MICROSTART Generator Controller

USING MICROSTART

This document gives a brief guide to using Microstart once it has been correctly installed and set up (see our leaflets 'Installation and Connection' and 'Programming'). Further technical assistance on how to operate Microstart is also available direct from Modex on the numbers below.

INTRODUCTION - FRONT FACIA CONTROLS

The main features of Microstart's facia (see diagram opposite) are as follows:

① Operating mode keyswitch

A three position keyswitch, used to select Microstart's operating mode:-

O (OFF/RESET) — Resets all functions. The generator will not respond to any external stimulus (see 'operation in off mode' below).

(MANUAL) — Puts the generator under the manual control of operator (see 'operation in manual mode' below).

(AUTO) — Puts the generator on standby, ready to automatically start in response to a mains failure or 'remote start' condition (see 'operation in auto mode' below). A 'system test' function is also available in this mode.

Amber and green LEDs around the keyswitch respectively indicate when Manual or Auto modes are selected. Turning the key from Off to either Manual or Auto positions initiates an automatic, three second lamp test cycle, after which operation returns to normal. Microstart's key is removable in the Off and Auto positions only, and is common to all units (each key can be used in any Microstart).

② The display

During normal operation, the 2 line by 20 character, back-lit liquid crystal display (LCD) gives information to the operator about the current system status, e.g. operating mode, generator status, fault information, remaining time delays and measured values, e.g.:

```
AUTO: gen. on load
Gen freq 50 Hz.   ↑↓
```

The above is a typical default message, but the operator can also bring up further information about the system status by use of.....

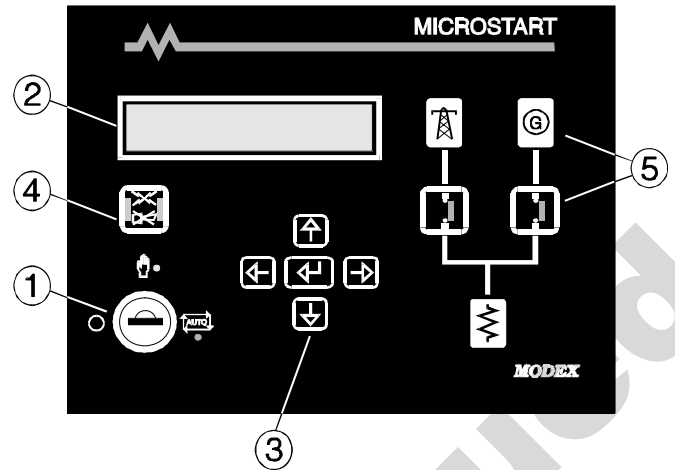#### ③ The Cursor Keys (⬆ ⬇ ⬅ ➡ and ⏎)

In normal operation, pressing the ⬆ or ⬇ cursor keys causes the display to step through additional information about the current plant status, including 3 phase generator voltage and frequency, 3 phase mains voltage and frequency, hours run, battery voltage, event input status (see 'displaying further information' below for further details).

In Auto mode, when mains is healthy, the ⏎ button may be used to initiate a 'system test' (see separate section below).

The cursor keys and display are also used in the setting of Microstart's programmable functions. This should already have been completed before commissioning of the generator. (If further information about programming is required, please refer to our separate literature.)

④ Klaxon mute button

The operator may use this button to silence the klaxon after a fault has been signalled. When Microstart detects a fault, the button's two red LEDs initially flash on and off; after the button is

pressed, the LEDs remains continuously lit until either the fault clears or Microstart is reset (see 'responding to faults' below). Pressing this button does not in any way affect the displayed fault message (which remains on the screen).

⑤ Contactor control

The right hand half of Microstart's front facia is dedicated to the status and load control of the mains and generator supplies.

Two lamps - 📶 and ⓖ - respectively indicate when mains and generator supplies are operating within their pre-programmed limits (i.e. available for use). Below each of these lamps is a contactor control button, each with its own green LED. The LEDs work in both auto and manual modes, lighting whenever the respective contactor is engaged. The push buttons only work in manual mode, when they may be used to carry out manual load transfers (see 'operation in manual mode' below).

