M550 & M560

MOTOR PROTECTION RELAY

Figure 1 M550 Motor protection relay

TECHNICAL REFERENCE GUIDE   VOLUME 3.7

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1. Introduction

About this manual

This manual was prepared to aid the engineer in the configuration, setup and implementation of the M550 in electrical systems with easy to understand terms and procedures.

About the M550

The M550 motor protection relay is the most advanced motor protection and motor management relay on the market to date. It is a fully configurable relay and offers true RMS voltage measurement up to 1700Vac phase to phase direct or 33kV with a VT and true RMS current measurements up to 10 000 Amps per phase. Sensitive earth leakage protection measures 30mA to 10A. One or Five amp secondary current transformer inputs are software selectable. The last 1020 events are logged with date and time stamp. Trending (recording of voltage, current measurements and analogue inputs) is available.

About the M560

The M560 motor protection relay, is the same core protection relay as the M550 with the added benefits of advanced data recording.

The M550 offers:

Four true RMS voltage channels;
Four true RMS current channels;
Up to eleven binary NO/NC inputs;
Up to five 4-20mA or 0 – 5V inputs;
Three 4-20mA outputs;
Five voltage free relay contacts;
USB, RS485 or Profibus communication;

The M550 is manufactured to international standards utilizing the best components available. We offer 24/7 toll free technical support, backup service and training.

The M550 has all the following protection functions available.
Accurate true RMS voltage and true RMS current measurement
Over/under voltage protection
Three-phase thermal overload protection (IEC255-8) or definite time trip
Three-phase under current protection with definite time trip
Voltage and current unbalance protection
Phase loss and phase rotation protection
Start-up protection with I²T protection and thermal stress calculation
Sensitive earth leakage protection with definite time trip
Three-phase short circuit protection
Lock rotor protection
Real time clock for event logging with date and time stamp
Cumulative start-up counter with starts per hour protection
Emergency start function
Data logging of all events including Stop, Start, Power up and power down
Trending
Analogue inputs
Analogue outputs

The M550 and M560 differences.

The M550 and M560 offer the same motor protection functionality.

- The M550 has the option of RS485 Modbus or Profibus communication
- The M560 has no real time communication except via USB
- The M550 has a trending option that needs to be configured and connected to a PC to retrieve
- The M560 V2 logs all data in prestart, start and run modes at a 4sample per second rate, directly to a SD card in .csv (comma separated variable) format, that can easily be opened in any spread sheet program (eg Excel)

M550 HMI (human machine interface)

The M550 operates as a user friendly device with real time data available to the operator. All the data is available on the large 160x32 graphic display and all parameters are adjustable via personal computer, handheld infra-red remote control, local network or the local keypad. All the measurements and data are available to the network via USB, MODBUS RTU RS485 or Profibus.
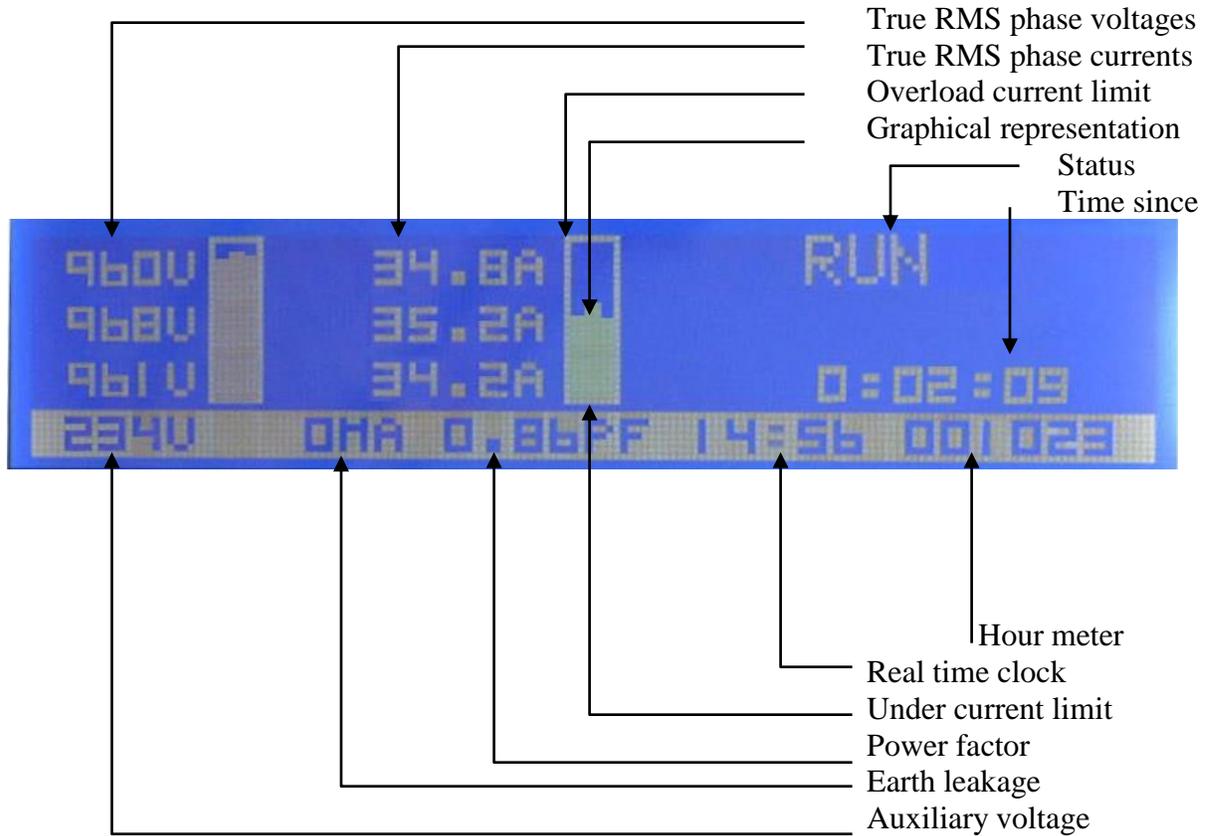
Figure 2 Graphic display lay out

 The easy to use local keypad or handheld infra-red remote control is used to Stop/ Start or navigate through the menu and adjust any of the settings.

Current Display

If the measured current is below 1000A the current is displayed in 0.1A resolution. If the measured current is 1000A or more the current is displayed in 1A resolution. The M550 measures true RMS current by performing full signal analysis. This ensures true current readings even with distorted waveforms.

Start

Stop/Exit

Enter Menu/Scroll up

Decrease Value/Enter history

Increase Value/About (Serial no.)

Save settings

Scroll down/Adjust Date & Time
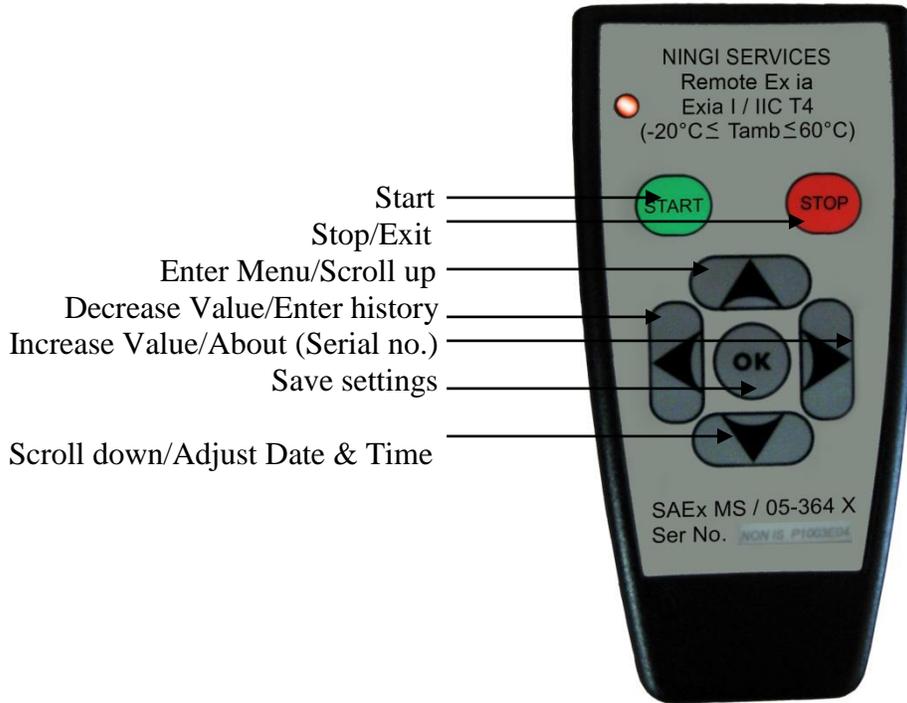
Figure 3 Infra-red remote control

Start

Stop/Exit

Scroll down/Adjust Date & Time

Enter/Scroll up

Save settings

Decrease Value/Enter history

Increase Value/About (Serial no.)
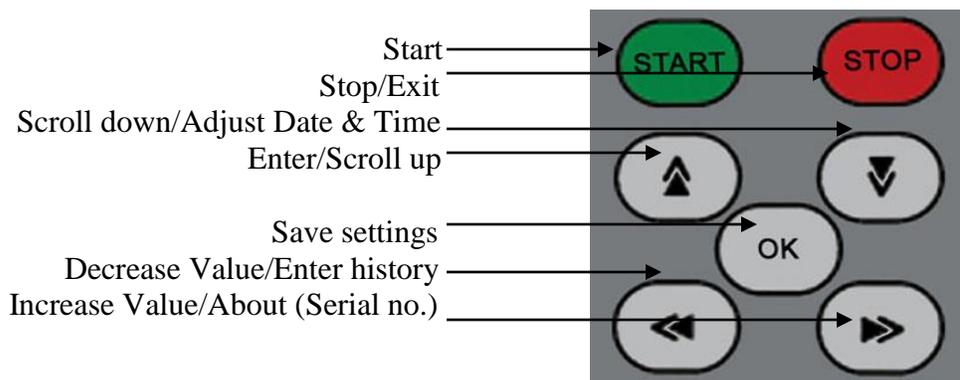
Figure 4 Local keypad on M550

2. Warranty

The M550 carries a one year limited warranty on all parts and labour

3. Safety information

Dangerous voltages can occur on the connectors, even if the auxiliary voltage has been disconnected.

Only a certified electrician is allowed to carry out the electrical installation.
Breaking the seal on the fixing screws of the device will result in loss of warranty.
Electrical safety regulations must always be followed.

4. M550 Configuration

About the configuration

The M550 is a fully configurable motor protection relay. The M550 can be configured with the configuration program **M550Config.exe** (available free of charge www.tech4000.com). The program is a windows based GUI (graphical user interface) program to configure the M550 via USB as required.

With the configuration cleared no inputs, outputs or relays are connected.

The configuration allows the engineer:
THREE INPUTS A, B and C WHICH CAN BE CONFIGURED AS NORMALLY OPEN OR NORMALLY CLOSED INPUTS

FIVE INPUTS WHICH CAN BE CONFIGURED AS 4-20mA INPUTS OR EIGHT DIGITAL INPUTS

THREE OUTPUTS WHICH CAN BE CONFIGURED AS 4-20mA outputs

THE REAL TIME CLOCK WHICH CAN BE CONFIGURED TO START/STOP OR OPERATE ANY RELAY IN REAL TIME

FIVE VOLTAGE FREE CONTACT RELAYS WHICH CAN BE CONFIGURED TO OPERATE FROM ANY INPUT OR MOTOR PROTECTION FUNCTION (LATCH OR MOMENTARY)

BUZZER

Any combination of inputs can be connected to Stop or Start the M550 or operate one or more relays with or without intervention from the motor protection block. The real time clock can be connected to Start or Stop the M550 or operate any relay without intervention from the motor protection block. This leaves the design engineer free to configure the M550 at will.

Note: The M550 comes standard with the default configuration loaded into memory.

Default Configuration:
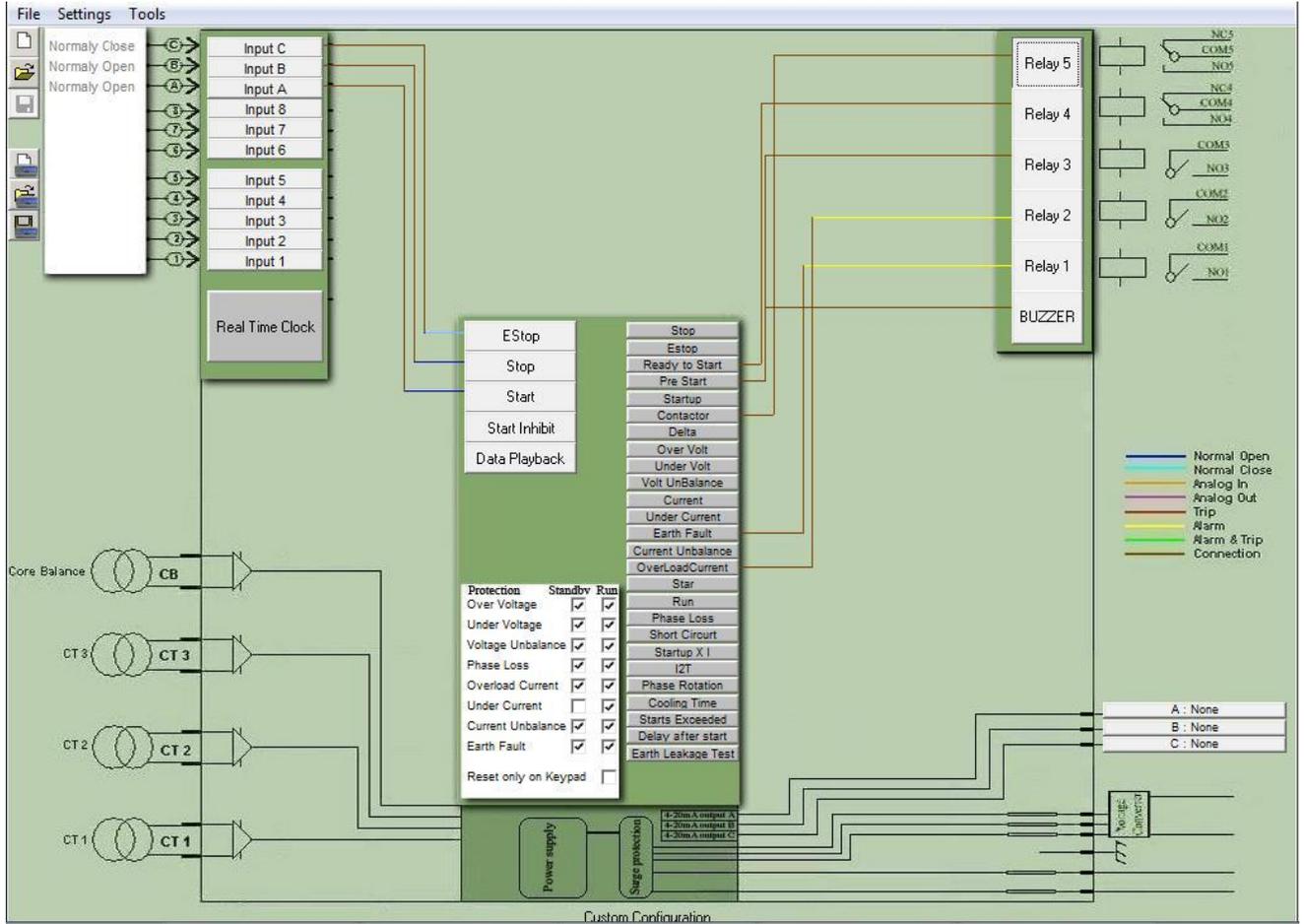
Figure 5 M550 Default configuration

Configuration cleared:

When the M550 configuration is cleared, all inputs are disconnected from the outputs leaving the design engineer free to connect any input to the motor protection block and relays
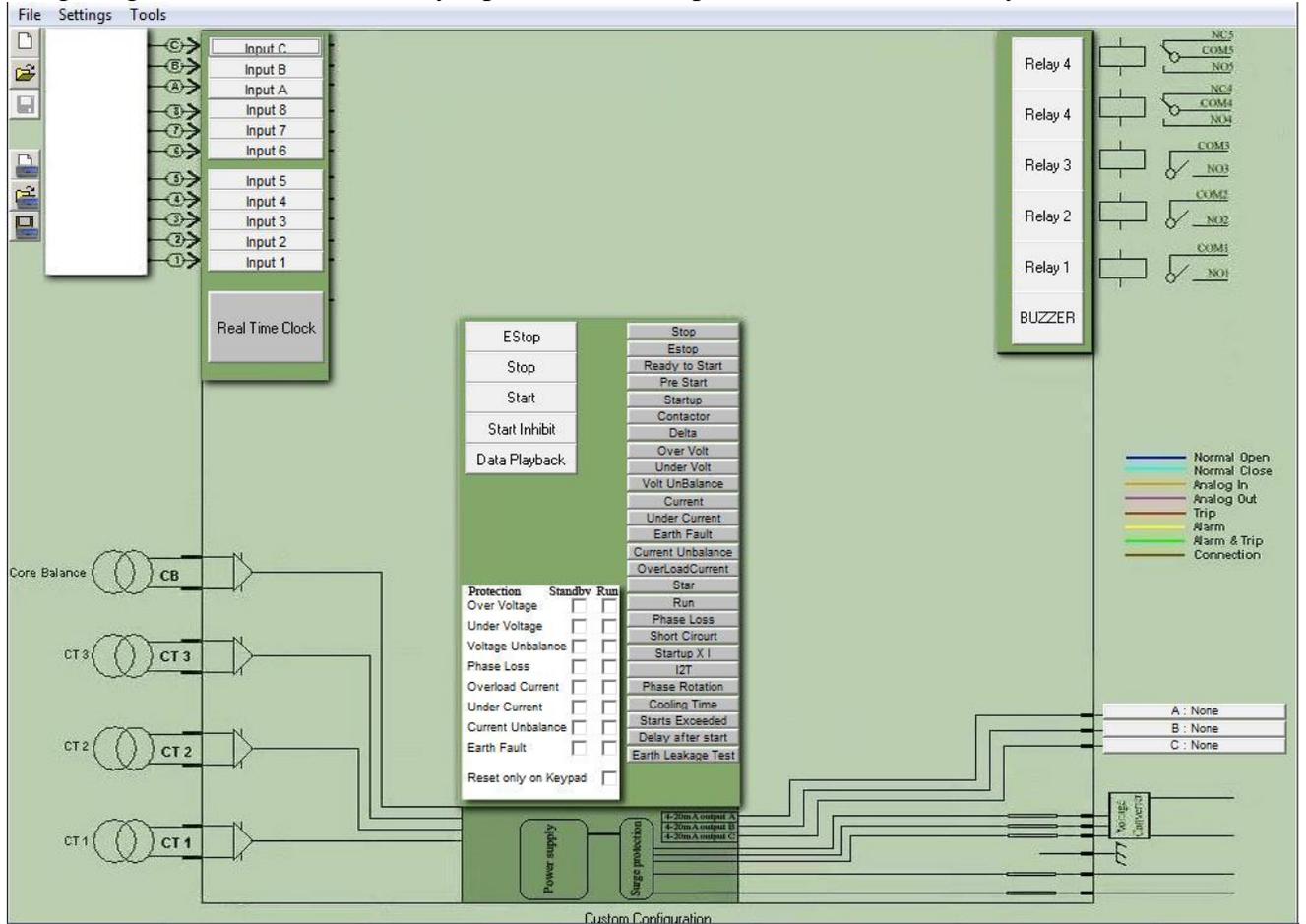
Figure 6 M550 Configuration cleared

Example 1:

Requirement: Input B to start the M550, Input C to Stop the M550. Main contactor connected to relay 4 and Pre start alarm connected to relay 1.

