FEEDERVISION
THE INTELLIGENT GENERATION

FEEDERVISION 2 (FV2)
(Inc. TFV2, EFV2 & FPC)
Technical Manual

P&B Engineering (UK) Ltd
Boundary Street
Manchester
M12 5NG

t +44 (0)161 230 6363 **f** +44 (0)161 230 6464 **w** www.pbeng.co.uk **e** mail@pbeng.co.uk

PBSI GROUP

Contents

1. P&B Feedervision 2 (FV2).

The P&B FV2 is a highly sophisticated microprocessor based feeder protection and control unit, specifically designed to be used on low or medium voltage feeders as an integral part of any type or manufacture of distribution equipment. All of the latest features are included in the FV2 to allow total control, protection and monitoring of distribution and transformer feeders either by direct hard wire inputs or via the RS485 serial port, optional RS232 front port or optional Profibus.

FV2 can be used to control air circuit breakers, vacuum circuit breakers and contactors and true RMS current sampling at less than 1msec intervals enables the unit to be used in conditions where the measured current has a high harmonic content.

FV2 monitors current and voltage inputs to provide a comprehensive feeder protection package. This is combined with all the necessary control and monitoring functions and a high-speed communications facility. The unit is a small easily installed package supplied at a very competitive cost, which makes FV2 the most attractive Feeder Protection and Control device available today.

All hard-wired control inputs are connected to the device via optically isolated inputs to enable all opening, closing and tripping commands to be carried out by the unit. Status of all individual hard-wired contacts is also provided both locally via the liquid crystal display and remotely via the RS485 communications port.

All Setting parameters are programmed independently for each unit via the integral keypad and liquid crystal display on the front plate or via the RS485 communications port and the PC based software package available for the FV2 series of products.

During operational conditions the LCD also gives access to accurate load, statistical and fault data such as; Volts, Phase Amps, Time to Trip, In Service Hours, Number of operations.

Large Light Emitting Diodes mounted on the front plate give visual indication of the breaker status i.e. OPEN/CLOSED/TRIPPED and ALARM/TRIP/HEALTHY conditions etc.

Flexible high speed control via PLC or DCS systems is obtained through the FV2's RS485 communications port, allowing computer access to full control and monitoring of feeder data, including: measured data, statistical data and control input status.

Note:
Relay references:
Standard Feedervision is referred to throughout as FV2, when the FV2 is fitted with the TCS functionality it is then referred to as TFV2, EFV2 is the reference for the Feedervision fitted with additional digital inputs, relay outputs and TCS.
The FPC relay operates in the same manner as the FV2 with the exception that the relay is equipped only with a single VT input and the additional options of TCS and extended I/O are not available as the FPC is mounted in a smaller case size.
For FPC users, the FV2 manual should be read as applying directly to the FPC relay unless stated otherwise.

Protection Functions.

Undervoltage Protection.
Overvoltage Protection.
Earth Fault 1 High Set (HS) Protection.
Earth Fault 1 Protection
Load Increase Protection
Overcurrent 1 Protection
Overcurrent 2 Protection
Low Set (LS) Overcurrent Protection
High Set (HS) Overcurrent Protection
OverPower Protection
Overfrequency Protection
Underfrequency Protection
Break fail Protection
Programmable External Faults 1 to 15
Serial Timeout protection
Internal Error Protection
Trip Circuit Supervision (Optional)
Synchronisation (Extended Feedervision 2 (EFV2))

Displayable Feeder Data.

Phase Current.
Earth Fault Current.
Standby Earth Fault Current.
Phase Volts
Phase Power kW
Phase Power Factor
Phase Apparent Power
Phase Real Power
Kilowatt Hours
Total Power
Transducer Output (4-20 mA), (Optional)
Total Hours in Service
Hours since closure
No. of Operations
Time to Trip
Sync Voltage and Angle of Sync (Extended Feedervision 2 (EFV2))

Displayable Feeder Status.

Open / Closed
Healthy / Fault.
Service / Test
Alarm - Description - Pre-Alarm Values.
Trip Description - Pre- Trip Values.
Auto / Manual Mode.

Control Functions.

Via Hardwired inputs:
Open, Close, Reset, Local/Remote Select, Auto/Manual Select

Via Comms input:
Open, Close, Reset, Set/Clear Inhibit

Control Output Relays.

Output Relay #1 (Close), Output Relay #2 (Trip), Output Relay #3 (Programmable), Output Relay #4 (Programmable).

Output Relays 5-8 (programmable) (Extended Feedervision 2 (EFV2)).

Some of the Output Relays (1 and 2) are pre-set. Others can be programmed by the user. They can be programmed as follows: -

Not Used, Warn1, Warn 2, Alarm, Indicator 1, Indictor 2, Indicator 3, Indicator 4, Alarm FS, Indicator 1 FS, Indicator 2 FS, Indicator 3 FS, Indicator 4 FS, Dead bus, Healthy Bus, Serial Available Panel Available, Remote Available, Available, Trip & Lockout, Follow A, Follow B.

2. Technical Specification.

Power Supply.

Auxiliary Power Supply & Low Voltage Power Supply	
AC Nominal	Range 80 – 265V AC / DC Range 24V AC / 24-48V Dc (Low Voltage Power Supply Optional Extra)
Frequency	45 - 65 Hz
Maximum Power Consumption	10VA, 15VA Nominal

Measurement.

Phase Current Measurement	
Method	True RMS, Sample time <1ms
Range	0.1 to 16x Phase CT Primary Amps
Full Scale	16 x Phase CT Primary Amps Setting
Accuracy	± 3% at Phase CT Primary amps
Earth Phase Current Measurement	
Method	True RMS, Sample time <1ms
Range	0.05 to 2.0x E/F CT Primary Amps
Full Scale	2.0 x E/F CT Primary Amps Setting
Display Accuracy	± 3% of Reading Over Range
Pick Up accuracy	± 3% of setting
Voltage Reference Measurement	
Suitable for connection preferably via isolating transformers (VT) or direct connection to max phase to phase system voltage not exceeding the rated voltage.	
Method	True RMS, Sample time <1ms
Rated Insulation Voltage	1000V
Range	90 – 750V AC
Display Accuracy	± 3%
Power accuracy	± 5% of Nominal
VT Burden	0.01 VA

Protection Functions.

Overload Alarm and Trip Curves	
Fault Time Accuracy	± 200mS up to 10 seconds ± 2% of trip time over 10 seconds
Threshold Current Level	Overload Setting ± 2%
Earth Fault Time Delay	
Earth Fault Trip	0.1 to +0.2 sec. for less than 1 second
Total Run Time	Accuracy ± 2%
Time Delays	
Accuracy	± 0.5 seconds or ± 2% of time
Exceptions	
Earth Fault Trip	+150mS,-0.0@ 1.1 x setting +60mS,-0.0@ 2 x setting +40mS,-0.0@ 5 x setting
Total Run Time	Accuracy ± 2%
Auto Restart delay on Restart Time	± 0.2 seconds

Relay Contacts Ratings.

Output Relays	
Rated Load	12A @ 120 AC 12A @ 28V DC
Maximum Operating Voltage	330V AC
Max Making Current	1.2A
Max Breaking Current	100-200mA

3. Environmental Tests.

CLIMATIC	TEST STANDARD	SEVERITY LEVEL
Temperature Dry Cold Operational	IEC 60068-2-1	-20 deg C ,96 hrs
Temperature Dry Cold Transportation & Storage	IEC 60068-2-1	-40 deg C , 96hrs
Temperature Dry Heat Operational	IEC 60068-2-2	+60 deg C , 96 hrs
Temperature Dry Heat Transportation & Storage	IEC 60068-2-2	+85 deg C , 96 hrs
Damp Heat Steady State	IEC 60068-2-30	95% Non-condensing, Cyclic Test Db
Enclosure	IEC 60529	front IP52 , rear IP00
MECHANICAL		
Vibration	IEC60255-21-1	Class I
Shock & Bump	IEC60255-21-2	Class I
Seismic	IEC60255-21-3	Class I
ELECTRICAL		
Insulation resistance	IEC 60255-5	500 Vdc , 5 secs
Dielectric Test	IEC 60255-5	Series C of table 1 2.5 kV 50Hz , 1 min 1.0 kV open contacts , 1 min
High Voltage Impulse	IEC 60255-5	5 kV peak 1.2/50uS,0.5J 3 pos , 3 neg
Voltage Dips , Short Interruptions & Voltage variations immunity	IEC60255-11 IEC 61000-4-11	3 dips & 3 interruptions at 10 sec intervals of duration between 10mS and 500mS at zero crossings. Variations 40% &70%
Ripple in dc supply	IEC 60255-11	12% ac ripple
VT input Thermal Withstand		120% Vn , continuous
CT input Thermal Withstand		250xIn half wave,100xIn for 1 second 30 xIn for 10 second , 4 xIn cont.
ELECTROMAGNETIC COMPATIBILITY		
Electrical fast Transient/Burst	IEC 60255-22-4 IEC 61000-4-4	Class IV-4.0kv Power supply Class III -2.0 kV Other inputs 1 min each polarity
Oscillatory Waves 1 Mhz Burst	IEC 60255-22-1	Class III Longitudinal 2.5 kV , 2sec Transverse 1.0 kV , 2 sec
Electrostatic Discharge	IEC 60255-22-2	Class III 8 kV contact 15kV air discharge , 10 discharges at 1 sec intervals
Conducted Disturbance RF fields	IEC 61000-4-6	0.15 to 80 Mhz Severity Level 10Vrms +sweeps 0.05-0.15MHz & 80-100MHz
Radiated e-m field from digital portable telephones	ENV 50204	900 & 1890mhz at 10V/m
Radiated RF e-m field immunity test	IEC 60255-22-3	ClassIII test method A +sweep 500-1000mhz or IEC 1000-4-3 80-1000mhz severity 10V/m 80% modulated 1 kHz
Surge Immunity	IEC 61000-4-5	4kV common mode 2kV differential mode , 1.2/50uS
Power Frequency Magnetic Field	IEC 1000-4-8	1000A/m for 1 sec 100A/m for 1 minute
Pulse Magnetic Field	IEC 61000-4-9	6.4/16uS , 1000A/m
Damped Oscillatory Magnetic Field Immunity	IEC 61000-4-10	0.1 & 1.0 Mhz , 100A/m
Conducted & Radiated RF Interference Emission	EN55022 or EN55011or EN50081-2	Class A interference limits
Power frequency conducted immunity, common mode	IEC 61000-4-16 IEC 60255-22-7	DC to 150kHz sweep test level 4 300V at 16 2/3 & 50/60Hz

4. FV2 Terminations.

External connections are made using Phoenix type terminals grouped in plug in sections, CT inputs are screw terminals, these are suitable for accepting 2.5 sq. mm wire. Pre-wiring can be carried out prior to fitting into the switchgear. All other Phoenix terminals are suitable for accepting 1.5 sq. mm wire.
See Appendix 1 for terminal assignment.

5. FV2 Analogue Inputs.

Power Supply Live

The FV2 requires an AC or DC Voltage to supply the unit. A separate AC/DC voltage is required to supply the digital inputs (Control Supply), this can be taken from the Auxiliary Supply, or a completely isolated supply can be used.

The FV2 can also be fitted with a Low Voltage Power Supply (PSU) and / or Low Voltage digital inputs. See section 3.1

Voltage Reference.

The FV2 monitors three phase voltage which can be directly connected for voltages up to 415V. With the use of Voltage Transformer the FV2 can monitor voltages up to 33kV. FV2 will display the phase to neutral and phase to phase voltages of the primary system.

Note: On the FV2 the single voltage reference connector is redundant, on the EFV2 this connector is used for the check sync application which can be connected phase to neutral or phase to phase.
FPC does not have three phase voltage inputs and relies upon the single input connection (either phase to neutral or phase to phase) to monitor voltage and determine energy values.

Conventional Current Transformers.

The FV2 has provision to allow connection of standard 1, amp or 5 amp secondary current transformers. The Earth fault measurement can either be a residual connection from the three phase CT's, an internal residual earth fault or via a Core Balance Current Transformer (CBCT).

Overcurrent Poles.

The FV2 allows the connection of either of the following:

Two Phase Current and Two Earth Fault Phases
Three Phases Current and One Earth Fault Phase.

In the case of Two Earth Fault Phases the currents in Phase I1 and I2 are measured from the RED and YELLOW phase. I3 is calculated from the readings of I1 and I2. (I3 is the NEGATIVE VECTOR SUM of I1 and I2). This is to allow the connection of Earth Phase Currents, Istby and Ie.
See Appendix 3 for wiring diagrams)

6. FV2 Control Outputs.

Output Relays.

The FV2 has 4 output relays, which can be assigned as follows:

OUTPUT RELAY NUMBER	ASSIGNED OUTPUT RELAYS
1	CLOSE
2	TRIP
3	Programmable
4	Programmable

OUTPUT RELAY NUMBER	ASSIGNED OUTPUT RELAYS (EFV2 Only)
5	Programmable
6	Programmable
7	Programmable
8	Programmable

Output Relays 1 and 2 are pre set to CLOSE and TRIP. Relays 3 and 4 (3 to 8 in EFV2) are programmable and the user can choose what is assigned to that relay from the list below: -

1. Not Used
2. Warn 1
3. Warn 2
4. Alarm
5. Indicator 1
6. Indicator 2
7. Indicator 3
8. Indicator 4
9. Alarm Fail Safe
10. Indicator 1 Fail Safe
11. Indicator 2 Fail Safe
12. Indicator 3 Fail Safe
13. Indicator 4 Fail Safe
14. Dead Bus
15. Healthy Bus
16. Serial Available
17. Panel Available
18. Remote Available
19. Available
20. Trip & Lockout
21. Follow A
22. Follow B

Relay Settings.

Pre Set Outputs.

Close.

Once receiving a command to close the circuit breaker the output relay closes, thus sending a close signal to the circuit breaker. This signal remains closed until the relay is informed that the breaker has changed state. The relay determines the status of the breaker via the digital input that is assigned to "ACB Feedback". Once the status of this digital input has changed the output relay opens. In the case where no change of breaker status is detected, the output relay remains closed until the time specified in the Breaker Fail Protection Function has elapsed.

Trip.

This output is used to trip the circuit breaker and follows the same pattern as above. I.e. when a trip command is received the output relay closes and remains closed until the breaker is seen to open via the "ACB Feedback" input or the time specified in the Breaker Fail Protection Function has elapsed.

Programmable Outputs.

Not Used.

This option switches off the use of that particular output relay.

Warn 1.

If an output relay is assigned as “Warn 1” then this relay will change state from de-energised to energised when triggered by any protection function or external device connected to the relay that is configured with Warn 1 enabled.

The relay will only be energised while the protection function or external device registers that a pickup setting or fault status has been violated. When the pickup setting is no longer violated the output relay assigned as “Warn 1” will be de-energised.

“Warn 1” output relay will be energised as soon as a protection features pickup has been exceeded despite any delays that may have been assigned.

Warn 2.

If an output relay is assigned as “Warn 2” then this relay will change state from de-energised to energised when triggered by any protection function or external device connected to the relay that is configured with “Warn 2” enabled.

The relay will only be energised while the protection function or external device registers that a pickup setting or fault status has been violated. When the pickup setting is no longer violated the output relay assigned as “Warn 2” will be de-energised.

“Warn 2” output relay will be energised as soon as a protection features pickup has been exceeded despite any delays that may have been assigned.

Alarm.

If an output relay is assigned as “Alarm” then this relay will change state from de-energised to energised when triggered by any protection function or external device connected to the relay that is configured to alarm.

The alarm operates after the expiry of the programmed time delay assigned to the protection feature.

Indicator 1-4.

If an output relay is assigned as any of the 4 available Indicators then this relay will change state from de-energised to energised when triggered by any protection function or external device connected to the relay that is configured to indicate on that same indicator channel.

Once activated the output relay will be latched and requires a reset before returning to its normal state. Unlike Warn 1 and Warn 2 which are activated as soon as a protection feature pickup is exceeded, Indicators will only be activated after the expiry of the time delay assigned to the protection feature.

Alarm Fail-Safe.

If an output relay is assigned as “Alarm FS” then this relay will change state from energised to de-energised when triggered by any protection function or external device connected to the relay that is configured to alarm. The alarm operates after the expiry of the programmed time delay assigned to the protection feature.

Indicator 1-4 Fail-Safe.

If an output relay is assigned as any of the 4 available fail safe indicators then this relay will change state from energised to the de-energised relay contact when triggered by any protection function or external device connected to the relay that is configured to indicate on that same indicator channel.

Once activated the output relay will be latched and requires a reset before returning to its normal state. Unlike Warn 1 and Warn 2 which are activated as soon as a protection feature pickup is exceeded, Indicators will only be activated after the expiry of the time delay assigned to the protection feature.

Dead Bus.

If an output relay is assigned as “Dead Bus” then this relay will change state from de-energised to energised when the voltage is not present on the VT terminals.

Healthy Bus.

This output activates when the voltage level is between the under voltage setting and the over voltage threshold setting.

Serial Available.

