INTRAC™-204

INTELLIGENT TRACKING ANTENNA CONTROL UNIT
FOR 1,2 or 3 AXES

INSTALLATION & USER MANUAL

ISSUE 1.1

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PREFACE

This equipment manual provides user/operational and installation information on the Advantech AMT Limited INTRAC-204 Satellite Tracking Antenna Controller with integral 36V DC drive circuits and (optional) integral L-band beacon receiver.

This manual covers 1, 2 or 3 axis systems. Some functions are not available in 1 or 2 axis systems and this is noted in the effected sections.

The axes are always referred to as **Az**imuth, **El**evation and **Pol**arisation although some systems may use polar mounts where the main axes might be described as Hour-Angle and Declination (or Dip) axes. Azimuth corresponds to Hour-Angle and Elevation corresponds to Declination.

MANUAL SECTIONS :-

Introducing the INTRAC-204	An overview of the INTRAC-204 and INTRAC-204 basic systems.
Safety	Safe usage of the INTRAC-204.
Specification	The equipment specification.
Operation	How to use and operate the INTRAC-204.
Alarms	A description of the alarm conditions which can occur.
Technical Description	A technical description of the operation of the INTRAC-204.
Installation	How to install and set-up an INTRAC-204 system, includes information on the external connections to the INTRAC-204.
Fault Finding	Assistance in finding any faults which may arise.
Warranty and Repair Information	Warranty and repair service provided by Advantech AMT Ltd.
Appendices	Various information, some installation specific.

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INTRODUCING THE INTRAC-204

The INTRAC-204 INtelligent TRacking Antenna Controller is a microprocessor based controller for antennas in earth station service.

The INTRAC-204 builds a model of the satellite's orbit using a mathematical algorithm. To build the orbit model the INTRAC makes measurements by perturbing the antenna pointing angle very slightly and monitoring the change in received beacon signal strength. These small movements enable the INTRAC to estimate the satellite's position and this estimate is used to build the model.

The system always tracks the satellite from the model. The small movements of antenna pointing are used to maintain and update the model. By using the model to point the antenna the INTRAC system ensures that the antenna is always pointed accurately at the satellite.

The regular measurements made by the INTRAC ensure that changes in the apparent orbit, due to station keeping manoeuvres or other causes, are identified. The model is modified and refined to incorporate these changes and accurate tracking is automatically maintained. The INTRAC will automatically increase the measuring rate if necessary in order to obtain sufficient information on a changing orbit.

As the INTRAC tracks using its orbit model it will continue to track the satellite if the tracking signal is degraded or lost. The satellite position may be accurately predicted from the model for up to 72hrs without a tracking signal.