To connect input B to Start. Click on INPUT B and select the input normally open.
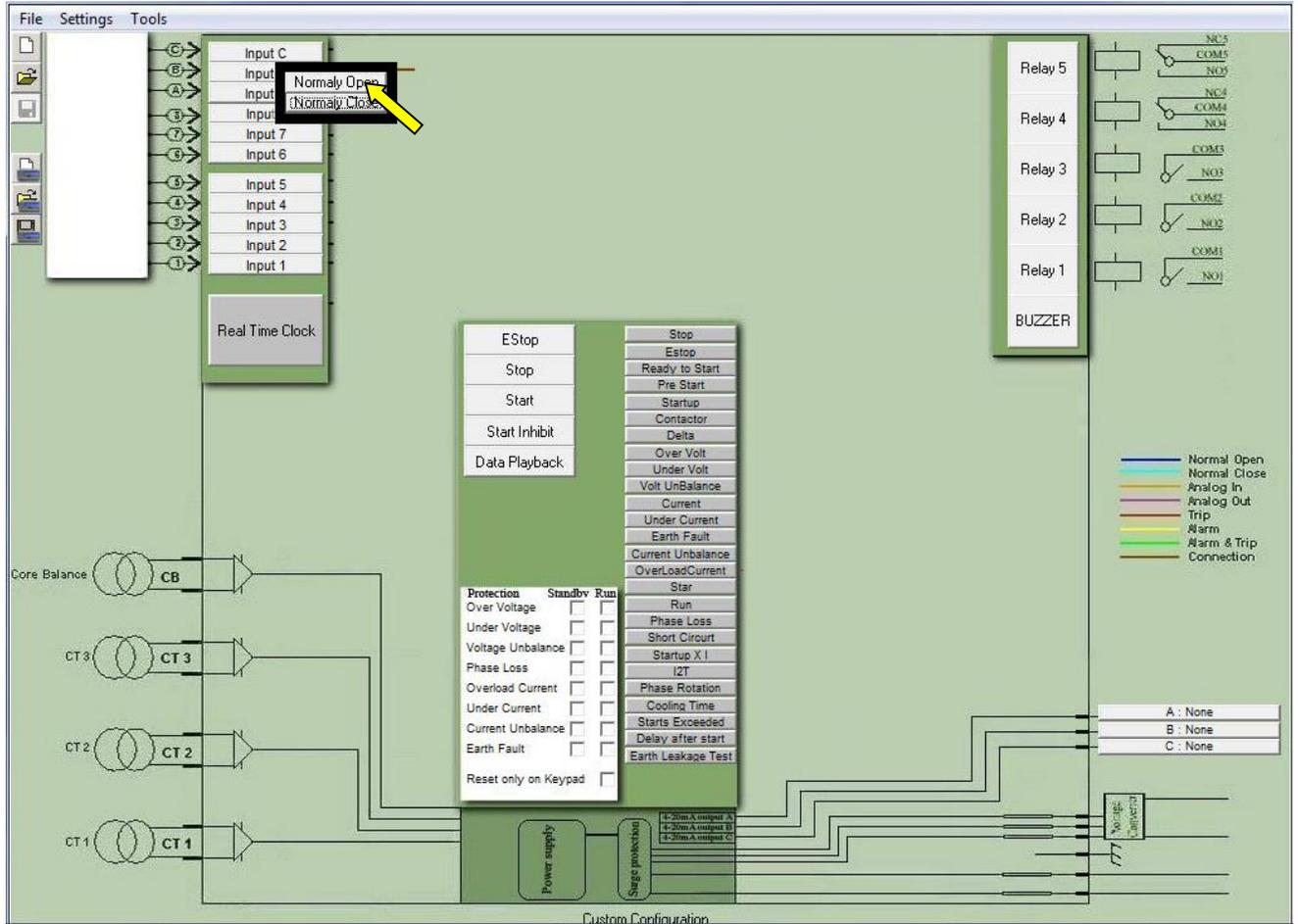
Figure 7 Example 1 Configuration step 1

Draw the line and click on the Start button on the motor protection block
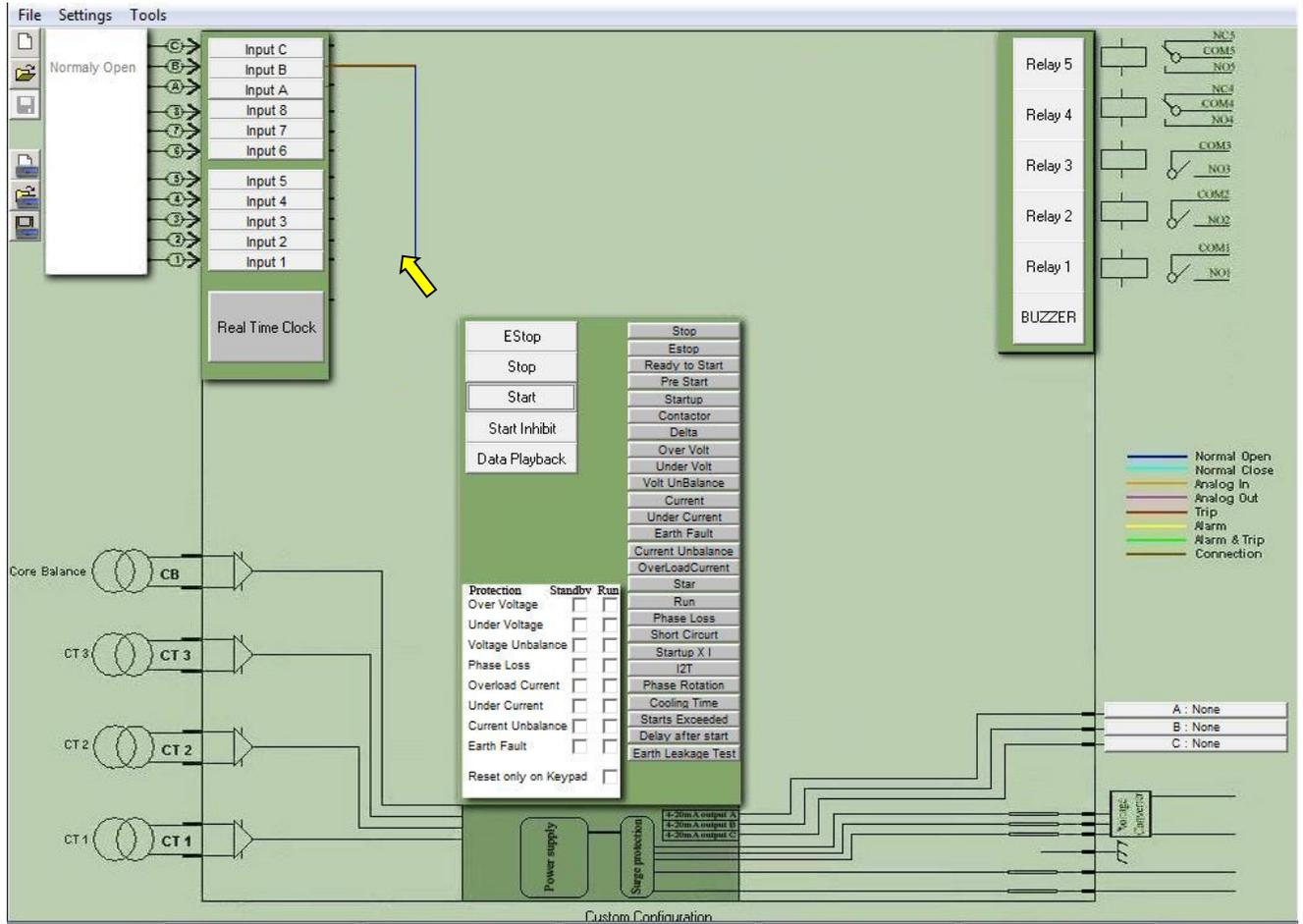
Figure 8 Example 1 Configuration step 2

Input B is now connected as a normally open input and can start the M550.

Click on input C and select normally closed and connect to the stop button on the motor protection block. Connect the Contactor relay output from the motor protection block to relay 4 and the pre start output from the motor protection block to relay 1.
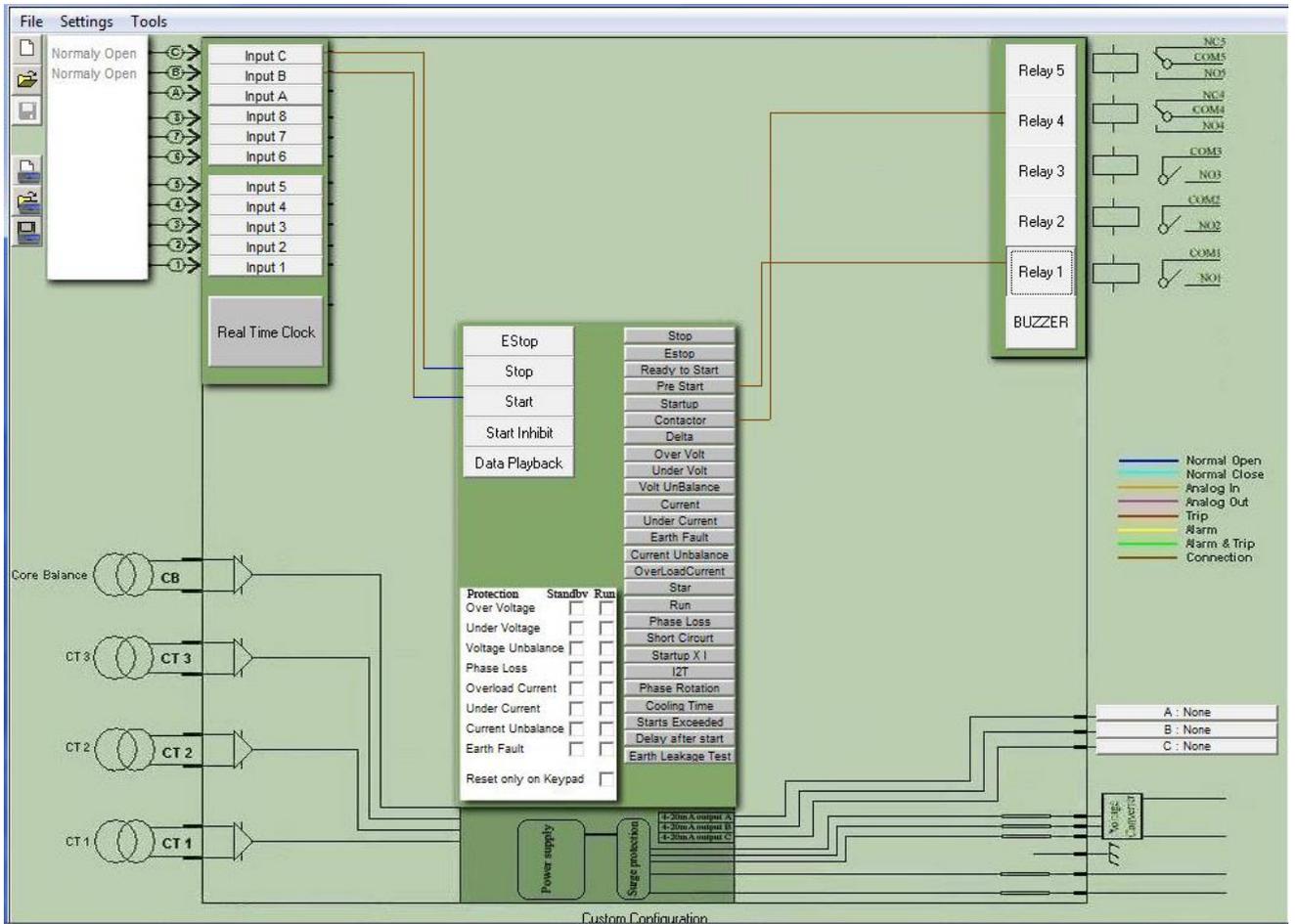
Figure 9 Example 1 Configuration step 3

To remove a connection, right click on the connection. Select the connection, then click remove. The line is now removed.
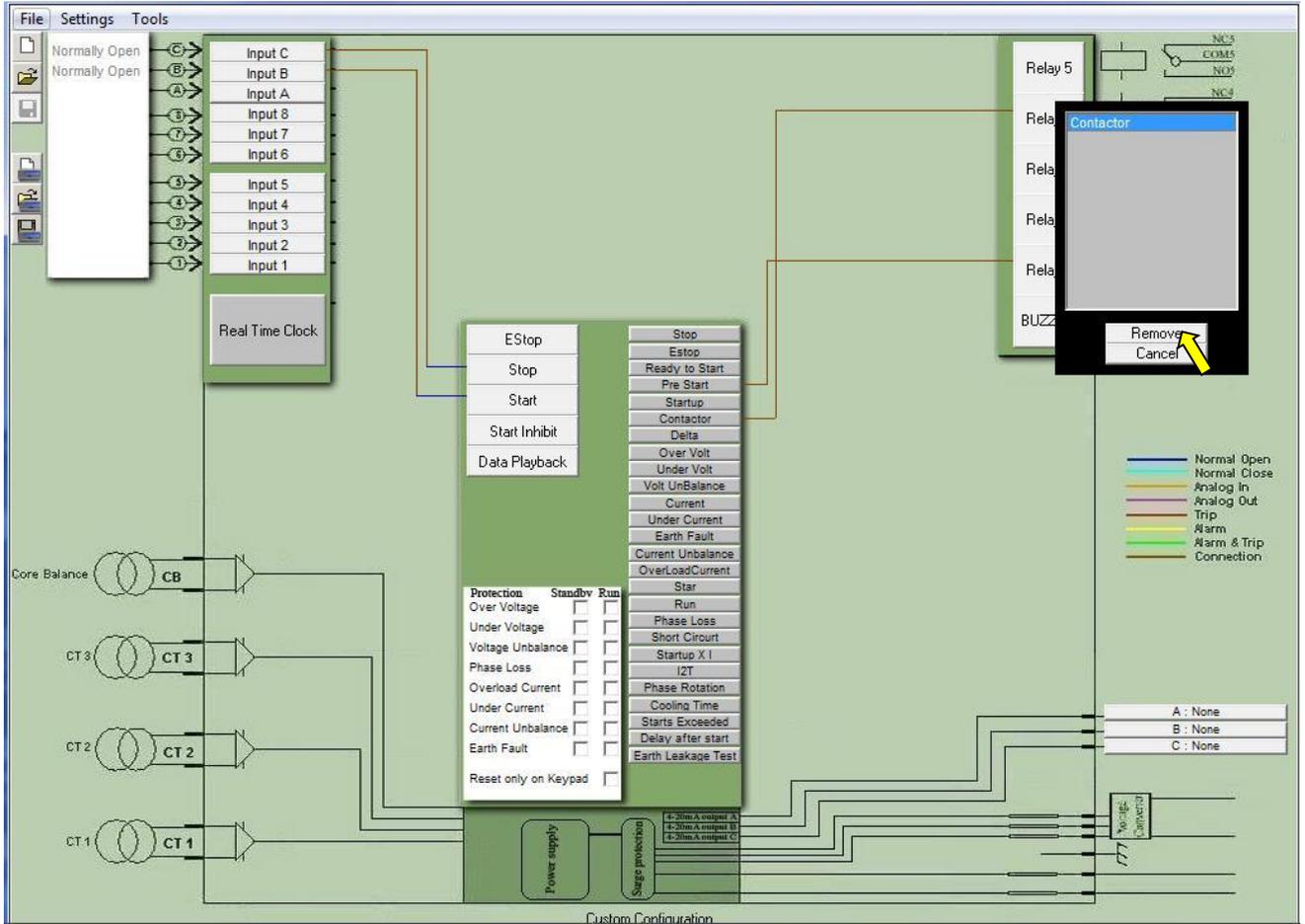
Figure 10 Example 1 Configuration step 4

Customize the inputs to user preference. Right click on the input and select rename. Type the required name and enter.
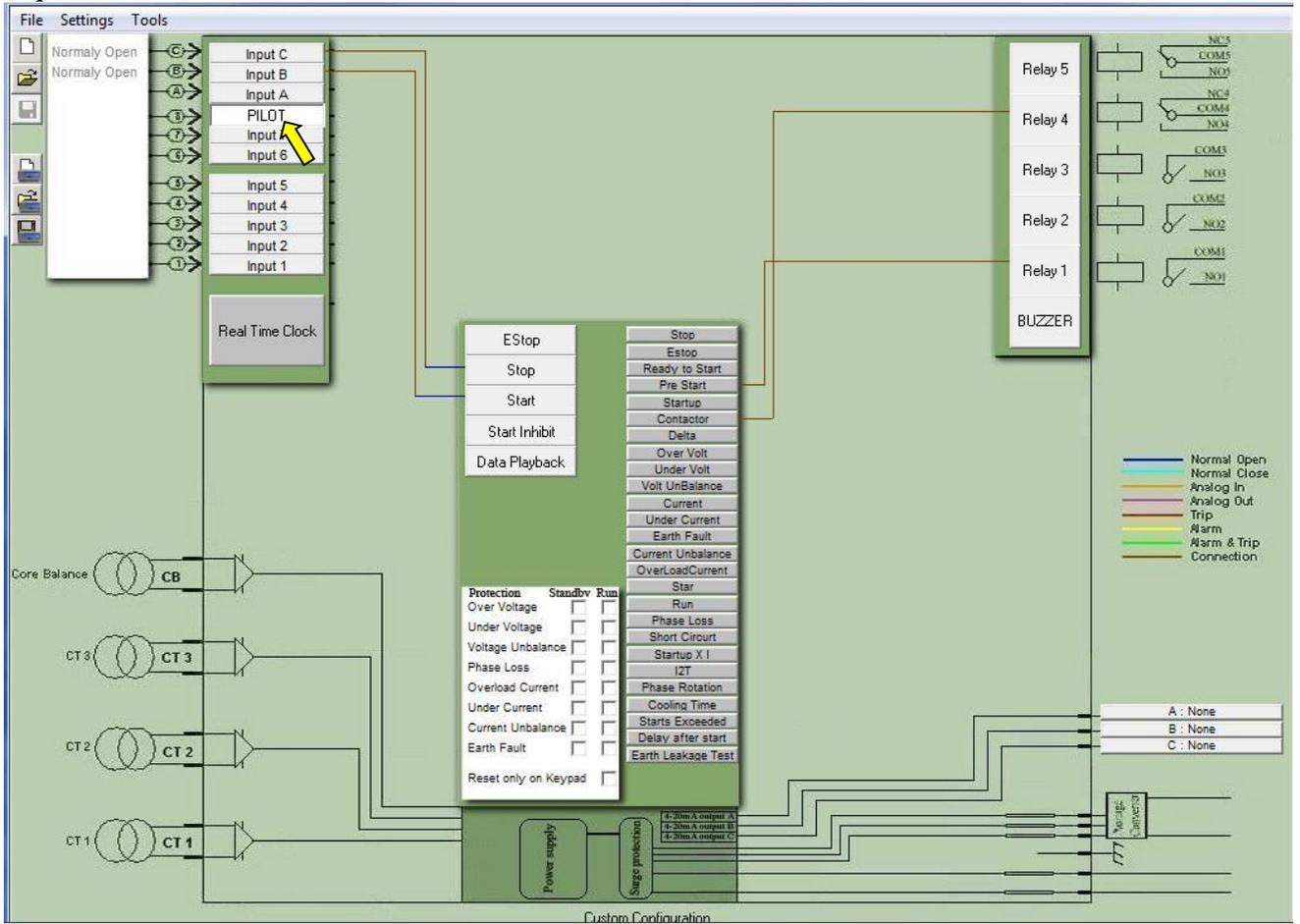
Figure 11 Example 1 Renaming inputs

The M550 will display the renamed inputs on the graphic display when active. The event recorder will save the renamed input when the input causes an event.