If an output relay is assigned as ‘Serial Available’ this relay will be energised only when the breaker is available to be closed through the serial port, via a serial command. For details on configuring possible close sources see section 11.5.1.1.1 and 15

Panel Available.

If an output relay is assigned as “Panel Available” this relay will be energised only when the breaker is available to be closed from the front panel of the relay. For details on configuring possible close sources see section 11.5.1.1.1 and 15

Remote Available.

If an output relay is assigned as ‘Remote Available’ this relay will be energised only when the breaker is available to be closed from a remote station via a digital input. For details on configuring possible close sources see section 11.5.1.1.1 and 15

Available.

If an output relay is assigned as 'Remote Available' this relay will be energised only when the motor is available to be started from a remote station via a digital input. For details on configuring possible close sources see section 11.5.1.1.1 and 15

Trip and Lockout.

If an output relay is assigned as "Trip & Lockout" then this relay will change state from the de-energised to the energised relay contact when triggered by any protection function or external device connected to the relay that is configured to trip the circuit breaker. Once "Tripped" the FV2 will not permit any further control of the circuit breaker until the fault has been acknowledged by means of a reset. Trip and Lockout will provide a permanent open signal to the circuit breaker thus preventing manual closure of the circuit breaker onto a possible fault condition. The Trip and Lockout relay is a maintained relay action.

Follow A.

If an output relay is programmed as "Follow A" its state will mirror the state of output relay 1.

Follow B.

If an output relay is programmed as "Follow B" its state will mirror the state of output relay 2.

4-20mA Output (Option).

As an option FV2 has an isolated 4-20mA output control to provide a signal proportional to the average voltage or power of the feeder or transformer being protected. Thereby allowing a simple method for interfacing remote panel meters or other displays. This feature is set within the calibration set up and as such should be requested at the time of ordering.

An external 24V DC supply is required to power this isolated Output.

7. FV2 Control Inputs.

The FV2 offers 12 (24 for EFV2) digital inputs to provide full control and indication. The supply to these terminals is derived from a separate Control Supply to the relay. As the digital inputs are completely isolated from the relays internal supply it is possible to have field input signals at a different voltage or phase from the relays' auxiliary power supply.
The condition of all these inputs can be viewed at any time via the Digital Inputs page of the Data Menu which enables complete wire checking without the need to disconnect or even gain access to the rear panel wiring.

The 12 (24 for EFV2) inputs are chosen by the user from the list described in the following sections.

Close.

A digital input assigned as "Close" will allow the circuit breaker being controlled by the relay to be closed manually via the remote switch connected to this input provided the close setup source within the software has been configured to allow remote closure of the breaker.

For closure to occur the feeder must be free from any conditions that may inhibit the FV2 from permitting a close. Any fault condition must be cleared.

Note: A circuit breaker may only be closed provided all conditions which inhibit such an action are healthy including password security.

Open.

A digital input assigned as "Open" will allow the circuit breaker being controlled by the relay to be opened manually via the remote switch connected to this input provided the open setup source within the software has been configured to allow remote opening of the breaker.

Only a momentary digital input signal is required for the "Close" and "Open" commands.

Reset Fault.

This input enables the operator to reset FV2 Fault or Alarm conditions. The Input can only perform a reset if the following conditions are met:

1. The Protection Settings for the specific fault or alarm are set to allow remote resets.
2. The condition that caused the Fault or Alarm to occur no longer exists.

Providing conditions 1 and 2 are met an operator can override the settings in the Protection Settings by closing the Authorise digital input and pressing the Reset digital input.

Auto/Manual and Local/Remote Inputs.

These inputs are used to determine the source of both the Close Signal and Open Signal to the breaker. They are configured in the Close Setup Source and the Open Setup Source. See Section 11.5.1.1.1 and 15.

Test / Service.

A digital input assigned as “Test” allows the FV2 to enter Test Mode when the associated digital input is energised. The FV2 may be configured to inhibit any of the protection functions when in Test mode. This allows full functional testing of the relay to be performed without the need for voltage or current injection and will allow secondary injection testing to be carried out on all protective functions except for those disabled by the feature.

Authorise.

This function can be programmed as a digital input to allow a physical key switch to override the password and reset all faults. This input can be used to restrict fault and alarm reset, if the Auto and Panel reset options of protective functions are disabled a fault can only be reset from the panel if the authorised input is closed. The use of the "Authorise" function will override the password. All data menus, display scroll and drive control are accessible without requiring the use of the "Authorise" or "Password" functions if these are enabled.

Should a digital input be set to Authorise then the user will be unable to disable the Password Setting on the relay. To disable the password the Authorise input must be assigned as another digital input or set to ‘Not Used’.

ACB Feedback.

A digital input assigned as “ACB Feedback” allows the FV2 to monitor the status of the circuit breaker being controlled by the relay. The status of the switchgear is determined and shown via the front plate LED's and LCD display. An auxiliary contact on the Circuit Breaker provides the signal for this digital input.

Monitoring of this input provides protection against circuit breaker faults. In the event the FV2 issues a close command and no feedback is reported from the switchgear to confirm its closure then “Breaker Fail” will be displayed on the screen and the FV2 may be configured to trip, alarm and/or indicate as a result. Similarly if the FV2 issues an open or trip command and registers that the switchgear remains closed then “Breaker Fail” will be reported on the screen and the relay may be configured to execute a response.

Blocking Input.

A digital input configured as a “Blocking input” will provide the facility to block any FV2 protection function configured to be “Blockable”. Most of the FV2 protection features may have blocking logic assigned. In the event this digital input changes to a blocking status then all those protection features configured as “Blockable” will be disabled for the duration of time the blocking input is energised. This feature may be beneficial in blocking the likes of Undervoltage protection during the starting of large machines connected to the feeder/transformer being protected.

External Fault 1-15.

The flexibility of the External Fault inputs gives FV2 an intelligent PLC aspect to protective relaying.

External Faults are voltage based and are assigned to digital inputs to perform a wide variety of roles. Multiple plant interlocking, process shutdown or for use as a gateway onto the serial network for digital signals via the FV2.

External Faults can be configured as independent protective functions and can be configured to any combination of; *Trip*, *Alarm*, *Inhibit* etc. The normal reset types are available; *Auto*, *Panel*, *Serial* and *Remote*. Any combination of 4 indicators can be used to drive output relays configured to the same Indicator function.

The fault status of the input is programmable such that *OFF = Fault* or *ON = Fault* where the input is fed from either a normally closed (NC) or normally open (NO) source.
The trip time (or time to take the configured action) is settable in the range 1 to 60 seconds.

Each External Fault text string (EXTERNAL 1 etc) can be reconfigured to any character and numerical string desired via the keypad (*Unit Settings > Edit Custom Strings*) or via any of the serial ports.

8. FV2 Serial Port

8.1. RS485.

The Serial Port supplied with FV2 as standard utilises a half duplex RS485 protocol allowing up to 32 units to be daisy-chained together, or to be multi-drop connected with a single shielded twisted pair cable.
The FV2 in addition to its very comprehensive protection and control features has been equipped with a very powerful data communications system. It provides high-speed data acquisition to supervisory computers to form a complete feeder management system.

Each FV2 can be connected to an isolated data highway using RS485 communications. Up to 32 units can be connected to each data highway. The host system can interrogate the unit to monitor breaker status, historical data and fault data as well as control functions such as a close and open to the breaker and reset fault / alarm conditions.

The FV2 is available with P&B network gold (P&B protocol) installed for use with the Xcell Data Concentrator for fully Integrated Protection, Control & Monitoring Systems with full dual redundancy or with a Slave implementation of Modbus RTU protocol for small systems and direct Modbus access to devices where data concentration is not required.

8.2. Profibus.

The FV2 can also be fitted with a standard 9-way D-type connector in place of the RS485 connection to provide a Profibus DP interface. See section 13.1

8.3. RS232.

When the Profibus option is chosen the unit is additionally fitted with a front mounted RS232 port to allow relay interface using the P&B Protocol.
This RS232 port is optional to the standard RS485 unit allowing access to historical and running data without disturbing the rear RS485 network. The front mounted serial port also allows disturbance recording traces to be extracted.

Full details of the protocols, device mapping, gsd files and other support documents are available on request.

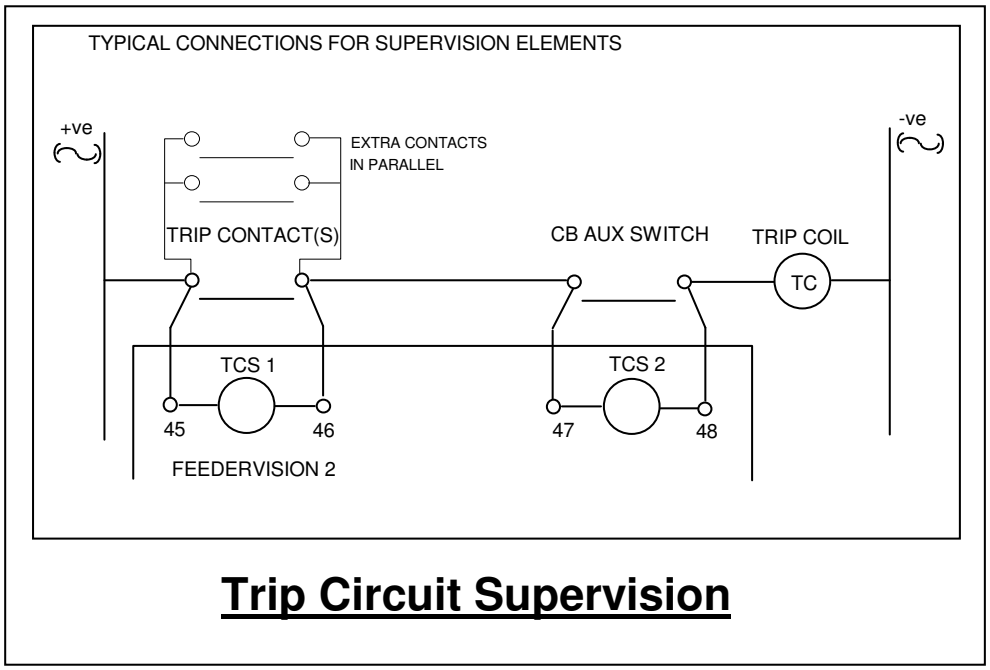
Information on the Xcell Data Concentrator is contained in the P&B Integrated Protection & Control System Integrators Manual, available on request.

9. Trip Circuit Supervision.

Trip Circuit Supervision is available as an option to the FV2, and standard with EFV2.

The trip circuit encompasses more than just the relay. It passes through external components such as fuses, links, relay contacts, auxiliary switch contact and others. Errors in any of these external components could lead to a trip not being called and the breaker remaining closed.

To protect against these failures the two trip circuit supervision input circuits, one to monitor the trip relay and one to monitor the circuit breaker. Should they both read the same input, i.e. a trip has been called and the breaker is closed, the assigned output relay changes state.



Trip Circuit Supervision

The TCS element consists of two input circuits and two dedicated change-over contact output relays operating in tandem. As the TCS board does not interact with the main relay processor one of the digital outputs provided by the Trip Circuit Supervision should be fed back into the FV2 or EFV2, as an External Fault input. The other output can be used to drive an indication lamp or other such application.

The Trip Circuit Supervision Output Relays are Fail Safe, this means that on power up the relays change state. Therefore in the situation where power is lost to the FV2 or EFV2 an indication is given through the Trip Circuit.

The output relays will enter an unhealthy state if one or both of the TCS Inputs are closed or if power is lost to the relay. The relays will only go back to a healthy state if both the inputs are open. The voltage supply to the elements can be either AC or DC within the range of the normal Aux. Supply (80-265 V AC/DC).

10. FV2 Faceplate Functions.

The FV2 Faceplate has been designed to provide display and access to all the required information an operator may require.

This is achieved by using 2 tri-colour LED's, a fully graphic LCD display and 4 software driven function keys.

This eliminates the need for additional indication devices on the front of the feeder panel such as Lamps, Ammeter, Voltmeter, Hours Run Indicator, Operations Counter, etc. which helps reduce the cost of the feeder panel and gives improved reliability by the reduction of separate components.

The following section details the function of the Front plate devices.

LED Status.

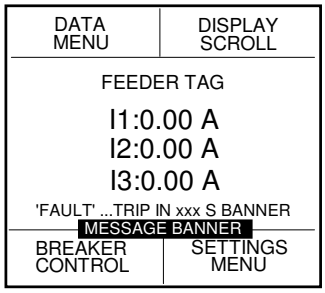
The LED's on the front of the FV2 operates as follows:

LED Colour	Left LED [Feeder Status]	Right LED [Fault Status]
Green	**Off**	**Healthy**
Yellow	**Inhibited**	**Alarm**
Red	**On**	**Fault**

11. Graphical Display.

The FV2's graphically display is fundamental to the philosophy of the Vision IED family of devices. The screen provides access to all dynamic and historical data, protection parameter set points and control set-up.

11.1. Menu Screens.



On power up the FV2 screen appears for a few seconds. The screen shows the software version and the unit serial number, which should be noted in all correspondence with P&B regarding the relay.

After the Introduction screen disappears then the Initial screen appears.

The main portion of the screen shows the main dynamic data of the feeder, various message banners can appear under different conditions to alert the operator to the present conditions. These can be time to trip messages, countdown to restart message, countdown to reset or clear inhibit messages and so on. The name of the fault condition causing the trip will also appear along with the timer.

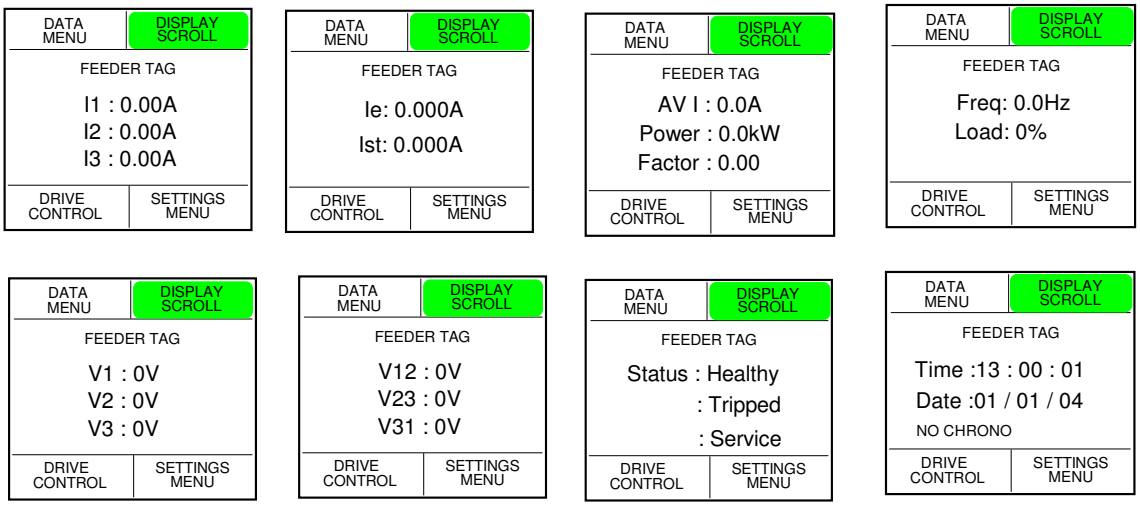
The four menu driven software keys each navigate to four main areas of the menu structure. These are *DISPLAY SCROLL*, *DATA MENU*, DRIVE CONTROL and the *SETTINGS MENU*. Using soft-keys provides a very easy to use environment in order to effectively navigate the entire menu system.

The *DISPLAY SCROLL* button scrolls in a loop displaying various measured values and drive status data. Any one of these pages can be selected as the 'default' page, so that if the unit is left whilst in a sub menu the screen can return to a pre-selected page after a set time-out period.

Separate 3-Phase Currents (A)
Earth and Standby Current (A)
Average RMS Current (A) / Power (KW) / Average Power Factor
Frequency (Hz) and Load (%)
Separate 3-Phase Voltage (V)

Status: Open/Closed, Healthy/Fault, Service/Test.
Time and Date. Plus GPS status.
Profibus DP mode (if activated)

11.2. Display Scroll.

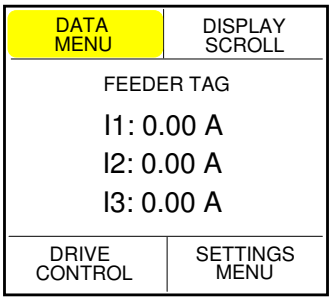


Examples of the Display Scroll screens.
Note: The FPC does not monitor 3-phase voltage and can only display a single phase voltage.

11.3. Data Menu.

Upon pressing the DATA MENU button, the menu buttons automatically change function to suit the next tier of menu access.
The main display scroll screen remains with the last selected page before the data menu button was pressed.

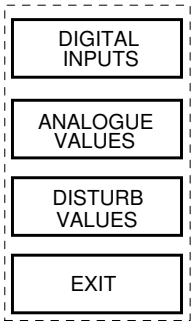
The function buttons now allow access to other data pages as shown.



The following pages describe in detail each sub page of the Data Menu beginning with the Measured Values.

