mode.

Note: *that it has also been requested to start in the Lights Off state.*

See the **'Lights Off Function'** in the Operating Modes section on page 45.

Press RUN to Start Operating

All the Signal Controllers should be started first, before pressing the **RUN** button at the Master controller.

See **'Operating a Metro Signal Controller'** on page 78 for details.

When ready to start, the master controller will display **"Ready:"** followed by the vehicle and/or pedestrian phase and the ACM Comms LED will be off.

After the **RUN** button is pressed, each Signal Controller will wait to connect to the Master controller.

Operating a Metro Master Controller as a Master

At this point the ACM Comms LED will be flashing and the controller will display **"Waiting:"**, followed by the vehicle and/or pedestrian phase. This will alternate with displaying the Group ID configured for the set of controllers.

This provides an opportunity for operatives to review the configuration of all controllers before pressing **RUN** on the master controller. This is important in terms of ensuring that the correct Signals are deployed in the correct places. Such checks also avoid the situation where a head fails to be found by the master at start-up due to an error in the configuration of one or more Signal Controllers.

When the RUN button is pressed on the Master controller will display **"Starting…"** and the ACM Comms LED will start by flashing fast while establishing connections with all the Signal Controllers.

If all Signal Controllers do not connect successfully on the first attempt, then ACM attempts connecting with another radio channel. In which case either **"Veh Fail"** or **"Ped Fail"** may be briefly displayed, identifying which controller did not connect. However, if not connected after more than 40 seconds then please refer to the **'Troubleshooting'** section for further advice.

"Comms Fail" may also be displayed at the Signal Controller, until the Master controller is restarted or during a change of radio channel.

When successfully connected the ACM Comms LED will remain on without flashing.

Unless starting at Lights Off, the system will initially perform a start-up sequence, transitioning all phases to red. Phase A will be the last to transition and usually goes straight to green, unless operating in Manual mode or All Red.

Runtime Functions

During operation, the Master controller displays a timer on screen which indicates the amount of time the signal has displayed.

During operation, the following can be done at any time:

- Use the Phase Bank Selection button to select the range of phases
- View or adjust the Traffic Phase All Red or Max Green timings with the **MAX GREEN** / **ALL RED** button and phase Timing Adjust buttons
- Adjust Pedestrian timings using the Invitation, Blackout or Clearance buttons
- Change Operating Mode using the Operating Mode button, including using Manual Mode for Manual Control
- Set phase demands manually using the Demand buttons, in Manual, VA, AutoGreen and Crossings modes

The **ALL RED** button can also be used to transition between normal operation and All Red. See the **'All Red Function'** in the Operating Modes section on page XX.

The Lights Off button can also be used to transition between normal operation and Lights Off. See the **'Lights Off Function'** in the Operating Modes section on page XX.

A range of additional information is also accessible in the Master controller for all connected controllers by pressing the **SELECT** button followed by the ◀ ▶ keys to cycle through the following information displays. Press **SELECT** at any time to exit.

- Local battery voltage
- Current radio channel
- Group ID selected
- Percentage of successful radio communications for each connected signal
- Battery voltages reported from each connected signal

This information enables operatives to quickly identify batteries that need changing and diagnose any poor radio communications performance with any controller from the Master controller.

The radio communications percentage is a measure of successful communications with a signal controller over the last two minutes. To get a reliable reading the system needs to be operational for at least 10 minutes. The system should operate reliably with 70% or more successful communications. If radio communication becomes unreliable then refer to the **'Troubleshooting'** section for further guidance.

Operating a Metro Master Controller as a Signal

A Metro Master controller can also be operated as a Signal controller. Although generally a Metro Signal controller is commonly used for each signal head. Details of how to operate the Metro Signal controller are provided in the following section.

A Signal controller receives instructions from the Master controller according to the signal phase for the vehicle or pedestrian head that it drives.

Configure Metro Master Controller as a Signal Controller

After turning on, the controller prompts for the following selections when set to Signal Mode:

1. Set Signal Mode
2. Select a Group ID (between 1 and 64)
3. Select the traffic head and/or crossing head for this Signal Controller

Selecting Signal Mode:

Use the ◀ ▶ keys to change between Master Mode or Signal Mode

Choose Signal Mode to operate a Metro Master controller as a Signal Controller then press **SELECT**.

Selecting Group ID:

Use the ◀ ▶ keys to change the Group ID between 1 and 64 then press SELECT.

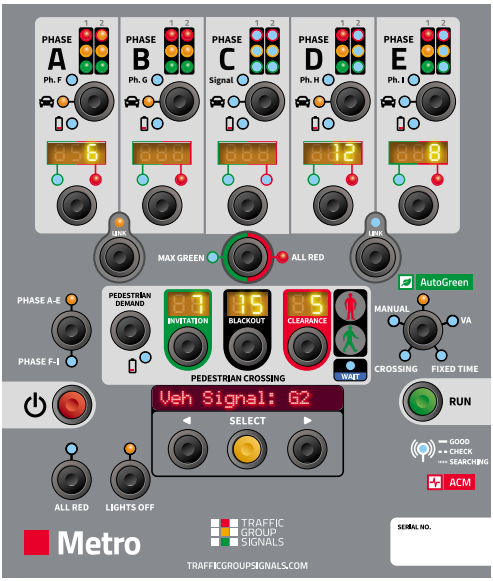
Only controllers operating on the same Group ID communicate with each other as a system. Therefore, the same Group ID must also be entered into the Signal Controllers for them to connect with the Master at a site.

Note: *that the choice of Group ID has no bearing on the radio channel that the system will choose to use. Choose a unique Group ID for the set of controllers at a site to ensure there is no conflict with any other controllers nearby.*

Choosing the Traffic Head for the Signal Controller:

Each traffic phase and head configured in the Master Controller must uniquely correspond to a Signal Controller configured for that traffic head to respond to instructions and operate in the correct sequence in the scheme.

When fitted with a traffic head the controller will prompt for the traffic head selection by displaying **"Veh Signal"** followed by the current traffic head selection.
Use the ◀ ▶ keys to change the traffic head selection as needed.



It is possible to select any of the 18 traffic heads, from 9 traffic phases A to I, together with either head 1 or 2 in each case. Alternatively press the Demand button of the corresponding phase once or twice to pick the head as needed. The Phase Bank Selection button can be used to pick from the additional phases.

Operating a Metro Master Controller as a Signal

The corresponding head mimics are illuminated to indicate the selection in either case. Press **SELECT** to confirm the choice.

Choosing the Pedestrian Crossing Head for the Signal Controller:

Each pedestrian crossing head configured in the Master Controller must uniquely correspond to a Signal Controller configured with the same pedestrian crossing head to respond to instructions for that head.

When fitted with a pedestrian head the controller will prompt for the crossing head selection by displaying **"Ped Signal"** followed by the current crossing head selection. Use the ◀ ▶ keys to change the pedestrian crossing head selection as needed.

It is possible to select any of the 16 pedestrian heads, from 4 pedestrian phases V to Y, together with heads 1 to 4 in each case. Press **SELECT** to confirm the choice.

Ready to Start Operating

When configuration is complete the Signal Controller will display **"Ready"**, indicating it is ready to start.

At this point pressing the **SELECT** button followed by the ◀ ▶ keys to cycle around a series of additional information displays. The **SELECT** button can be pressed at any time to exit then it returns to displaying **"Ready"**.

- Local battery voltage
- Controller serial number
- Software versions ("MB V" for main board, "FP V" for front panel, "RB V" for radio board)
- Configuration file CRC

Press RUN to Start Operating

All the Signal Controllers should be started first, before pressing the RUN button at the Master controller. When ready to start, a controller will display **"Ready:"** followed by the vehicle and/or pedestrian phase and the ACM Comms LED will be off.

After the **RUN** button is pressed, each Signal Controller will wait to connect to the Master controller. At this point the ACM Comms LED will be flashing and the controller will display **"Waiting:"**, followed by the vehicle and/or pedestrian phase. This will alternate with displaying the Group ID configured for the set of controllers.