Connect the M550 with the USB cable to the PC. Select Tools and Send Configuration to M550 (or use the shortcut key F3). *Ensure that the USB drivers are installed and that the correct com port is selected.*
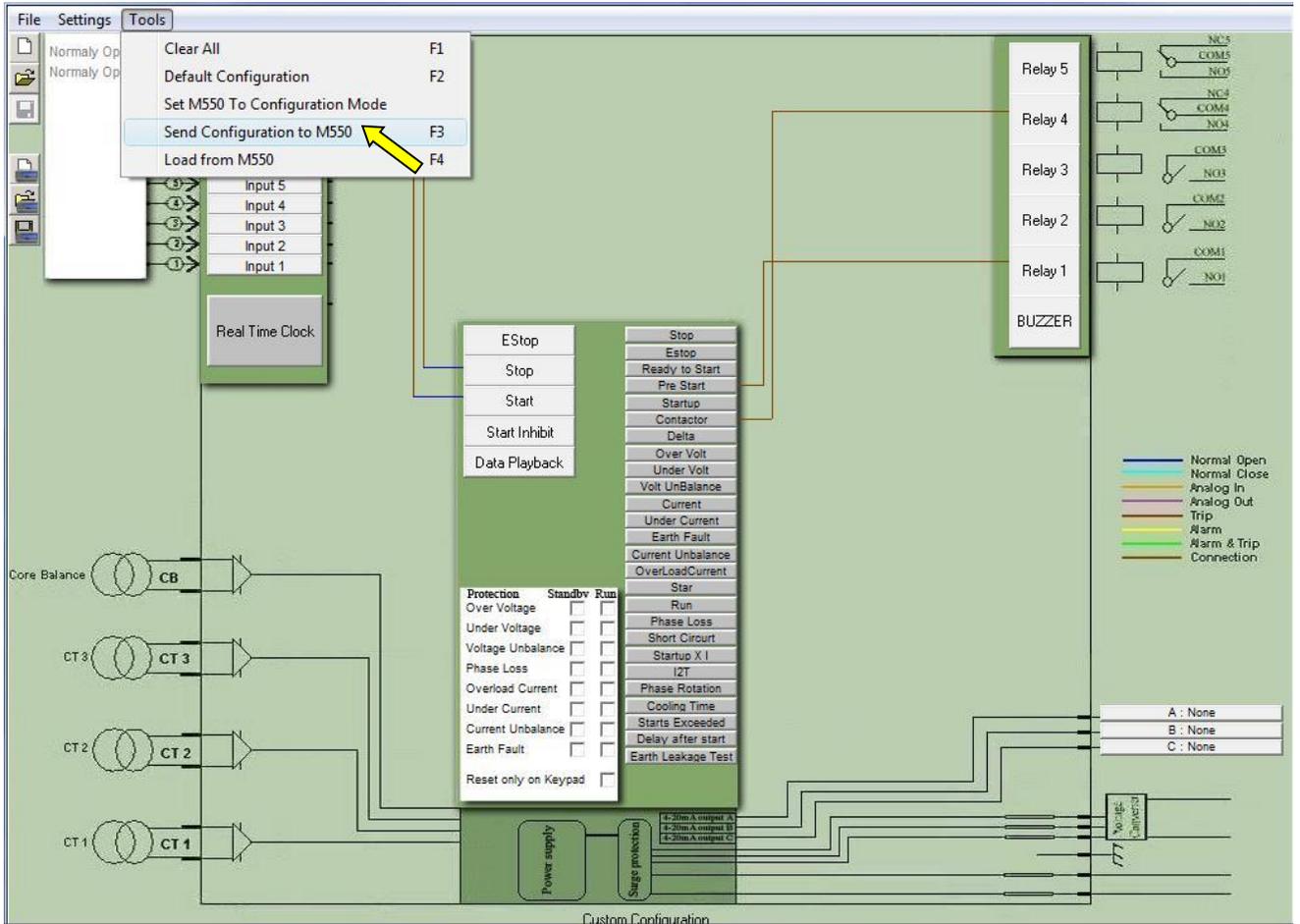
Figure 12 Example 1 Configuration step 5

The M550 is now configured. The configuration may be saved or loaded at any time.
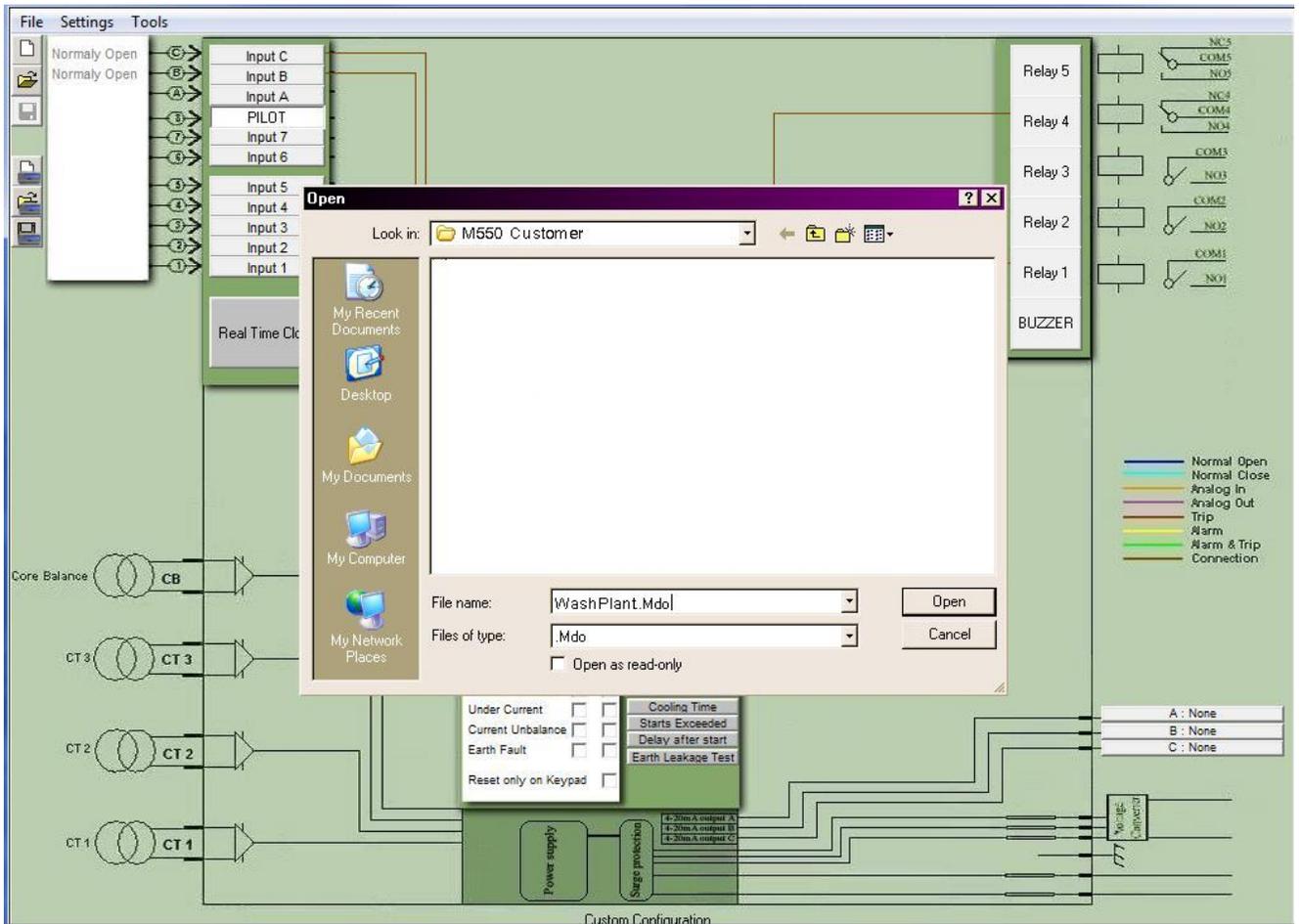
Figure 13 Save or load configuration

5.   M550 Menu

About the Menu

The M550 menu contains all the settings for the trip levels, timer functions and trip delays as well as the communication settings. The menu settings are located in non-volatile memory (settings remain unchanged when powered down). The M550 menu settings can be changed by personal computer, infra-red remote control, I Link (handheld IRDA device), local keypad (if enabled) and network.

Note: The menu can only be accessed when the motor is not running.

How to change the settings

Press the ⏏ button on the local keypad or infra-red remote control to enter the menu. From there press ⏏ to scroll up through the menu, press ⏷ to scroll down through the menu. ◀◀ or ▶▶ will decrease or increase the value for that specific setting.

All relevant settings are grouped together (timers, voltage, start-up etc.). On entering the menu, the first setting is the Pre Start setting followed by all the timer settings, followed by the Voltage settings then followed by the Start-up settings etc.

By pressing the START button the menu will jump from the timer settings to the voltage settings etc., skipping the remainder of the timer settings. By pressing the STOP button the menu will do the same function as the START button but in the opposite direction. This will enable the user to reach the settings located in the middle of the menu much faster.

Press the OK button to exit the menu. To save the settings press the OK button again within 10 seconds. When saving the new settings the event (menu access) is logged in the non-volatile memory with date and time stamp.

List of Menu Settings

SETTING	GROUP	MIN	MAX	DEFAULT	UNIT
Pre Start	Timers	OFF	999:59	0:05	min/sec
Auto Start	-	OFF	999:59	OFF	min/sec
Auto Stop	-	OFF	999:59	OFF	min/sec
Auto Start @	-	OFF	23:59	OFF	min/sec
Auto Stop @	-	OFF	23:59	OFF	min/sec
Low Restart 1	-	OFF	999:59	15:00	min/sec
Low Restart 2	-	OFF	999:59	60:00	min/sec
Emergency Start	-	OFF	ON	OFF	Digital
Cooling Time	-	OFF	60:00	10:00	min/sec
Start-up time	-	OFF	60:00	0:10	min/sec
Phase Loss	Volts	OFF	ON	ON	Function
Phase Rotation	-	OFF	ON	ON	Function
Under Voltage	-	OFF	1700/33000	OFF	Volts
Under Voltage (time)	-	Instant	60:00	00:10	min/sec
Over Voltage	-	OFF	1700/33000	OFF	Volts
Over Voltage (time)	-	Instant	60:00	00:10	min/sec
Volt Unbalance	-	OFF	99	OFF	%
Volt Unbalance (time)	-	Instant	60:00	00:10	min/sec
Starts per hour	Start-up	OFF	20	6	Starts
I^2T	-	OFF	10000	2000	I^2T
Start-up x I	-	OFF	20	6	x I
Under Current (Amps)	Running	OFF	50000	OFF	Amps
Under Current (Time)	-	Instant	60:00	00:10	min/sec
Overload Current (Amps)	-	OFF	50000	OFF	Amps
Overload Current (Time)	-	Curve	60:00	Curve	min/sec
Current Unbalance (%)	-	OFF	99	OFF	%
Current Unbalance (Time)	-	OFF	60:00	00:10	min/sec
Motor Class	-	5	30	10	Class
Short Circuit X I	-	OFF	20	10	x I
Earth leakage start-up (mA)	Start-up	OFF	10000	1000	mA
Earth leakage (mA)	Running	OFF	10000	250	mA
Earth leakage (Time)	-	Instant	60:00	0:10	min/sec
RS485	Communication	OFF	ON	ON	Function
Baud Rate	-	600	38400	9600	Bps
RS485 Address	-	OFF	247	247	Address
Infra-Red Address	-	OFF	247	OFF	Address
Keypad access	Configuration	0	127	127	
CT Quantity	-	OFF	3	3	CT
CT Ratio	-	OFF	2000	200	:1
CT Input	-	1	5	1	Amps
VT Ratio	-	OFF	33.0	OFF	KV:110
Latch on Last Trip	-	OFF	ON	OFF	Function
Blow down timer	-	OFF	ON	OFF	Function
Return to Last State	-	OFF	ON	OFF	Function
Mode	-	OFF	5000	OFF	Function
IO 1 4-20 H	-	OFF	20.0	0	mA
IO 1 4-20 L	-	OFF	20.0	0	mA
IO 2 4-20 H	-	OFF	20.0	0	mA
IO 2 4-20 L	-	OFF	20.0	0	mA
IO 3 4-20 H	-	OFF	20.0	0	mA
IO 3 4-20 L	-	OFF	20.0	0	mA
IO 4 4-20 H	-	OFF	20.0	0	mA
IO 4 4-20 L	-	OFF	20.0	0	mA
IO 5 4-20 H	-	OFF	20.0	0	mA
IO 5 4-20 L	-	OFF	20.0	0	mA
Delay after start	Other	OFF	3600	0	Sec
A 4-20ma Gain	Analogues	OFF	2000		
B 4-20ma Gain	Analogues	OFF	2000		

C 4-20ma Gain	Analogues	OFF	2000		
Current Relay	Analogues	OFF	5000.0		
Delay Input A	Analogues	OFF	999.9		
Delay Input B	Analogues	OFF	999.9		
Delay Input C	Analogues	OFF	999.9		
4-20mA 1 Low	Analogues	OFF	999		
4-20mA 1 High	Analogues	OFF	999		
4-20mA 2 Low	Analogues	OFF	999		
4-20mA 2 High	Analogues	OFF	999		
4-20mA 3 Low	Analogues	OFF	999		
4-20mA 3 High	Analogues	OFF	999		
4-20mA 4 Low	Analogues	OFF	999		
4-20mA 4 High	Analogues	OFF	999		
4-20mA 5 Low	Analogues	OFF	999		
4-20mA 5 High	Analogues	OFF	999		
Input 5 Delay	Analogues	OFF	3600		
Input 4 Delay	Analogues	OFF	3600		
Input 3 Delay	Analogues	OFF	3600		
Input 2 Delay	Analogues	OFF	3600		
Input 1 Delay	Analogues	OFF	3600		

Pre Start
This setting will activate the relay or buzzer (as connected in the configuration) prior to starting for the set time in seconds to act as a pre start warning.

Auto Start
This function will auto start the M550 when all conditions are met.

Auto Stop
This function will auto stop the M550 after the pre-set time.

Auto start @
This function will Start the M550 or activate the relay/s (as connected in the configuration) when the time of the real time clock matches this setting.

Auto stop @
This function will Stop the M550 or de-activate the relay/s (as connected in the configuration) when the time of the real time clock matches this setting.

Low restart 1
If the M550 has tripped on an undercurrent condition (dry run) the M550 will auto restart after the set time has lapsed. Should the Auto start function be enabled the Low Restart 1 will override the Auto start function. If Low restart 1 is enabled (set to any value) the M550 will not latch on last trip in case of an undercurrent trip.

Low restart 2
If the M550 trips on an undercurrent condition immediately after a low restart 1, the M550 will restart once the Low Restart 2 set time has lapsed.

Emergency start
If this setting is set to ON, the M550 will allow one emergency start while in cooling time or if the starts per hour have been exceeded. To enable the emergency start the E Stop must be activated. The emergency start is then performed by a normal Start action.

Cooling Time
If the M550 trips on an overload condition the cooling time comes into effect. No starts are allowed during cooling time. If the Emergency Start is enabled one emergency start is allowed during cooling time. The cooling time is not cleared during power down. If Mode is set to 80 the thermal memory is cleared.

Start-up time
This is the time allocated for a motor start-up. When in start-up time the I²T, Start-up X I and Earth leakage at Start-up protection is active.

Phase Loss
Phase loss detection is active when this setting is ON. Phase loss detection may be selected in the configuration setup to be active during Standby and/or Run

Phase Rotation
Phase rotation detection is active when in Standby and the setting is ON.

Under Voltage
The under voltage detection level is determined by this setting.

Under Voltage (time)
The setting allows for a delayed trip in the event of an under voltage.

Over Voltage
The over voltage detection level is determined by this setting.

Over Voltage (time)
The setting allows for a delayed trip in the event of an over voltage.

Voltage unbalance
The reason why unbalanced phase voltages require disconnection from the load is that any unbalance in the voltage results in a negative phase sequence current component which produces a rotating field in the opposite direction to the rotating field produced by the applied system voltage. This counter-rotating field will cause induced currents in the rotor of almost twice the normal system frequency, resulting in overheating and possible damage. This result is derived from the negative phase sequence component in a three-phase system. If the voltage unbalance exceeds the set limit and time delay the M550 will trip. The voltage unbalance is derived from the formula:

Unbalance phase 1 = ((V1 – V average) /V average) * 100
Unbalance phase 2 = ((V2 – V average) /V average) * 100
Unbalance phase 3 = ((V3 – V average) /V average) * 100

Where:
V average = (V1 + V2 + V3) / 3

The M550 will trip on any phase that exceeds the set limit.

Voltage unbalance time
This setting is the time allowed in an unbalance situation.

Starts per hour
The M550 utilize a starts per hour counter. If the starts per hour counter exceeds 60 no more starts are allowed, if the starts per hour counter is less than 60 a start is allowed.

Example: If a setting of 10 is selected, one start equals six minutes (60 minutes, 10 starts = 6 minutes). For every start 6 minutes is added to the starts per hour counter. If the starts per hour counter exceeds 60 no more starts are allowed.
After each minute the starts per hour counter is decremented by one. If the starts per hour counter are less than 60 a start is allowed.
If the starts per hour counter exceed 60 and the Emergency start function is enabled one Emergency start is allowed.

I²T (I = Multiples of full load current)
If the motor is allowed to exceed the overload current setting six times for ten seconds at start-up, this setting must be set to 6^2 x 10 = 360.

Start-up x I
This is the multiples of the overload current that is allowed during the start-up time.

Example:
Overload current setting = 30A
Start-up x I = 6

Maximum start-up current allowed 180A

Under current
If the current on any phase drops below this setting the M550 will trip after the delay time has lapsed. If the low restart timer is enabled the M550 will restart after that condition is met.

Under current time
This is the time that the motor is allowed to operate in an undercurrent condition. If the alarm function is enabled the alarm relay will activate when the under current is detected.

Overload current
This setting is the current level where the motor enters an overload condition. See **overload current time** and **motor class** for trip time characteristics.

Overload current time
If set to *curve* the M550 will trip according to the IEC 255-8 specification on an overload condition. Any other value will trip at a definite time on an overload condition.