Exit whenever pressed restores the screen to the previous page.

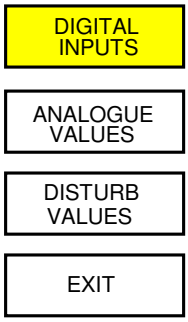
11.3.1.1. Measured Values.

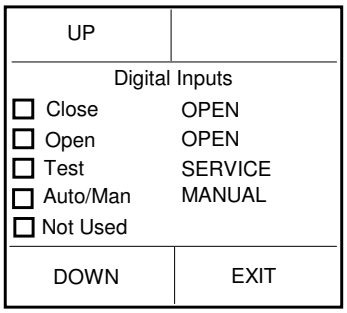


This screen continues to show all the data that is given by the initial screen but there are sub screens accessible to the user by pressing either of the four buttons.

This sub menu page is only visible when the optional Disturbance Recording feature is enabled.

11.3.1.1.1. Inputs> Digital Values.



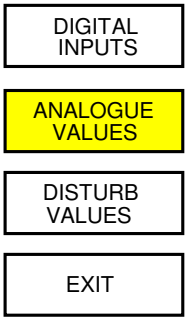


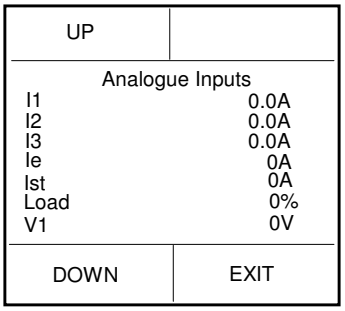
This screen displays the state of the digital inputs to the relay.
The list of data can be scrolled through using the top-left button (UP) and the bottom-left button (DOWN). The status of the 12 digital inputs can be viewed here.

A 'bit' box to the left of the digital input gives a representation of the voltage on that terminal.

A filled box represents an active or energised input, a clear box represents a de-energised input.

11.3.1.1.2. Inputs> Analogue Values.





This screen displays the values of the analogue inputs to the relay.

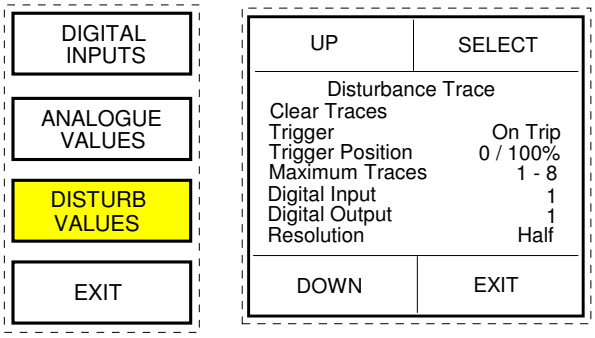
The list of data can be scrolled through using the top-left button (UP) and the bottom-left button (DOWN).

The analogue inputs that can be viewed are as follows:

I1 (A)	V1 (V)	PWR 3 (KW)	KVAr2	EE BLOCK
I2 (A)	V2 (V)	TOTAL PWR (KW)	KVAr3	
I3 (A)	V3 (V)	PF1	KVA APP PWR1	
IE (A)	FREQUENCY (Hz)	PF2	KVA APP PWR2	
Ist (A)	PWR 1 (KW)	PF3	KVA APP PWR3	
LOAD %	PWR 2 (KW	KVAr1	DIAG STATUS	

Note: As the FPC has only a single voltage input it will not display V2, V3 or any energy values derived from those voltages.

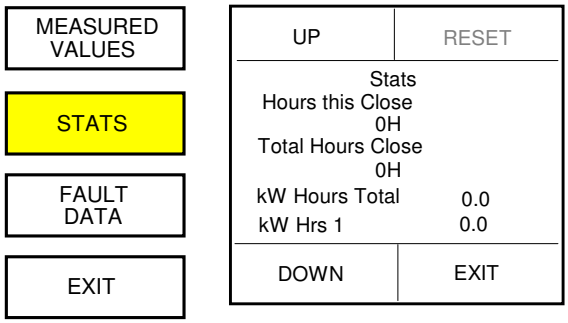
11.3.1.2. Disturbance Values.



If Disturbance Recording is enabled, this screen is accessible and allows the viewing and configuring of the disturbance traces.

This facility is explained in further detail in (section 19)

11.3.2. Stats.



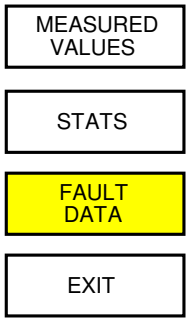
The list of data can be scrolled through using the top-left button (UP) and the bottom-left button (DOWN).

The bottom-right button takes you back to the DATA MENU. The RESET button (top-right) resets the value highlighted to zero. The list of statistical data is as follows:

Note: FPC will only display values associated with V1.

Hours this Close	kVA Hours 1	Last Close (Time & Date)
Total Hours Closed	kVA Hours 2	Last Open (Time & Date)
Kilowatt Hours Total	kVA Hours 3	Fault Trips
Kilowatt Hours 1	Peak demand 1	Total Closes
Kilowatt Hours 2	Peak Demand 2	
Kilowatt Hours 3	Peak Demand 3	

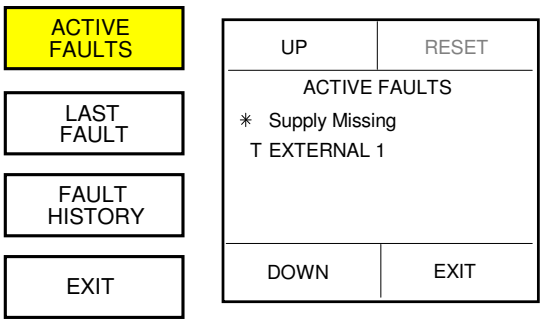
11.3.3. Fault Data.



This screen lists the options for the viewing of previous alarms and faults that have occurred as well as faults and alarms that are currently active. There are three further screens that are accessible:

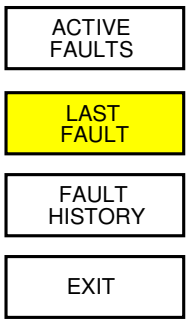
If a fault occurs which results in a TRIP, the unit automatically displays the active faults page.

11.3.3.1. Active Faults.



This menu lists the Active Faults of the relay if there are any.
A Reset button will appear if the fault is no longer active and if *PANEL RESET* is *Enabled* in the Protection Function.
The '*' next to the fault means that the fault is still active.
The characters preceding the fault description denote the action taken, a T denoting a TRIP, an A denoting an ALARM and an I denotes an INHIBIT.

11.3.3.2. Last Fault.

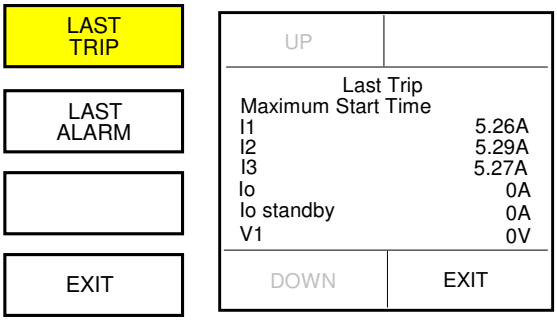


The Last Fault menu allows access to the last recorded TRIP and the last recorded ALARM.

Both Events would also appear with their time and date stamp at the top of the associated fault history pages.

The Analogue data for the last historical event is recorded at the time of Trip or Alarm.

11.3.3.2.1. Last Trip.



This screen displays the *LAST TRIP* event and selected analogue values at the time of the trip. The values are as follows-

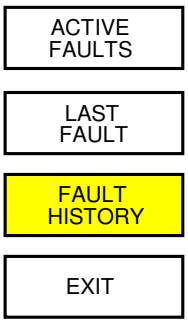
I1 (A)	V2 (V)	Factor 1
I2 (A)	V3 (V)	Factor 2
I3 (A)	Frequency (Hz)	Factor 3
I0 (A)	Power 1	
I0 standby (A)	Power 2	
V1 (V)	Power 2	

Note: FPC will only display values associated with V1.

11.3.3.2.2. Last Alarm.

This screen displays the same as the *LAST TRIP* screen above except that it shows the *LAST ALARM* event that occurred.

11.3.3.3. Fault History.

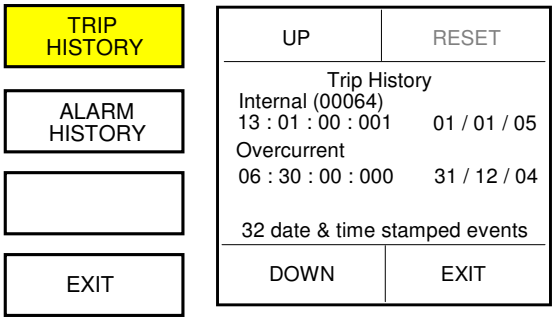


Fault History allows viewing of the last 32 TRIP events and the last 32 ALARM events, each event is time and date stamped to the millisecond.

The two lists operates on a first-in first-out principle meaning any recent events will force the earliest events from the register.

Single events can be deleted providing the password is known.

11.3.3.3.1. Trip History.



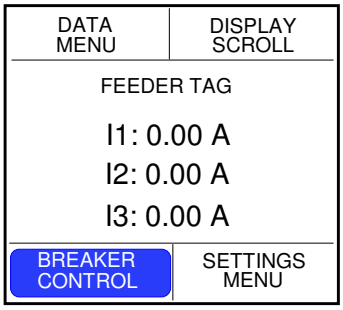
Each occurrence in both the Trip and Alarm histories will be time and date stamped to an accuracy of 1 millisecond.

This can help to identify tripping and alarm trends of the drive and also to aid identification as to the cause of any cascade tripping sequences.

11.3.3.3.2. Alarm History.

This screen displays the same as the *TRIP HISTORY* screen above except that it shows the previous alarm events that have occurred.

11.4. Breaker Control.

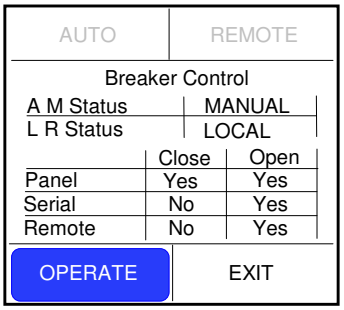


The *BREAKER CONTROL* page allows local or more accurately, *PANEL* control of the Breaker.

The breaker control page displays the breaker availability matrix which shows in a very effective format from which sources the breaker can be closed and opened.

Panel refers to any command issued via the face plate buttons.
Serial refers to any command issued via any of the serial ports.
Remote refers to any command issued via the digital inputs.

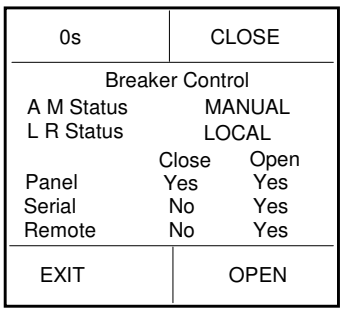
The Auto / Manual status and Local / Remote status of the breaker are also shown.
If the feeder is in TEST MODE then both the AM and LR status would display *TEST*.



The permissive and inhibit sources displayed here for the breaker control are dictated by the set-up made to the close and open sources under the breaker Settings.

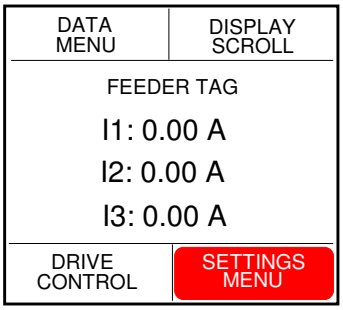
Those settings transpose directly into this page producing the YES and NO indications for each source.

If inputs Auto/Manual and/or Local/Remote are not selected as digital inputs then toggle buttons will appear at the top of the screen to allow the user to select their configuration.



To operate the circuit breaker press the “OPERATE” button and the BREAKER OPERATION MENU SCREEN will be provided where control functionality may be executed. Provided the panel is a valid control source the user may close (press the “CLOSE” button) or open (press the “OPEN” button) the circuit breaker. The options available on the screen will depend on how the user has configured the Close and Open Setup Sources

11.5. Settings Menu.

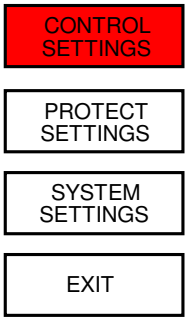


The Settings menu is divided into three main sub menus allowing complete manipulation of the set points associated with the protection and relay set-up.

These are: *CONTROL SETTINGS*, *PROTECT SETTINGS* and *SYSTEM SETTINGS*.
Each of these headings provide sub menu access for the parameter configuration and control set-up.

As the four software driven buttons change function depending upon what page (or equally what type) of data is being changed, this section also details the use of: pop-up boxes, changing values and timers, handling tick box applications and multiple choice settings.

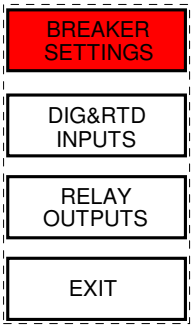
11.5.1. Control Settings.

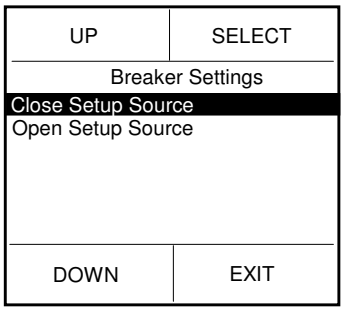


The *CONTROL SETTINGS* sub menu of the Settings Menu allows manipulation of the necessary functions required to set-up the device for each particular application.

The Digital Inputs, Relay Outputs and the Breaker Settings functions are all configured under this menu header.

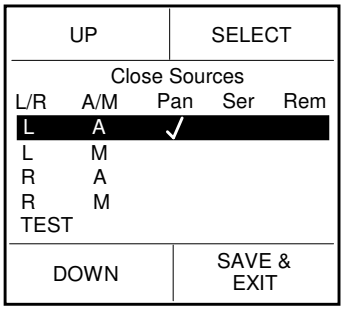
11.5.1.1. Breaker Settings.





The Breaker Setting menu allows the access and configuration to the Close and Open setup sources see section 11.5.1.1.1

11.5.1.1.1. Close / Open Source Settings.

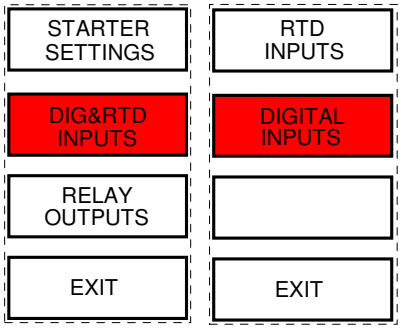


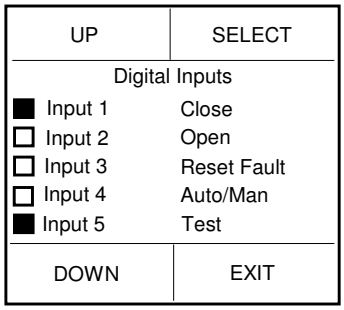
In this screen the user can define from where the Feeder can be Closed (Panel, Serial, Remote) depending on the positions of the Local/Remote, Auto/Manual and Test inputs.

By pressing select repeatedly the 'ticks' build similarly to logic. Each 'tick' represents a YES in the drive control page, a blank denotes a NO.

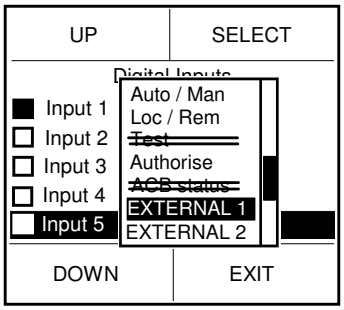
The same procedure is followed for the Open sources. In the case left, the breaker can only be closed whilst in LOCAL and AUTO from the relay front panel.

11.5.1.2. Digital Inputs.





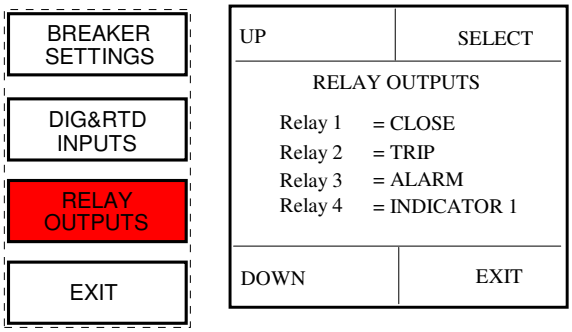
In this screen the 12 (24 EFV2) digital inputs can be assigned to a function. When an input is selected using the SELECT button an option change pop-up overlays the main screen, the menu buttons will now operate the over-laid pop up menu. As in the DATA MENU the left hand box operates similarly.



If a digital input is already assigned to an input no. then it cannot be set to another input no. it will appear in the list lined-out.

This pop-up format also applies to Relay Outputs selection or where a list of selectable options is available.
On exit from this screen Input 5 will be set to EXTERNAL 1.