This provides an opportunity for operatives to review the configuration of all controllers before pressing **RUN** on the master controller. This is important in terms of ensuring that the correct signals are deployed in the correct places. Such checks also avoid the situation where a head fails to be found by the master at start-up due to an error in the configuration of one or more Signal Controllers.

If previously connected and waiting to reconnect then **"Comms Fail"** may be displayed at the Signal Controller, until the Master controller is restarted or during a change of radio channel.

Runtime Functions

During operation, the Signal Controller displays a timer on screen which indicates the amount of time the signal has displayed.

The **ALL RED** button can also be used at the Signal Controller to remotely request a transition to All Red. See the **'All Red Function'** in the Operating Modes section on page 47.

A range of additional information is also accessible for the Signal Controller by pressing the **SELECT** button followed by the ◀ ▶ keys to cycle through the following information displays. Press **SELECT** at any time to exit.

- Local battery voltage
- Current radio channel
- Group ID selected
- Local phase and head

Operating a Metro Signal Controller as a Signal

The Metro Signal controller only operates as a signal controller in signal mode in a simple to use package. Metro Signal has no ability to function in master mode.

A Signal controller receives instructions from the Master controller according to the signal phase for the vehicle or pedestrian head that it drives.

Note that the Metro Signal controller has a four-character starburst display, therefore text messages are often abbreviated to fit.

Configure a Metro Signal Controller

After turning on, the controller prompts for the following selections:

1. Select a Group ID (between 1 and 64)
2. Select the traffic head and/or crossing head for this Signal Controller

Selecting Group ID:

Shortly after turning on a Metro Signal controller it first displays the Group ID setting **"GP12"**. This must be set to the same Group ID as the Master controller for the controllers to communicate as a system.

To change the Group ID, press the **OPTION** button to increment the number up to 64, after which it rolls back to 1 and continues to increment.

Press **SELECT** when the required Group ID setting is displayed.

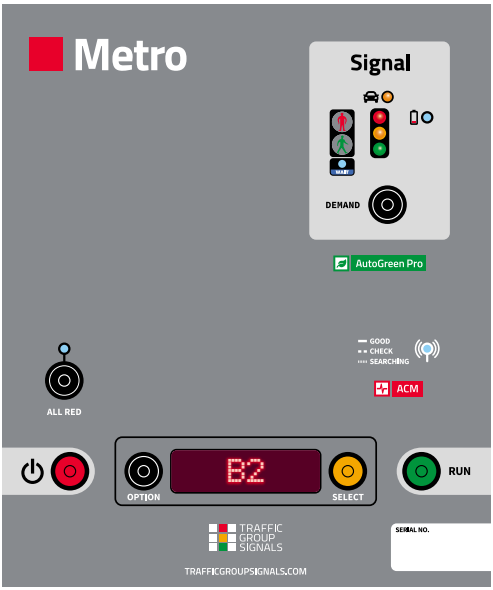
Note: *that the choice of Group ID has no bearing on the radio channel that the system will choose to use. Choose a unique Group ID for the set of controllers at a site to ensure there is no conflict with any other controllers nearby.*

Choosing the Traffic Head for the Signal Controller:

Each traffic phase and head configured in the Master Controller must uniquely correspond to a Signal Controller configured for that traffic head to respond to instructions and operate in the correct sequence in the scheme.

When fitted with a traffic head the Signal Controller illuminates the traffic head mimics. Press the **OPTION** button to cycle through the list of signal heads. It is possible to select any of the 18 traffic heads, from 9 traffic phases A to I, together with either head 1 or 2 in each case. Then press the **SELECT** button when the correct head is displayed.

In the example below **"B2"** is a traffic phase B head 2.



Operating a Metro Signal Controller as a Signal

Choosing the Pedestrian Crossing Head for the Signal Controller:

When fitted with a pedestrian head the Signal Controller illuminates the pedestrian mimics. Press the **OPTION** button to cycle through the list of signal heads. It is possible to select any of the 16 pedestrian heads, from 4 pedestrian phases V to Y, together with heads 1 to 4 in each case. Then press the **SELECT** button when the correct head is displayed. For example, "V3" indicates this is a pedestrian phase V head 3.

Ready to Start Operating

When configuration is complete the Signal Controller will display **"RDY"**, indicating it is ready to start.

At this point pressing the **SELECT** button will display a series of additional information displays. Press **OPTION** to cycle around each display. The **SELECT** button can be pressed at any time to exit (or when no button is pressed for a time) then it returns to displaying "RDY".

- Local battery voltage
- Controller serial number
- Software versions ("MB V" for main board, "FP V" for front panel, "RB V" for radio board)
- Configuration file CRC

Press RUN to Start Operating

All the Signal Controllers should be started first, before pressing the **RUN** button at the Master controller. When ready to start, the Signal Controller will display **"RDY"**.

After the **RUN** button is pressed each Signal Controller will wait to connect to the Master controller. At this point the ACM Comms LED will be flashing and the controller will display **"WAIT"**, followed by the vehicle and/or pedestrian phase. This will alternate with displaying the Group ID configured for the set of controllers.

This provides an opportunity for operatives to review the configuration of all controllers before pressing **RUN** on the master controller. This is important in terms of ensuring that the correct signals are deployed in the correct places.

Such checks also avoid the situation where a head fails to be found by the master at start-up due to an error in the configuration of one or more Signal Controllers.

If previously connected and waiting to reconnect then **"CF"** (Comms Fail) may be displayed at the Signal Controller, until the Master controller is restarted or during a change of radio channel.

Runtime Functions

During operation, the Metro Signal controller displays the phase and head.

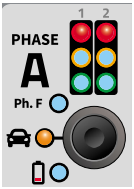
The **ALL RED** button can also be used at the Signal Controller to remotely request a transition to All Red. See the **'All Red Function'** in the Operating Modes section on page 47.

A range of additional information is also accessible for the Signal Controller by pressing the **SELECT** button followed by the **OPTION** key to cycle through the following information displays. Press **SELECT** at any time to exit (or when no button is pressed for a time).

- Local battery voltage ("LOCV" then battery voltage)
- Current radio channel ("CH##", where ## is the current radio channel number 1 to 17)
- Traffic and/or pedestrian phase / head, with reported battery voltage

Signal Head Mimics and Phase Status Indicators

Traffic Signal Mimics and Demand Indicators on Metro Master

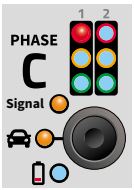


The Metro Master controller has an arrangement of indicator LEDs on the front panel that mimic the traffic signal heads, radar demand and battery status for up to five traffic phases.

An additional four traffic phases can also be displayed using these mimics by pressing the Phase Bank **SELECT** button to toggle between the phase banks. There is a LED under the phase letter which indicates when the alternate phase is being shown.

When operating as a Master Controller these mimics repeat the current states for each of the connected traffic phases.

During configuration, the mimics are also used to pick the required phases, heads, and nudge setting as described in earlier sections.



When operating as a Signal Controller the current state for just the local traffic signal head are repeated using the mimic LEDs for the middle phase (C) regardless of the phase or head they represent. The Signal LED flashes as a reminder that this is the mimic of the local head at the signal controller. The Signal Controller's traffic phase and head is displayed on the OLED dot matrix display.

Traffic Signal Fault Indication on Metro Master

When operating either as a Master or Signal Controller any fault with one of the traffic signal aspects is indicated by flashing the corresponding mimic LED along with displaying a fault message on the OLED dot matrix display.

For further details refer to the **'Signalling Faults'** next section.

Pedestrian Mimics and Wait Indicators on Metro Master

The Metro Master controller has an arrangement of indicator LEDs on the front panel that mimic the pedestrian crossing signals, wait lamp and battery status.

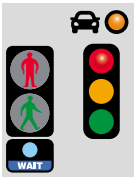
When operating as a Master Controller these mimics indicate the combined status for all the connected pedestrian crossing heads.

When operating as a Signal Controller these mimics indicate the current state for just the local signal head. The Signal Controller's pedestrian phase and head is displayed on the OLED dot matrix display.