The M550 uses a full memory model considering prior load with thermal memory preservation when powered down.
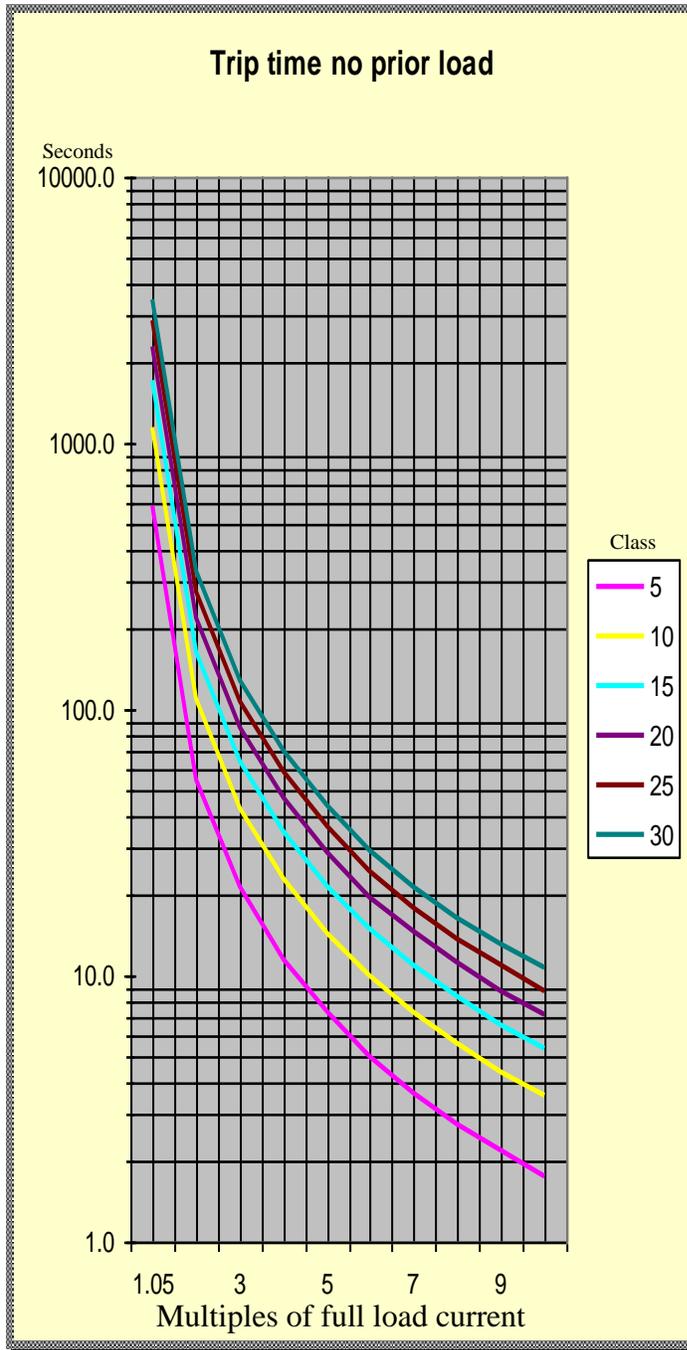
Figure 14 Trip time no prior load
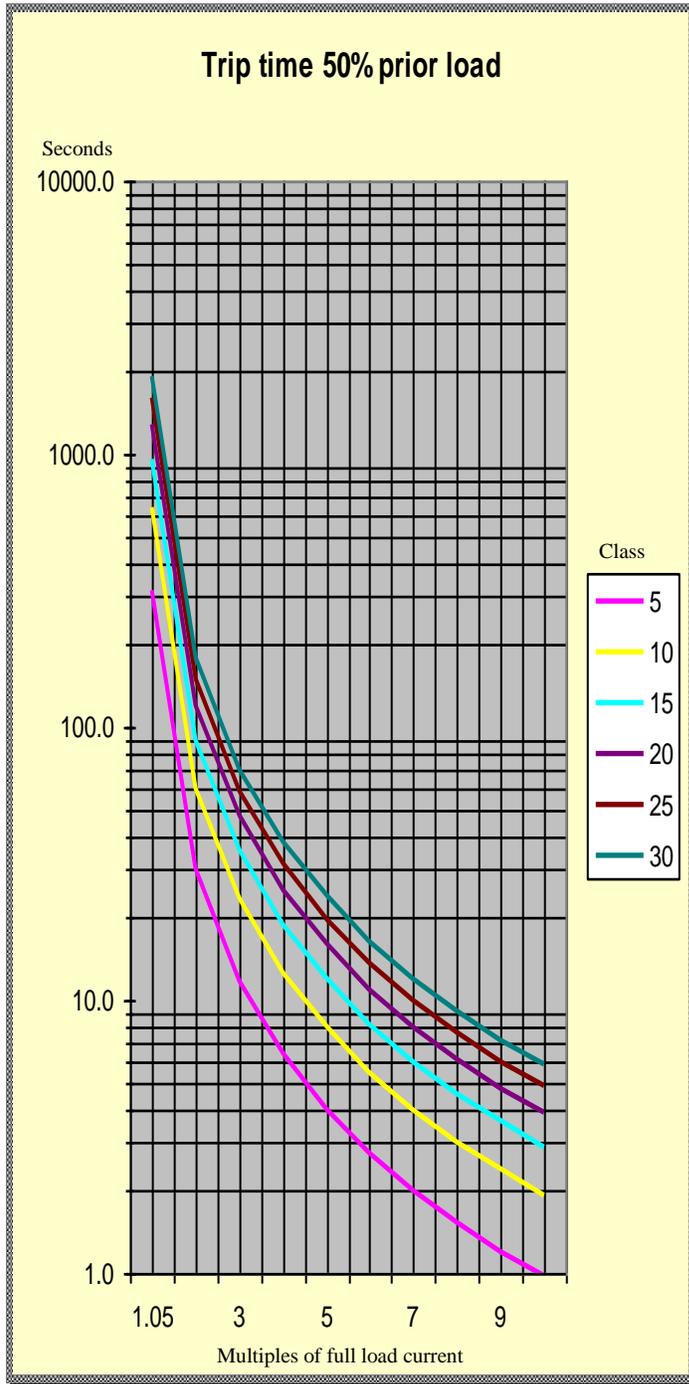
Figure 15 Trip time 50% load
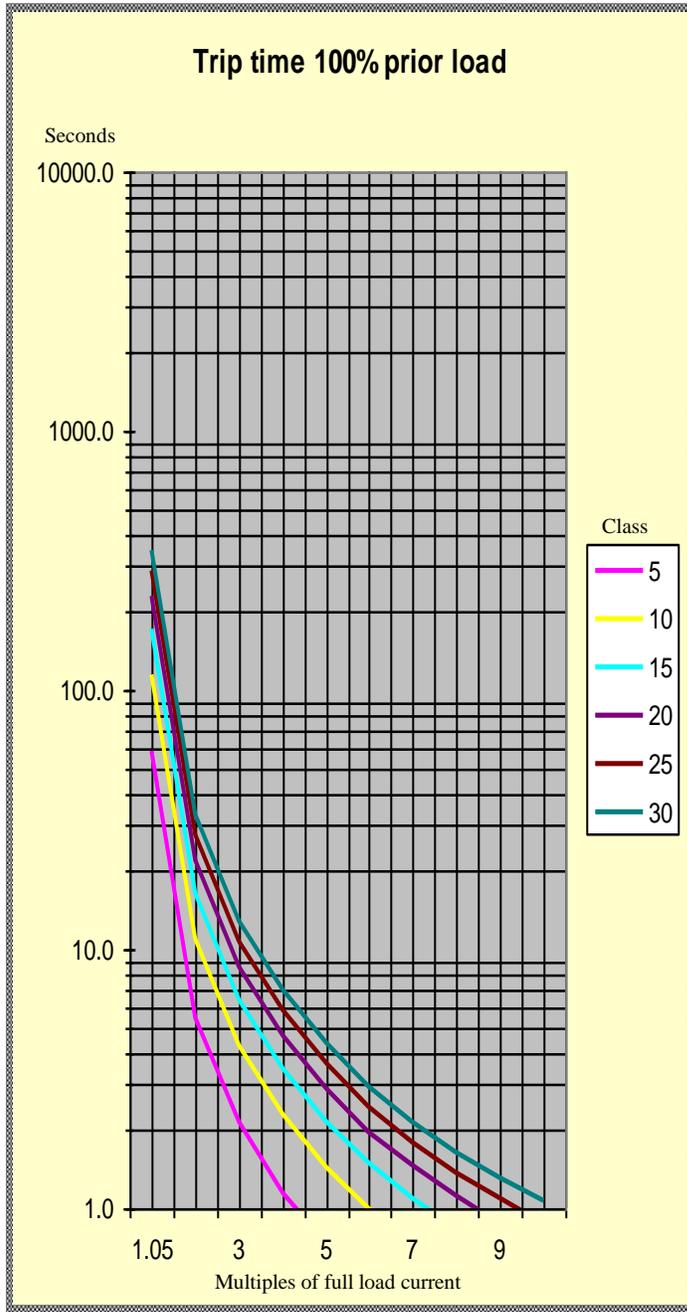
Figure 16 Trip time 100 % load

Current unbalance

The reason why unbalanced phase currents require disconnection from the load is because any unbalance in the current results in a negative phase sequence component which produces a rotating field in the opposite direction to the rotating field produced by the applied system voltage. This counter-rotating field will cause induced currents in the rotor of almost twice the normal system frequency, resulting in overheating and possible damage. This result is derived from the negative phase sequence component in a three-phase system. If the current unbalance exceeds the set limit and time delay the M550 will trip. The current unbalance is derived from the formula:

Unbalance phase 1 = ((I1 – I average) /I average) * 100
Unbalance phase 2 = ((I2 – I average) /I average) * 100
Unbalance phase 3 = ((I3 – I average) /I average) * 100

Where:
I average = (I1 + I2 + I3) / 3

The M550 will trip on any phase that exceeds the set limit.

Current unbalance time

This setting is the time allowed in an unbalance situation.

Motor class

This setting determines the motor class for the thermal overload curve. Refer to the overload current time for more detail.

Short circuit x I

This is the multiples of the overload current setting that is allowed after the start-up time has lapsed. Example: an overload current setting of 45A and a short circuit x I setting of 10 will trip on a short circuit fault if 450A is exceeded. If a relay is assigned to this fault the relay will trip 200ms before the main contactor does.

Earth leakage at start-up

The M550 will trip instantaneous if the earth leakage fault exceeds this setting at start-up.

Earth leakage in run

The M550 will trip if the earth leakage fault exceeds this setting and the delay time is exceeded (earth leakage time).

Earth leakage time

This is the delay time before trip in the event of an earth leakage fault.

RS485

The RS485 communication port can be enabled or disabled by this setting.

Baud rate

The baud rate for the communication ports can be set between 600 and 38400 bps. The protocol is one start bit, eight data bits, no parity and one stop bit.

RS485 Address
This setting is the unique RS485 address for the M550.

Infra-red address
The infra-red address on the M550 can be set to match the infra-red address on the I Link to ensure a secure infra-red link.

Keypad access
Any button on the keypad can be enabled or disabled by this setting. This will enable the design engineer to have only certain functions available to the operator.
Each key on the keypad has a unique number. The value for this menu setting is obtained by adding the numbers of the required keys together.
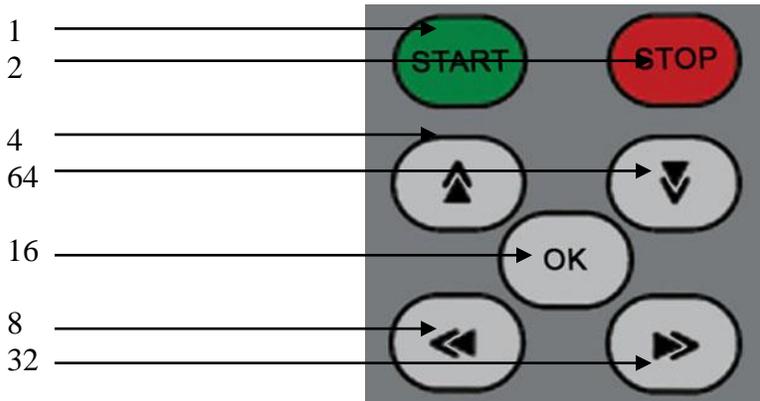

```
1  ──────────── START
2  ──────────── STOP

4  ────────────
64 ────────────

16 ────────────  OK

8  ────────────
32 ────────────
───
127
```

Figure 17 Keypad access on M550

Example:
All buttons disabled on the keypad	- Value = 0
Only Start and Stop enabled	- Value = 3
All functions except Save Settings (OK)	- Value = 111
All buttons enabled	- Value = 127

CT Quantity
The M550 can operate on One, Two or Three current transformers. This setting is used to select the number of current transformers connected to the M550. If one CT is selected the CT must be connected to CT1. If two CT's are selected it must be connected to CT1 and CT2.

CT Ratio
The CT ratio can be selected in increments of 10. If the secondary is selected as 1A, the range is 10:1 to 2000:1 or if the secondary is selected as 5A the range is 10:5 to 2000:5.

CT Input
The CT secondary output can be selected as 1A or 5A

VT Ratio
If measurement higher than 1700Vac is required, a VT (Voltage transformer) with a 110Vac secondary must be used. The over and under voltage settings can be selected from zero to 33 000Vac if a VT is used.

Latch on last trip
If this is set to ON the M550 will latch on the last trip, except if low restart 1 is enabled and the M550 tripped on under current. On a trip condition the graphic display will show the last trip. Reset the M550 by pressing the Emergency Stop button.

Blow down timer
When the blow down timer is set, the blow down timer will count down after any stop event, the blow down timer needs to expire before it will allow a start.

Return to last state
Not used

Mode
This setting is used for special functions. Functions include internal test routines, configuration, calibration and firmware upgrades.

User settings:

The following modes will display:
Mode 4	Display analog inputs (vibration and temperature)
Mode 5	Display Phase to neutral voltages
Mode 6	Display 4-20mA readings
Mode 7	Kilowatts
Mode 8	Display the three phase kilowatt readings

The following modes will:
Mode 10	Clear hour meter 2
Mode 11	Clear hour meter 3
Mode 12	Clear seconds meter
Mode 20	Start trending recorder
Mode 21	Stop trending recorder
Mode 22	Download trending to PC
Mode 23	Select what to trend
Mode 24	Download calibration values to PC
Mode 32	Download renamed inputs to PC
Mode 42	Download auto earth leakage test report to PC
Mode 50	Stop motor when communication lost (Profibus)
Mode 51	Do not stop motor when communication lost (Profibus)
Mode 52	Stop motor when PLC stop (Profibus)
Mode 53	Do not stop motor when PLC stop (Profibus)
Mode 54	No volts or current on display
Mode 61	Clear trending memory
Mode 80	Clear thermal image
Mode 81	Clear kilowatt hour meter
Mode 82	Clear auto earth leakage test report memory
Mode 100	Enable lock mode
Mode 101	Disable lock mode

Mode 102	Relay 5 invert
Mode 103	Relay 5 normal
Mode 127	Set the M550 to the configuration mode for configuration via USB from the PC
Mode 255	Default the menu settings to factory values

IO 1 4-20 H, IO 1 4-20 L

The settings for IO1 to IO5 perform the same functions.

IO 1 4-20 H is the mA set point where the input will switch on. The **IO 1 4-20 L** is the mA set point where the input will reset. This offers hysteresis to the input. Example, if **IO 1 4-20 H** is set to 12.0 mA and **IO 1 4-20 L** is set to 10.0 mA and IO1 is connected to relay 1. Relay 1 will switch on at 12.0 mA and switch off at 10.0 mA.

Delay after start

The relay connected (in the configuration) will switch over after the set time has lapsed after start-up. This contact can be used to allow the deco wheel or speed switch to come into operation.

6. Event Logging

About event logging

The M550 has a large non-volatile memory to store events with date and time stamp. The M550 stores the last 1020 events with date, time, the three phase voltages, the three phase currents, auxiliary voltage, earth leakage reading, and event. Events include Stop, Start, Trip, Menu access, Power down, Power up.

The data can be played back on the graphic display as screen shots, retrieved via USB, retrieved via the network or downloaded via IRDA with the *I*-Link handheld device for analysis on a personal computer.

Playback events on the graphic display

Press the ⏪ button when the motor is not running to display the history events. The event log displays the last event first. Pressing ⏪ or ⏩ will display more events. Pressing STOP or OK will exit the event log.

Figure 18 Data playback screenshot

7. Date & Time

About date & time

The real time clock operates from the internal lithium battery to ensure timekeeping when the M550 is powered down. The lithium battery should last for ten years but it is recommended that the battery be replaced every five years.

Setting the date & time

Press the ⌄ button to enter the date and time menu when the M550 is in standby mode.

Navigate through the menu with the ⌃ and ⌄ buttons. Adjust the settings with the ◄◄ and ►► buttons. Save the new date and time with the OK button.

8. About the M550

The ►► button on the infra red remote control or local keypad (if enabled) will display:

Version 1.01.01 A	Version number
Serial no. 48AC-B21F	Unique serial number
Warranty Date 2005/09/30	Date logged after 1 hour of operation for warranty
Hour1 Hour2 Hour3 Starts	See **X**
NINGI SERVICES	Company
www.ningi.com	Web site
0800 000 400	24/7 Toll free telephone technical support
082 556 7682	Contact number (Tino)

X:-

> **Hour 1**
> First hour meter, non resettable hour meter
> **Hour 2**
> Second hour meter, resettable hour meter (mode 10)
> **Hour 3**
> Third hour meter, hour meter running above a preset load (to measure the hours that the motor worked under load)
> **Starts**
> Total motor starts

9. Communication

About communication

The M550 offers various channels of communication. Profibus **or** RS485 (Modbus RTU). USB, infra-red and IRDA are standard on all M550 motor protection relays.

About USB

USB is standard on all M550 motor protection relays. USB implements the Modbus RTU protocol for communication.
USB is used:
To upgrade the firmware.
To change the menu settings via the PC program
To download the data logged events
To communicate with Scada or M550 PC program
To download trending

About RS485 (Modbus RTU)

RS485 is used for the same functions as USB but offers longer communication distances (1200M) and allows for multiple devices on the same network (32 devices). See Modbus RTU protocol.

About Ether (Modbus TCP)

Modbus TCP allows the M550 to be connected directly to a Ethernet network and uses the Modbus TCP protocol to communicate with the relay. See Modbus RTU protocol. See Modbus RTU protocol.

About Profibus DP

PROFIBUS is available as an option on the M550 relay.

The M550 offers automatic recognition and support of data transmission rates up to 12 Ambit/s. The integration of the PROFIBUS DP protocol, 4K Byte communication RAM and the configurable processor interface are features that create high-performance PROFIBUS DP-Slave applications.

Four states of the Profibus communication.
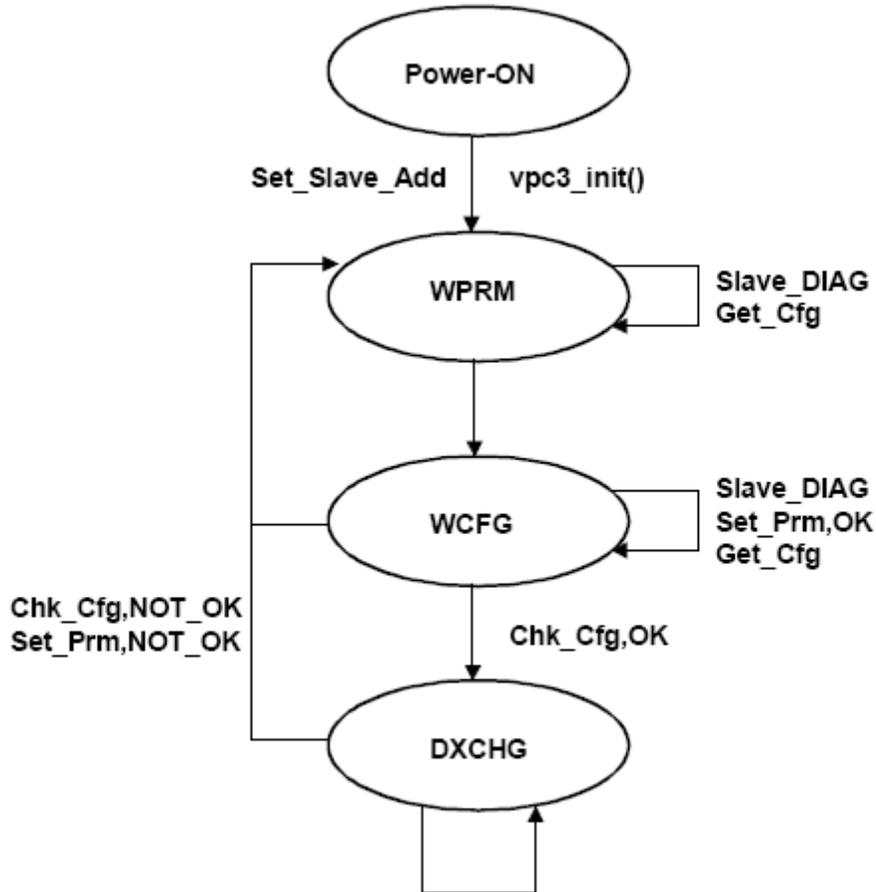
To set the Profibus address, set the RS485 address on the M550 (RS485 address – Menu Settings)

Cyclic data input registers (9 bytes) read only.