11.5.1.3. Relay Outputs.



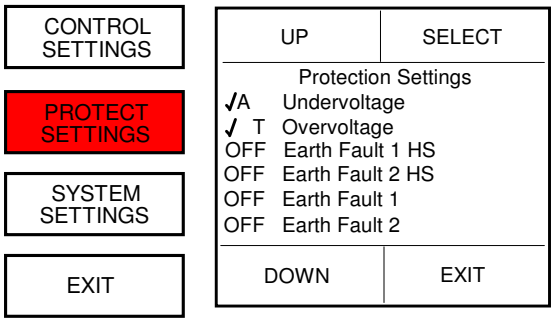
In this menu the output relays can be assigned. A pop-up box overlays the main screen and output relay functions can be chosen.

OUTPUT RELAY NUMBER	ASSIGNED OUTPUT RELAY'S
1	Close
2	Open
3	Programmable
4	Programmable
5 (EFV2 ONLY)	Programmable
6 (EFV2 ONLY)	Programmable
7 (EFV2 ONLY)	Programmable
8 (EFV2 ONLY)	Programmable

Programmable settings	Programmable settings
Not Used.	Serial Available
Warn 1-2.	Panel Available
Alarm.	Remote Available
Indicator 1-4.	Available
Alarm Fail Safe.	Trip & Lockout
Indicator 1-4 Fail Safe.	Follow A
Dead Bus	Follow B
Healthy Bus	

Where Programmable appears in the table above it means that the user can choose what is assigned to that relay from the list to the right (Programmable settings).

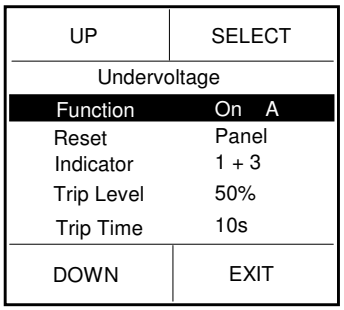
11.5.2. Protection Settings.



On selecting, this page displays all protective function available.
Each function can be selected using the UP and DOWN keys, each function can then be configured.
At a glance the left-hand coloumn shows whether a function is active or not and what configuration or action it is set to.

✓ indicates that the function has been enabled.
A indicates the ALARM is enabled for that function.
T indicates the TRIP is enabled for that function.
OFF means that the function is not used.

11.5.2.1. Protective Functions.

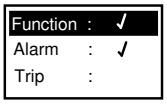


In this example the configuration for the behaviour of Undervoltage protection can be controlled.
There are four setting groups:

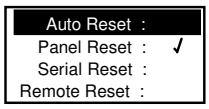
Function: Set ON / OFF, Set ALARM, Set TRIP.
Reset: Auto / Panel / Serial or Remote or combination.
Indicator: Relay output indicators 1, 2, 3, 4 or combination.
Trip Time: The settable time to action the configured function.

Each option moves a 'pop-up box' forward to select the desired operation.

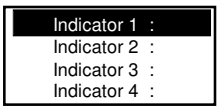
Function



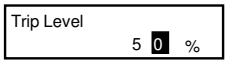
Reset



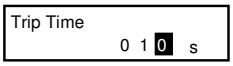
Indicator



Trip Level

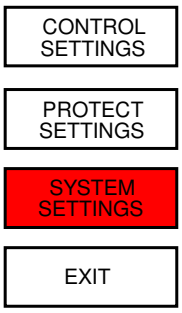


Trip Time



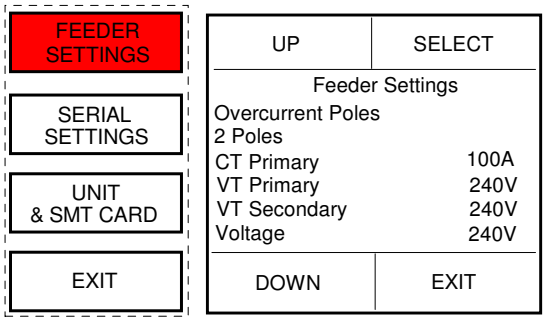
Each protective function has specific settings associated with that particular function so in some cases parameters can be fixed or limited to a degree. The settable options for each protective function is explained in further detail in sections 12.2 and 16

11.5.3. System Settings.

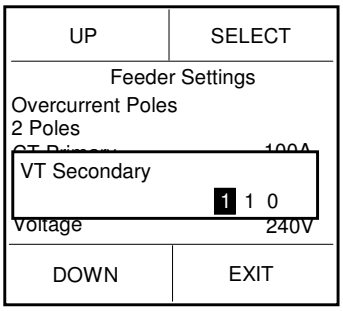


The System Settings menu provide access to a further sub set of menus, Feeder settings, Serial Settings, Unit Setting and if activated the Smart Card settings.

11.5.3.1. Feeder Settings.



This screen allows the user to change the Feeder settings of the relay. The list of values to be changed can be scrolled through by pressing the UP and DOWN buttons (top-left and bottom left). A value can be selected to have its value changed by pressing the SELECT button (top-right) when the value is highlighted. This then brings up the VALUE CHANGE SCREEN



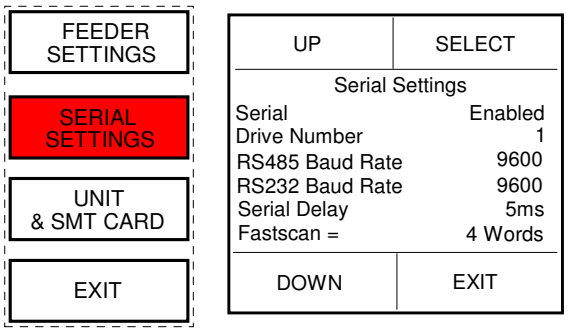
The Value Change pop-up allows you to alter settings in specified steps within the minimum and maximum values of the particular setting range. The pop-up over lays the main screen, the menu buttons operate the pop-up as normal. The Exit button becomes a Next function in this window to skip along to the next character. If an undesired value is inserted incorrectly use the Next button to skip past the last character to the left the Select option button now operates as a Discard to dump the new value without saving. Reverting back to the original value on initial selection.

The values to be changed are as follows:

Overcurrent Poles, CT Primary, VT Primary, VT Secondary, Voltage, CCR, EFCT Primary 1, EFCT Primary 2, kW sample Period.

The Feeder Settings are explained detail in sections 12.1 and 14.

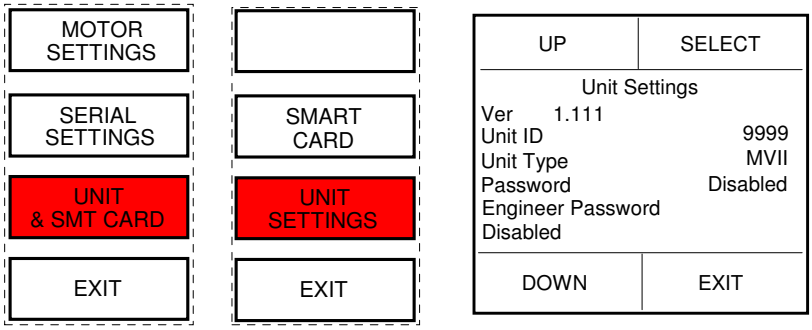
11.5.3.2. Serial Settings.



This screen allows the user to change the communication port aspects of the relay.

Section 13 describes in detail the function of each of the available serial settings.

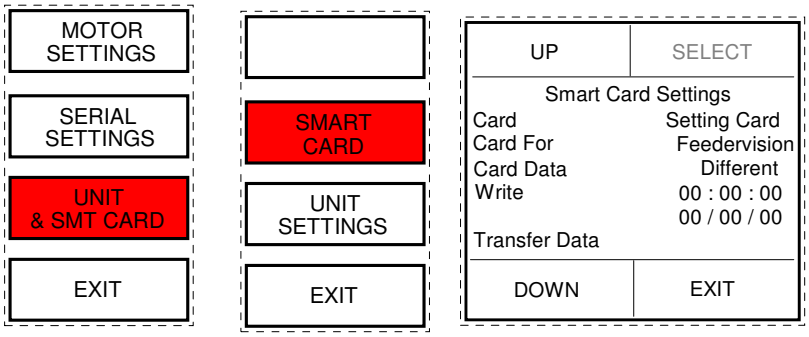
11.5.3.3. Unit Settings.



This screen allows the user to change certain global characteristics of the relay.

Each setting is explained in detail in section 17.

11.5.3.4. Smart Card Settings.



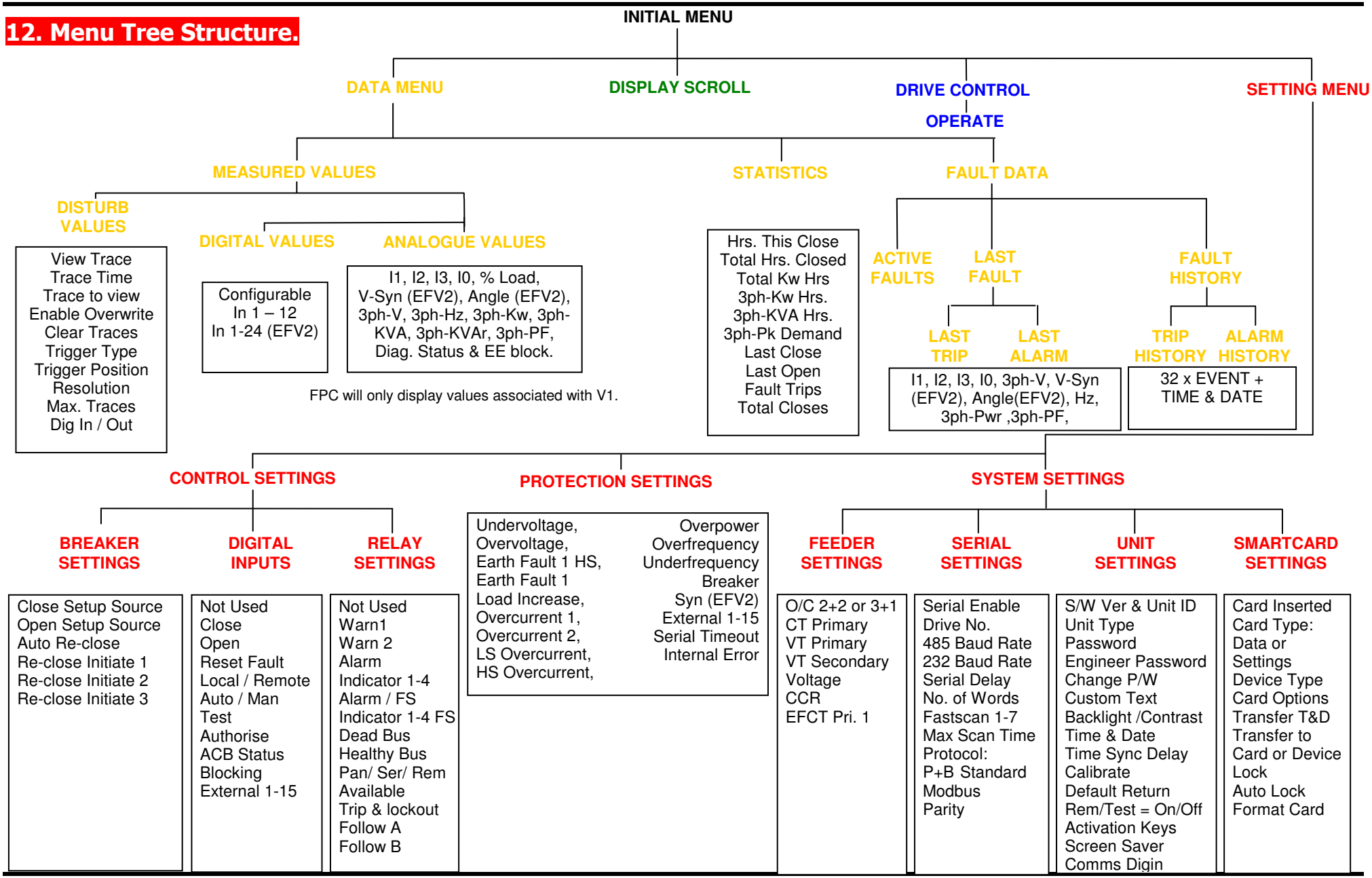
The Smart Card is a removable eeprom memory card which can be supplied with FV2 on request.

An activation code is required to access this menu system in order to allow full manipulation of the card.

The Smart Card can be used for parameter storage and for cloning like feeders or it can be formatted as an extended data card which will log and store events.

The Smart Card is explained in detail in section 18

12. Menu Tree Structure.



12.1. Setting Pages Summary

	Range	Steps	Default
Serial settings:			
Serial	Enabled / Disabled	1s	Enabled
Drive Number	1-32 (1-125 profibus)	1	1
RS485 Baud Rate	9600/19200/38400		9600
RS232 Baud Rate	4800/9600		4ms
Serial Delay	1ms-250ms	1ms	1ms
Fast Scan Words	4 Words / 6 Words / 8 Words		4 Words
Fastscan Analogue 1	0-254	2s	0s
Fastscan Analogue 2	0-254	2s	0s
Fastscan Analogue 3	0-254	2s	0s
Fastscan Analogue 4	0-254	2s	0s
Fastscan Analogue 5	0-254	2s	0s
Fastscan Analogue 6	0-254	2s	0s
Fastscan Analogue 7	0-254	2s	0s
Max Fast Scan	1-30s	1s	2s
Serial Protocol	Modbus / P&B Standard		P&B Standard
Parity	Even / Odd / None		Even
Feeder Setting:			
Overcurrent Poles	2+2, 3+1		2+2
CT Primary	1-4000A	1A	100A
VT Primary	100V-33000V	5V	415V
VT Secondary	100V-415V	1V	100V
Voltage	50-125% Of VT Primary	5V	240V
Voltage Sync *.	Ph-N/Ph-Ph		Ph-N
Constant Current Rating (CCR)	50-100%	5%	100%
E/F 1 CT Primary	1-4000A	1A	100A
KW Sample Period	1-60min	1min	5min
Digital Settings:			
Output Relays 1-4 (1-8 for EFV2*)	Not Used, Warn 1-2, Alarm, Indicator 1-4, Alarm FS, Indicator 1FS-4FS Dead Bus, Healthy Bus Serial Available, Panel Available, Remote Available, Available Trip & Lock, Follow A, Follow B		
Digital Inputs 1-12 (1-24 for EFV2*)	Not Used, Close, Open, Reset Faults, Local/Remote, Auto/Manual, Test, Authorise ACB status, Blocking, External Faults 1-15.		
Unit Settings:			
Password	Enabled/Disabled		Disabled
Engineering Password	Enabled/Disabled		Enabled
Change Password	5 Characters		6363
Edit Custom Strings	11 Characters		
Default Return Time	No Return (Off) 1-5min	1min	1min
Time			
Date			
Time Sync Delay	0-200ms	1ms	0ms
Remote	On/Off		On
Test	On/Off		On
Smart Card Key	6 digits		
Disturbance Key	6 digits		
VTM Key	6 digits		
Scrn Saver	Enabled/Disabled		Disabled
Scrn Saver Time	60-3600s	1s	3600s
Chronovision	Enabled/Disabled		Disabled
Comms Digin	FV1/FV2		FV1
Invert LED Colour	Yes/No		Yes
Hours In Service			

* EFV only

12.2. FV2 Protection Setting Summary.

● Selectable Option
■ Not Selectable

EVF2 & FV2 with TCS ONLY
EFV2 ONLY
FV2, FV2 with TCS & EFV2

ANSI No.	Protective Function	Available Action							Available Reset				Indicators 1-4	Change Name	Variable	Range	Step
		Trip	Alarm	Warn 1	Warn 2	Act in Test	Inhibit	Block	Auto	Panel	Serial	Remote					
27	Undervoltage	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time	50-95% 0.1-60s	5% 0.1s
59	Overvoltage	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time:	105-150% 1-60s	5% 1s
50n/64	Earth Fault 1 HS	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time	10-2500% 0.1-20s	5% 0.1s
50n/64	Earth Fault 2 HS	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time	10-2500% 0.1-20s	5% 0.1s
51n/64	Earth Fault 1	●	●	●	●	●	●	●	●	●	●	●	●		Characteristic Trip Level Time Multiplier	DEFT, NINV, VINV, EINV 5-200% 0.01-10	 5% 0.01
51n/64	Earth Fault 2	●	●	●	●	●	●	●	●	●	●	●	●		Characteristic Trip Level Time Multiplier	DEFT, NINV, VINV, EINV 5-200% 0.01-10	 5% 0.01
51	Load Increase	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time:	50-150% 1-120s	10% 1s
51	Overcurrent 1	●	●	●	●	●	●	●	●	●	●	●	●		Characteristic Trip Level Time Multiplier	DEFT, NINV, VINV, EINV 10-400% 0.01-10	 10% 0.01
50	Overcurrent 2	●	●	●	●	●	●	●	●	●	●	●	●		Characteristic Trip Level Time Multiplier	DEFT, NINV, VINV, EINV 10-400% 0.01-10	 10% 0.01
51	LS Overcurrent	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time	10-1000% 0.1-20s	5% 0.1s
50/51	HS Overcurrent	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time	10-2500% 0.1-20s	5% 0.1s
32	Overpower	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time	2-8MW 1-120s	0.1MW 1s
81H	Over Frequency	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time	40-70Hz 1-60s	1Hz 1s
81L	Under Frequency	●	●	●	●	●	●	●	●	●	●	●	●		Trip Level Trip Time	40-70Hz 1-60s	1Hz 1s
36fb	Breaker	●	●	●	●	●	●	●	●	●	●	●	●		Trip Time	0.5-10s	0.1s
25	Synchronisation	●	●	●	●	●	■	●	●	●	●	●	●		Angle voltage Difference Time In Sync	2-30° 1-20% 0.3-5s	1° 1% 0.1s
36	External 1-15	●	●	●	●	●	●	●	●	●	●	●	●	●	Polarity Trip Time	Off=Fault, On=Fault 0.4-60s	 0.1s
	Serial Timeout	●	●	●	●	●	●	●	●	●	●	●	●		Timeout In	1-120s	1s
	Internal Error	●	●	●	●	●	●	●	●	●	●	●	●				
	Profibus Fault	●	●	●	●	●	●	●	●	●	●	●	●		Trip Time:	1-60s	0.1s
74TC	* Trip Circuit Supervision								■								

13. Serial Setting.

Serial Enabled / Disabled.