Pedestrian Signal Fault Indication on Metro Master

When operating either as a Master or Signal Controller any fault with one of the pedestrian crossing aspects is indicated by flashing the corresponding mimic LED along with displaying a fault message on the OLED dot matrix display. For further details refer to the **'Signalling Faults'** next section.

Signal Head Mimics and Status Indicators on Metro Signal



Although presented with a different layout, the Metro Signal has the same indicator LEDs on the front panel that mimic the traffic signal heads, radar demand, pedestrian crossing signals, wait lamp and battery status.

These mimics indicate the current state for just the local signal heads. The Signal Controller's traffic or pedestrian phase and head is displayed on the text display.

Traffic or Pedestrian Signal Fault Indication on Metro Signal

Any fault with one of the traffic signal or pedestrian crossing aspects is indicated by flashing the corresponding mimic LED along with displaying a fault code on the starburst display.

For further details refer to the **'Signalling Faults'** next section.

Signal Head Mimics and Phase Status Indicators

Fault Indication

The following messages can be displayed when there is a fault detected with one of the aspects for a traffic or pedestrian signal head or a tactile. This may appear shortly after turning on the controller or when detected during operation.

The associated signal mimic will flash to indicate which signal aspect has failed.

Master	Signal	Brief description
TACTILE FAULT	TCTF	Pedestrian Tactile short circuit or unexpectedly on.
WAIT FAULT	WAIT	Pedestrian Wait open circuit or unexpectedly on.
GREEN MAN FAULT	GRNM	Pedestrian Green open circuit or unexpectedly on.
RED MAN FAULT	REDM	Pedestrian Red open circuit or unexpectedly on.
AMBER FAULT	AMBF	Traffic Amber open circuit or unexpectedly on.
GREEN FAULT	GRNF	Traffic Green open circuit or unexpectedly on.
RED FAULT	REDF	Traffic Red open circuit or unexpectedly on.
NEAR + FAR SIDE	PEDF	Ped near and far side head configuration are incompatible types.
GREEN CONFLICT	SIGE	A conflict has been detected between two traffic phases at green.
WRONG HEAD TYPE	WRHD	Pedestrian/Traffic head detected when configured for other type.
TACTILE PRESENT	TCTY	Pedestrian Tactile is present when not expected. Press SELECT to continue.
NO TACTILE	TCTN	Pedestrian Tactile is not present when expected. Press SELECT to continue.
TACTILE FAULT ##	TF##	Pedestrian Tactile phase ## is open circuit or not present as expected.
SIG HEAD MISSING	NOHD	No signal head is connected when expected.

For further advice refer to **'Traffic or Pedestrian Head, Lamp, Tactile, Wait'** in the Troubleshooting section on page 96.

Signal Head Mimics and Phase Status Indicators

Lamp Failure and Signalling Faults

The failure of a lamp is not considered to be safety critical unless the failure introduces a dangerous conflict between approaches or endangers pedestrians.

However remember that when no signal is displayed on a traffic approach this may be interpreted as **"proceed with caution"**.

Therefore the failure to display a stop signal at a traffic approach when required can be considered a safety issue if it conflicts with the green on another approach or puts pedestrians at risk.

A failed green or amber signal is therefore not considered to be safety critical as no conflict is introduced. Also where an approach has double heads, a single failed red is not considered to be safety critical since a stop signal is still present.

Even with a fault it is better that the signals continue to operate so long as it is safe to do so. Otherwise it is best if all signals default to lights off, thus allowing drivers to **"proceed with caution"** from all approaches.

IMPORTANT: The responsibility lies with the operator and organisation managing the temporary signals to resolve any failure at the earliest opportunity and not continue to operate signals with a fault.

CAT3 Signalling Fault

A **CAT3** Signalling Fault occurs when the red aspect fails to display a stop signal at a single approach. In response the master controller instructs any opposing green signal to extinguish to prevent a signalling conflict with the failed red signal.

This allows drivers to **"proceed with caution"** some of the time when those approaches are impacted by the failed stop signal.

Note that where a scheme includes a pedestrian phase, this **CAT3** Signalling Fault is never raised. In this scenario any red failure is handled as a **CAT1** Signalling Fault.

The Fault Responses tables opposite illustrate when a Category 3 Signalling Fault applies.

CAT1 Signalling Fault

A **CAT1** Signalling Fault occurs in either of the following cases:

- A red aspect fails to display a stop signal at a single approach and there is a pedestrian crossing phase.
- There is a failure to display stop signals for more than one approach.

In response the master controller immediately instructs all signals to extinguish to Lights Out as it is not possible to continue to operate the signals safely.

This allows drivers to **"proceed with caution"** on all approaches until the signals recover or the faults are resolved.

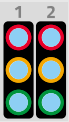
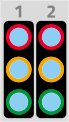
The Master Controller initiates an Auto Recovery countdown and restart to attempt to recover from a **CAT1** Signalling Fault, as described later in this section.

The Fault Responses tables below illustrate when a Category 1 Signalling Fault applies.

System Status Indications and Fault Handling

Signal Head Mimics and Phase Status Indicators

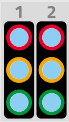
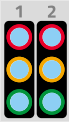
Fault Responses to Traffic Red, when Pedestrian Crossings are Excluded

TRAFFIC ONLY	 Single No Fault	 Single Red Fault	 Double 2 Red Faults	 Double 1 Red Fault	 Double No Fault
 Single No Fault	Normal Operation	CAT3 Fault	CAT3 Fault	Continue Operating	Normal Operation
 Single Red Fault	CAT3 Fault	CAT1 Fault	CAT1 Fault	CAT3 Fault	CAT3 Fault
 Double 2 Red Faults	CAT3 Fault	CAT1 Fault	CAT1 Fault	CAT3 Fault	CAT3 Fault
 Double 1 Red Fault	Continue Operating	CAT3 Fault	CAT3 Fault	Continue Operating	Continue Operating
 Double No fault	Normal Operation	CAT3 Fault	CAT3 Fault	Continue Operating	Normal Operation

⊗ = failed red aspect

Signal Head Mimics and Phase Status Indicators

Fault Responses to Traffic Red, when Pedestrian Crossings are Included

TRAFFIC ONLY	 Single No Fault	 Single Red Fault	 Double 2 Red Faults	 Double 1 Red Fault	 Double No Fault
 Single No Fault	**Normal Operation**	**CAT1 Fault**	**CAT1 Fault**	**Continue Operating**	**Normal Operation**
 Single Red Fault	**CAT1 Fault**	**CAT1 Fault**	**CAT1 Fault**	**CAT1 Fault**	**CAT1 Fault**
 Double 2 Red Faults	**CAT1 Fault**	**CAT1 Fault**	**CAT1 Fault**	**CAT1 Fault**	**CAT1 Fault**
 Double 1 Red Fault	**Continue Operating**	**CAT1 Fault**	**CAT1 Fault**	**Continue Operating**	**Continue Operating**
 Double No fault	**Normal Operation**	**CAT1 Fault**	**CAT1 Fault**	**Continue Operating**	**Normal Operation**

⊗ = failed red aspect

Communications and ACM Indications

The **ACM** LED indicates the status of communications at the controller.

The **ACM** LED is **OFF** when the radio is **OFF**, such as before **RUN** or the signals are not operational.

The **ACM** LED is **ON** when the controller is connected, with good radio communications and the signals are operating normally.

The **ACM** LED also flashes either slow or **fast** as explained below.

Comms Status	ACM Indication		Interpretation
No comms:		OFF	The controller is not yet connected or operational.
Comms good:		ON	The controllers are connected, with good communications and operating normally.
Check:		Slow flash	Temporary loss of communications or possible interference detected.
Searching:		Fast flash	Seeking and (re-)connecting with signal controllers.

Temporary Loss of Communications

The **ACM** LED indicates with a slow flash (or usually just a single blink off) when there is a temporary loss in communications of more than half a second, perhaps due to a short period of interference. Note that the signals enter a **CAT2** condition at this point (more on this later in this section).