Byte **0** Status register – The decimal value represents the M550 status.

Decimal	Description
0	Not used
1	STOP
2	ESTOP
3	Ready to start
4	Pre Start
5	Start-up
6	Start
7	RUN
8	Over Voltage
9	Under Voltage
10	Current Relay
11	Voltage Unbalance
12	Under Current
13	Earth Fault
14	Current Unbalance
15	Overload Current
16	Start STAR
17	Run DELTA
18	Phase Loss
19	Short Circuit
20	Start-up x I exceeded
21	I²T exceeded
22	Phase Rotation
23	Cooling time active
24	Starts exceeded

Status register for Profibus are changed from prioritized numerical to bit structure as from version 4.01.01.A. The HEX file is available free of charge on request from andre@tech4000.com

Status register bit structure for Profibus.

PROFIBUS CYCLIC DATA STATUS REGISTER

Version 4.01.01.A

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
Tripped	Pre Start	Starts Exceeded	Cooling Time	Phase Rotation	Phase Loss	Over Current	Current Unbalance

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Earth Fault	Under Current	Voltage Unbalance	Under Voltage	Over Voltage	Running	Ready to Start	Stop

Bits are set when preset conditions occur (alarm and trip). Refer to specific configuration and settings on M550 motor protection relay.

Byte 1,2 (bitwise word) Represent the 11 inputs on M550

Input 1	Bit 1
Input 2	Bit 2
Input 3	Bit 3
Input 4	Bit 4
Input 5	Bit 5
Input 6	Bit 6
Input 7	Bit 7
Input 8	Bit 8
Input A	Bit 9
Input B	Bit 10
Input C	Bit 11

Bit 12 to 15 Spare

If the Input on the M550 is pulled low the corresponding bit is set.

Byte 3,4 (word) Average current - ((Phase 1 + Phase 2 + Phase 3)/3)

Example

Current	Actual Current	WORD read as
Amps x 10	98.6 A	986

Byte 5,6 Spare

Byte 7,8 Spare

Cyclic data output registers (2 bytes) write only

Byte 0 (bitwise)

Relay 1	Bit 0	0x01
Relay 2	Bit 1	0x02
Relay 3	Bit 2	0x04
Relay 4	Bit 3	0x08
Relay 5	Bit 4	0x10
Spare	Bit 5	0x20
STOP M550	Bit 6	0x40
START M550	Bit 7	0x80

Example write 0x01 will set Relay 1, write 0x80 will Start the M550
Example write 0x00 will clear all Relays

Byte 1 Spare

Modbus RTU & TCP Protocol

The protocol for Modbus RTU consists of a string of bytes. The string starts with the RS485 address, the function required, addresses, data bytes and ends with CRC (cyclic redundancy check). The Modbus TCP uses the same register values as Modbus RTU, but a different physical connection.

Read input registers 30000

The real time voltage and current measurements and other important data are available on the input registers.

Below is a list of the available input registers. Any amount of data may be requested by the Modbus RTU protocol.

REGISTER	NAME	DESCRIPTION
30001	year	Year
30002	month	Month
30003	day	Day
30004	hours	Hours
30005	minutes	Minutes
30006	seconds	Seconds
30007	Status	The status of the M550 *See – Status codes
30008	V1	RMS voltage phase 1
30009	V2	RMS voltage phase 2
30010	V3	RMS voltage phase 3
30011	V Aux	RMS voltage control circuit
30012	I1rms	RMS current phase 1
30013	I2rms	RMS current phase 2
30014	I3rms	RMS current phase 3
30015	EL	Earth leakage fault
30016	Seconds Meter	Seconds Meter
30017	VUB	Voltage unbalance
30018	IUB	Current unbalance
30019	HM1	Hour meter 1
30020	HM2	Hour meter 2
30021	HM3	Hour meter 3
30022	IO1	Input 1 status / 4-20 mA value
30023	IO2	Input 2 status / 4-20 mA value
30024	IO3	Input 3 status / 4-20 mA value
30025	IO4	Input 4 status / 4-20 mA value
30026	IO5	Input 5 status / 4-20 mA value
30027	IO6	Input 6 status / 4-20 mA value
30028	IO7	Input 7 status / 4-20 mA value
30029	IO8	Input 8 status / 4-20 mA value
30030	IPA	Input A status
30031	IPB	Input B status
30032	IPC	Input C status

30033	RSN	Reason for last Start/Stop *See – RSN Codes
30034	V average	Average voltage of the 3 phases
30035	I Average	Average current of the 3 phases
30036	V minimum	Minimum voltage of the 3 phases
30037	V maximum	Maximum voltage of the 3 phases
30038	I minimum	Minimum current of the 3 phases
30039	I maximum	Maximum current of the 3 phases
30040	Kw1	Kilowatt phase 1
30041	Kw2	Kilowatt phase 2
30042	Kw3	Kilowatt phase 3
30043	Kilowatt hour H	Kilowatt hour meter high byte
30044	Kilowatt hour L	Kilowatt hour meter low byte
30045	PF1	Power factor phase 1
30046	PF2	Power factor phase 2
30047	PF3	Power factor phase 3
30048	Kilowatt total	Total kilowatt 3 phases

All input registers are 16 bit in length (high byte and low byte). Example the year 2005 is send as 20Hbyte & 05Lbyte. 56 minutes as 00Hbyte & 56Lbyte. 800 volt equals 0320 hex and is send as 0x03Hbyte & 0x20Lbyte.

Example – Read all input registers

Example - Slave address = 5

Read request

Slave Address	Function	Start Address Hi	Start Address Lo	No Points Hi	No Points Lo	CRC Lo	CRC Hi
05	04	00	00	00	14	F1	81

Read response

Slave Address	Function	Byte Count	Data Hi	Data Lo	……..	Data Hi	Data Lo	CRC Lo	CRC Hi
05	04	28	XX	XX	XX	XX	XX	XX	XX

Example – Read Volts, Amps and Earth Leakage

Example - Slave address = 5

Read request

Slave Address	Function	Start Address Hi	Start Address Lo	No Points Hi	No Points Lo	CRC Lo	CRC Hi
05	04	00	07	00	08	41	89

Read response

Slave Address	Function	Byte Count	Data Hi	Data Lo	……..	Data Hi	Data Lo	CRC Lo	CRC Hi
05	04	10Hex	XX	XX	XX	XX	XX	XX	XX

RSN Codes

Code	Description
1	Input 1
2	Input 2
3	Input 3
4	Input 4
5	Input 5
6	Input 6
7	Input 7
8	Input 8
9	Input A
10	Input B
11	Input C
12	IR Remote
13	Keypad
14	Auto-Start/Auto-Stop
15	Power UP
16	Network/Profibus

Status Codes

Code	Description
1	STOP
2	ESTOP
3	Ready to start
4	Pre Start
5	Start-up
6	Start
7	RUN
8	Over Voltage
9	Under Voltage
10	Current Relay
11	Voltage Unbalance
12	Under Current
13	Earth Fault
14	Current Unbalance
15	Overload Current
16	Start STAR
17	Run DELTA
18	Phase Loss
19	Short Circuit
20	Start-up x I exceeded
21	I²T exceeded
22	Phase Rotation
23	Cooling time active
24	Starts exceeded

Holding registers 40000

The menu settings are available for read and write and are located in the holding registers.

REGISTER	NAME	MIN	MAX	Default
40001	Pre Start	0	59999	5
40002	Auto Start	0	59999	0
40003	Auto Stop	0	59999	0
40004	Auto Start @	0	1439	0
40005	Auto Stop @	0	1439	0
40006	Low Restart 1	0	59999	900
40007	Low Restart 2	0	59999	3600
40008	Emergency Start	0	1	0
40009	Cooling Time	0	5999	600
40010	Start-up time	0	5999	10
40011	Phase Loss	0	1	1
40012	Phase Rotation	0	1	1
40013	Under Voltage	0	1700	0
40014	Under Voltage (time)	0	5999	10
40015	Over Voltage	0	1700	0
40016	Over Voltage (time)	0	5999	10
40017	Volt Unbalance	0	99	0
40018	Volt Unbalance (time)	0	5999	10
40019	Starts per hour	0	20	6
40020	I²T	0	10000	0
40021	Start-up x I	0	20	6
40022	Under Current (Amps)	0	50000	0
40023	Under Current (Time)	0	5999	10
40024	Overload Current (Amps)	0	50000	0
40025	Overload Current (Time)	0	5999	10
40026	Current Unbalance (%)	0	99	0
40027	Current Unbalance (Time)	0	5999	10
40028	Motor Class	0	30	10
40029	Short Circuit X I	0	20	10
40030	Earth leakage start-up (mA)	0	10000	1000
40031	Earth leakage (mA)	0	10000	250
40032	Earth leakage (Time)	0	5999	10
40033	RS485	0	1	1
40034	Baud Rate	0	6	4 *See note 1*
40035	RS485 Address	0	247	247
40036	Infra Red Address	0	247	0
40037	Keypad access	0	127	127
40038	CT Quantity	0	3	3
40039	CT Ratio	0	2000	200
40040	CT Input	1	5	1
40041	VTRatio	0	33000	0
40042	Latch on Last Trip	0	1	0
40043	Alarm before Trip	0	1	0

40044	Return to Last State	0	1	0
40045	Mode	0	5000	0
40046	IO 1 4-20 H	0	20.0	0
40047	IO 1 4-20 L	0	20.0	0
40048	IO 2 4-20 H	0	20.0	0
40049	IO 2 4-20 L	0	20.0	0
40050	IO 3 4-20 H	0	20.0	0
40051	IO 3 4-20 L	0	20.0	0
40052	IO 4 4-20 H	0	20.0	0
40053	IO 4 4-20 L	0	20.0	0
40054	IO 5 4-20 H	0	20.0	0
40055	IO 5 4-20 L	0	20.0	0
40056	Delay after start	0	3600	0
40057	4-20mA output 1 Gain	0	2000	0
40058	4-20mA output 2 Gain	0	2000	0
40059	4-20mA output 3 Gain	0	2000	0
40060	Current Relay	0	5	0
40061	Delay Input A	0	999.9	0
40062	Delay Input B	0	999.9	0
40063	Delay Input C	0	999.9	0
40064	4-20mA 1 Low	0	999	0
40065	4-20mA 1 High	0	999	0
40066	4-20mA 2 Low	0	999	0
40067	4-20mA 2 High	0	999	0
40068	4-20mA 3 Low	0	999	0
40069	4-20mA 3 High	0	999	0
40070	4-20mA 4 Low	0	999	0
40071	4-20mA 4 High	0	999	0
40072	4-20mA 5 Low	0	999	0
40073	4-20mA 5 High	0	999	0
40074	Input 5 Delay	0	3600	0
40075	Input 4 Delay	0	3600	0
40076	Input 3 Delay	0	3600	0
40077	Input 2 Delay	0	3600	0
40078	Input 1 Delay	0	3600	0

Note 1The baud rate is interpreted as 0=600, 1=1200, 2=2400, 3=4800, 4=9600, 5=19200, 6=38400 bps
All input registers are 16 bit in length (high byte and low byte).
Example Pre start - 10 minutes =600 seconds
Send 600 Seconds as 0x02High byte and 0x58Low byte.

Example – Read all holding registers

Example - Slave address = 5

Read request

Slave Address	Function	Start Address Hi	Start Address Lo	No Points Hi	No Points Lo	CRC Lo	CRC Hi
05	03	00	00	00	43	04	51

Read response

Slave Address	Function	Byte Count	Data Hi	Data Lo	……..	Data Hi	Data Lo	CRC Lo	CRC Hi
05	03	86	XX	XX	XX	XX	XX	XX	XX

Example – Write to holding registers
Example - Slave address = 5

Write request

Slave Address	Function	Start Address Hi	Start Address Lo	No Registers Hi	No Registers Lo	Byte Count	Data Hi	Data Lo	CRC Lo	CRC Hi
05	10	00	00	00	XX	XX	XX	XX	XX	XX

Write response

Slave Address	Function	Start Address Hi	Start Address Lo	No of Registers Hi	No of Registers Lo	CRC Lo	CRC Hi
05	10	00	00	00	XX	XX	XX

10. Trending

About trending

The M550 motor protection relay offers trending of up to sixteen parameters. The interval is selectable from 100ms at start-up or 1 second to 18 hours during run, fault conditions or standby. The data is date and time stamped at regular intervals.

Parameters

Up to sixteen user selectable parameters include the following.

Rms voltage phase 1, 2, 3
Rms auxiliary voltage
Rms current phase 1, 2, 3
Earth leakage
Voltage unbalance
Current unbalance
Input 1, 2, 3, 4, 5 (digital switch, 4-20, temperature, pressure, liquid level)
Input/output 6, 7, 8 (digital switch, 4-20 output)
Input a, b, c (digital input)
Average voltage of the three phases
Average current of the three phases
Minimum voltage on the three phases
Maximum voltage on the three phases
Minimum current on the three phases
Maximum current on the three phases
Kilowatt phase 1, 2, 3
Power factor phase 1, 2, 3

Trending interval

The trending interval is user selectable from 100ms on start-up, 1 second to 18 hours any other time.

When to trend

The trending is user selectable to trend always, on start-up, in run or in alarm condition. Any combination of the above is allowed to enable the user to maximize the trending capability. If only start-up is selected, trending will only be active during start-up.

Memory size

The trending memory can store about 32000 parameters. If for example ten parameters are selected for trending and the interval is 1 hour then 32000/10=3200 hours (133 days) will be stored. If 3 parameters are selected at 10 second intervals then 32000/3=10666 events could be stored 10 seconds apart. 10666/360=29 hours will be stored.

If trending is selected at 100ms intervals for three parameters and for start-up only and the start-up time is 10 seconds, then the M550 will log 32000/3=10666, 10666/100=106 start-ups.

If the memory reaches its limit the old data will be overwritten storing the last 32000 parameters.

If the interval is selected at 1 hour the selected parameters are accumulated each second. After 1 hour the sum of the accumulated parameters are divided by 3600 to get the average of the selected parameters over 1 hour. The average is then stored to memory.

Some functions are available from the keypad (if enabled) or the infra red remote control. To use the functions enter the menu, change MODE and save. *See How to change the settings*

MODE 20   Starts the trend recorder
MODE 21   Stops the trend recorder
*MODE 22   Downloads the trend recorder to PC (**note 1**)*
MODE 23   Trend selections
MODE 61   Clears the trend recorder

Note 1. Select how many pages to download. A page consists of about 128 parameters.

Example of a page downloaded to a PC

V1	V2	V3	Amp1	Amp2	Amp3	PF1	PF2	PF3		
419	426	422	7.8	8.6	8.2	0.78	0.79	0.75	2005/11/28	16:40:46
418	425	421	8.6	9.0	8.5	0.76	0.79	0.75		
419	425	421	8.6	9.0	8.4	0.76	0.79	0.73		
419	425	421	8.6	8.9	8.3	0.76	0.78	0.71		
419	425	421	8.7	9.0	8.4	0.77	0.79	0.75		
419	425	422	8.7	9.0	8.4	0.76	0.79	0.76		
420	426	422	8.7	9.0	8.4	0.77	0.79	0.75		
420	426	422	8.7	9.1	8.5	0.76	0.79	0.72		
419	426	421	8.7	9.0	8.4	0.77	0.79	0.74		

The data downloaded from the M550 may be saved and opened with any spread sheet program for further analysis.

STARTUP 415V 5.5KW DOL
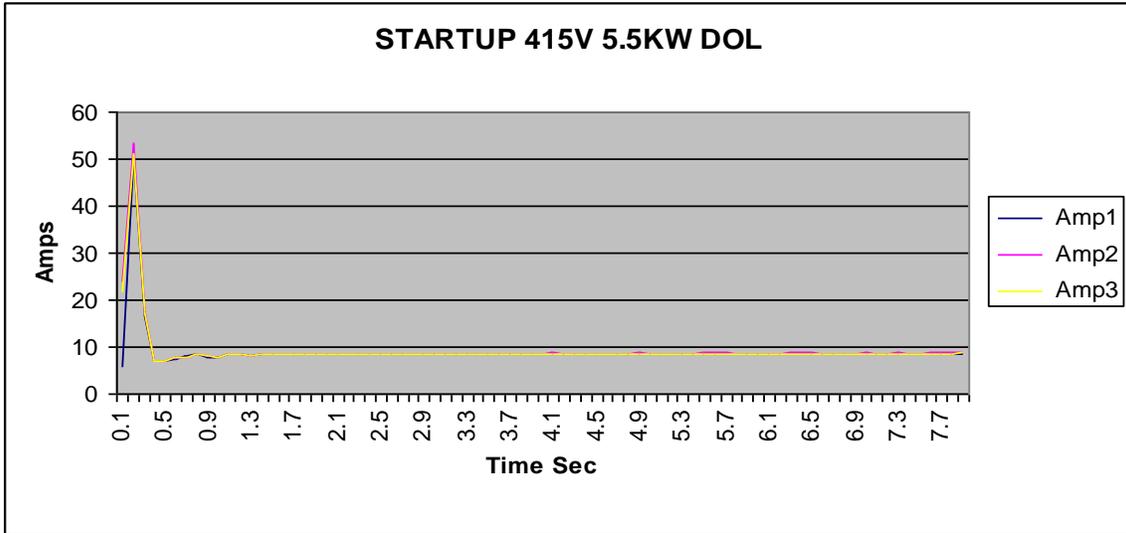
Figure 19 Example of a start-up trend
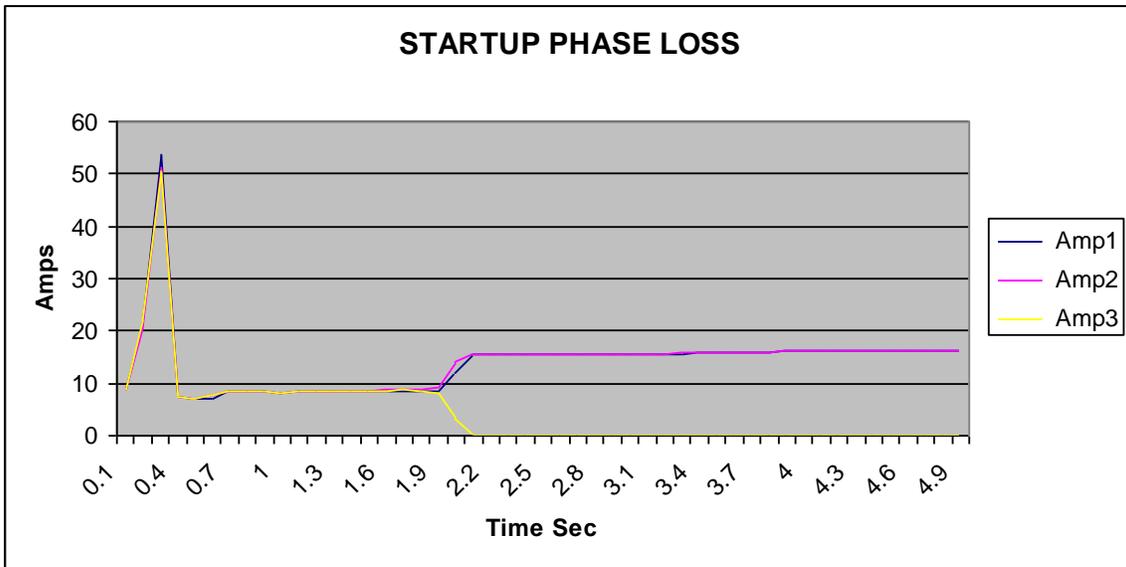
STARTUP PHASE LOSS