This setting allows the user to enable the FV2 serial communications port. This setting must be set to “Enable” if communication with the relay through the serial link is required.

Drive Number.

This setting range 1 to 32 0r 1-125 with Profibus, with a default setting of 1, identifies the FV2 unit to the Xcell unit (or any Master device connected to the Data highway) to which the RS485 or Profibus port is connected. When updating firmware the auto program mode requires the drive number to be 1.

RS485 Baud Rate.

This setting allows the user to configure the appropriate communications baud rate such that the FV2 can communicate effectively on the Data Highway to which it is connected.

RS232 Baud Rate.

This setting allows the user to configure the baud rate for the front mounted RS232 port.

Serial Delay.

The FV2 may be configured to respond to a request for information from the serial port instantly or after a designated delay.

A communications delay may be beneficial to ensure the Master device on the Data Highway receives all information sent back by the FV2 without enduring data collisions on the network.

Fast Scan Words.

A Fast Scan is a system used when operating in conjunction with the XCell Data Concentrator. As the XCell polls relays attached on its network, the fastscan settings allows the user to select important data to be read back faster.

The data on the communications link is broken into Fast Scan Data (or Process Critical Data) and Slow Scan or Full Read Data (Electrical Engineering Data).

The amount of Fast Scan Data to be sent back to the XCell in response to a request is configurable. This setting has the range 4, 6 or 8 Words. A setting of 4 Words will give 3 Fast Scans. The remaining Word is taken up by the Total Power. A setting of 6 Words will give 5 configurable Fast Scans and a setting of 8 Words will allow 7 configurable Fast Scans.

The configuration of Fast Scan is not necessary unless the FV2 in used in conjunction with the XCell unit.

Fast Scan 1 to 7.

Each Fastscan number can be programmed to export important data when requested. This number references an internal address in FV2 and allows configurable data mapping between units. Typical data could be 3-Phase Current, 3-Phase Voltage and so on. A table of the Fastscan reference numbers can be found in appendix 4

Max Scan Time.

This setting need only be used in order to limit the amount of data traffic on a RS485 network. Dynamic data can change rapidly, this setting allows the FV2 to limit the number of updates it makes to its Fast Scan values.

Protocol.

The RS485 serial communications port may be configured to operate using a slave implementation of Modbus RTU® or P&B Engineering's own protocol "P&B Standard" designed to remove some of the speed issues associated with a function based protocol like Modbus.

Parity.

This setting allows the user to set the parity to match that of the host system on the serial link. The options are "Odd", "Even" and "None".

13.1 PROFIBUS (Optional).

PROFIBUS-Interface Pin-layout.

The PROFIBUS can be accessed via a 9-pin connector located at the rear of the FV2, this replaces the 3 wire RS485 connection.

The interface has separated potentials and a pin-layout as specified in the DIN 19245.

Pins	Signal
1	n.c.
2	n.c.
3	Data B (RxD/TxD-P)
4	CNTR (Repeater control
5	GND
6	Termination-Power
7	n.c.
8	Data A (RxD/TxD-N)
9	n.c.

If three-wire configuration is used, only Pin 3,8 and 5 are required to be connected.

Profibus cable.

The PROFIBUS standard DIN 19245 Part1 and Part3 permits two types of bus cable (Cable A and Cable B).

Profibus cable parameter.

Parameter	Cable A PROFIBUS-DP DIN 19245 Part 3 Chap. 6.2	Cable B DIN19245 Part 1 / 4.91 Chap. 3.1.2.3
Type of cable	Two-conductor shielded twisted pair cable	Two-conductor twisted pair cable
Impedance	135 ... 165 □ (3 ... 20 MHz)	100 ... 130 □ (f > 100kHz)
Capacity	< 30 pF/m	< 60 pF/m
Loop resistance	< 110 W/km	-
Diameter	> 0,64 mm > 0,34 mm²	> 0,53 mm > 0,22 mm²

The maximal bus length depends on the type of cable and the baud rate (see table).

Maximum bus length.

Baud rate KBit/s	9,6	19,2	93,75	187.5	500	1500
Cable A, max. distance in (without repeater)	1200	1200	1200	1000	400	200
Cable B, max. distance in (without repeater)	1200	1200	1200	600	200	-

The maximum bus length can be extended until approx. 10 km with repeaters. The max. number of repeaters that can be used in a network depends on the type of the repeater and is between 3 and 10.

Main features of the FV2 Profibus link.

1. It Supports the following baud rates: -

   i) 9.6K
   ii) 19.2K
   iii) 93.75K
   iv) 187.5K
   v) 500K
   vi) 1.5M

NOTE: Recognition of data transfer rate is automatic.

2. When VPC3+ carries out a DP communication, internally within the relay it automatically sets up all standard DP-SAPs. The following SAPs are supported: SAP53, SAP55, SAP56, SAP57, SAP58, SAP59, SAP60, SAP61, SAP62 and Default SAP(Data exchange).

3. One master can communicate with up to 125 Profibus-DP slaves.

When using the FV2 with the dedicated PROFIBUS option, the following protocols can be used, P&B Std, MODBUS RTU, and P&B DP.
When using all but the P&B DP option, the protocol should be implemented in accordance with the protocol specifications.
However, if the P&B DP option is chosen then the communication is handled in the following way.

Data is automatically configured and transmitted by the FV2 to the PROFIBUS master without the need for the PROFIBUS master to send requests to the FV2, this is not the case when using any of the other protocol options. The amount of data returned by the FV2 is determined by the number of fastscan words chosen. Only one byte is used for the command outputs to the FV2.

When using the P&B DP protocol option then one of the following should be chosen from the GSD file module list: -

8 Bytes In + 1 Byte Out	(choose this option if fastscan words is set to 4)
12 Bytes In + 1 Byte Out	(choose this option if fastscan words is set to 6)
16 Bytes In + 1 Byte Out	(choose this option if fastscan words is set to 8)

P&B DP Input Structure.

First Byte	= FV2 Logic Status
Second Byte	= FV2 Power
Third & Fourth Bytes	= FV2 FS1
Fifth & Sixth Bytes	= FV2 FS2
Seventh & Eighth Bytes	= FV2 FS3

If 6 fast scan words chosen then the additional bytes are included.

Ninth & Tenth Bytes	= FV2 FS4
Eleventh & Twelfth Bytes	= FV2 FS5

If 8 fast scan words chosen then the additional bytes are included.

Thirteenth & Fourteenth Bytes	= FV2 FS6
Fifteenth & Sixteenth Bytes	= FV2 FS7

P&B DP Output Command Structure.

CLOSE = 80 Hex
OPEN = 81 Hex
TRIP = 82 Hex
RESET = 84 Hex

14. Feeder Settings.

14.1 Overcurrent Poles.

This setting allows the user to configure the FV2 to operate in either 2 Pole or 3 Pole mode. When in 2 Pole mode the FV2 monitors 2 phase currents and 2 earth fault currents. The 3rd phase current is calculated from the negative vector sum of the other two phases. When in 3 Pole mode the FV2 monitors 3 phase currents and a single earth fault current.

14.2 CT Primary.

This setting allows the user to program the primary current rating of the protection class current transformers on the supply phases. It is assumed that all phase current transformers are of the same rating.

14.3 VT Primary.

This setting allows the user to program the primary voltage rating of the three phase voltage transformers (if used). If a VT is not used enter the rated voltage for the direct connection. This is limited to 415V.

Note: Each of the 3 phase Voltage Inputs should be connected between a phase and neutral only. The Voltage Reference Input (check synch for EFV or V1 for FPC) may be connected between two phases or a phase and neutral.

14.4 VT Secondary.

This setting allows the user to program the secondary voltage rating of the voltage transformers (if used).

14.5 Voltage.

This should be set to the line voltage of the supply and is necessary for power calculations. The setting is also used for the Under/Overvoltage, Undervoltage Restart and Undervoltage Lockout protection features.

As an example if the voltage input was connected between two phases on a 415V system this setting would be 415V. If however the voltage input was connected between a phase and neutral then this setting should be 240V.

14.6 "Voltage Sync." – Voltage Synchronisation Reference.

The EFV2 provides the option for check synchronisation facilities. A separate voltage input reference is provided for this feature. The voltage input may be connected from phase to neutral or between two phases. Depending on the type of connection made the FV2 must be configured accordingly. The "Voltage Synch" setting allows the user to configure the type of connection used. This parameter can be set to Ph-N (Phase to Neutral) or Ph-Ph (Phase to Phase). For FPC this same input is used to monitor V1 only.

14.7 Constant Current Rating (CCR).

This setting allows the user to program the Constant Current Rating of the feeder or transformer supplying the load as a percentage of the CT Primary rating.

Since this setting is a percentage of the CT primary, any change in the CT Primary setting will alter the CCR setting. As a result it is recommended that the CT Primary be set first.

14.8 Earth Fault 1 Primary.

This setting allows the user to program the primary current rating of the protection class current transformer used to measure the primary earth fault current.

If the FV2 is used in 2 Pole mode a second earth fault CT Primary setting will be displayed named “EF CT Primary 2”.

14.9 Earth Fault 2 Primary.

If the FV2 is used in 2 Pole mode a second earth fault CT Primary setting will be displayed named “EF CT Primary 2”. This setting allows the user to configure the primary rating of the CT to be used for standby earth current. If a residual current transformer connection is used to detect earth fault then the phase current transformer primary rating should be used for this setting.

14.10 kW Sample Period.

This setting range 1 to 60 min in steps of 1min determines the period over which a measurement is taken to integrate the Kilowatt Hours value.

15. Breaker Settings.

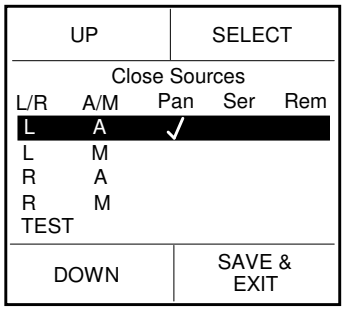
Close and Open Source Settings.

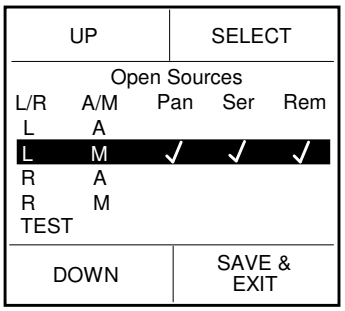
This setting is used to determine the allowable source control for the Close and Open signals to the breaker.
The Close and Open signals can come from three different type of input:-

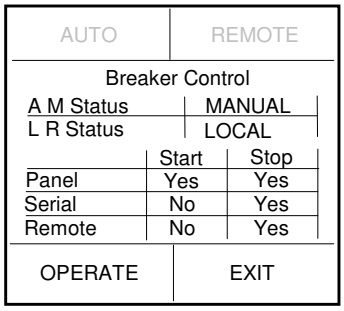
Panel	- the buttons on the front of the relay.
Remote	- from the digital inputs to the relay.
Serial	- through the serial link on the relay.

A matrix is displayed for both the Close and Open sources and the user can configure which source an allowable Close or Open command signal can come from.

The Close and Open permission configured here transpose directly in the availability matrix in the drive control page.





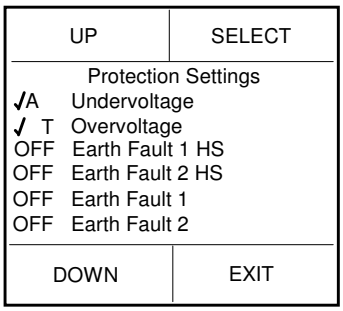


16. Protection Settings.

Each protection function is configurable independently of the others. The available action, the type of reset, the various threshold levels and trip timers for each and every protection function can be found in section 12.2
This section describes in detail what each function does and how it operates.

Function.

If a particular protective function is required for use it should be selected and set to Function: Enabled. That function now operates as per its configuration.
On exit the protective list will show to the left hand side of the name a tick if the function is enabled, and A or T, or both if set, to operate an Alarm or a Trip.
If a particular function is not required it can be left disabled and it will display OFF next to the function.



Warn 1.

When set to Enabled this setting activates the Output Relay that is programmed to Warn 1 indicating that a trip is imminent after the trip time has been exceeded. It is activated when the Trip Level has been exceeded.

Warn 2.

When set to Enabled this setting activates the Output Relay that is programmed to Warn 2 indicating that a trip is imminent after the trip time has been exceeded. It is activated when the Trip Level has been exceeded

Alarm.

An Alarm is considered as a high level function. If enabled, an A will appear alongside the protection setting description. If the function activates it will be recorded as part of the alarm history and cause FV2 to enter an alarm state; the fault will be displayed in the active faults page and the right hand LED will turn orange.
If an output relay is set as Alarm it will change state with the fault.

Trip.

A Trip is considered as a high level function. If enabled, a T will appear alongside the protection setting description. If the function activates it will be recorded as part of the trip history and cause FV2 to enter a trip state; the fault will be displayed in the active faults page and the unit will automatically display that page, the right hand LED will turn RED.

Inhibit.

An Inhibit is considered as a high level function. If enabled and the function activates it will display in the active faults page with a letter 'I' to indicate the function is causing an inhibit. The feeder may continue to remained closed but cannot be reclosed whilst the inhibit remains.
The left hand LED will turn orange.

Active In Test.

When Enabled this will allow the Protection Function to be Enabled when the Test Digital Input is set to Test. It is normal that when in the Test position certain Functions are disabled to allow easier testing. With this option the user is able to choose which functions are disabled during test.

Blockable.

Enabling this function will allow the Protection Function to be blocked when the corresponding blocking digital input is closed, thereby allowing the user to block certain Protection Functions from being active.

Reset.

The configuration of the reset allows that particular function to be cleared or reset to a healthy condition providing the condition that caused the fault, alarm or inhibit has been removed.
If a fault remains active an asterix appears with the T, A or I and fault description in the active faults page.

Auto Reset.

This option, when enabled, automatically resets the Fault when the situation that caused the trip has been removed.

Panel-Reset.

This option, when Enabled, allows a reset of a fault to be carried out from the front panel of the relay. A reset button will be displayed in the active fault page if any fault has been removed and is enabled for a panel reset.

Serial-Reset.

This option, when Enabled, allows a reset of a fault to be carried out through the serial link of the relay.

Remote-Reset.

This option, when Enabled, allows a reset of a fault to be carried out through the digital inputs to the relay. A digital input must be set to Reset Faults and must be closed after the fault condition has been removed in order for the reset to operate.

Indicators.

The indicators can be used for transparent signalling when a protective condition is active. There are 4 separate indicators to choose from.

The indicators are considered as a low level function meaning no automated response arises from an active condition, i.e the unit does not trip (unless activated to) or indicate via the LEDS.

The Indicators are used to drive output relays and can be used a specific function output or hardwired interlocking control when driven from the External Fault based protective functions.

The output relay must also be configured as an indicator to operate in this manner.

16.1 Protection Functions.

16.1.1 Undervoltage.

The FV2 may be configured to trip, alarm and/or indicate as a result of an Undervoltage condition on any phase. Undervoltage may be due to large machines starting due to inrush currents creating voltage dips. As such, Undervoltage protection should be set with the ability to ride-out some Undervoltage conditions to avoid unnecessary tripping.

Trip Level.
The Undervoltage pickup is set as a percentage of the Voltage setting. If this should decrease and remains below the threshold level action is taken after the trip time has elapsed.

Trip Time.
The trip time is set to determine how long an Undervoltage condition can persist before the configured action is taken.

16.1.2 Overvoltage.

The FV2 may be configured to trip, alarm and/or indicate as a result of an overvoltage condition on any phase.

System overvoltages or swells may be as a result of capacitor bank switching for example, so care must be exercised to avoid nuisance tripping. The overvoltage trip delay should be programmed to prevent nuisance tripping during such transients whilst providing protection against longer swell conditions not typically seen or that have adverse effects on equipment.