OPERATION IN AUTO MODE

In Auto mode, Microstart puts the generator on 'standby', ready to automatically respond to a mains fail or 'remote start' command.

If Microstart detects either of these conditions, it attempts to start the generator and put it on load. Then, once mains has fully returned to a healthy state, or if a 'remote start' is no longer signalled, it transfers the load back to the mains and returns the generator to 'standby'. The generator operation should therefore be totally automatic; the operator should only need to intervene in the event of a fault (see 'responding to faults below').

During this automatic cycle, the display gives continuous information about the current system status. A typical 'mains fail' display sequence is:

```
AUTO: mains healthy
                 ↑↓ ⏎
```
Mains O.K. and on load; generator stationary and on standby.

```
AUTO: Mains healthy
MF latency   x Sec   ↑↓
```
Mains voltage below limits, but not considered as failed until the end of the mains fail latency time (x seconds remaining). Microstart attempts to keep mains on load (although the contactor may have dropped out due to lack of volts).

```
AUTO: Mains failure
Start delay   x Sec   ↑↓
```
Mains now considered as failed and off load. Microstart waiting for the end of the start delay (x seconds to go) before attempting a generator start. The unit will return to 'standby' if mains returns during this time.

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AUTO: Start Attempt 1
Preheat   x Sec

The generator is now committed to start; the engine is being pre-heated (x seconds to go). During the last few seconds of preheating, the display flashes and the klaxon sounds to warn of....

AUTO: Start Attempt 1
Cranking   x Sec

...engine cranking. Starter stays on until the engine fires or until the end of the maximum crank time (x seconds remaining). If the engine fails to fire at the first attempt, Microstart waits for a 'crank cool' time, followed by subsequent preheat/crank/cool cycles until it either fires or is   shut down indicating 'start fail'.

AUTO: engine running
Warmup   xx Sec   ↑↓

Engine running, but Microstart awaiting the 'warm-up' time to expire (xx secs remaining) before putting the generator on load.

AUTO: Gen on-load
Gen freq 50.0Hz   ↑↓

Mains still failed; generator now running normally on load.

AUTO: Mains healthy
Restoration   x:yy:zz

Mains returned, but generator remains on load until restoration delay expires (x hrs, yy mins,   zz secs to go). The restoration timer resets if mains fails again.

AUTO: Engine running
Contactor   x Sec   ↑↓

The generator is now off load; mains will come on load in x secs.

AUTO: Engine Running
Eng cooling   x:yy:zz

Mains healthy and now back on load. Generator running off load, x hrs. yy mins zz secs before generator returns to.....

| |
|---|
| AUTO: Mains healthy |
| ↑↓ ↵ |

.....standby mode.

Although Microstart is designed to display the most relevant and highest priority messages, the operator can bring up additional information on the display by the simple use of the cursor keys (see 'displaying more information' below). Besides the displayed information, the condition and status of the mains and generator supplies is always shown on the two 'source within limits' lamps and the two 'contactor engaged' LEDs at the right of the front facia.

Note: in Auto mode, Microstart does not permit any manual control of the generator or contactors; it simply ignores any press of the front facia contactor control buttons or manual mode start and stop buttons. (The *manual* stop button should not be confused with any *emergency* stop buttons; pressing the latter will <u>always</u> shut down the generator.)

System Test

When Microstart is in Auto mode and on standby (i.e. mains healthy and generator stopped), the operator is able to carry out a 'system test'. Once initiated, a system test is designed to start up, run, and shut down the generator in a simulation of a mains failure.

According to how Microstart has been programmed, the test either includes a load transfer to the generator (exactly simulating a mains failure) or excludes a load transfer (when only the start up of the generator needs to be tested and it is preferable that the load stays connected to the mains supply).

To start a system test, press and hold (for about 1 second) the ↵ key. The display should then read:

SYS TEST - enter PIN
XXXX ←↑↓→↵

As a measure to prevent a test being carried out by unauthorised personnel, the operator must then enter the correct personal identification number (PIN) before Microstart will continue further.

The PIN is likely to be have been pre-programmed by the generator manufacturer, and should have been given to   the authorised generator operator(s) at commissioning.