ACM can tolerate occasional loss of communications without impacting signalling operations, provided any loss does not exceed 3 seconds in duration or the message success rate remains better than around 70%.

Seeking and (re-)connecting

The **ACM** LED indicates with a fast flash when the signal controllers seek the channel and connect with the master controller. This is quite normal and generally completes in under 6 seconds (sometimes 12 seconds).

This occurs routinely during start-up after **RUN** is pressed or when a restart occurs after Auto Recovery (more on this later in this section).

Channel Hopping

However when there is a loss of communications exceeding 3 seconds then **ACM** responds with a reactive channel change resulting in a seek and reconnect. Thus the **ACM** LED indicates this with change from slow to fast flash. Note that the signals enter a **CAT4** condition at this point (more on this later in this section).

However, **ACM** can mostly pre-empt a reactive channel change. A proactive channel change occurs when an available radio channel has a better signal quality. This occurs seamlessly and the operator will be unaware of the change unless checking the current channel using the **SELECT** button.

For further information see '**Active Channel Management (ACM®)'** in the New Technology and Features section on page 18.

Signal Head Mimics and Phase Status Indicators

Frequent or Regular Channel Hopping

If the ACM LED indicates a fast flash at frequent or regular intervals, then this may indicate a problem with site deployment that requires further investigation.

Press the **SELECT** button to check the runtime diagnostic information display for the message success rate for each connected signal, which needs to be consistently better than 70% to be reliable.

For further advice please refer to **'Radio Communications Problems'** in the Troubleshooting section on page 98.

Failure to Establish Communications

At start-up or when a restart occurs, if ACM has not successfully established communication between all the controllers after 12 seconds of seeking, then ACM tries different channels, and the ACM LED continues to indicate a fast flash.

At this point the Master Controller displays one of the following messages to identify a phase that failed to connect. No message is displayed at a Signal Controller.

Master	Signal	Brief description
VEH FAIL ##		Failed to establish communications with Traffic head ##.
PED FAIL ##		Failed to establish communications with Pedestrian head ##.

If this persists for more than 30 seconds then check that a controller for the phase is present, turned on, operating OK and is correctly configured. Otherwise this may indicate a problem with site deployment that requires further investigation.

For further advice please refer to **'Phase and/or Communications Failure'** in the Troubleshooting section on page 97.

Persistent Communications Failure

When a loss of communications persists and ACM is unable to re-establish communications between all the controllers after 12 seconds, then the Master Controller responds with a **CAT1** Fault condition and initiates Auto Recovery (see below).

At this point any of the controllers may display the following message. The Master Controller also identifies a phase that has failed to communicate (although the failure may not be limited to a single phase).

Master	Signal	Brief description
COMMS FAIL ##	CF	Permanent loss of communications (head ## identified on master).

The **ACM** LED indicates with a fast flash at the Signal Controllers, as they continue to seek until successfully reconnected with the master controller.

However the **ACM** LED goes to **OFF** at the Master Controller as it stops radio transmission during the Auto Recover count down. On completion the Master Controller attempts to re-connect and restart, as described above.

CAT1 Fault, Auto Recovery and Restart

If one of following conditions occur (as previously described) then the master controller responds with a Category 1 Fault sequence to automatically recover and restart.

- CAT1 Signalling Fault – see page 84
- Persistent Communications Failure – see page 88

The master controller responds to the **CAT1** Fault by automatically instructing all signals to go to Lights Out immediately and ceases signalling and radio transmission for a period. This allows drivers to **"proceed with caution"** until the signals are restarted.

To minimise nuisance call outs the master controller automatically attempts a restart after a recovery period. During this period, the master controller displays **"Auto Recover"** with a countdown timer as well as a message identifying the fault condition.

The recovery period is initially 15 secs but any further re-occurrence within 10 minutes will cause this period to ramp up from 1 minute to 2, 5, 15 and finally 30 minutes. Pressing **RUN** at any point will immediately end the recovery countdown.

When the auto recovery countdown completes then the controller automatically attempts to reconnect and then the signals start-up again.

CAT2 and CAT4 Temporary Loss of Comms

The agility of **ACM** mostly ensures that the best channel with the least interference is selected, as explained previously. Although much less likely, this does not eliminate a sudden unexpected loss of communications.

Any temporary loss of communications generally has no impact on signalling operations unless it occurs moments before to a signal change or exceeds 3 seconds in duration.

Technically this is treated as a **CAT2** condition as the loss of communications can result in a loss of synchronisation. In response the state of the signals is held briefly.

However the critical timing of signal transitions via amber (3 seconds for the closing amber and 2 seconds for the starting amber) are protected and continue unaffected anyway. Just occasionally the timings of the red or green signals may be extended by 1 or 2 seconds.

However when there is a sudden loss of communications that exceeds 3 seconds then this is treated as a **CAT4** condition as there is now a sustained loss of communications.

In response to the **CAT4** condition **ACM** reacts with a channel change. Any signals that are held at green are immediately extinguished whilst continuing to hold any signals a red. This ensures that there is no signalling conflict (in case there is an unreported failure). The reactive channel change can take a further 3 seconds as described previously.

Any loss of communications that persists for longer than 12 seconds is treated as a **CAT1** Fault as described previously.

Battery Care and Good Practice

The following sections describe how best to manage batteries: display battery voltage, capacity, and health; as well as charge and hot swap batteries.

Please also read the **'Endurance Power System'** in the New Technology and Features section on page 20.

Battery Care and Good Practice

Reliable batteries that perform well for many years is fundamental to efficient operation. Therefore it is vitally important to establish a good battery care regime that follows good practice.

The following guidelines should be incorporated into operating procedures and observed at all times:

1. Fully charge batteries at the earliest opportunity and ideally between 10 and 25°C. Avoid charging cold batteries (never below 5°C).
2. Do not keep batteries in a discharged state for longer than necessary.
3. Take batteries off charge as soon as they reach fully charged. Do not overcharge or leave on the charger until use.
4. Do not charge at a faster rate or with a higher current than recommended.
5. Avoid partial charging before use or storage.
6. Replace damaged or defective batteries or batteries that lose charge spontaneously or have a consistently short runtime.
7. It is recommended to replace Batteries routinely after 4 years.

For more advice please go to:
www.trafficgroupsignals.com

Battery Protection

Generally when fully charged the battery voltage settles at around 12.8V to 12.9V (a few hours after charging).
A battery should not routinely be discharged below 10.9V as this causes irreparable degradation to the battery chemistry and thus reduces the capacity and lifetime of the battery. When Battery Low is indicated (see below) recharge at the soonest opportunity.

When the controller is indicating Battery Empty (see below) it cannot start or restart signalling, but for safety reasons it continues to operate as long as possible. However loss of power is imminent and urgent action is required. The controller must switch off at 10.5V to prevent irreparable damage to the battery caused by deep discharge.

Battery Endurance Expectations

Each Metro controller typically operates with two or three batteries, although the product is designed to house up to six batteries.

Typically runtimes of one week per battery can be expected in normal use over battery lifetime, provided the recommended batteries are used and kept in good condition by following the guidelines and charging with the recommended charger.

Operating Condition:	Four batteries single head:	Six batteries double head:
Average UK Summer (ave. daily 17°C, 16 hrs daylight)	Up to 28 days[2]	Up to 21 days[2]
Average UK Winter (ave. daily 2°C, 8 hrs daylight)	Up to 26 days[2]	Up to 19 days[2]

Note: *It is best to operate each unit with batteries of the same age and condition. The overall runtime performance or reliability can be impaired by a single battery in poor condition or with a lower capacity than the others.*

[2] The runtimes quoted are an approximate guide and can vary with temperature, number of batteries, capacity, condition, age, and power requirements.

[3] When a battery indicator is fast flashing then it is not possible to restart operations until the indicated battery is replaced. Beware that if a controller in this condition is powered off (e.g. to add / remove a phase)

Battery Care and Good Practice

Low and Empty Battery Alerts

All controllers monitor the voltage of their own battery. Additionally when operating a Master controller monitors the voltages reported over the radio from all the signal controllers that are connected.