Trip Level.
The overvoltage pickup is set as a percentage of the Voltage setting. If this increases and remains above the threshold level action is taken after the trip time has elapsed.

Trip Time.
The trip time is set to determine how long an overvoltage condition can persist before the configured action is taken.

16.1.3 Earth Fault 1 High Set.

The FV2 also provides a high set instantaneous or definite time Earth Fault element. This feature allows for faster tripping on earth fault conditions than would otherwise be provided by the IDMT (inverse definite minimum time) curves. Thereby allowing FV2 to trip, alarm and/or indicate as a result of an earth fault.

Generally it is desired that Earth Fault protection be instantaneous although in some applications transient Earth Fault currents may be seen, particularly during switching of equipment, which can result in the call for a small delay to be imposed to prevent nuisance tripping. In most cases however the earth fault protection feature should be set to the smallest setting whilst ensuring appropriate coordination with other downstream devices.

Trip Level.

The Earth Fault 1 HS pickup is set as a percentage of the EF CT Primary. If the current rises and remains above the threshold level, action is taken after the trip time has elapsed.

Note: the range of this is affected by EF CT Primary 1 settings, if this setting is 2501 and over then the trip level is 10 - 1600%. If EF CT Primary is set to 2500 under then the trip level range is 10 - 2500%.

Trip Time.

The trip time is set to determine how long an earth fault condition can persist before the configured action is taken.

16.1.3 Earth Fault 2 High Set.

This setting acts the same way as Earth Fault 1 HS, but is only available if the relay is set to 2 Pole Operation, in the Feeder Settings.

Note: the range of this is affected by EF CT Primary 2 settings, if this setting is 2501 and over then the trip level is 10 - 1600%. If EF CT Primary is set to 2500 under then the trip level range is 10 - 2500%.

16.1.4 Earth Fault 1.

The FV2 may be configured to trip, alarm and/or indicate as a result of an Earth Fault condition. The relay provides Inverse Definite Minimum Time (IDMT) earth fault protection to IEC standard curves.

The FV2 provides the following IEC inverse curves to choose from:

- Normal Inverse
- Very Inverse
- Extremely Inverse
- Definite Time also provided.

Characteristic.

This corresponds to a set of time curves (Definite Time, Normal Inverse, Very Inverse and Extremely Inverse) that dictate the time delay to trip depending on the Earth Fault current and the characteristic chosen. This is used when co-ordinating and discriminating between faults on larger systems. See Section 20

Trip Level.

The Earth Fault 1 pickup is set as a percentage of the EF CT Primary. If the current rises and remains above the threshold level, action is taken after the trip time has elapsed.
reaches this level and is maintained for the Time Delay an alarm or a trip will occur.

Trip Time.

The trip time is set to determine how long an earth fault condition can persist before the configured action is taken.

Note: this setting is only available when the characteristic setting is set to Definite Time

Time Multiplier.
This setting is available when the Characteristic is set to Normal Inverse, Very Inverse and Extremely Inverse. It refers to the value tI> used in the calculation of the Trip Time Curves in See Section 20

16.1.5 Earth Fault 2.

This is only available if the relay is set to 2 Pole Operation in the Feeder Settings, and acts the same way as Earth Fault 1.

16.1.6 Load Increase.

The FV2 may be configured to trip, alarm and/or indicate as a result of a load (current based measurement) increase condition.

Trip Level.
The load increase pickup is set as a percentage of the Constant Current Rating (CCR). Depending on the application a load increase may be a frequent occurrence and care must be taken to prevent nuisance tripping.

Trip Time.
The trip time is set to determine how long an increased load condition can persist before the configured action is taken.

16.1.7 Overcurrent 1 & 2.

The FV2 provides the user with 2 independent Inverse Definite Minimum Time (IDMT) overcurrent elements for increased flexibility when coordinating with other overcurrent devices. The relay may be configured to trip, alarm and/or indicate as a result of an overcurrent condition.

Characteristic.
This corresponds to a set of time curves (Definite Time, Normal Inverse, Very Inverse and Extremely Inverse) that dictate the time delay to trip depending on the phase current and the characteristic chosen. This is used when co-ordinating and discriminating between faults on larger systems. See Section 20

Trip Level.
The Overcurrent pickup is set as a percentage of the CT Primary If the current rises and remains above the threshold level action is taken after the trip time has elapsed.

Trip Time.
The trip time is set to determine how long an Overcurrent condition can persist before the configured action is taken.

Note: this setting is only available when the characteristic setting is set to Definite Time

Time Multiplier.
This setting is available when the Characteristic is set to Normal Inverse, Very Inverse and Extremely Inverse. It refers to the value tI> used in the calculation of the Trip Time Curves in See Section 20.

16.1.8 Overcurrent 1 test (Only available in Overcurrent 1 Protection Setting)

This setting activates the Overcurrent trip test, by selecting "Start Test" the FV2 will run an internal test program and display the trip time, shown under the heading Trip Test Results

Note: OC1 Test Current must be set before "Start Test" is selected.

OC1 test current (Only available in Overcurrent 1)
Under this setting the desired fault current can be chosen from the list in the menu pop-up screen. This should be selected before the "Start Test" function in the Overcurrent 1 test menu is selected.

Trip Test Result (Only available in Overcurrent 1)
The Trip time for the Overcurrent 1 test is displayed under this heading and is accurate to the nearest 0.01 second

16.1.9 Low Set Overcurrent.

In addition to the two IDMT Overcurrent protection elements the FV2 also provides a low set instantaneous or definite time overcurrent element. This feature allows for faster tripping on low magnitude overcurrent conditions than would otherwise be provided by the IDMT curve.

Trip Level.
The LS Overcurrent pickup is set as a percentage of the CT Primary If the current rises and remains above the threshold level action is taken after the trip time has elapsed.

Trip Time.
The trip time is set to determine how long an LS Overcurrent condition can persist before the configured action is taken.

16.1.10 High Set Overcurrent.

The FV2 also provides a high set instantaneous or definite time overcurrent element. This feature allows for faster tripping on high magnitude overcurrent conditions than would otherwise be provided by the IDMT curve.

Trip Level.
The HS Overcurrent pickup is set as a percentage of the CT Primary. If the current rises and remains above the threshold level action is taken after the trip time has elapsed.

Trip Time.
The trip time is set to determine how long an HS Overcurrent condition can persist before the configured action is taken.

16.1.11 Over Power.

The FV2 may be configured to trip, alarm and/or indicate as a result of an Over Power condition.

Depending on the application an overpower condition may be a frequent occurrence and care must be taken to prevent nuisance tripping.

Trip Level.

The Over Power pickup is selected under this option. If Over Power should rises and remains above the threshold level action is taken after the trip time has elapsed.

Trip Time.

The trip time is set to determine how long Over Power condition (above the pickup setting) can persist before the configured action is taken.

16.1.12 Over Frequency.

The FV2 may be configured to trip, alarm and/or indicate as a result of an over frequency condition. Frequency is auto-sensing (50 or 60Hz) and is determined by the VT input (V1).

Trip Level

If the frequency increases and remains above the set level, action is taken after the trip time has elapsed.

Trip Time

The trip time is set to determine how long an over frequency condition can persist before the configured action is taken.

16.1.13 Under Frequency.

Under Frequency protection operates similarly to Over Frequency protection with the exception that measured frequency must fall and remain below the set threshold level for the duration of the trip time before the configured action is taken.

16.1.14 Breaker.

The FV2 provides the facility to monitor the status of the circuit breaker used to control the feeder supply. Auxiliary contacts on the circuit breaker are used to provide the current state of the switchgear to the FV2**.** The FV2 then compares the physical status of the circuit breaker with the state it should be in according to the FV2.

If the FV2 detects the circuit breaker closed via the digital inputs after an open/trip command has been issued the relay will display “Breaker Fail” on the screen and may be configured to re-attempt to open the breaker, alarm and/or indicate.

Similarly if the FV2 detects the circuit breaker open and has already executed a close command to the circuit breaker “Breaker Fail” will be reported and action may be initiated.

Note: ACB feedback must be enabled for this to function.

Trip Time

The trip time is set to determine how long a delay is implemented for the FV2 to receive a feeder back of the breaker status that matches the FV2 status via the digital inputs

16.1.15 Programmable External Fault 1-15.

The external faults are digital input based, configurable action inputs. Up to 15 are available and bring a flexible PLC approach to the normal protective functionality. Each is independently configurable and can be used to provide permissive interlocking or process commands.
Each External fault can be renamed to an eleven character user defined text string, Unit Settings > Edit Custom Strings.

Function.

The function can be set to any combination of Alarm, Trip, Inhibit, Warn 1-2 or Blockable. The function can also be set to Test option which allows the function to be active when in the test mode.

Reset.

Normal reset options apply, Auto or a combination of Panel, Serial and Remote.

Polarity.

This option determines the polarity of the digital input that activates this function. 'OFF=Fault' (typically fed from a NC contact), means that when the digital input is Open the External Fault will action.
'ON=Fault' (typically fed from a NO contact), means that when the digital input is Closed the External Fault will action.

Trip Time.

Determines the time an external input can remain in its fault state before any action is taken.

16.1.16 Serial Timeout.

For a set period of inactivity on the rear communication port the unit can be configured to take some action in the event.
It is worth noting that the FV2 device is slave to any host system, the unit will not send information via the serial port unless it has been requested by a master device.

16.1.17 Internal Error.

The FV2 incorporates an internal software and hardware watchdog feature to monitor the integrity of both on board hardware and software systems. This feature may be configured to indicate as a result of any registered problems. If a problem with the hardware or software is located during the error check routines the FV2 will generate an error code (or diagnostic status) which will be reported at the very bottom of the Analogue Values, Measured Values screen.

16.1.18 Synchronisation (EFV2 only).

Voltage synchronisation can be achieved using the single Vref input as the secondary source supply. This input allows connection of Ph-n or Ph-Ph inputs. This signal is compared against the primary 3-ph supply connected to the normal Voltage inputs on the FV2. Voltage synchronisation is supplied as an option to FV2 along with Extended Inputs and outputs, it is then referred to as Extended Feedervision 2 (EFV2). EFV2 can be configured to inhibit the closing of the breaker if the two supply sources exceed the set thresholds below.

Angle

This setting allows for the error of the angle to be set, if the phase angle between the two voltage sources was to exceed this setting then the relay will carry out the action to which it is set.

Voltage Difference

This setting allows for the error of the voltage difference to be set, if the voltage difference was to go over this setting then the relay will carry out the action to which it is set.

Time in sync

This setting allows for the error of the time in sync to be set, if the time in sync was to go over this setting then the relay will carry out the action to which it is set.

17. Unit Settings.

Software Version.

Displays the operating firmware loaded on to the unit. This should be noted along with the serial number when corresponding about this equipment

Unit ID. / Unit Type.

Displays the Serial number and device type.

Password.

If the password is set to enabled the default password (6363) may be used to change setting and reset statistical data. If the password has been changed to something else the new password must be used.
If a digital input is set to Authorise, by energising this digital input you can change settings without being prompted for a password.

Engineering Password.

If enabled the Engineer Password will allow access using the standard password. Generally if a password is requested a prompt will offer ‘AAAAA’, changing the second A to a B ‘ABAAA’ allows access.

The settings may only be modified when the correct password has been entered.

Change Password.

The FV2 default password is '6363'. It is recommended for security purposes this password be changed. The password may be up to 6 characters long and alphanumeric if desired.
If the User Password is lost and the Engineers Password has been disabled the only options are to either Read the information via the serial Link or execute a Configuration Reset on the relay to restore all of the factory defaults.

Edit Custom Strings.

The FV2 provides the user with the ability to assign a unique user definable name to External 1 to 15 functions, and assign a ‘Motor Tag’ which appears across each page in the display scroll.

Each name can be up to 11 characters.
.

LCD Backlight and LCD Contrast.

These functions allow the user to change the display contrast and backlight.

Time and Date.

These functions allow the user to set the date and the time on the relay.

Time Sync Delay. (Only for use with Chronovision).

Chronovision is a GPS based device which connects on the RS485 network and synchronises the time and date of each connected unit. This delay prevents immediate updating of the RTC.

Calibration.

Each unit is calibrated prior to dispatch and a signed test report is issued. The user may however access these settings if required and re-calibrate the device if deemed necessary. In addition to the calibration of analogue inputs the Calibration Sub Menu provides some useful diagnostic tools and configuration settings for the 4-20mA output signal.
After entering the password the Calibration Sub Menu will be displayed and allows access to the following settings:

Gain and Offsets for each analogue channel.
Reset Cal Factors

Run Offset Cal	O/P Relay Tests
Auto I Cal	Noise Check
Auto V Cal	Feeder Type
Digin Diagnostics	4-20mA Output

It should be noted that the Calibration should be left alone as it could result in the invalidation of the factory calibrations test certificate.

Set Default Page.

Any of the display scroll data pages can be nominated as the default page and returned to after a set period of key press inactivity. To set the page, select the required one using the display scroll button, then enter the unit setting and select ‘set default page’.

Default Return Time.

If the FV2 is not being accessed using the buttons on the front of the relay after a predetermined time the relay will default to the Initial Screen. In this setting you can control that feature. You are able to switch off the return feature or specify a time for the delay before the return to the Initial Screen.

Remote / Test.

ON /OFF setting only applies to the orientation of the remote/local and test/service behaviour of the digital input.

Software Activation Keys.

In order for some functions to operate a unique activation code is required to access hidden menu screens.

Screen Saver.

To help extend the life of the LCD we can power the display down if the application suits. The screen will power down after the set time from the last key press. The FV2 will still operate and can be remotely controlled via digital inputs or the serial interface.
On any key press or active fault the display will re-activated.

Chronovision.

When enabled allows the real time clock to be updated via the broadcast GPS sync signal from Chronovision.

Comms DigIn.

This setting allows the FV2 to convert it's mapping to FV1, thereby allowing the upgrading from FV1 to FV2 hassle free.

Invert LED Colour.

Required to be set to YES when the green-screen LCD version is used.

Hours in Service.

The hours in service is a counter which increments whilst the unit is in service or energised, this is used to help determine MTBF figures.

18. Smart Card Settings.

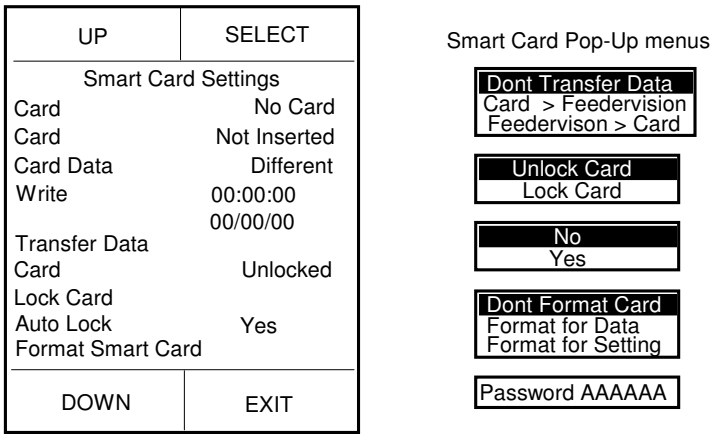
The Smart Card was developed to provide secure parameter storage and ease of data retrieval.
The smart card gives users the ability to transfer data between similar devices using the inbuilt card reader/writer, it can be formatted and controlled via the relays' LCD interface or with a PC and dedicated smartcard reader.

Smart Cards are available in two forms, both can be password protected and once formatted for a particular device type they cannot be used in another device type (MV2 for example) without re-formatting.
The two forms are:

Settings Card
- Password protected up to 6 characters (default AAAAA)
- All parameter settings for a single relay can be saved on one card
- Fast transfer time, typically 5 seconds
- One card can be used to clone multiple relays with the same settings
- Data transfer can be controlled without the need of external equipment

Data Card
- Password protected up to 6 characters (default AAAAA)
- Selectable events to record
- 64K of memory available for data logging (150-4500 events)
- Time and date stamping of events to 1ms
- Stored in text file format

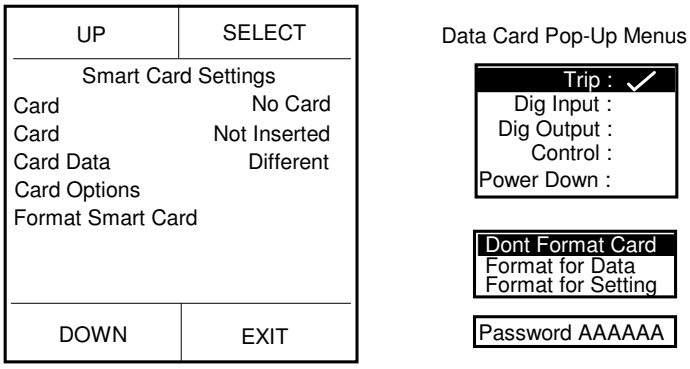
Settings Card:



The Card detail is displayed on the first two lines, the card data indicates whether the parameter settings both on the card and those programmed into the relay concur with each other. Any single setting change causes Compare Fail to be displayed across the screen.
The time and date of the last setting transfer are recorded for that particular card.
The card can be locked against overwriting by means of the password or if set to auto lock the card will be automatically password protected on removal. The password required to unlock and transfer the parameter settings is the password which was set on initial formatting.