To enter the PIN, use ← and → to select each of the four   digits in turn (this is initially displayed as <u>X</u>XXX; the selected   digit is indicated by an underlining cursor) and ↑ and ↓ to   alter the value of each digit (to 1, 2, 3, etc.). When the correct number is displayed, press ↵ .

If the wrong PIN is entered, Microstart displays 'INCORRECT PIN ACCESS DENIED' before reverting after a few seconds to normal Auto mode operation. If the correct PIN is entered, the system test begins immediately. Other than observing the test, no further action need then be taken by the operator (once Microstart has completed the test, it automatically reverts to 'standby' mode).

During a system test, the display gives similar messages to those that occur during a mains fail, except that 'TEST' is displayed in the top left hand corner instead of 'AUTO'. Note: if at any time the mains fails, or a 'remote start' is signalled, Microstart abandons the system test and reverts to normal auto mode operation.

OPERATION IN MANUAL MODE 🖑

In this mode, the starting, stopping and load transfer of the generator are largely under the operator's manual control. There are two possible exceptions to this. Microstart may have been pre-programmed so that:-

a) <u>no</u> manual load transfers are permitted (the contactor control buttons detailed below are disabled), and/or

b) manual control of the generator is overridden during a mains failure (see separate section below).

Appropriate automatic action may also be taken (e.g. taking the generator off load, or shutting it down) if Microstart detects a fault, just as for Auto mode (see 'responding to faults' below).

Starting and Stopping the Generator

According to the generator requirements and panel wiring design, Microstart pins 46 and 47 may be wired to give one of two types of manual start and stop control.

If remote START and STOP push button switches are fitted to these terminals, Microstart is initially switched to 🖑 to select manual mode, whereupon control of the engine starting and stopping passes to the remote switches. Note: once the start button is pressed, it need not be held in or re-pressed; once   the operator initiates a start, Microstart attempts to start the generator automatically, as for Auto mode (e.g. 3 attempts,   each with 10 second crank/dwell times).

Alternatively, pins 46 and 47 may be hard wired to battery negative, in which case the generator starts up as soon as the key is turned to 🖑, and stops as soon as it is turned away from 🖑. Note that if Microstart is wired in this way, there must not be   an excessive delay when turning from Auto, through Manual, to Off - the engine could start as a result.

Controlling the Contactors

After a manual start of the generator, there is no warm up time or automatic load transfer (as there is in auto mode). Once the generator is running, the operator may use the contactor control buttons - below the 🎛 and ⊚ lamps - to manually transfer the load between the mains and generator supplies (unless the generator manufacturer has programmed Microstart so that these buttons are disabled, in which case no manual load transfers are then permitted).

<u>To transfer the load from mains to generator</u>, check that the ⊚ lamp is lit (i.e. generator available), then press the generator contactor button (below the ⊚ lamp).

Note: although load transfers are under the operator's control, Microstart still always observes the pre-programmed contactor delay.

Also: if ⊚ is not lit (i.e. the generator is out of limits) when the button is pressed, Microstart ignores the transfer command and the mains stays on load. If ⊚ goes out *after* the button is pressed, Microstart does not attempt to load the generator (and will also

shut down the engine if programmed to do so). If the mains is available, Microstart will automatically re-engage the mains contactor after any remaining contactor delay.

The same applies if the generator is running on load but falls out of limits (e.g. under volts); the generator contactor releases automatically, and the mains is automatically re-loaded if available.

To transfer the load from generator to mains, check that the 🔲 lamp is lit (i.e. mains available), then press the mains contactor button (below the 🔲 lamp).

Note: pressing the mains contactor button always results in the release of the generator contactor, but the mains contactor only engages at the end of the contactor delay if the mains is healthy. If the mains is 'failed' at this time, no attempt is made to engage the contactor. The operator then has the option of either waiting until mains returns (when 🔲 lights), in which case the mains contactor automatically re-engages, or of re-loading the generator by pressing the generator contactor button (the generator must, of course, be within limits, i.e. ⊚ lit).