The controller indicates a battery alert on the front panel by flashing the appropriate battery indicator, using either a slow or fast flash, when the battery voltage falls below a level that approximates to the following battery runtime:

Battery Status	Alert Indication	Remaining Battery Runtime and Interpretation
Battery OK:	 OFF	3 days[2] or better remaining.
Battery Low:	 Slow flash	**Warning:** Replace battery ASAP. Less than 3 days[2] remaining.
Battery Empty:	 Fast flash[3]	**Urgent:** Controller will shut down in less than 24-hours. Replace or charge battery immediately.
Battery Fail:	 ON	Battery voltage too low to operate; turning off.

Battery Management

The battery voltage can be checked at the controller as a guide to charge level as described below.

Monitoring Battery Capacity and Health

Battery voltage is a rough guide to charge level but should not be used to judge battery capacity or remaining runtime. There are other factors such as the temperature, battery age and condition and power requirements that determine actual capacity or runtime.

	Meaning	Capacity	Action
High	Fully charged	95% or better	Ready for use
	Good	50% to 90%	Operational
	OK	20% to 45%	Replace or charge soon
	Low	5% to 15%	Replace or charge ASAP
Low	Empty	Close to 0%	Critical, replace or charge immediately

Checking Battery Voltage at the Controller

The following is a rough guide to interpreting battery voltage in terms of the charge level. However as stated above this provides only an approximate guide to the remaining runtime.

Battery Voltage	Approx. Charge Level	Interpretation
12.8V or More		Fully Charged
12.5 to 12.8V		High - OK for Deployment
11.9 to 12.5V		Good
11.5 to 11.9V		Low - Charge or Hot Swap ASAP
11.5 to 11.0V		Very Low - Charge or Swap Immediately
11V or Less		Empty - Insufficient Charge to Operate

Monitoring Battery Capacity and Health

Displaying the Local Battery Voltage at the Controller

The controller can display the combined voltage of the batteries connected to it. To access this feature, press the **SELECT** button during configuration (before **RUN**) when displaying **'Ready' (or 'RDY')** or when operating or displaying 'Wait' (after RUN).

Note however that, as the battery voltages are combined this can mask the effects of one of the batteries being in poor condition or losing charge more quickly.

Displaying All Battery Voltages at the Master Controller

When operating the Master controller can display the battery voltages reported over the radio from all the signal controllers that are connected.

Just press the **SELECT** button during operation (after RUN) followed by multiple presses of either the ◀ or ▶ keys until the battery voltages are displayed for each phase.

Hot Swapping Batteries

The batteries in Metro are intended to be hot swapped and charged at the depot.

Follow the following procedure whilst the signals are in operation:

1. To avoid the signals from failing, first replace the battery with the lowest voltage or one that has failed.
2. Only disconnect one battery at a time, replace and reconnect before repeating for the others in the unit.
3. Always replace all batteries in each signal with freshly charged batteries at the same time. This is because power is always taken from the battery with the highest charge first. There is no benefit to replacing alternate batteries on each visit unless returning within a day or two.

Battery Charging

Metro does **NOT** support battery charging in the base unit. Batteries are charged at the depot in the stillage system used for transportation.

Always use the recommended Endurance Power charger and battery as supplied.

Battery Management

The battery voltage can be checked at the controller as a guide to charge level as described below.

Monitoring Battery Capacity and Health

Procedure for Charging

Only charge batteries in a well-ventilated area maintained ideally between 10 and 25°C. Never charge batteries when they are cold as this causes irreparable degradation to the battery chemistry and is potentially dangerous.

Refer to 'Battery Care and Good Practice'.

The charger is connected to the battery using an Anderson connector. The charger will reduce the rate of charge in cold environments and stop charging batteries with an **ERROR LAMP** indication if the battery is not charging normally as expected.

For operational safety, proceed as follows:

1. Do not connect to the battery first. Always connect the cable to the charger first, as it has output protection. Then apply mains power to the charger.
2. Select the **NORMAL BATTERY PROGRAM** using the **MODE** button. Never use either **AGM PROGRAM** or **LITHIUM PROGRAM**.
3. Connect the cable to the battery last, making sure the terminals are not shorted. Connect negative (black) to negative **('-')** and positive (red) to positive **('+')**.
4. The charger should start charging within a few seconds after performing some checks. If the Error Lamp is lit refer to the section: 'Troubleshooting'.
5. When **READY TO USE** is lit the battery is at least 80% charged and may optionally be disconnected for short runtime deployments (proceed to step 7). However, we recommend fully charging the battery whenever possible and at least every other cycle.
6. When **FULLY CHARGED** is lit then the battery is 100% charged and should be disconnected as soon as possible and stored ready for use.
7. Always disconnect the cable from the battery first.
8. Then disconnect the charger from the mains before disconnecting the cable.

Charger Operation

Whilst charging the battery voltage is gradually increased up to 14.6V during the 'Bulk' stage, whilst delivering a high charge current. The charger then indicates **READY TO USE** (step 5) when battery reaches 80% capacity at the start of the final 'Absorb' stage. The voltage is then held at 14.6V whilst the charge current reduces until the battery approaches 100% capacity.

At this point the charger turns off briefly whilst it checks the battery voltage. If the battery is holding its charge, then the charger indicates that the battery is **FULLY CHARGED** (step 6).

Whilst the battery remains connected the charger maintains the voltage at 13.6V and can occasionally deliver a pulse charge if capacity falls below 95%.

Voltage Loss after Charge?

When disconnected from the charger it is normal for the battery voltage to reduce and settle at around 12.8V to 12.9V over the first few hours without loss of capacity.

Healthy fully charged batteries should hold charge better than 95% for a few weeks without use.

Using the Charger 'RECOND PROGRAM'

It is recommended that this charger function should only be used as a last resort to attempt reconditioning batteries with reduced runtime capacity or not holding charge. It should not be used regularly as it may reduce battery life.

Fully discharge the batteries first by operating the Signal until a Battery Empty indication or after a Battery Fail.

Then when charging a battery in poor health, select the **RECOND PROGRAM** on the charger with the **MODE** button and allow the battery to complete to **FULLY CHARGED**.

This adds an additional stage in the charging process and attempts to reverse any accumulation of sulphate. If this does not recover battery runtime capacity then it is probably irreversible, in which case the battery should be replaced at the earliest opportunity.

Monitoring Battery Capacity and Health

Replacement and Disposal

Do not attempt to charge a damaged or leaking battery; it could be dangerous. Replace any defective or damaged battery or otherwise after 4 years as a matter of course. Safely and responsibly dispose of all batteries. This is best done when safely discharged. Recycle and protect the environment.

Troubleshooting

This section provides troubleshooting information covering a range of possible fault conditions. In addition to the self-service measures described here, the Traffic Group Signals Service Team are available to help with further queries or with on-site support services.

Controller Power and Battery Low, Empty, Fail

Controller appears to remain off / inactive when the power button is pressed

Check if this is caused by any of the following:

1. The controller may be disconnected from the batteries. Check connections.
2. The batteries may be depleted to 11.0V or less. Check battery voltages or try charging or replacing with known good batteries.
3. A fuse may have blown. Check fuse continuity and replace with an approved spare as needed.
4. The controller or unit may be damaged or non-functional. Check for any evidence of damage, such as physical, water ingress, electrical, …

If the cause cannot be identified or easily resolved, then please call service or support. Replace as needed.

Controller displays a battery fail, empty or low with flashing battery LED

When one of the following is displayed and/or a battery LED is flashing:

Display	Code	Solution
LOW BATTERY	LBAT	Battery Voltage Low Warning, charge as soon as possible
BATT EMPTY	BATE	Battery voltage Critical, too low to continue operating
BATT FAIL ##	BF##	System Shut Down due to Battery Failure (at Phase ##)
SYS BATT FAIL		
BATT EMPTY	BATE	Cannot run because battery voltage is too low to operate

Please refer to **'Low and Empty Battery Alerts'** in the Battery Management section on page 91.