Parameters are transferred by selecting Transfer Data.

Data Card.



As with the Settings card the card detail is displayed on the first two lines in the menu.
The card options allow the user to set which of the conditions the data card is required to store, single or multiple events can be set.

The format of data storage is as follows;

Trip Data:
Trip Event, Time & Date, All currents and Voltages, all other relevant measured data

Digital Input or Output:
Digital I/O Event, Time & Date, Digital I/O number, Digital I/O name, Final State (Open or Closed)

Control Data:
Control Event (open / close), Time & Date, Origin (serial / panel / remote / auto / trip)

Power Down:
Time& Date

The Smart Card reader is supplied as standard on FV2 but in order to use the facility the purchase of a unique Software Activation Key is required for the inbuilt card reader to operate.
Once keyed in the unit must be powered off and on, previously hidden menu screens will now be available.

We recommend that the device is isolated from the process during any smart card use.

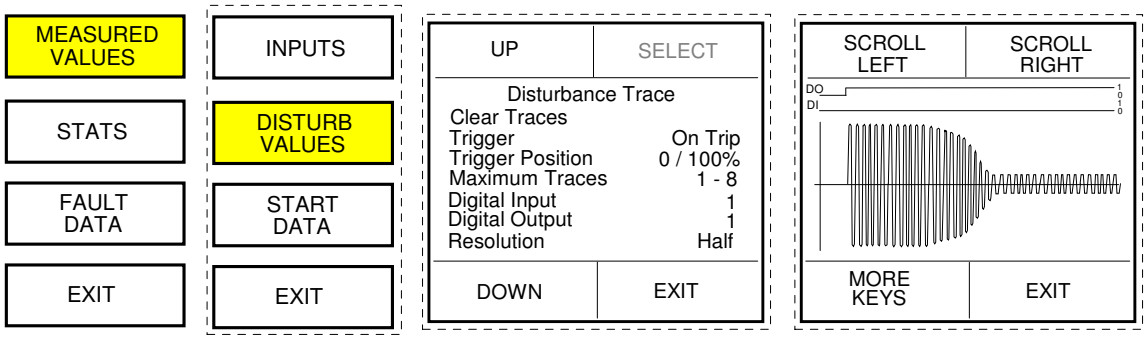
19. Disturbance Recording.

Disturbance and fault recording is a very effective tool for personnel to analyse the performance of the power system and related equipment during and after a major disturbance.
Utilising the graphical display to full effect an onscreen Disturbance Recording facility is now available using a unique software activation key similar to that of the smart card option.

A total of eight seconds recording can be achieved at half resolution with the ability to capture multiple traces, which can be weighted pre and post fault on selectable triggering events.
All the currents and voltages are captured on a single recording (viewable separately) along with a specified digital output and digital input.

The disturbance traces can also be extracted via the optional front mounted RS232 port in Comtrade format for high resolution analysis.

The four software function buttons allow limited manipulation of the image with the ability to zoom in and out, and scroll left and right allowing the entire oscillograph trace to be viewed without the need for any external equipment.



The More Keys button changes the function of Scroll Left and Scroll Right to Zoom In and Zoom Out.

Disturbance recording options:

View trace

Allows viewing of the selected disturbance via the graphical LCD

Trace Time

Displays the time and date of the selected trace, the trace recordings are identified by their time and date stamp which can be chosen from a pop-up selection.

Trace Input

Selects which of the measured values is be shown when the View trace is selected

Enable Overwrite

Once the maximum traces have been recorded “trace full” will be displayed on screen. If set to overwrite then new recordings will overwrite those previously stored on a fifo basis.

Clear Traces

This clears and permanently deletes all records traces in the buffer memory.

Trigger

Selects the trigger source to begin recording;
On Trip, On Pick-up, On DI Close or On Start.

Trigger Position

Selects the trigger point pre and post fault;
0-100%, 20-80%, 50-50%, 80-20% or 100-0%.

Resolution

The resolution can be set to half (allowing the full eight seconds) or full, which allows a maximum of four seconds recording.

Maximum Traces

Up to eight traces can be recorded. If set to the maximum with full resolution, then each trace length can only be a maximum of 500ms each.

Digital Input No.

Selects which of the 1-12 (1-24 EFV2 only) digital inputs is to be recorded along with the trace.

Digital Output No.

Selects which of the 1-4 (1-8 EFV2 only) output relays is to be recorded along with the trace.

20. Inverse Overcurrent Relay.

This time curves (Definite Time, Normal Inverse, Very Inverse and Extremely Inverse) dictate the time delay to trip depending on the current and the characteristic chosen. This is used when co-ordinating and discriminating between faults on larger systems.

Inverse time phase overcurrent relay.

Characteristics according to IEC 255-4 or BS 142

Normal Inverse $t = \frac{0.14}{(I/Is)^{0.02} - 1} tI>\ [s]$

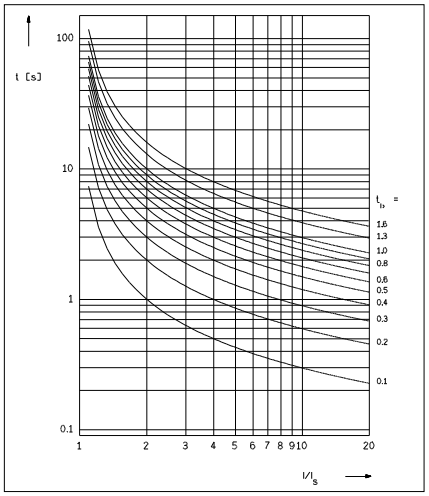
Very Inverse $t = \frac{13.5}{(I/Is) - 1} tI>\ [s]$

Extremely Inverse $t = \frac{80}{(I/Is)^{2} - 1} tI>\ [s]$

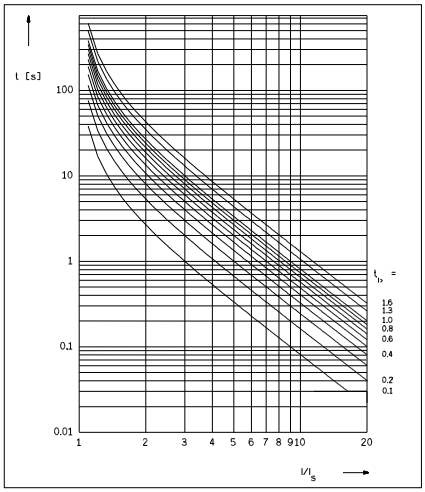
Where:
t = Tripping Time
tI> = Time Multiplier
I = Fault Current
Is = Inverse Time Overcurrent Pickup

Inverse time characteristics.

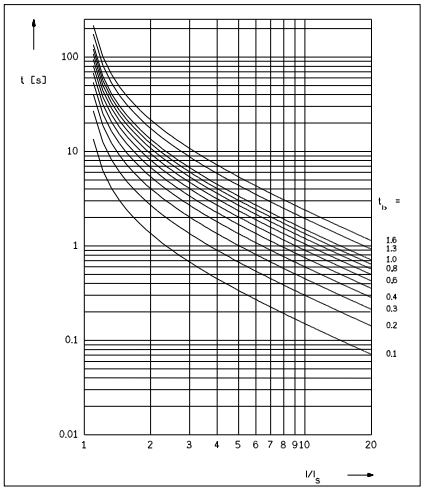
Normal Inverse



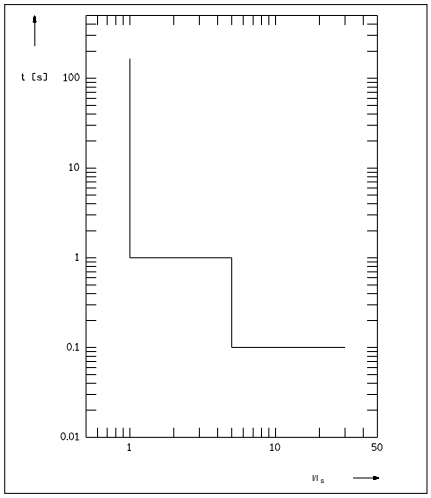
Extremely Inverse



Very Inverse

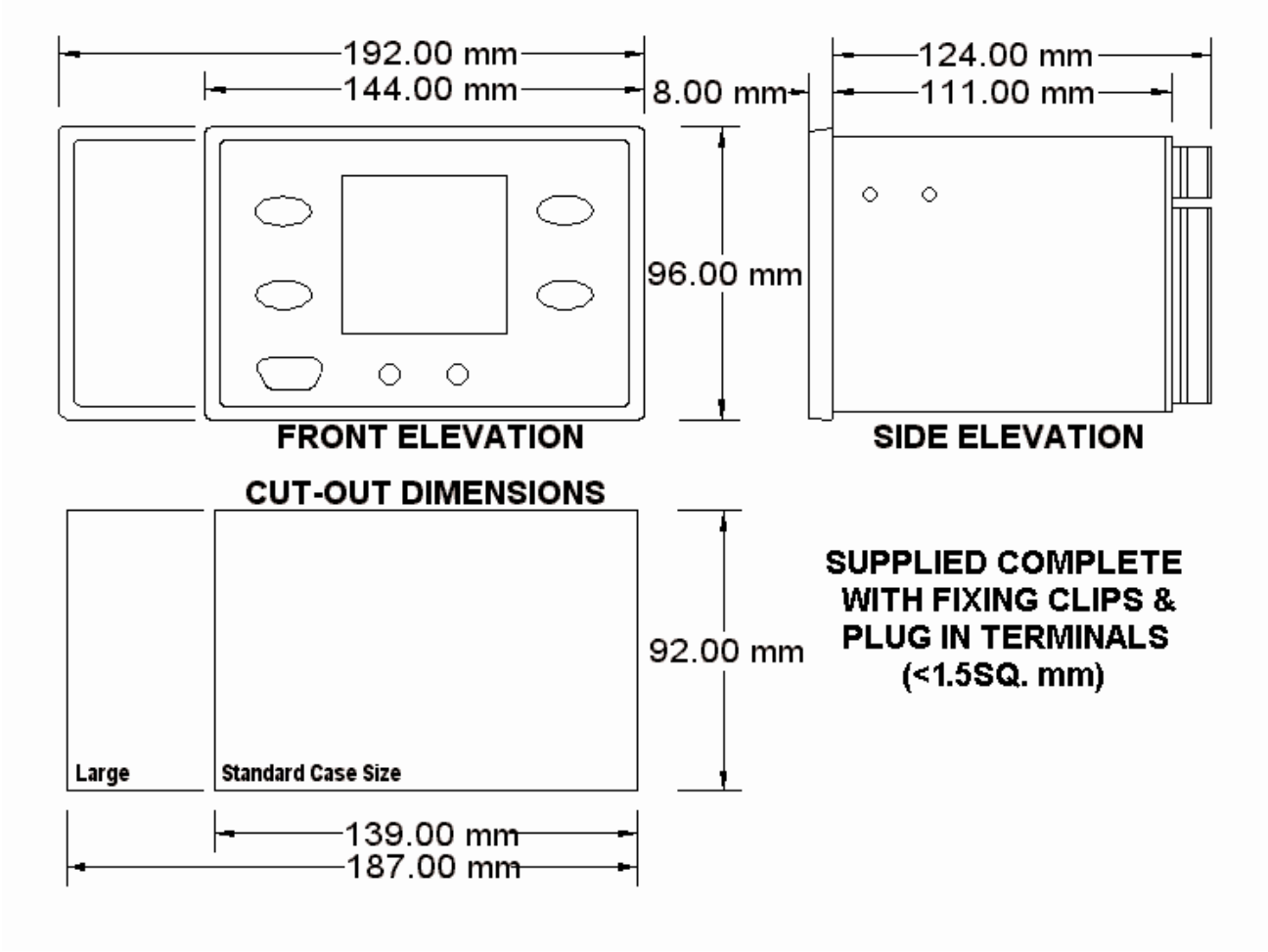


Definite Time



Appendix 1 FV2 Installation.

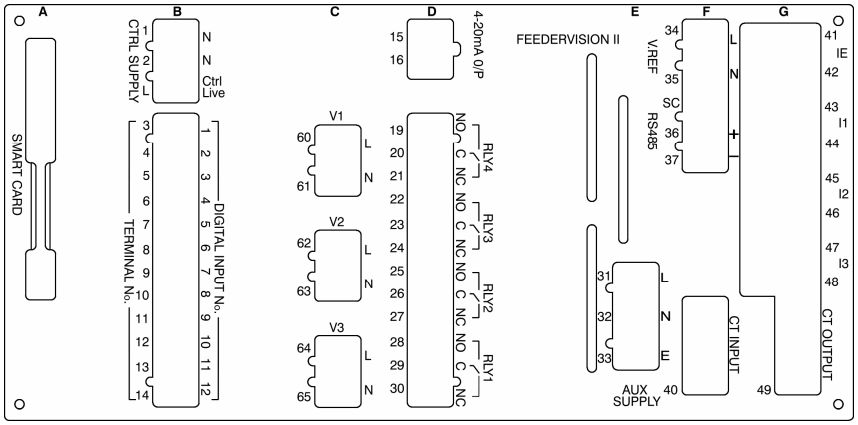
The FV2 is supplied in a DIN standard case suitable for flush mounting as detailed below. FV2, TFV2 & EFV2 are supplied in the 'large' case size, FPC is supplied in the 'standard' case size.



The case can be supplied with an optional sash lockable dustproof cover.

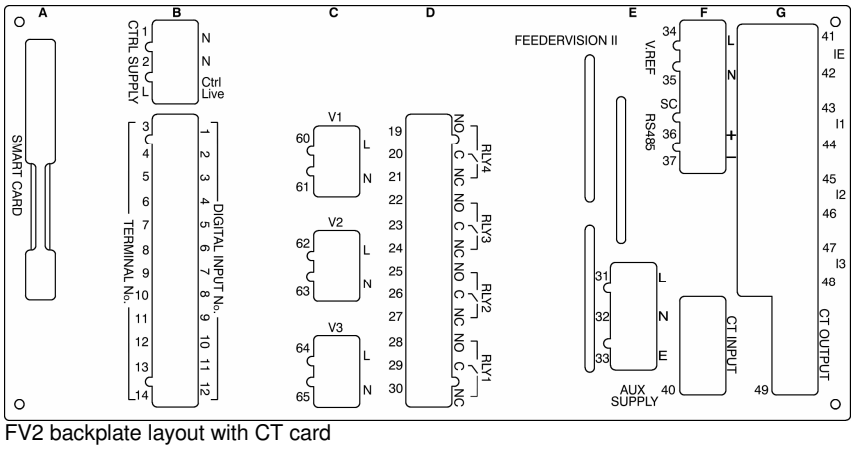
Appendix 2 Termination Numbers.

FV2



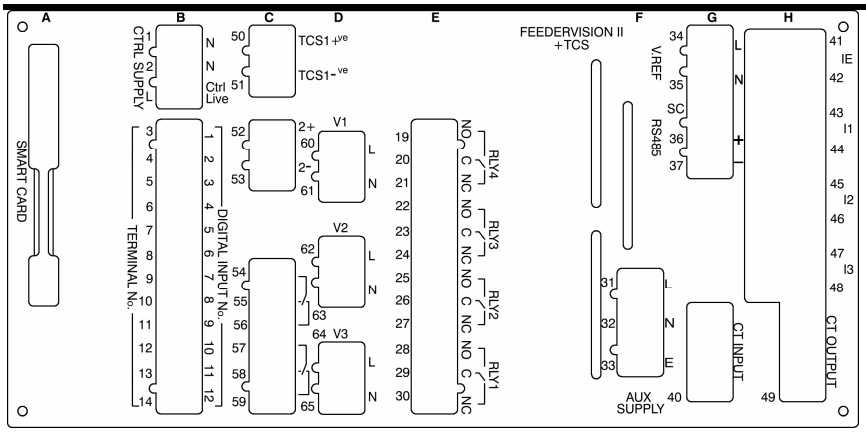
FV2 with 4-20mA backplate layout with CT card
Note: the RS485 port may can be replaced with optional Profibus (not shown)

A: Smart Card
B: Digital Input Card
C: 3-Phase Voltage Input
D: Relay Card with 4-20mA Output
E: Power Supply Card
F: Analogue Card
G: 1A/5A CT Card
See table 5.1 for specific use of terminals



FV2 backplate layout with CT card
Note: the RS485 port may be replaced with optional Profibus (not shown)

A: Smart Card
B: Digital Input Card
C: 3-Phase Voltage Input
D: Relay Card
E: Power Supply Card
F: Analogue Card
G: 1A/5A CT Card
See table 5.1 for specific use of terminals



FV2 with TCS backplate layout with CT card
Note: the RS485 port may be replaced with optional Profibus (not shown)

A: Smart Card
B: Digital Input Card
C: Trip Circuit Supervision card (TCS)
D: 3-Phase Voltage Input
E: Relay Card
F: Power Supply Card
G: Analogue Card
H: 1A/5A CT Card
See table 5.1 for specific use of terminals

FV2 Termination Numbers.