Mains Fail in Manual Mode

When Microstart senses a mains fail, it always releases the mains contactor, i.e. it acts as a voltage trip, in both Auto and Manual modes. The mains contactor also re-engages automatically if mains returns (subject to any remaining contactor delay), unless the generator is running on load. The subsequent generator response does, however, vary according to how Microstart's 'mains fail in manual' function has been programmed (to either 'yes' or 'no'):-

'no' means that Microstart takes no action and generator control remains with the operator. If the generator is to support the load, the operator must either turn the key to Auto, or manually start the generator if necessary and transfer the load.

'yes' causes Microstart to over-ride manual control, automatically starting the generator if necessary and transferring the load. This automatic over-ride of manual mode is indicated by the text at the top left of the display going from a continuous 'MAN' to a flashing 'AUTO', and the keyswitch LEDs changing from continuous amber to flashing green.

Once the generator is running on load, the operator may then either: a) turn the key to Auto, in which case no further action need be taken - Microstart returns the system to standby after the mains has returned; or b) leave the key in Manual - after a mains return and restoration delay, Microstart returns to normal Manual mode (note that the amber LED comes back on) and the generator continues to run on load until the operator carries out a manual transfer and shutdown.

Note: while Microstart is overriding manual control (while the green LED is flashing), the operator can neither perform manual load transfers, nor halt the generator using the manual mode stop switch.

A 'remote start' condition does not override manual control of the generator.

OPERATION IN OFF/RESET MODE (O)

When the key is turned to O (Off), all faults are reset, none of the front facia controls or indicators operate, and Microstart does not respond to any external stimulus (the generator will not start under any circumstances). Only two outputs are active:

a) The Off output, which can be used to remotely reset other equipment from Microstart.

b) The mains contactor output. When turned Off, Microstart's contactor control defaults to the mains contactor and the pre-programmed mains trip limits do not operate. On versions for use with DC coiled contactors, the mains contactor is held in by normally closed, electro-mechanical relay contacts. On AC coiled contactor versions, a solid state relay output is switched on (in an attempt to keep the mains on load) as long as the mains voltage remains above about 80 Vac. Although the output switches off below this voltage level, the mains contactor is likely to have already dropped out as a result of the low voltage on its coil.

DISPLAYING MORE INFORMATION

During Auto and Manual modes, the display is designed to default to the most relevant and highest priority messages. The operator can, however, bring up additional system status information on the display simply by pressing the ⬆ or ⬇ cursor keys. Pressing these keys does not affect the operation of generator in any way.

There are 5, sometimes 6, information 'screens':

```
Mains: Freq 50.0 Hz
r240V y240V b 00V   ↑↓
```
Displays mains frequency on the top line (to 0.1 Hz. resolution) and mains phase to neutral voltages on the lower line (to 1V resolution, with red, yellow and blue phases displayed left to right - the example shows blue phase as failed).

```
AUTO: gen on-load
Events: 00000101   ↑↓
```
The system status is shown on the top line. The lower line shows the state of the event inputs: events 1 - 8 are represented left to right by '1' (indicating a fault is present) or '0' (indicating an inactive channel). The example shows active channels 6 and 8. This screen can be useful when multiple alert faults occur (see 'responding to faults' below).

```
AUTO: gen on-load
Hours run 00000   ↑↓
```
The lower line displays the number of hours the generator has run with this Microstart.

```
AUTO: gen on-load
Eng speed 1500rpm  ↑↓
```
This screen is only displayed when a magnetic pickup is fitted. The lower line gives engine speed in RPM (10 RPM resolution).

```
AUTO: gen on-load
Battery 13.2V      ↑↓
```
Lower line displays battery voltage.

```
Gen: Freq 50.0 Hz
r240V y240V b240V  ↑↓
```
Generator frequency and 3 phase, line to neutral voltages (format and resolutions are as for the mains parameters screen).

Once any of the above screens has been selected, the information remains displayed for a minimum of 30 seconds. If the cursor keys are left untouched over this period, the display reverts to a default status message. If, however, the operator needs to monitor a parameter for longer than 30 seconds, pressing ⬅ or ➡ causes the information to be held indefinitely on the display until either ⬆ or ⬇ is pressed again or a higher priority message occurs (e.g. if a fault occurs).

RESPONDING TO FAULTS

Microstart has a comprehensive system for the monitoring of generator faults, for alerting the operator, and for taking appropriate automatic action where required (e.g. taking the generator off load, or shutting it down entirely).