Figure 20 Example of a start-up trend with phase loss

2005/11/29 17:34
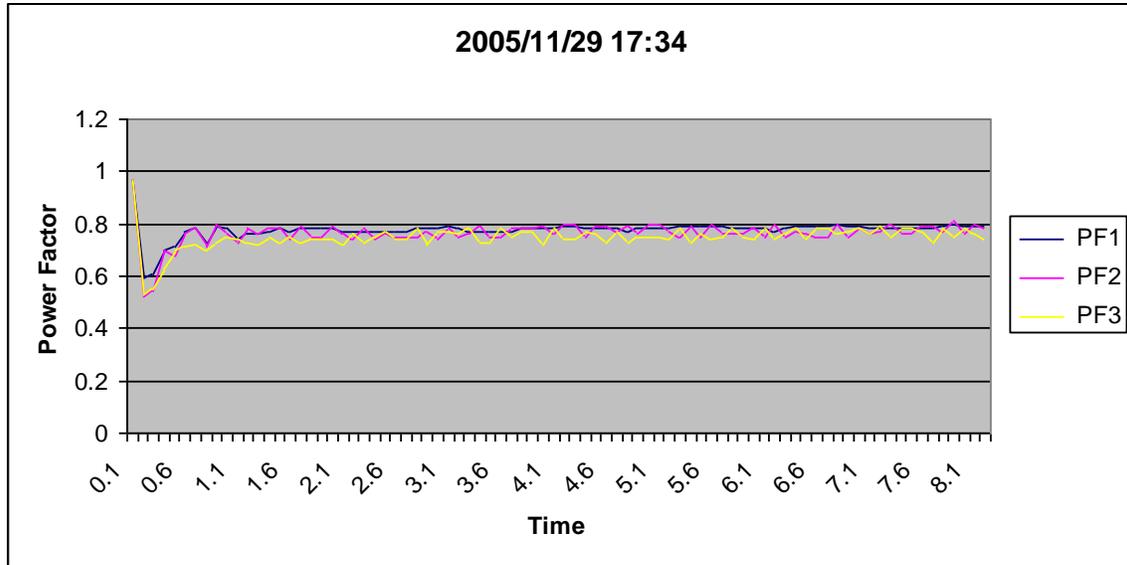
Figure 21 Example of power factor at start-up

Kilowatt/ Kilowatt hour meter

About kilowatt, kilowatt hour meter

This option must be enabled on the M550 before it is operational. Please contact the supplier.
The M550 measures true RMS voltage, current, power factor and energy on all three phases. The real power is measured for each phase and is available on the LCD screen and the INPUT registers. The power on the three phases is accumulated and then stored in the non volatile kilowatt/hour meter.

The readings are available on the LCD. To display the readings enter the menu, change MODE and save. *See How to change the settings*

MODE 7   Displays the kilowatt/hour meter on the bottom of the LCD
MODE 8   Displays the kilowatt per phase and the kilowatt/hour meter on the bottom of the LCD
MODE 81   Clears the kilowatt/hour meter

11. Data Recording

About Data Recording

The M560 motor protection relay stores all input register values with date and time stamps. Due to the fact that the M560 runs a second count there will be three to four samples captured per second, this allows for a more precise analysis of the running conditions.

The values are stored directly to the SD Card in a CSV format, with a single file created for every day that the unit is recording, Recordings take place during prestart, start-up, run and during fault conditions.

All columns storing data as reference codes can be matched to the relevant table associated with the same register under the Modbus section.

It is recommended to use a 2,4 or 8Gig micro SD card. When formatting the micro SD card it is recommended that the SD Card Label be set to the serial number of the M560 it is to be used on as the M560 does not have the ability to read the serial number off the core CPU.

Possible Issues

There may be some issues in getting the configuration and settings loaded onto or off of the M560. In the event that this is the case the Unit should be powered down and the SD card removed, the unit can now be powered up and the configuration and settings programs should function without any interference from the recoding section. Once configuration and settings have been updated the unit can be powered down and SD Card inserted for normal operation.

12. Software Installation

The M550 can be controlled and configured from PC based Software supplied with the unit.

Software Installation

The software can only be installed on Windows operating system, Administrator rights are required for the process to be completed.

1. Insert the CD into the computers CD-ROM, ensure that you are using the latest software on the CD M550_V20120918
2. If the PC is set to auto run CD's you will be presented with the following screen

Select Run M550Installation.exe

If not, open My Computer and then select the CD Drive and double click on the M550Installation.exe

3.   You will now be prompted with a Licence Agreement.
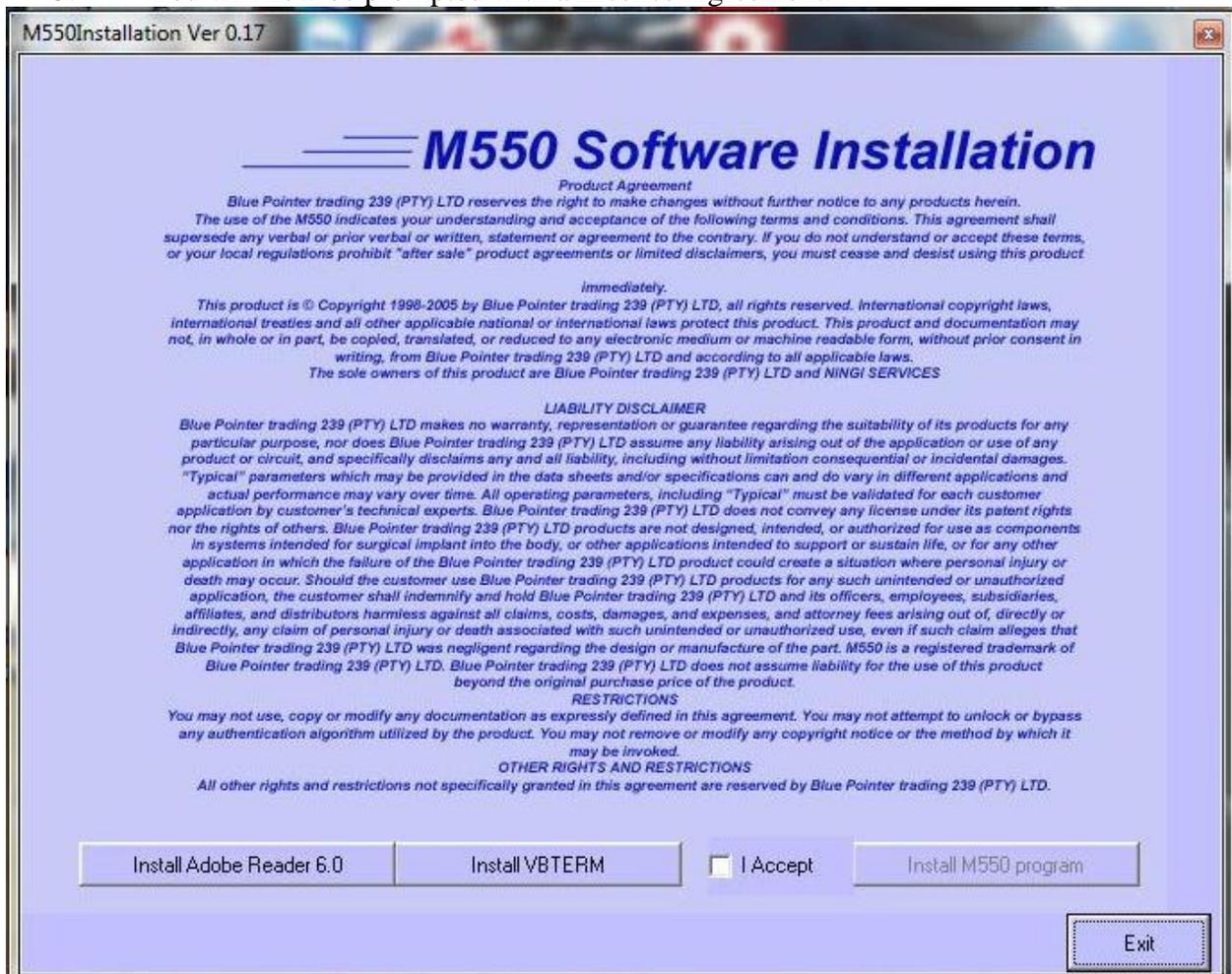
4. On the Licence agreement first click on the Install VBTERM icon, this component is required for new installations of the M550 software only, if you already have VBTERM loaded it is not necessary to load it again.

5. The following screen will popup initiating the installation of VBTERM, click on OK
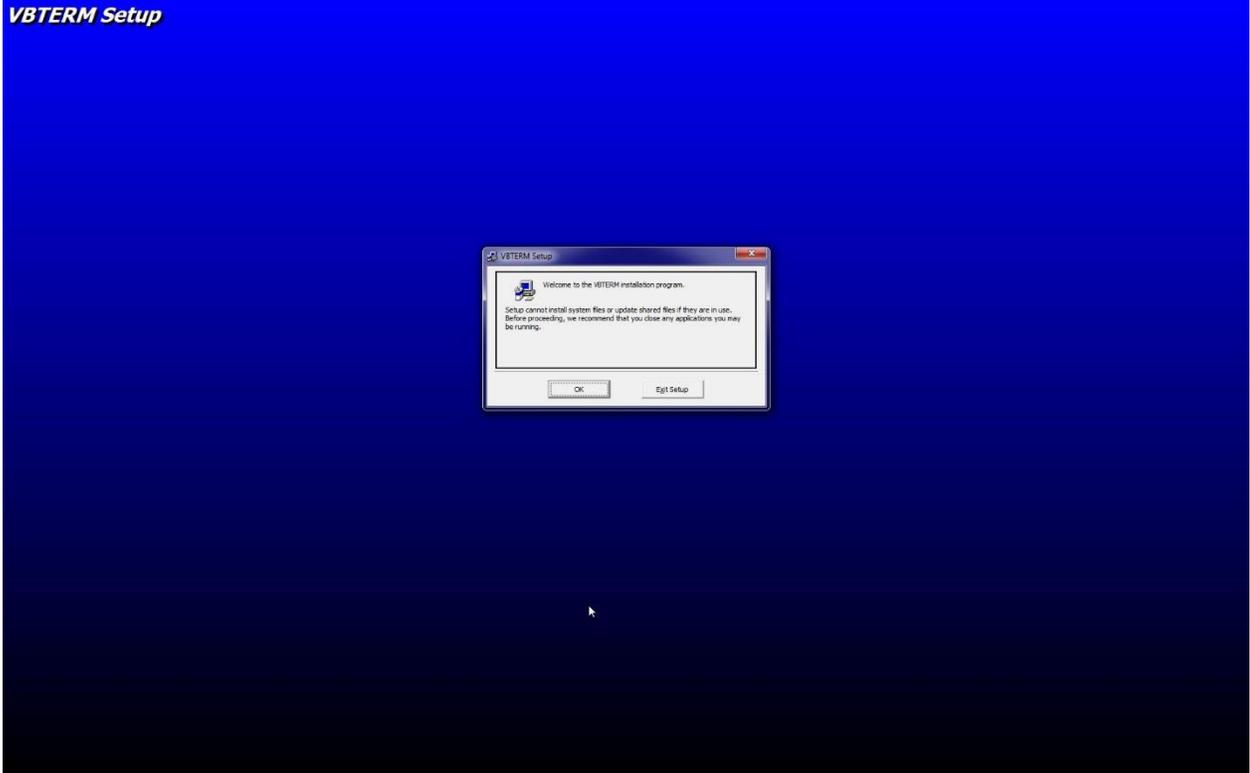
6. Click on the Icon of the Computer to start the installation
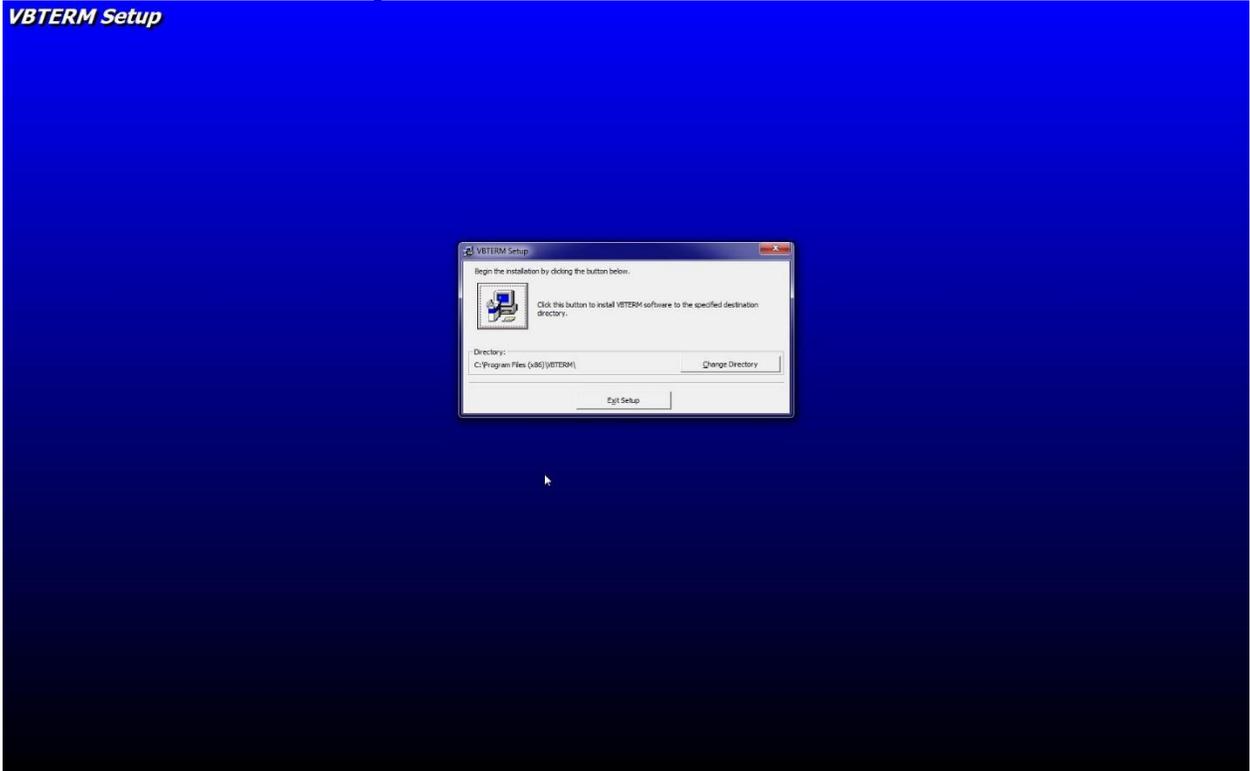
7.   Click on the continue icon