The following details the specific use of the terminals for FV2 and FV2 with 4-20mA, and FV2 with TCS2

Smart Card
CONNECTOR 1
SMART Card Socket

Digital Input Card	
3-WAY AUX. SUPPLY	
PIN NUMBER	SIGNAL.
1	NEUTRAL
2	NEUTRAL
L	CONTROL LIVE
12-WAY PLANT INPUTS	
PIN NUMBER.	SIGNAL.
3	PROGRAMMABLE INPUT 1
4	PROGRAMMABLE INPUT 2
5	PROGRAMMABLE INPUT 3
6	PROGRAMMABLE INPUT 4
7	PROGRAMMABLE INPUT 5
8	PROGRAMMABLE INPUT 6
9	PROGRAMMABLE INPUT 7
10	PROGRAMMABLE INPUT 8
11	PROGRAMMABLE INPUT 9
12	PROGRAMMABLE INPUT 10
13	PROGRAMMABLE INPUT 11
14	PROGRAMMABLE INPUT 12

3-Phase VT Card	
2-WAY VT INPUT	
PIN NUMBER	SIGNAL.
60	+ve
61	-ve
2-WAY VT INPUT	
PIN NUMBER	SIGNAL.
62	+ve
63	-ve
2-WAY VT INPUT	
PIN NUMBER	SIGNAL.
64	+ve
65	-ve

Relay Card	
2-WAY 4-20mA INPUT (OPTION)	
PIN NUMBER	SIGANL
15	+ve
16	-ve
12-WAY RELAY OUTPUT	
PIN NUMBER.	SIGNAL.
19	RELAY 4 NO
20	RELAY 4 C
21	RELAY 4 NC
22	RELAY 3 NO
23	RELAY 3 C
24	RELAY 3 NC
25	RELAY 2 NO
26	RELAY 2 C
27	RELAY 2 NC
28	RELAY 1 NO
29	RELAY 1 C
30	RELAY 1 NC

Table 5.1

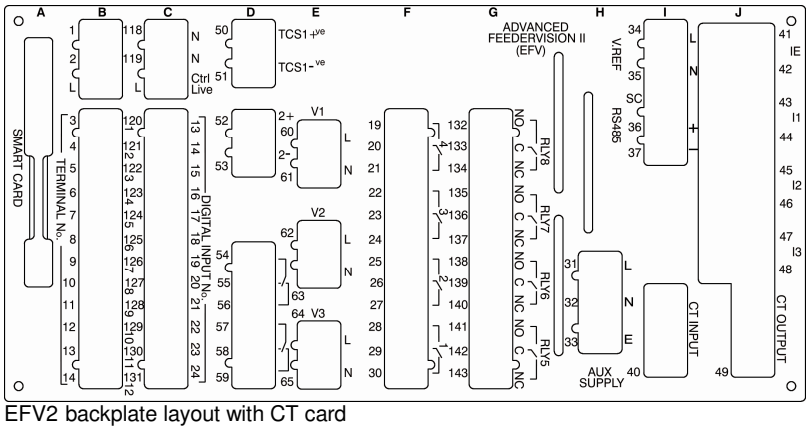
Power Supply Card	
3-WAY AUX. SUPPLY INPUT	
PIN NUMBER.	SIGNAL.
31	LIVE
32	NEUTRAL
33	EARTH

Analogue Card	
2-WAY VOLTAGE REFERENCE	
PIN NUMBER.	SIGNAL.
34	LIVE
35	NEUTRAL
3-WAY RS 485 COMMUNICATION	
PIN NUMBER.	SIGNAL
SC	RS485 Screen
36	RS485 TX+
37	RS485 TX-
10-WAY CURRENT SENSOR I/P	
PIN NUMBER.	SIGNAL.
40	CURRENT SENSOR

1A/2A/5A CT Card	
8-WAY CT INPUT	
PIN NUMBER.	SIGNAL.
41	I0 S1
42	I0 S2
43	I1 S1
44	I1 S2
45	I2 S1
46	I2 S2
47	I3 S1
48	I3 S2
8-WAY CT SIGNAL	
PIN NUMBER.	SIGNAL.
49	CT SIGNAL

Trip Circuit Supervision Card (TCS)(Option)	
2-WAY TCS INPUT 1	
PIN NUMBER	SIGNAL
50	TCS 1 +ve
51	TCS 1 -ve
2-WAY TCS INPUT 2	
PIN NUMBER	SIGNAL
52	TCS 2 +ve
53	TCS 2 -ve
12-WAY TCS Output	
PIN NUMBER	SIGNAL
54	RELAY 1 C
55	RELAY 1 NC
56	RELAY 1 NO
57	RELAY 2 C
58	RELAY 2 NC
59	RELAY 2 NO

EFV2.



EFV2 backplate layout with CT card
Note: the RS485 port may be replaced with optional Profibus (not shown)

A: Smart Card
B: Digital Input Card
C: Digital Input Card
D: Trip Circuit Supervision card (TCS)
E: 3-Phase Voltage Input
F: Relay Card
G: Relay Card
H: Power Supply Card
I: Analogue Card
J: 1A/5A CT Card
See table 5.1 and 5.2 for specific use of terminals

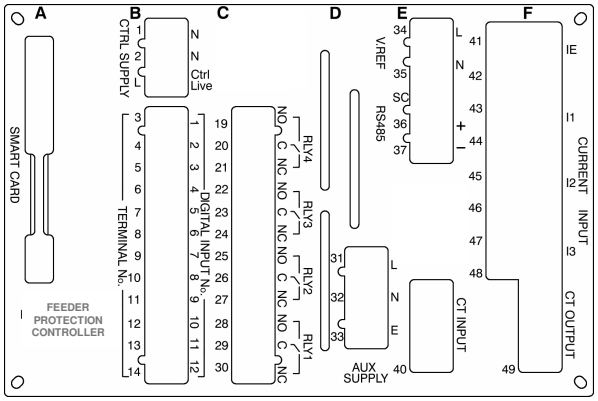
Digital Input Card	
3-WAY AUX. SUPPLY	
PIN NUMBER	SIGNAL.
118	NEUTRAL
119	NEUTRAL
L	CONTROL LIVE
12-WAY PLANT INPUTS	
PIN NUMBER.	SIGNAL.
120	PROGRAMMABLE INPUT 13
121	PROGRAMMABLE INPUT 14
122	PROGRAMMABLE INPUT 15
123	PROGRAMMABLE INPUT 16
124	PROGRAMMABLE INPUT 17
125	PROGRAMMABLE INPUT 18
126	PROGRAMMABLE INPUT 19
127	PROGRAMMABLE INPUT 20
128	PROGRAMMABLE INPUT 21
129	PROGRAMMABLE INPUT 22
130	PROGRAMMABLE INPUT 23
131	PROGRAMMABLE INPUT 24

Relay Card	
12-WAY RELAY Output	
PIN NUMBER.	SIGNAL.
132	RELAY 8 NO
133	RELAY 8 C
134	RELAY 8 NC
135	RELAY 7 NO
136	RELAY 7 C
137	RELAY 7 NC
138	RELAY 6 NO
139	RELAY 6 C
140	RELAY 6 NC
141	RELAY 5 NO
142	RELAY 5 C
143	RELAY 5 NC

Profibus	
PIN NUMBER	**SIGNAL**
1	n.c.
2	n.c.
3	Data B (RxD/TxD-P)
4	CNTR (Repeater control signal TTL)
5	GND
6	Termination-Power
7	n.c.
8	Data A (RxD/TxD-N)

Table 5.2

FPC.



FPC2 backplate layout with CT card
Note: the RS485 port may be replaced with optional Profibus (not shown)

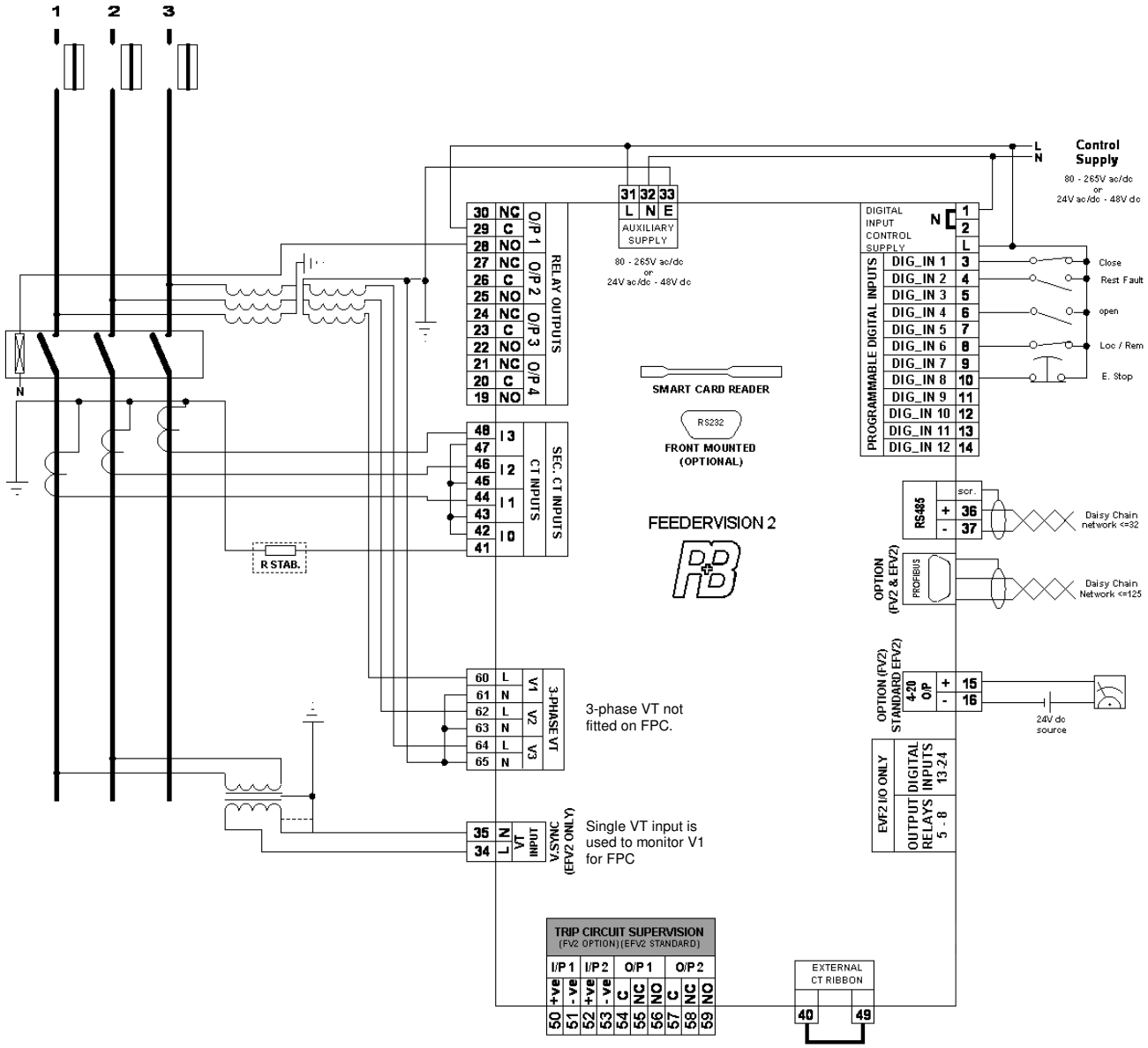
A: Smart Card
B: Digital Input Card
C: Relay Card
D: Power Supply Card
E: Analogue Card
F: 1A/5A CT Card

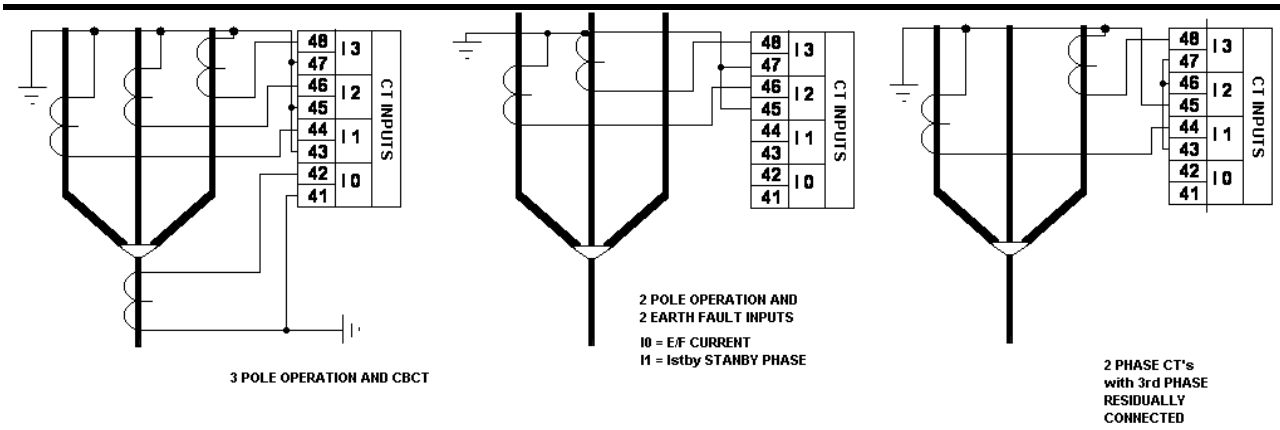
Terminal numbering as per table 5.1 with the exception of the three phase VT card and TCS card.

Appendix 3 FV2 Schematic Diagram.

The following diagram's shows the connection diagram of the FV2 unit in conjunction with the following:

- FV2 with 3 Pole Operation
- FV2 with 3 Pole Operation and CBCT.
- FV2 with 2 Pole and 2 Earth Fault Inputs Operation
- FV2 with 2 Pole with 3rd Pole Residually connected Operation





In the residual earth connection it may be a requirement to addition a stabilising resistor in the earth return leg, this is generally only required when EF protection is set at a low threshold and fast operating time.
The spill current (errors in the CT matching) during the initial energising can cause the drives to trip due to earth fault.

Appendix 4 Fast Scan Numbers.

FSN	Function
0	Current Phase I1
2	Current Phase I2
4	Current Phase I3
6	Earth Current
8	Standby Earth Current
10	Reserved
12	V1
14	V2
16	V3
18	V12
20	V23
22	V31
24	Power 1
26	Power 2
28	Power 3
30	Power Factor 1
32	Power Factor 2
34	Power Factor 3
36	Reserved
38	Undervoltage
40	External Fault 1

FSN	Function
42	Reserved
44	Reserved
46	Total Hours Run
48	Control Input Status 1-12
50	Control Input Status 13-24
52	Reserved
54	Output Relay 1-8
56	Hours Run This Close
58	Number Of Operations
60	KiloWatt Hours 1
62	KiloWatt Hours 2
64	KiloWatt Hours 3
66	KW Peak Demand 1
68	KW Peak Demand 2
70	KW Peak Demand 3
72	Pre Trip I0
74	Pre Trip Istby
76	Pre Trip I1
78	Pre Trip I2
80	Pre Trip I3
82	Trip Fault number

FSN	Function
84	Pre Trip V1
86	Pre Trip V2
88	Pre Trip V3
90	Pre Alarm I0
92	Pre Alarm Istby
94	Pre Alarm I1
96	Pre Alarm I2
98	Pre Alarm I3
100	Alarm fault number
102	Pre Alarm V1
104	Pre Alarm V2
106	Pre Alarm V3
108	Total Kilowatt Hours
110	Total Kilowatt
112	Reserved
114	Reserved
116	Reserved
118	Reserved
120	Reserved

Note: FPC will only display and export information associated with V1.

Appendix 5 Order Sheet.

PBSI Ltd trading as
P&B ENGINEERING

FEEDERVISION2 FAX BACK ORDER FORM

		PART NUMBER									
	QUANTITY	STANDARD UNIT			OPTIONS						
			FV2								
Device Type:											
Standard Feedervision			FV2								
Feedervision with TCS	(TFV2)	T									
Extended Feedervision	(EFV2)	E									
Advanced Feedervision	(AFV2)	A									
Feeder Protection Control	(FPC2)		FPC								
CT's:											
4x 1A				1A							
4x 5A				5A							
3x 1A and 1x 5A				1/5A							
3x 5A and 1x 1A				5/1A							
Options:											
4-20mA Control					4-20						
Profibus						PB					
Front RS232 port (standard if PB is selected)							232				
Low voltage PSU and Digital Inputs								LV			
Smart Card Software Activation Code*									SC		
Disturbance Recording Software Activation Code										DR	

Note:
Hybrid CT's and options beyond 4-20mA are deemed to be special build and are subject to longer delivery times and additional cost

* Smart Cards should be ordered separately

FV2 / TFV2 / EFV2 & AFV2 DIN Case 192x96x110mm
FPC DIN Case 144x96x110mm

before we can process an order we must be in reciept of an official purchase order along with your company details

Please feel free to contact us if you wish to discuss a specific application.

Due to our continuing efforts to bring you the very best in motor protection and control all information contained within this publication is subject to change without prior notice

Publication number FV2 Issue 7