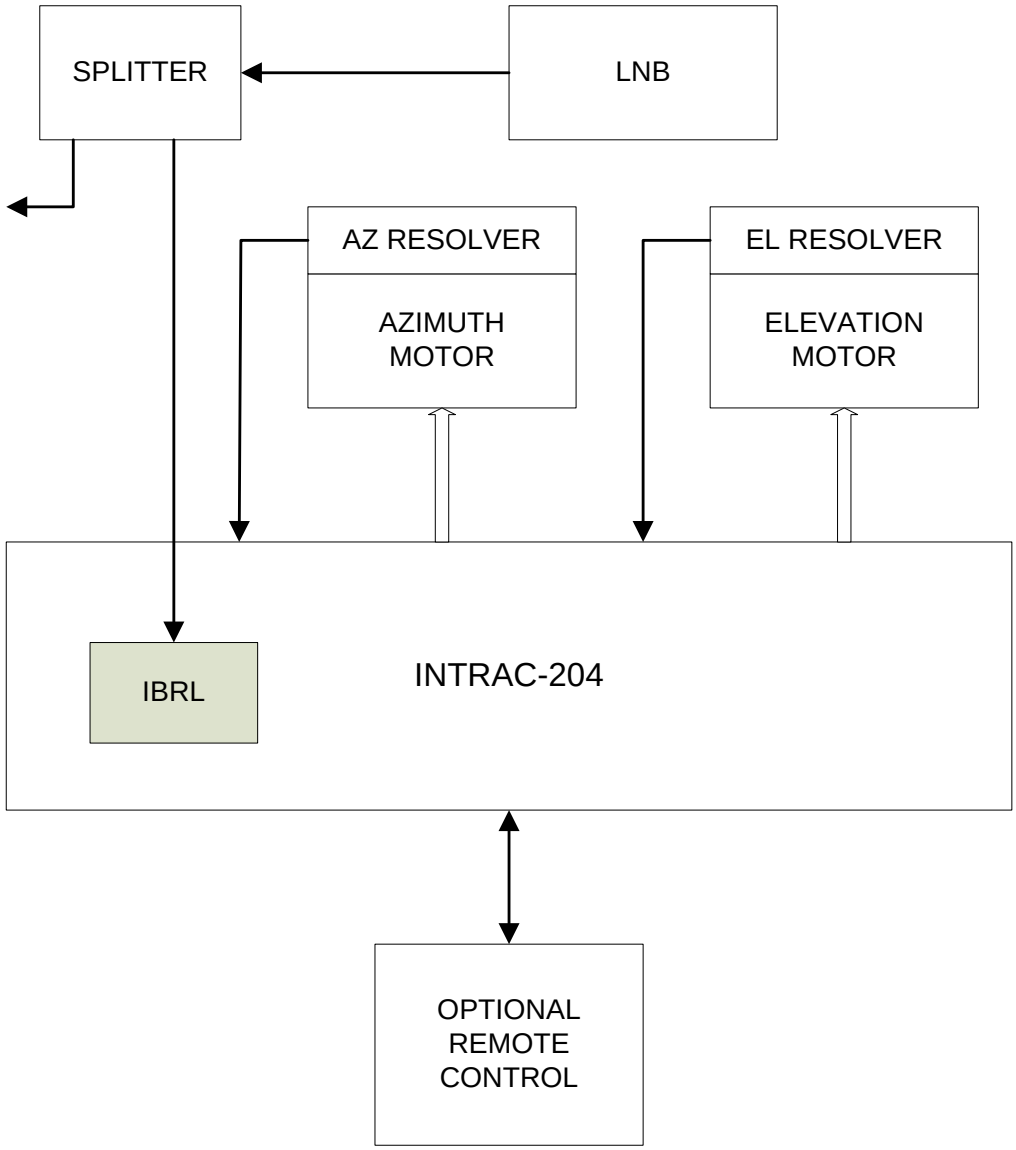
An INTRAC system provides this exceptional tracking performance for satellites with any inclination and at any look angle entirely automatically.

The INTRAC-204 incorporates drive circuits to directly drive low voltage (24V or 36V) motors up to 8 amps. The motor voltage must be specified at time of order.

The INTRAC-204 normally incorporates an IBRL integral L-band beacon receiver.

The INTRAC-204 can be supplied in different variants for controlling 1, 2 (Az and El) or 3 (Az, El and Pol) axes. This manual is applicable to all these variants. .

A Typical 2 Axis System



The Elevation & Azimuth resolvers provide antenna pointing information and the IBR-L beacon receiver provides tracking signal strength. (A signal strength derived dc voltage from an external receiver may be used in place of the IBR-L).

The integral Motor Drive Circuits receive the antenna drive commands internally and drive the antenna to point at the satellite. Limit switches on the antenna prevent it from being driven beyond pre-set positions.

The INTRAC-204 may be controlled from its front panel or from an optional PC based remote control terminal package such as the Advantech AMT Ltd RCM-6 or RCM-7.