The system includes:

8 event inputs	monitoring remote switch sensors or fault contacts, e.g. oil pressure, engine temperature, earth fault, etc.
charge fail	two circuits for monitoring both mains battery charger and charge alternator.
generator measured values	monitoring for generator under and over voltage, frequency and speed.
emergency stop	activated by remote push-to-break switches.
'intelligent' alarms	Microstart can detect inconsistencies between the expected plant state and the actual state as measured through its inputs, e.g. start fail, mag. pickup failure, contactor failed to engage, generator stopped for no reason, etc.
self-diagnostic alarms	Microstart has a self diagnostic system for the detection of internal faults.

Microstart's response to faults is generally the same in both Auto and Manual modes. If a fault occurs, the operator is usually signalled by use of an audible alarm driven from Microstart's klaxon output. On arriving at the generator panel, the operator should see a fault message displayed on Microstart's screen, and two, red, flashing LEDs in the klaxon mute button. The klaxon can be silenced by pressing this button, without in any way affecting the displayed message or clearing the fault. (Note that when the button is pressed, its LEDs go from flashing to continuous.) DO NOT TURN THE KEY TO OFF AT THIS INITIAL STAGE.

After pressing the button, the operator's response to the fault message will depend on the type of fault. Microstart generally classifies faults into one of three types: 'alert', 'alarm' and 'other'.

Some faults are always of a specific type (e.g. an engine overspeed is always treated as an 'alarm' fault); some faults are programmable (e.g. the event inputs may have been programmed to 'alarm' or 'alert', according to the generator manufacture's preference).

'Alert' faults

These are designed to warn the operator that some action - usually preventative - is required, e.g. low fuel, low coolant, charge failure. Because such faults do not generally result in plant damage, Microstart does not instigate a generator shut down or prevent it from starting. Also, these faults may be sensed at any time, regardless of whether the generator is running or not.

An alert fault condition is non-latching and the displayed message therefore clears as soon as the operator has investigated and corrected the problem (e.g. when the fuel is topped up). If several alert faults occur at once, Microstart has a system for prioritising the messages (lowest channel number has highest priority); as each fault is cleared, the next highest priority fault is displayed.

Typical alert type fault messages are:

An event fault sensor has been triggered (the 8 event inputs can be individually programmed to 'alert' or 'alarm').

```
AUTO: gen on-load
LOW FUEL LEVEL
```

Warning that there is a battery charging fault, either with the charge alternator (if the engine is running), or with the battery charger (if the engine is stationary).

```
AUTO: gen on-load
CHARGE FAILURE
```

Warning that there is a magnetic pickup failure. If this occurs, Microstart automatically switches to sensing speed from the main alternator output while the fault is investigated.

```
AUTO: gen on-load
MAG PICKUP FAILURE
```

Note that during an alert fault, the ⬆ and ⬇ keys can still be used to display other information about the system status as detailed in 'displaying more information' above. The 'event status' screen can be particularly useful when multiple alert event faults occur.

'Alarm' faults

This type of fault results in the automatic and immediate shut down and latching out of the generator (e.g. during an engine low oil pressure fault). All but one of these faults are only monitored by Microstart while the generator is running; the exception is 'emergency stop', which can be triggered at any time.

Whenever Microstart shuts down the generator, the generator contactor is always automatically released. Once Microstart is in the shutdown state, it will automatically engage or release the mains contactor according to whether mains is within limits or not. The operator is then able to further investigate the cause of the fault - the displayed fault message is the obvious starting point, some typical examples of which are:

```
ENGINE HALTED      ↑
↓
FAILED TO START
```

Microstart has not detected an engine start after the programmed maximum number of attempts.

```
ENGINE HALTED      ↑
↓
LOW OIL PRESSURE
```

An event fault sensor has been triggered (the 8 event inputs may be individually programmed to 'alarm' or 'alert').

```
ENGINE HALTED
Emergency Stop !
```

The emergency stop button has been pushed, or there is a fault (open circuit) on this input. To make this function as fail-safe as possible, the circuit has been designed to directly cut off the supply to Microstart's fuel and start relay coils (independently of signalling Microstart's main control circuitry). An emergency stop is different from other alarm type faults in that it can be initiated at any time, regardless of whether the generator is running or not.

```
ENGINE HALTED      ↑
↓
GEN OVER SPEED
```