Traffic or Pedestrian Head, Lamp, Tactile, Wait

Controller displays a traffic or ped lamp fault, missing head, tactile or wait lamp

When one of the following is displayed and/or a flashing traffic or ped mimic LED:

Display	Code	Solution
SIG HEAD MISSING	NOHD	No aspects connected to a Signal Controller. Check that the controller is connected to the head.
RED FAULT	REDF	Traffic Red open circuit or unexpectedly on.
AMBER FAULT	AMBF	Traffic Amber open circuit or unexpectedly on.
GREEN FAULT	GRNF	Traffic Green open circuit or unexpectedly on.
RED MAN FAULT	REDM	Pedestrian Red open circuit or unexpectedly on.
GRN MAN FAULT	GRNM	Pedestrian Green open circuit or unexpectedly on.
WAIT FAULT	WAIT	Pedestrian Wait open circuit or unexpectedly on.
TACTILE FAULT	TCTF	Pedestrian Tactile short circuit or unexpectedly on.
NO TACTILE	TCTN	Pedestrian Tactile open circuit or not present as expected.
TACTILE PRESENT	TCTY	Pedestrian Tactile is present when not expected.

When first powered on a controller tests the integrity of all connected aspect lamps, tactile device and pedestrian wait lamp. Both Master and Signal Controllers will report any aspect failures at power-on with an error message.

When operating the same fault messages and indications can also be reported after **RUN**. If the fault is intermittent or temporary, then it can clear again when resolved.

Where an aspect mimic LED starts to flash, this indicates a failure with that aspect on the signal head and the type of failure is displayed in an error message (as above).

Check the function and connections to the signal head, aspect, lamp or tactile indicated by the fault. Inspect for any evidence of a poor connection or damage.

In the event of a lamp fault, replace the Metro pole and head assembly on the affected pod with the appropriate spare supplied. Return the faulty pole / head assembly to TGS Service for further investigation and replacement.

Note that a few individual failed LEDs within the aspect is not considered to be a fault.

Please refer to **'Signal Head Mimics and Phase Status Indicators'** in System Status Indication section on page 80.

Phase and/or Communications Failure

A controller displays fail message after pressing RUN with fast flashing ACM LED

When the ACM Comms LED is flashing fast and one of the following is displayed:

Display	Code	Solution
VEH FAIL ##	VF##	Loss of connection with a controller for Traffic head ##.
PED FAIL ##	PF##	Loss of connection with a controller for Pedestrian head ##.
COMMS FAIL	CF	General or sustained loss of communications.

This indicates that the Master controller failed to connect or lost communications with a Signal Controller for the Traffic or Pedestrian head. At start-up this could indicate that one of the signals is missing, not running or not correctly configured. Otherwise it might occur when a signal has failed or there is sustained loss of communications between the Master and Signal Controllers.

The **'Veh Fail'** or **'Ped Fail'** may be displayed briefly after pressing **RUN**, when a Signal Controller does not connect successfully on the first attempt. **ACM** will retry using a different channel.

If this behaviour persists for more than 40 seconds at start-up, then please check the following for possible causes:

1. Check that the master controller is correctly configured:
   - Is the indicated phase intended to be included in the scheme?
   - For a traffic phase, is it correctly set to single or double head?
2. Identify the Signal Controller for the indicated phase and check:
   - Is the Signal Controller turned on, running and within range?
   - Is the Signal Controller set to the same Group Id as the master?
   - Is it correctly set-up to be a signal with the right phase identifier?
   - For a traffic phase, does it have the right the head identifier?
   - For a pedestrian crossing, does it have the right crossing identifier?

If this does not correct the problem or the problem is more general, persistent, or intermittent then check for the following possible causes:

1. Check the antennas for any damage or poor connection.
2. Look for any obstruction of the radio signal; if necessary, try repositioning (just a meter or two can make the difference).
3. Try relocating the master controller for better site coverage.
4. Check for any faulty radios by trying substitution.
5. Look for any sources of interference and resolve as needed.

Troubleshooting

This section provides troubleshooting information covering a range of possible fault conditions. In addition to the self-service measures described here, the Traffic Group Signals Service Team are available to help with further queries or with on-site support services.

Signal(s) at Lights Out

If the **LIGHTS OFF** button has been pressed, then this is indicated by the LED indicator above the button. If so, pressing the LIGHTS OFF button again restores the signalling starting with the amber to red start-up sequence.

Signals are at lights out and text display shows "Auto Recover ##"

The signals have been forced to a 'lights out' condition. The master controller displays **"Auto Recover"** with a countdown timer as well as a message identifying the fault condition. This is a **CAT1** response and is a fail-safe feature. It allows drivers to "proceed with caution" until the signals are restarted.

The controller will automatically attempt a restart at the end of the recovery period displayed on screen. The **RUN** button can be pressed to attempt an immediate restart.

If recovery is unsuccessful or the **CAT1** is persistent or frequent, then further diagnosis may be required to identify and resolve the problem.

Please refer to the following that can cause a **CAT1** response:

- CAT1 Signalling Fault – see page 84
- Persistent Communications Failure – see page 88

Signals are cycling but some are regularly not showing a green signal

This behaviour is due to a response to a **CAT3** Signalling Fault, which occurs when the red aspect fails to display a stop signal at a single approach. Thus the cause is reported as a **"Red Fault"**.

Please refer to **'Lamp Failure and Signalling Faults'** in the System Status Indications section on page 84.

Signals are occasionally not showing a green signal

This behaviour is due to a response to a **CAT4**, sudden loss of communications that exceeds 3 seconds. ACM reacts with a channel change and any signals that are held at green are immediately extinguished whilst continuing to hold any signals a red. This ensures that there is no potential signalling conflict until communications is restored.

Please refer to **'CAT2 and CAT4 Temporary Loss of Comms'** in the System Status Indications section on page 89.

Radio Communications Problems

ACM LED occasionally blinks once or twice or flashes slowly for a few seconds

This occurs when there is a temporary loss of communications. An occasional temporary loss of communications is quite normal and does not interfere with normal operation of the system.

Please refer to **'Communications and ACM Indications'** in the System Status Indications section on page 84.

ACM LED flashes quickly for a few seconds or more

This indicates that the radio channel has changed, and the signal controllers are re- connecting with the master controller. This is quite normal at start-up after pressing RUN and may also occur during operation following a loss of communications. Generally it completes in 6 seconds but may take longer if not successfully on the first attempt.

However if this continues for 40 seconds or more then please refer to **'Phase and/or Communications Failure'** in the Troubleshooting section on page 97.

ACM LED flashes quickly at frequent or regular intervals

Frequent or regular changes in radio channel may indicate a problem with site deployment that might be caused by any of the following:

- Check that the distances between master and signals are within the normal operating range and not obstructed in some way (e.g. by buildings).
- Check for any damage may have affected the performance of the radio system (such as the antenna).
- Consider potential sources of radio interference operating within the 458.5 to 459.0 MHz frequency band. In particular, are walkie-talkies being used on the site in very close proximity to the signals (less than 10m). Request walkie-talkie users to stand further away from the lights.

Press the **SELECT** button to check the runtime diagnostic information display for the message success rate for each connected signal. This needs to be consistently better than 70% to be reliable. Try moving the master controller or any signal that has a poor signal. Even moving by a few meters can make a difference.

If the cause cannot be identified or easily resolved, then please call TGS Service.