8.   This screen will indicate the completion of the VBTERM installation, click on OK

9.   You can now select the I Accept box of the Licence agreement, and click on Install M550 Program

10.   Click on Next

11.   Select the drive you would like to have the software installed to and click on Install
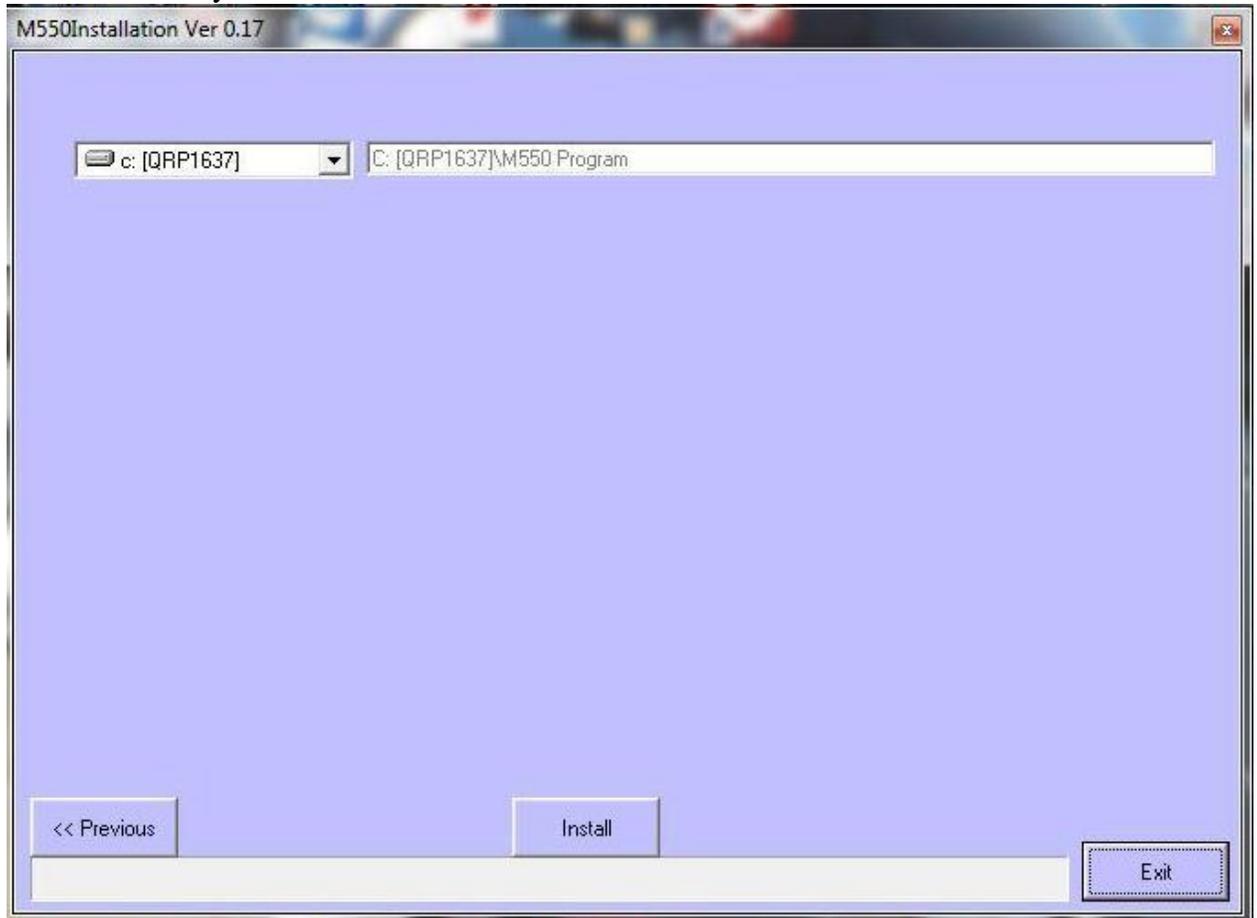
12.   Select the sections of the Program you would like to password protect. We recommend at least protecting the Programming portion, and click on install
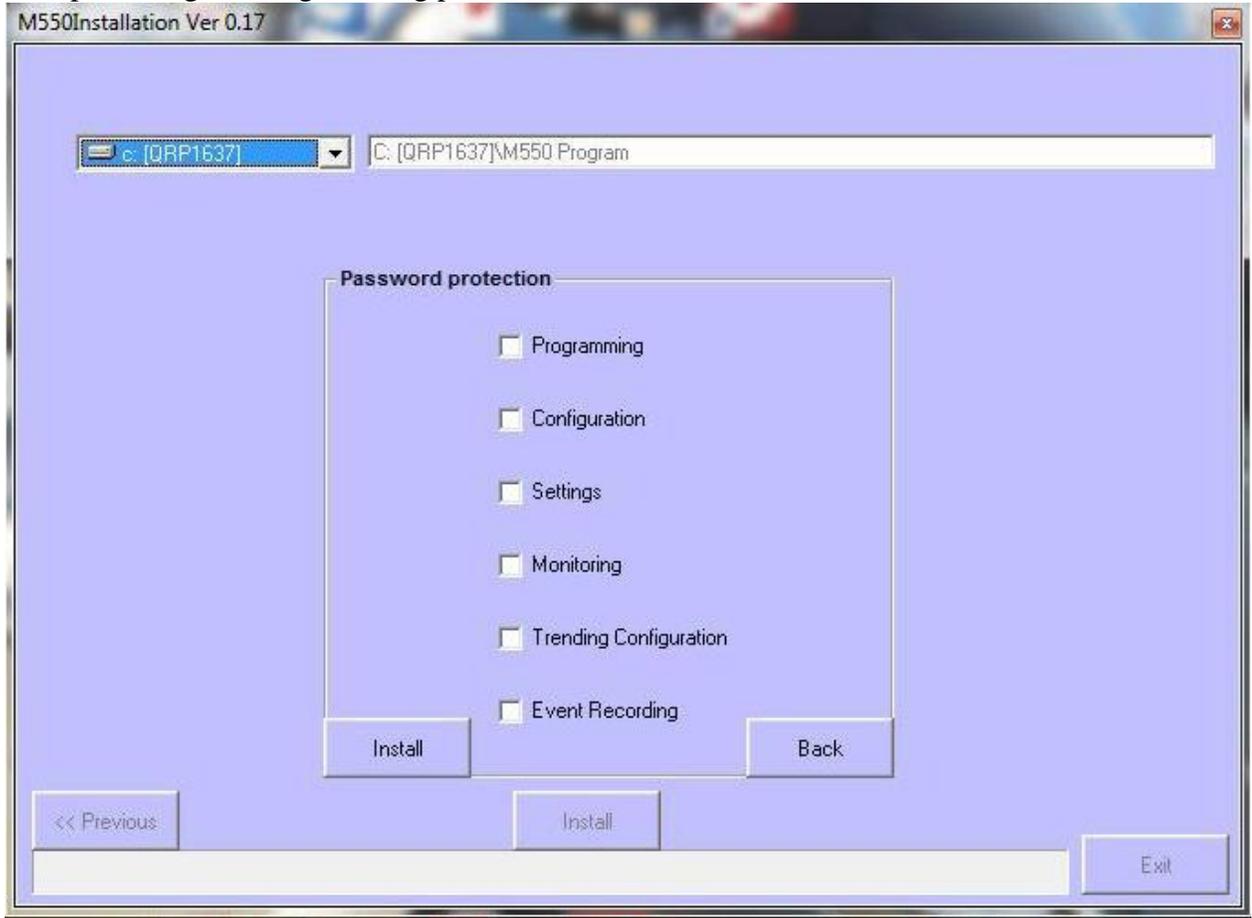
13.   Enter a password and click on ok
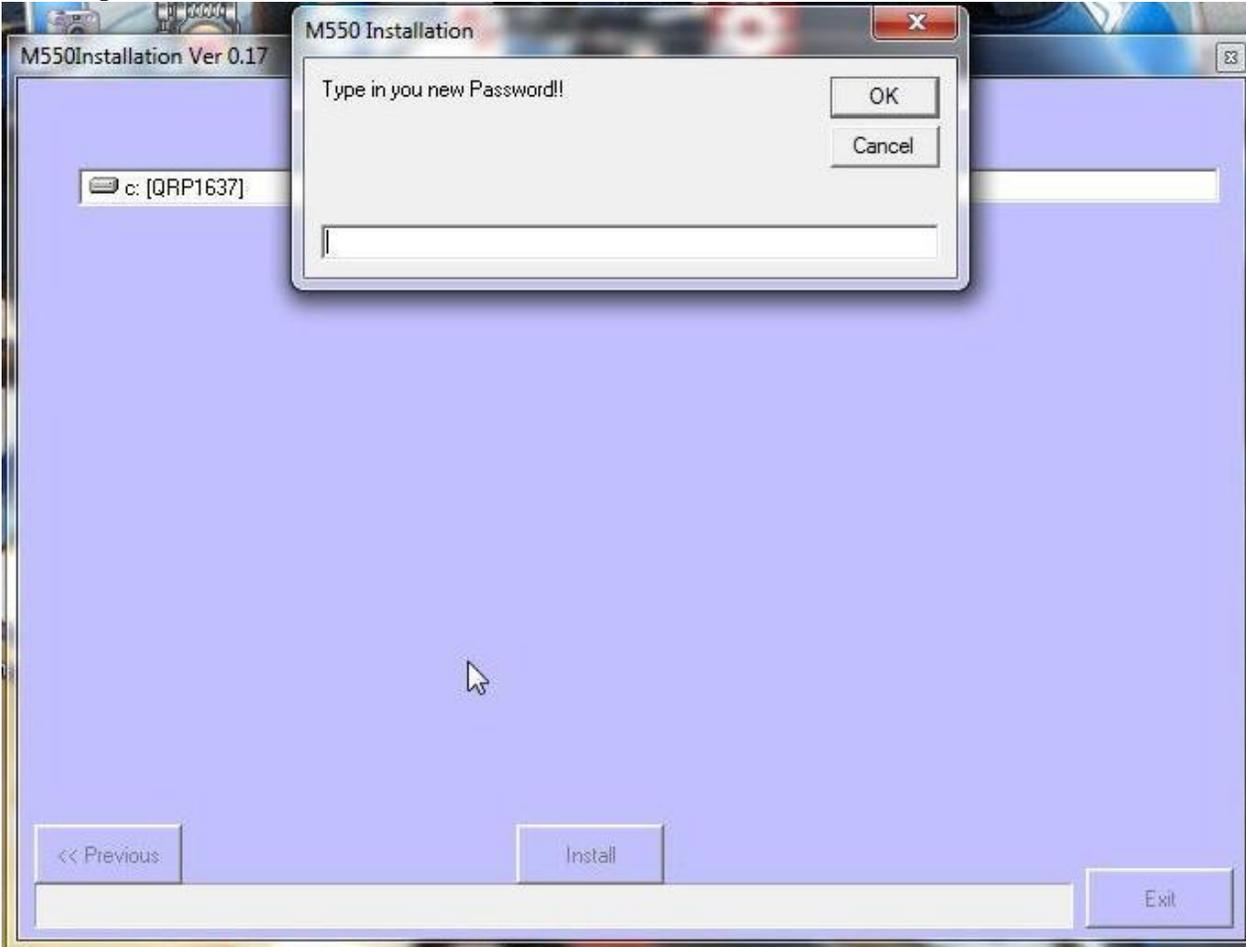
14. Re-enter the password to confirm that it was typed correctly and click on ok
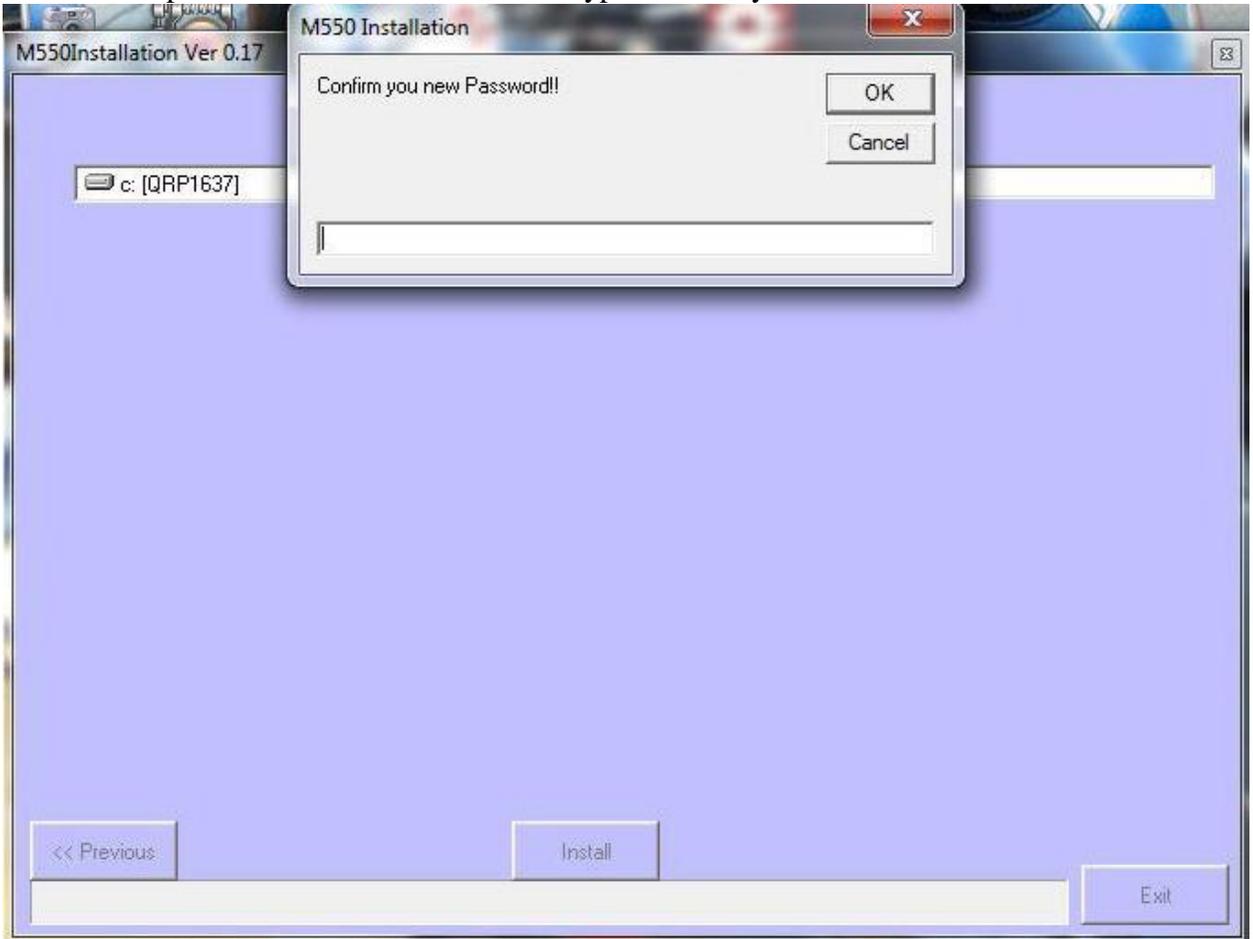
15. The progress bar will show how far the installation is.
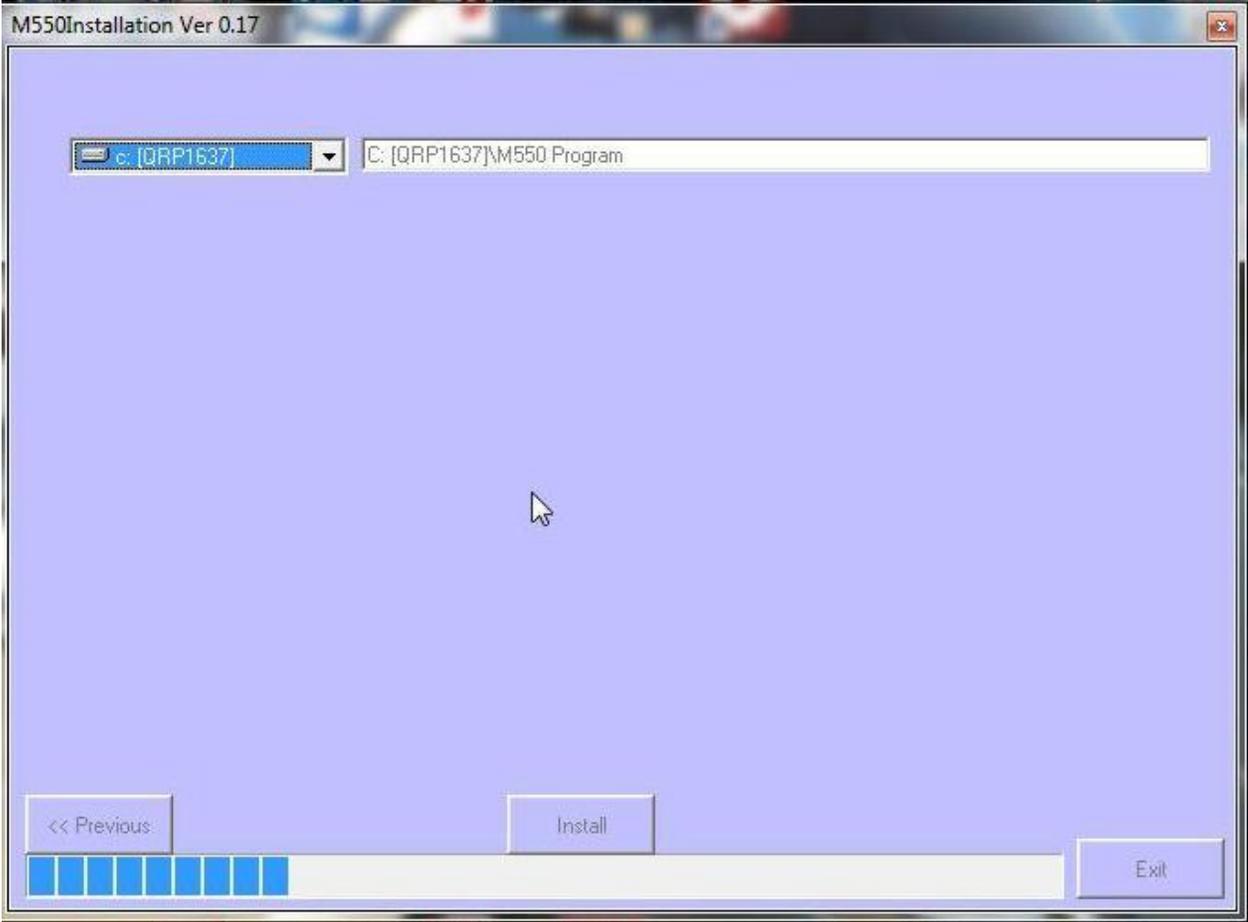
16.   Once the Progress bar is full and the popup window shows "Installation complete!!!" click on ok.
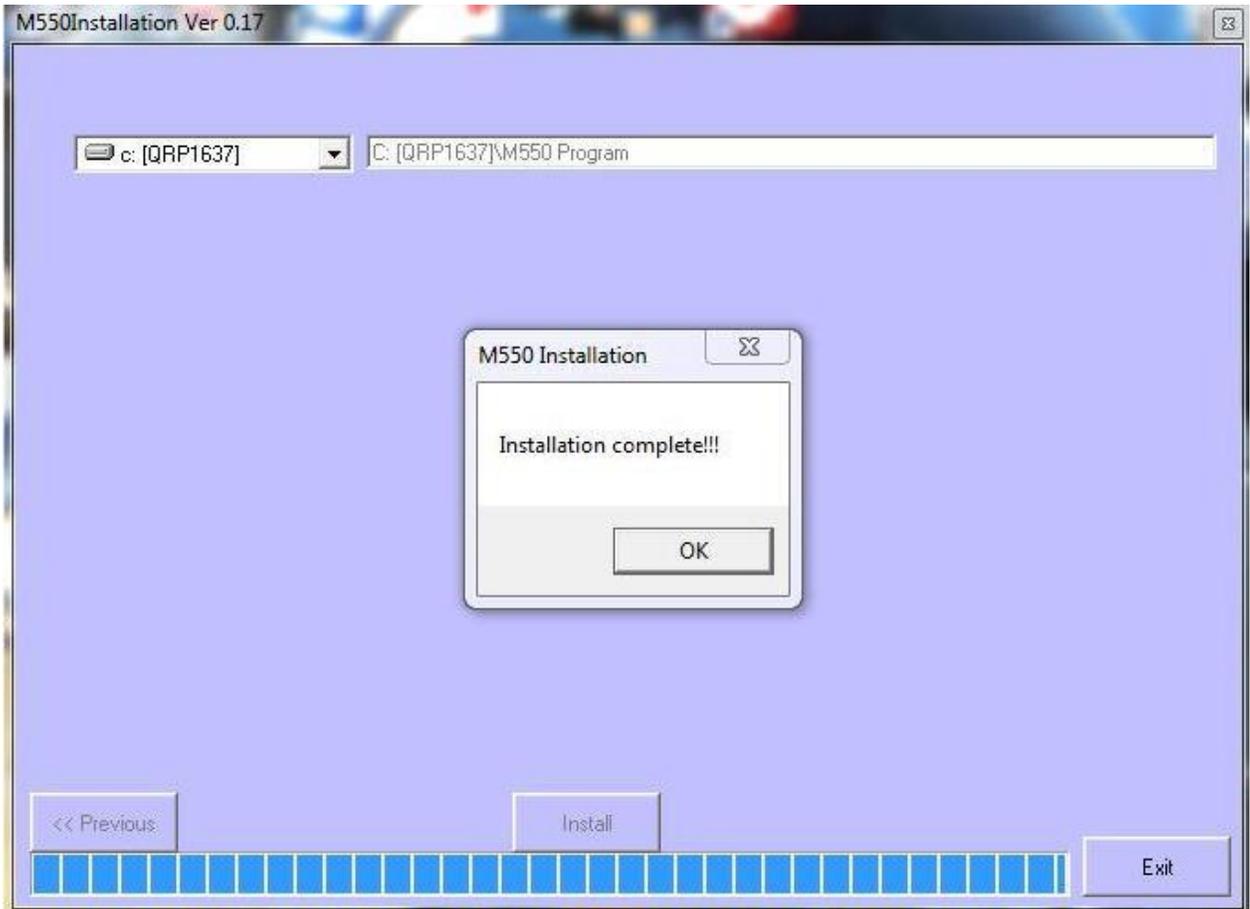
17.   The installation has been completed and M550 Main.exe – Shortcut has been added to your desktop. If no shortcut is created program can be found under the following directory C:\M550 Program\M550 Main

M550 Driver Installation (Windows 7)