Microstart has detected an engine overspeed. There are similar messages for over frequency and over voltage faults.

```
ENGINE HALTED      ↑
↓
GEN UNDER VOLTS
```

Microstart has detected an under voltage condition and has been programmed to shut down the generator in this event (there are similar messages for under speed and under frequency).

```
ENGINE HALTED      ↑
↓
CAUSE UNKNOWN
```

Microstart has shut down the generator because it could not detect any generator voltage or speed signal, even though the engine should have been running.

```
SYSTEM FAULT:
NVRAM FAILURE
```

Microstart has shut down the generator after detecting a fault with its own operation (in this case with its own memory, but other types of fault will result in different lower-line messages). Any Microstart with a system fault should be returned to Modex for further investigation.

```
START INHIBITED
Bad plant state
```

The 'bad plant state' alarm is the fault state of last resort, often caused by an inconsistent series of inputs. The example shown can occur if a 'bad oil pressure' fault (see 'other faults' below) does not resolve itself following the time allowed for the preset number of start attempts, or shortly after a generator start if the voltage/ frequency never rises to within the normal operating limits.

After a shut down, the operator can still use the ⬆ or ⬇ keys to step through more plant information on the display. The parameters displayed are the same as those which can be accessed during normal running - generator voltage and frequency, event input states, battery voltage, etc. - but with the difference that the information shown is that which was recorded *just before* the shut-down, rather than the present values. (Note: the exception to this is the mains voltage/frequency screen, which continues to display the present measured values). This historical information may or may not be useful in determining the reason for the shutdown.

Once an alarm fault has been fully investigated, Microstart can only be unlatched from its shut-down state by turning to O (off/reset). The key should only then be turned back to Auto or Manual once the cause of fault has been rectified and the generator is ready for normal operation.

'Other' faults

Microstart has several other fault conditions that cannot be readily classified as 'alarm' or 'alert'. Most of these are attempts to give an 'intelligent' response when Microstart senses an inconsistency between the expected state of the plant and the actual state as measured through its inputs.

For instance:

Microstart has detected a generator under voltage, under frequency or underspeed, and has been programmed to simply release (or 'dump') the load rather than shut down the set. The klaxon does not sound, and Microstart automatically re-loads the mains if it is available. In Manual mode, the generator continues to run off load; in Auto mode, the set is automatically returned to standby after a short period.
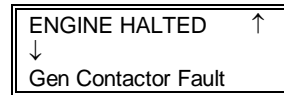
Just before attempting to preheat and crank the engine, Microstart checks the state of the engine oil pressure. If it senses that oil pressure is good, then there is a problem: either the sensor or wiring is faulty, or the engine is already running, or Microstart has been incorrectly programmed for the type of sensor and wiring polarity used.

While this state exists, the start attempt is inhibited (the fuel, preheat and starter outputs stay off). The klaxon is not immediately sounded. If the unit is in Auto mode and the mains does not return, and the fault does not correct itself within a certain period (determined by the pre-programmed number and length of the start attempts) Microstart eventually shuts down the generator on a 'bad plant state' alarm.

A command has been given to start the engine (e.g. by pushing the manual mode start button), but Microstart senses that the engine is still running. In this event, the start command is simply ignored (the fuel, preheat and start outputs are not activated). The klaxon does not sound in this situation.

Microstart has detected that a contactor (in this case the generator contactor, but there is a similar message for the mains contactor) is not in the state that Microstart expects (Microstart monitors this through two inputs connected to the contactors' auxiliary contacts).

All contactor faults are initially treated as 'alerts' (the klaxon sounds to warn the operator), but Microstart's subsequent response will vary according to when the fault occurs (see our full manual for further details). If, for instance, the generator contactor fails to engage after an automatic generator start, Microstart *initially* treats the fault as an 'alert', but after a short delay will shut down the generator and indicate....

```
ENGINE HALTED        ↑
↓
Gen Contactor Fault
```

...following which the mains contactor is free to re-engage as and when mains returns.