Connectivity Issues with UTC or TMdesk

Radar Function

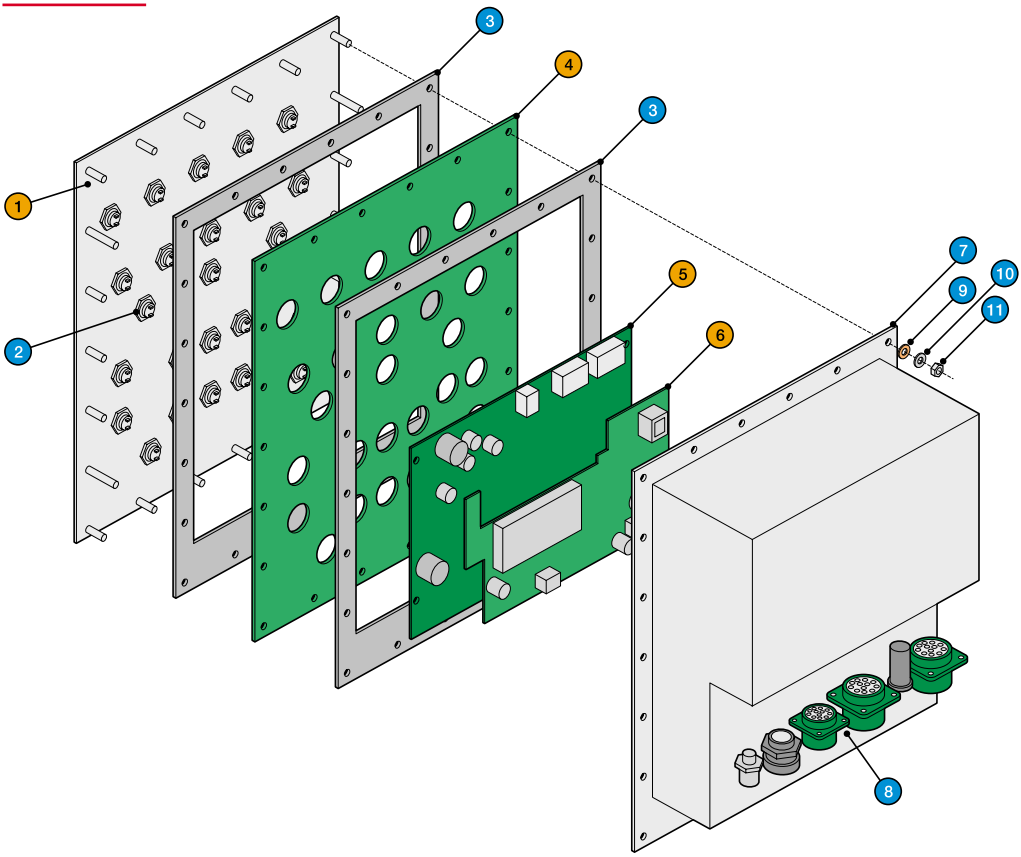
The function of the radar is not monitored by the controller but is indicated on the Demand LED for the phase when in VA, AutoGreen & Crossing modes.

The radar should not be adversely affected by proximity to high voltage power lines or railway or weather conditions. The radar is self-checking and if it fails it will fail-safe to continuous demand. When disconnected the radar input also fails to continuous demand.

The radar also has an integral LED which provides visual indication of detection and confirm that it is functional. The function of the radar can usually be checked by doing a walk test (walk 4 or 5 fast paces towards the radar from the front).

End Of Life – Disposal Instructions (EOL)

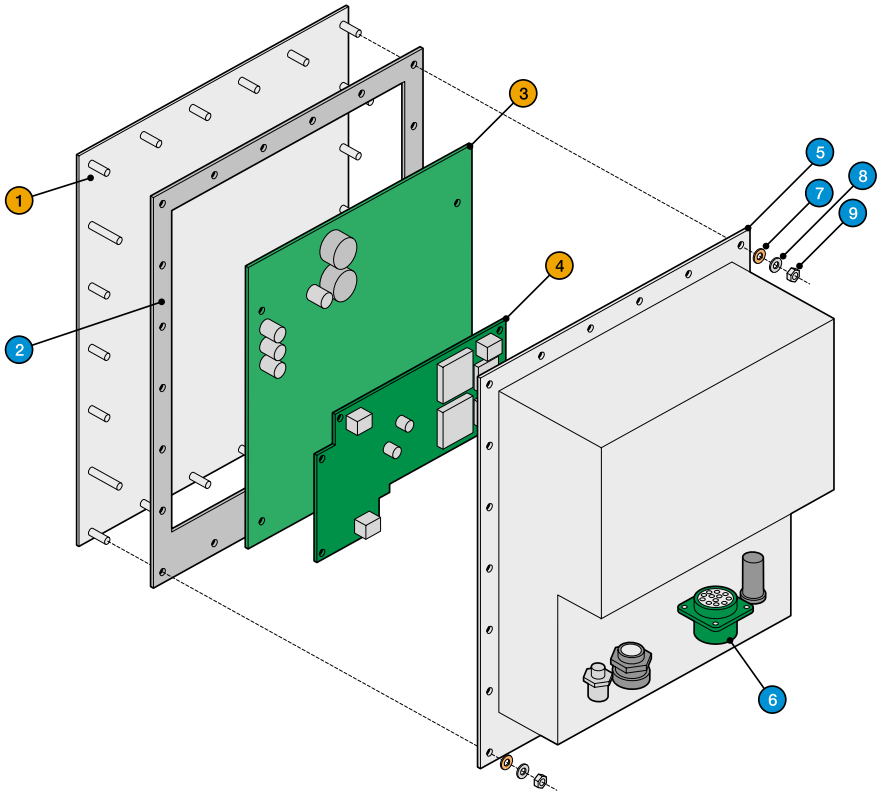
Metro Master Controller



Item	Qty	Item	Material	Action
1	1	Fascia	Aluminium with vinyl cover, switches & stainless steel bolts	**Separate and recycle**
2	1	Waterproof seal	Neoprene	**Reuse/recycle**
3	1	Main controller board	FR-4 glass epoxy with electronic components (may also include Lithium battery x 1)	**Separate and recycle**
4	1	Communications board	FR-4 glass epoxy with electronic components	**Separate and recycle**
5	1	Rear cover	Mild steel sheet	**Reuse/recycle**
6	4	Connectors & fuse holder	Mixed metals and plastic	**Reuse/recycle**
7	22	Fibre washer	Glass fibre	**Reuse/recycle**
8	22	Washer	Steel	**Reuse/recycle**
9	22	Nyloc nut	Steel	**Reuse/recycle**

End Of Life – Disposal Instructions (EOL)

Metro Signal Controller



Item	Qty	Item	Material	Action
1	1	Fascia	Aluminium with vinyl cover & stainless steel bolts	Separate and recycle
2	27	Push button	Mixed metals and plastic	Reuse/recycle
3	2	Waterproof seal	Neoprene	Reuse/recycle
4	1	Front panel assembly	FR-4 glass epoxy with electronic components	Separate and recycle
5	1	Main controller board	FR-4 glass epoxy with electronic components	Separate and recycle
6	1	Communications board	FR-4 glass epoxy with electronic components	Separate and recycle
7	1	Rear cover	Stainless steel	Reuse/recycle
8	6	Connectors & fuse holder	Mixed metals and plastic	Reuse/recycle
9	22	Fibre washer	Glass fibre	Reuse/recycle
10	22	Washer	Stainless steel	Reuse/recycle
11	22	Nyloc nut	Stainless steel	Reuse/recycle

Safety Precautions

It is important that the products concerned should be installed and maintained by competent persons in accordance with good engineering practice, statutory requirements and codes of practice.

In cases of special junction applications the permission of the appropriate authority must be sought.

It is necessary to utilise batteries within the systems covered by this Manual that involves a need for managed handling, usage and disposal techniques to ensure the safety of operatives and care of the environment.

All work must be performed in accordance with company working practices, in-line with adequate risk assessments. Only skilled and instructed persons should carry out work with the product.

Attention is drawn to the following;

1. This system is compliant to the Restriction of Hazardous Substances (RoHS - European Union directive 2011/65/EU).

2. No user-maintainable parts are contained within the product. Removing or opening the outer casing is deemed dangerous and will void all warranties.

3. Under no circumstances should a product suspected of damage be used. Damage may be suggested by unusual behaviour, an unusual odour or damage to any of the outer enclosures of the system. Please contact Traffic Group Signals Limited for further advice.

4. 'Control of lead at Work Regulations 2002' The Approved Code of Practice for the Control of Lead at Work' from the Health and Safety Commission.

5. Storage batteries are classed as hazardous and therefore must be stored, transported, managed and disposed of in accordance with the following pieces of legislation and guidance.