1.   When the M550 is connected to the computer, it will detect a device and fail to load the drivers.

2.   Go to computer properties in one of the following manners
   a. Click on start, click on control panel, click on system
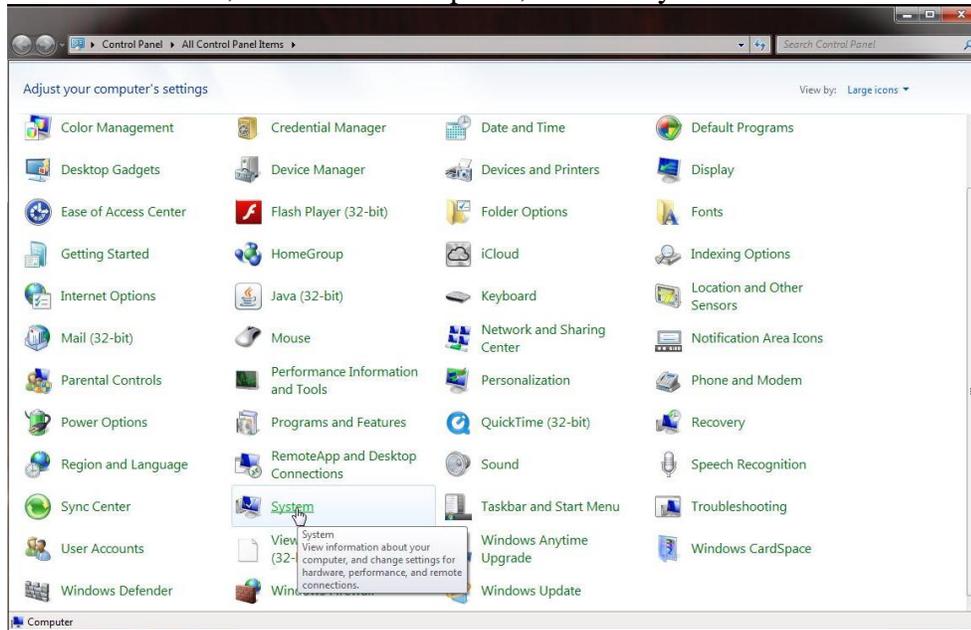
   b. Click on start, click on control panel, click on System and Security
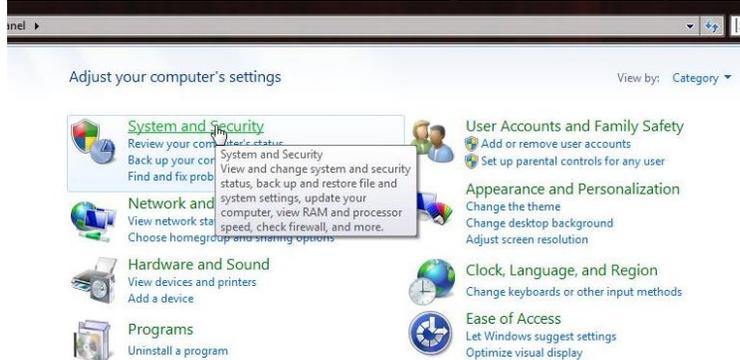
c.   Click on system

d.   Right click on My computer on the desktop and click on properties

e.   Click on Start, right click on Computer and select properties
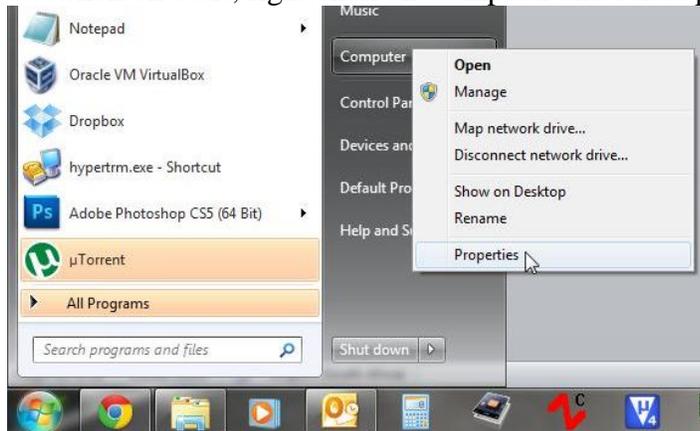
3.   This will bring up the View basic information screen
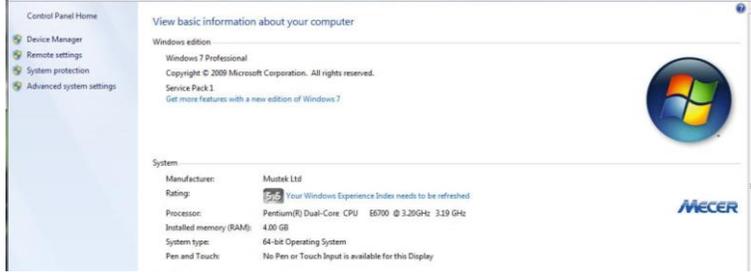
4.   On this screen make a note of the System type, either 32-Bit or 64-Bit; you will need this information later.

5.   In the Left hand menu click on device manager.

6.   This will open up the device manager screen
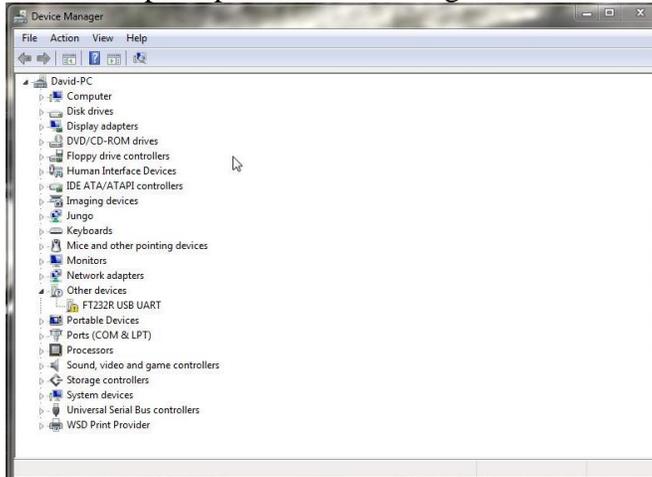
7.   In the device manager screen you will see either a M550 Icon with a yellow exclamation mark, or a M550 Icon with a red cross or a FT232R USB UART with a yellow exclamation mark.

8.   Right click on the Icon and select Update Driver Software

9.   Select Browse my computer for driver software
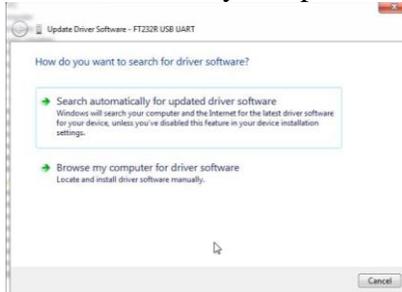
10.   Click on Browse

11. Click on the CD drive, then on the FTDI driver folder 2012-09-18 and click OK
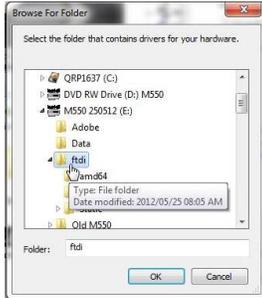
12.   Click on Next

13.   The screen will show installing driver
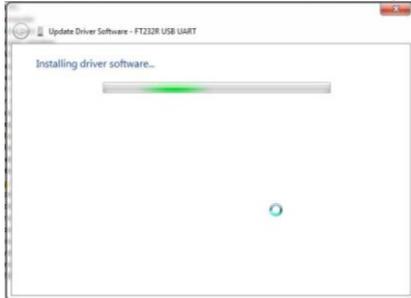
14.   Once it is completed it will show USB serial Converter
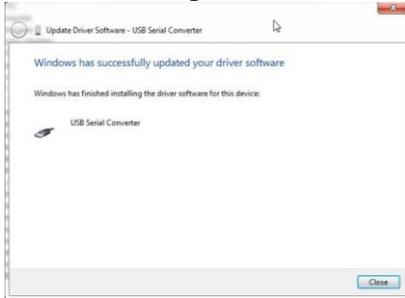
15.   Click on Close

16.   The computer will detect a device and fail to load the drivers
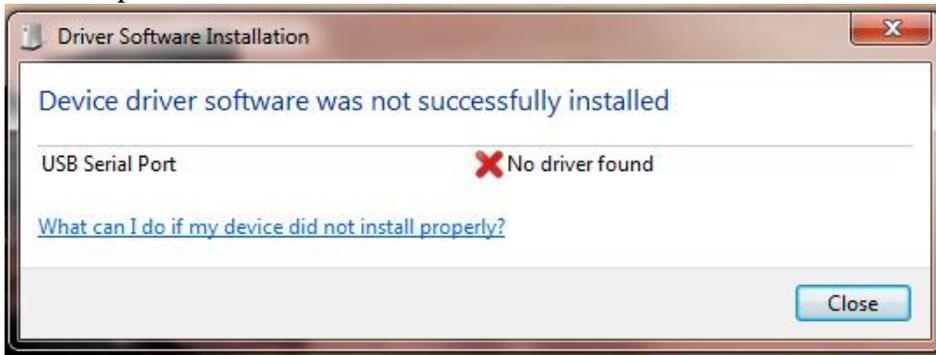
17.   In device Manager you will see a USB Serial Port with a yellow exclamation mark.
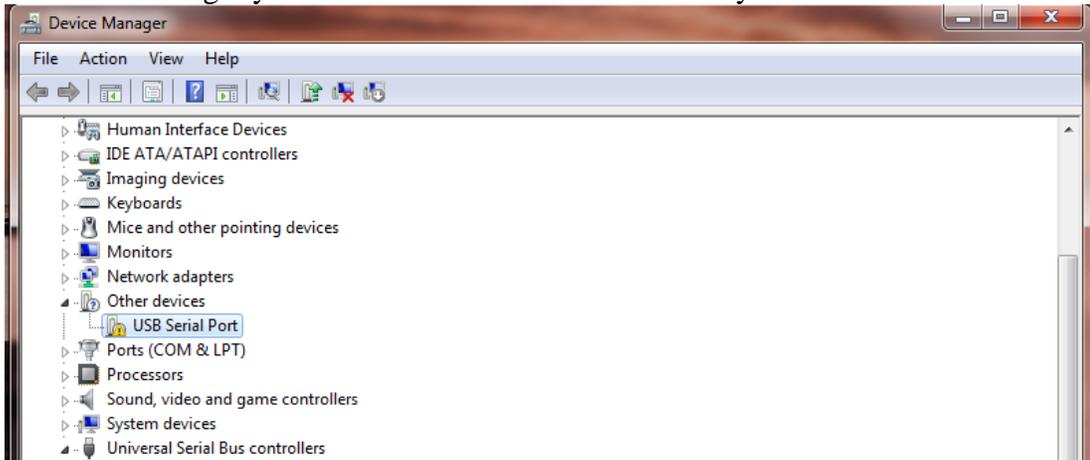
18.   Righ click on the USB Serial Port and select update driver
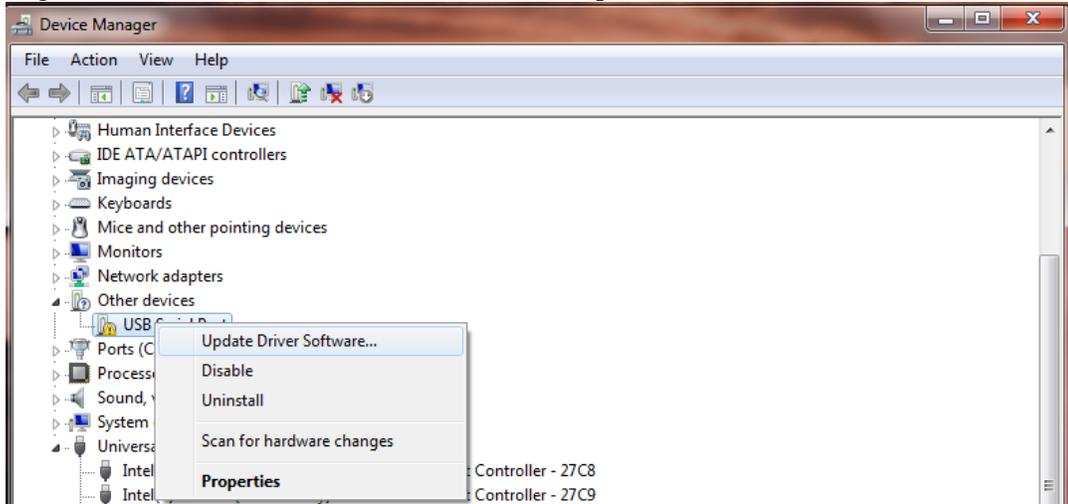
19.   Select Browse my computer for driver software
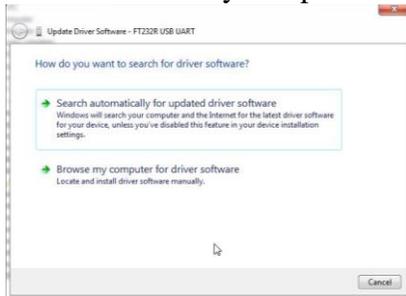
20.   Click on Browse
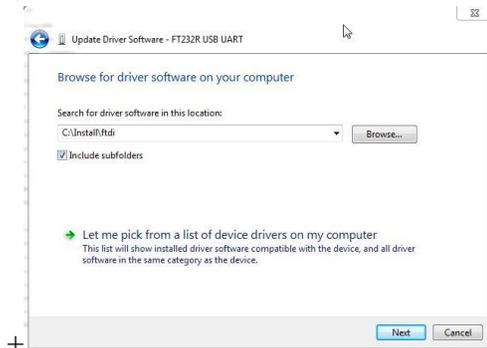
21.   Click on the CD drive, then on the FTDI driver folder 2012-09-18 and click OK
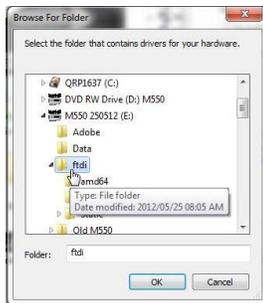
22.   Click on Next

23.   The screen will show installing driver
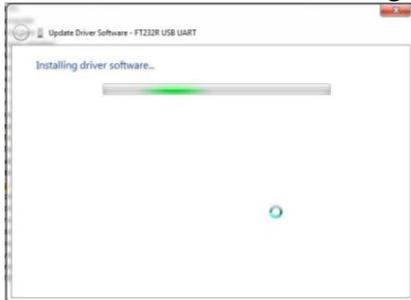
24.   Once it is completed it will show USB serial Port or M550 depending on driver thats loaded
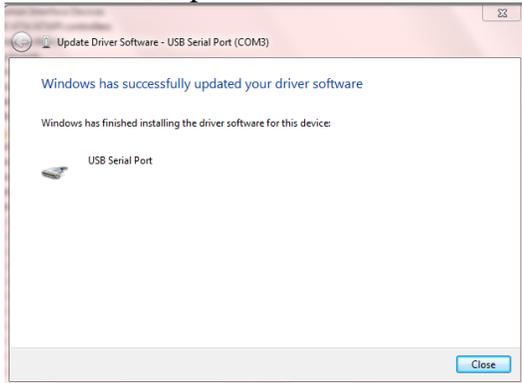
25.   You can close Device Manager
26.   Your M550 software in now ready to be used

13. Electrical specifications

	Min	Typical	Max	Unit
Control voltage	85		265	VAC
Control voltage		24		VAC
Control voltage		15 - 30		VDC
Power consumption		2	5	VA
Phase input voltage (with voltage converter)	0		1700	VAC
Phase input voltage (with VT secondary)	0	110	850	VAC
Phase voltage sample rate		32000		S/Sec
Phase voltage accuracy			1	%
Relay contacts (2 x CO, 3 x NO)	40		240	VAC
Relay contacts (2 x CO, 3 x NO)	0.1		10	A
CT input 1A selected continuous	0	1	25	A
CT input 5A selected continuous	0	5	25	A
CT input 1A selected 1 Sec			70	A
CT input 5A selected 1 Sec			70	A
Current measurement sample rate		32000		S/Sec
Current measurement accuracy			1	%
Earth leakage input (core balance secondary)	0.001		5	A
Earth leakage measurement range	0.03		10	A
IO 6,7,8 selected as inputs	0		24	VDC
IO 6,7,8 selected as 4-20 MA outputs	0		27	VDC
IO 1,2,3,4,5 selected as 4-20MA inputs	0		33	MA
IO 1,2,3,4,5 selected as binary inputs	0		27	VDC
Input A,B,C	0		48	VDC
Communication channel RS485 (MODBUS RTU)	600		38400	Bps

14. Example Schematic
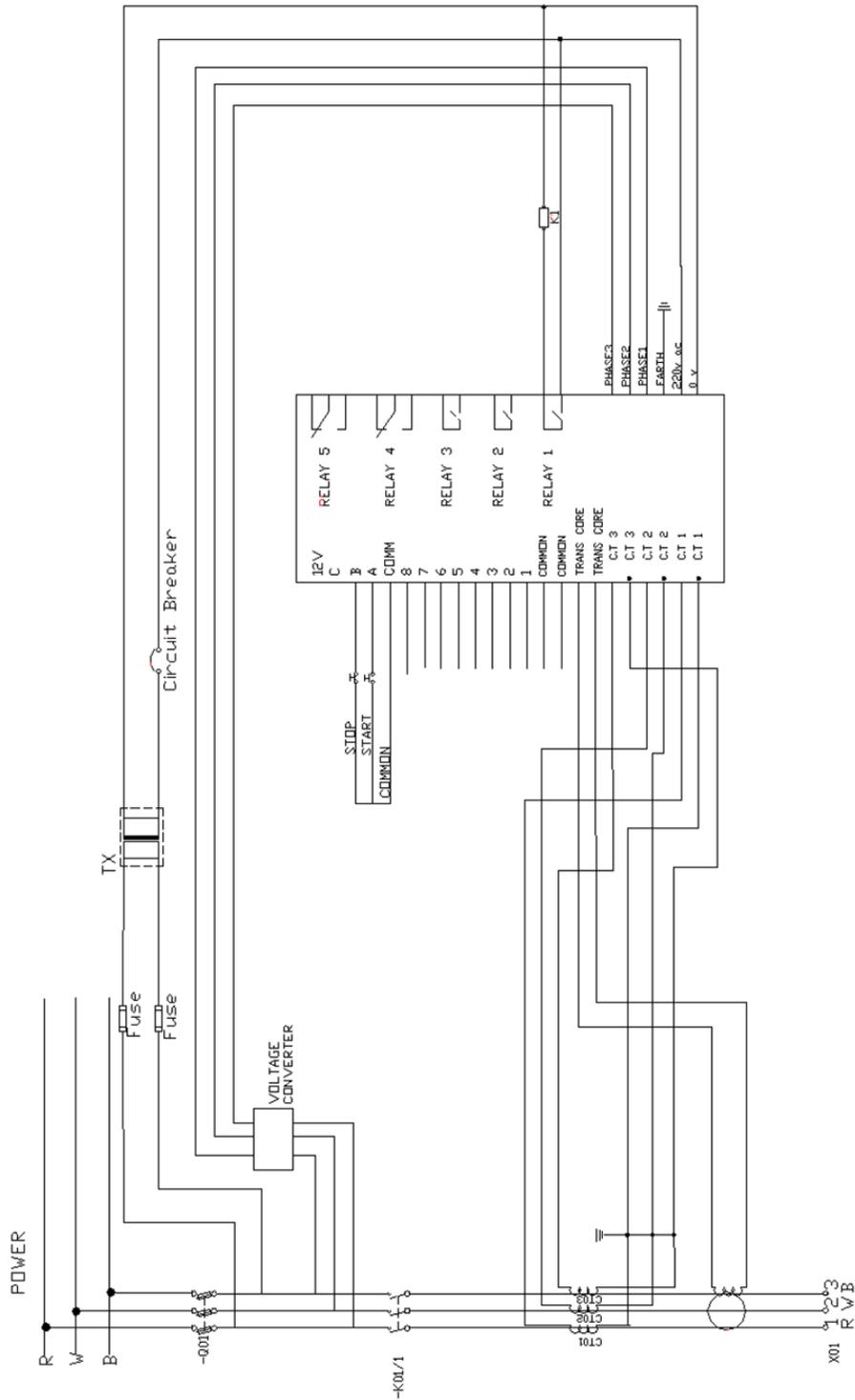
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