MAINTENANCE

The correct operation of Microstart and the generator should be regularly tested by using the 'system test' function as detailed above, or as recommended by the generator manufacturer. The unit itself should be kept free from any ingress of moisture or build up of dust (remove with a dry lint-free cloth), but is otherwise designed to be largely maintenance free.

The only user-serviceable component within Microstart it its internal Ni-Cd battery. This is located in a small removable case at the rear of the unit as shown right. The battery has an estimated service life of several years, but may be visually checked at more regular intervals for signs of leakage or damage, and replaced if necessary. IMPORTANT: replace only with a PP3 sized, pre-charged Ni-Cd battery, and observe the correct polarity.

(For information: the Ni-Cd battery is used as a temporary power supply backup during engine cranking, when the main generator battery voltage can dip to below Microstart's minimum steady state operating voltage. Any fault with the battery is therefore likely to manifest itself as some erroneous operation of Microstart or generator during cranking, e.g. the starter may not stay engaged for the full programmed time, or the front facia LEDs/lamps may dim. In normal operation, the battery is automatically kept at full charge whenever Microstart's DC supply is connected.)
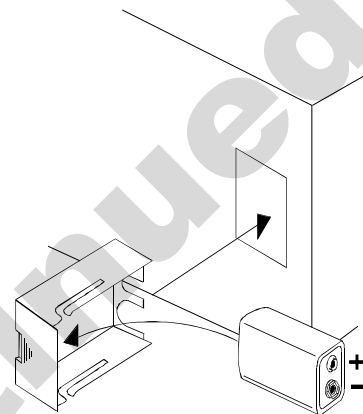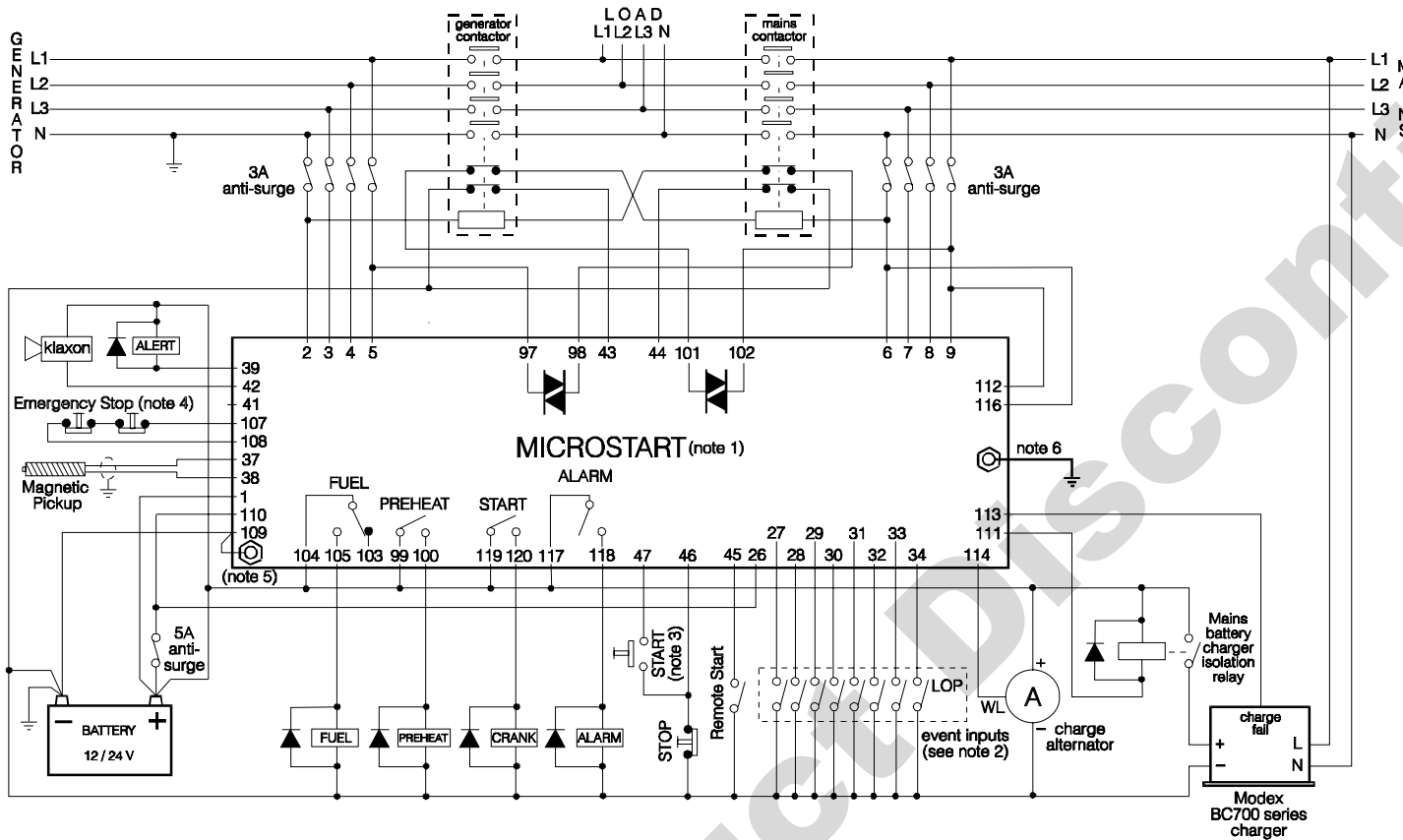
Aside from the battery, Microstart contains no user-serviceable parts. No attempt should therefore be made to dismantle or repair the unit; such attempts can cause irreparable damage to Microstart and will invalidate any warranty. In the event of a generator operating fault, always consult the generator/panel manufacturer before attempting to remove Microstart.

```
AUTO: Engine running
GEN OUT OF LIMITS
```

```
START INHIBITED
BAD OIL PRESSURE
```

```
START INHIBITED
ENGINE NOT
STOPPED
```

```
AUTO: engine running
Gen Contactor Fault
```