Environmental Protection Act 1990, Part II 2.

Environmental Protection (Duty of Care) Regulations 2014

The Waste Management Licensing Regulations 1994

The Controlled Waste (Registration of carriers and seizure of vehicles) Regulations 2012

Hazardous Waste Regulations 2011 and List of waste regulations 2011

The Carriage of Dangerous Goods by Road Regulations 2009

HSE - Using Electric Storage Batteries Safely; https://www.hse.gov.uk/pubns/indg139.pdf

Radio Equipment Directive (2014/53/EU)

BE	BG	CZ	DK	DE	EE	IE	EL	ES	
FR	HR	IT	CY	LV	LT	LU	HU	MT	
NL	AT	PL	PT	RO	SI	SK	FI	SE	UK

6. Guidance for the correct deployment of signals and the associated signage can be found in; Traffic Signs Manual Chapter 8: Traffic Safety Measures and Signs for Road Works and Temporary Situations and Chapter 6: Traffic Control.

7. Advice and Guidance contained in DfT Portable Traffic Signal for the Control of Vehicular Traffic and TAL 3/11 Signal-Controlled Pedestrian Facilities at Portable Traffic Signals.

8. This product contains a Radio Communications system which operates at 458MHz and can only be operated in the UK.

System Safety Integrity

Hardware

Every signal in the scheme is assigned its own controller which performs the safety monitoring of the signal. This includes the red lamp monitoring as well as the battery voltage and radio comms integrity.

Each individual controller has a double processor architecture with a safety heartbeat. Should either processor in any controller loose system interlock then a safety fault is immediately generated.

Communications

The Metro system uses ACM radio comms technology. The system monitors the radio packet completion rate on every signal and is agile to always select the clearest radio channel to operate on. If the radio comms are significantly compromised and a clear channel cannot be self-selected or the quality of the comms falls below a pre-determined safe level then a safety fault is immediately generated.

Scheme Design

Schemes are designed on the Signal Studio software platform. The scheme tool is integrates with the functionality of the signals in the scheme being deployed. At the design stage only those signalling functions which the signals are capable of are able to be incorporated into the design. The Signal Studio scheme design tool is equipped with many warnings and built-in guidance to avoid potentially unsafe designs at the concept stage. The designs

The design is fully simulated and adjusted for optimal signal performance and safety before sign-off.

Factory Acceptance Testing (FAT)

After the scheme has been designed and checked it is them implemented in the main system controller at the Depot. The whole signalling system is then assembled in the depot and functionally checked against the design as part of a full FAT. In many instances where the scheme is part of a UTC implementation the Local Authority can take control of the whole functional signalling system within the depot with their UTC system over VPN as if it were street deployed and sign off the FAT.

Site Acceptance Testing (SAT)

The Signal Studio scheme tool provides a comprehensive site deployment plan for setting up the site. When satisfactorily deployed the site can be initiated and functionally tested in ‘lamps out’ mode. This is in so all the comms and functional operations and sequencing can be checked before the systems is set to run. When this is satisfactorily passed the system can go through its standard signal start-up routine so signal control of traffic can commence.

Operational Monitoring

Whilst the system is operational, remote diagnostic monitoring is available depending on the complexity of the system deployed. All systems will have remote TMdesk basic access where battery levels and other monitoring is available. For more complex sites which run staging TMdesk pro is available for remote monitoring and site management. This enables high levels of monitoring and alerts so the site can be safely managed.

Warranty

Evo controllers are guaranteed against failure subject to fair wear and tear, correct operation and return to our works carriage paid. We undertake to repair or replace this equipment free of charge providing:

- It has been maintained in good condition and operated with due care, and
- Any failures are directly traceable to faulty material or workmanship.

The following warranty periods apply:

LED Aspects (Vehicle and Pedestrian)	**3 years****
LED Wait Indicators	**3 years**
Metro Controllers	**3 years**
AGD Radars	**2 years**

Chargers and all other components 1 year.

Batteries are excluded from this warranty provision.

However, we cannot entertain any claims for labour or other expenditure in connection therewith. Items or components subject to another manufacturer's guarantee are subject to the terms of that guarantee only.

Any warranty given is void if seals on equipment are subsequently found to have been broken without prior permission by Traffic Group Signals Limited.

Any item of equipment repaired by Traffic Group Signals Limited is guaranteed from failure for three months from the date of repair, provided that the item has been subjected to fair usage and regular maintenance.

Please refer to our Terms and Conditions of Sale for further details on warranty provision.

**See special warranty provision regarding failure of individual LED's within a signal aspect.

Disclaimer

While we **(Traffic Group Signals Limited)** endeavour to keep the information in this manual correct at the time of print, we make no representations or warranties of any kind, express or implied, about the completeness, accuracy, reliability, suitability or availability with respect to the information, products, services, or related graphics contained herein for any purpose.

Any reliance you place on such information is therefore strictly at your own risk. In no event will we be liable for any loss or damage including without limitation, indirect or consequential loss or damage, or any loss or damage whatsoever arising from loss of data or profits arising out of, or in connection with, the use of this manual.

This product has been designed, developed and extensively tested as required to ensure its safety and reliability in service. It should be deployed and operated at all times in accordance with the User Manual and all current portable traffic signalling guidance by suitably trained personnel only. Training should cover both the general concepts of portable traffic signalling and the operation of this product itself.

In particular, your attention is drawn to the following:

- **An Introduction to the Use of Portable Vehicular Signals (The Pink Book)**
- **TAL 2/11 & TAL 3/11**
- **Safety at Street Works and Road Works – A code of Practice (The Red Book)**
- **Traffic Signs Manual Chapter 8 and Chapter 6**

Training should be periodically refreshed. It shall be drawn to the operator's attention that with incorrect deployment and / or configuration, this product has the potential to create unsafe traffic conditions.

In the unlikely event that the unit suffers a failure or in any other way performs in a manner that is deemed to be unexpected or potentially incorrect by the operator, all lights at the site in question should be powered off. No attempt to operate the system should be made until such time as the system has been inspected by suitably qualified service personnel.

Certification

Declaration of Conformity

TRAFFIC GROUP SIGNALS

Traffic Group Signals Ltd
White Lion House, Gloucester Road
Cheltenham, GL51 0TF
T: 0345 460 9699
E: info@trafficgroupsignals.com
trafficgroupsignals.com

Certificate No: CE-002 Issue: 1

We Traffic Group Signals Ltd
White Lion House
Gloucester Road
Staverton
Cheltenham
Gloucestershire
GL51 0TF
UNITED KINGDOM

declare that the DoC is issued under our sole responsibility and belongs to the following products:(s)

Equipment Model Type(s): Metro System

Equipment Description: Temporary Traffic Signal

Conform with the relevant UK Statutory Instruments (and their amendments):
The Radio Equipment Regulations 2017 (SI2017/1206)

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (SI 2012/3032)

and that the following standards have been applied:

EMC EN 50293:2012
EN 301 489-51 v2.1.0
EN 301 489-1 V2.1.1
EN 301 489-3 V2.1.1

Safety EN 62368-1:2014/AC:2015
EN 60950-22:2006
EN 50556:2011
EM 62479:2010

Spectrum EN 300 220-2 V3.1.1
EN 300 440 V2.2.1

ROHS EN IEC 63000:2018

Signed ..... Dated: Monday 11th April 2022

For and on behalf of Traffic Group Signals Ltd
P M Hutchinson Managing Director

Registered in England and Wales • No. 04552828 • GB 125 4646 19

Declaration of Conformity

TRAFFIC GROUP SIGNALS

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For and on behalf of Traffic Group Signals Ltd
P M Hutchinson Managing Director

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Notes

M1 Junction 15 at Northampton

4 month duration: Feb 2022

43 signals

10 stages

Remotely monitored and managed

Highlights

Multiple scheme designs to facilitate changing works throughout project duration

Site remained standing during highest ever recorded wind speed in England during storm Eunice.


WHEN RED
LIGHT SHOWS
WAIT HERE

Metro

For more information

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or visit **web**: trafficgroupsignals.com

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