MICROSTART - Typical Connection Circuit

Product Specification Summary

Supply:	
Operating voltage range	9 - 40 V DC continuous, will withstand voltage dips to 5 V DC for 1 second without erroneous operation
Typical current consumption	500mA at 12V DC, 300mA at 24V DC
Inputs:	
DC inputs (events, remote start)	
Positive input range	80% to 100% of battery +ve
Negative input range	-1V to +2V w.r.t. GND terminal
Mains and generator AC:	
maximum input voltage	300 V AC rms or 425 V peak
input isolation	1kV DC
frequency range	20 - 99 Hz.
Magnetic pickup:	
operating range	10 - 80 V AC rms
frequency range	625 to 21000 Hz. (i.e. suitable for nominal engine speeds of 750 to 3600 RPM, with 50 to 350 flywheel teeth).
Outputs:	*(all ratings are continuous maximums, for resistive loads)*
Start, preheat & alarm relays	SPNO, 16A @ 24V DC
Fuel relay	SPCO, 16A @ 24V DC
Mains and generator contactor control	
AC version (solid state relays)	3A @ 240 V AC
DC version (electromech. relays)	SPNC (mains) and SPNO (gen.) contacts, 16A @ 24 V DC
Klaxon, OFF, alert and charge control	open collector (active low), 250mA max. @ 33 V DC
General:	
Ambient temperature: operating	0 to +50 °C
storage	-20 to +70 °C
Vibration	5 G, 10 Hz to 150 Hz. (BS2011, pt. 2.1)
Dimensions (W x H x D)	192 x 144 x 225 mm
Panel cut-out (tolerance)	186 (-0.0, +1.1) mm wide 138 (-0.0, +1.0) mm high
Weight	approx. 2.5 Kg

Notes:

1. Microstart MS1A shown (solid state relays controlling AC contactor coils)
2. Event inputs can be individually programmed for sensors which 'close to -ve' DC on fault (as shown), 'open from -ve', 'close to +ve' or 'open from +ve'.
3. Link pins 46 and 47 to battery negative for immediate generator start on selecting manual mode.
4. Link out pins 107 and 108 if emergency stop buttons are not fitted.
5. Rear facia earthing shown for system with AC neutral and -ve DC commoned to earth.
6. Low impedance, high frequency earth. An earth rod and 10mm thick braid is recommended.