1. SAFETY

WARNING

POSSIBLE LETHAL POTENTIALS EXIST WITHIN THIS EQUIPMENT

THE COVERS SHOULD NOT BE REMOVED EXCEPT BY QUALIFIED PERSONNEL.

SWITCH OFF POWER AND ISOLATE SUPPLY BEFORE REMOVING COVERS.

IF IT IS NECESSARY TO OPERATE THE EQUIPMENT WITH THE COVERS REMOVED FOR SERVICING PURPOSES ALL NECESSARY PRECAUTIONS SHOULD BE TAKEN TO PROTECT AGAINST ELECTRIC SHOCKS

ELECTRICAL

Fusing

The unit is protected by a fuse in the live/phase power supply line. This fuse is located in the AC power inlet module on the rear panel.

Care should be taken to ensure that the power cable is correctly connected to the power source such that the live/phase connection of the INTRAC is connected to the live/phase terminal of the supply.

When replacing the fuse be sure to do so with one of the correct value and type.

The DC motor circuit is protected by an additional 10A fuse in the 36V supply line. This fuse is located in a separate fuse holder on the rear panel.

Earthing

It is important that the electrical supply has a good and proper earth which is connected through to the INTRAC-204 via the power cable.

Battery Disposal

The processor board contains a Nickel Cadmium (NiCd) or Lithium battery. These elements are toxic. The battery should be disposed of according to national requirements. DO NOT PLACE IN NORMAL GARBAGE OR IN A FIRE.

Emergency Stop

There is a mechanically latching Emergency stop switch on the INTRAC front panel. Pressing this switch will remove power from the antenna drive motors and the INTRAC will enter Standby mode. To restore drive the switch should be twisted to reset the switch and any mode should be selected, e.g., Standby, Manual, Auto.

An input for normally closed external emergency stop switches is provided on the rear panel. Note that this input is not latched in all modes and **IT IS ESSENTIAL** that , if fitted,

these external switches should be of the mechanical self latching type.

MECHANICAL

Mounting The INTRAC-204 must not be mounted so that it is supported solely by the front panel. A proper rack mounting kit must be used. This may be either of the fixed mounting type or the sliding rail type. Suitable mounting slides are available as an accessory.

2. SPECIFICATION & REQUIREMENTS

Required Mechanical Characteristics of the Antenna System

To enable the full tracking performance of the INTRAC-204 system to be achieved the antenna system must conform to certain overrun and tracking constraints.

The tracking drive speed should normally be less than $^{1}/_{10}$ of the antenna Receive beamwidth per second and the overrun (drift) when power is removed from the motors must be less than $^{1}/_{20}$ of the beamwidth.

If the system does not conform to these requirements please consult with Advantech AMT Limited.

SPECIFICATION

Tracking Accuracy	Typically <0.1dB RMS signal degradation after tracking for 24 hours (with tracking signal), independent of orbit inclination up to 10°.
Prediction Accuracy	Typically <0.1dB RMS signal degradation over 24hrs after loss of tracking signal (after tracking with signal for 24hrs) independent of orbit inclination up to 10°.
Tracking Signal	Derived from the L band Integral Beacon Receiver (IBR-L). The internal IBR-L requires an L-band signal with a level in the range -80dBm to -45dBm and C/No >40dB. Stability better than ± 150KHz. The receive frequency is selected from the INTRAC front panel or from a remote terminal.
Antenna Position Encoders	Single resolver units, with an operating frequency of 800Hz nominal, provide angular position feedback. Two types are available :-
BareSize 11	A bare size 11 resolver. This unit is not weather resistant and must be mounted in a weatherproof enclosure. This unit has short flying leads and is supplied without cable. It would normally only be used for weather protected polarisation axis feedback.
R11W	*A size 11* resolver that has been fitted with a weatherproof (IP66) shroud and a front shaft seal. This unit is supplied with 10m of cable. Longer cable lengths (up to 100m) can be supplied if specified at time of order.
Position Offset	The indicated pointing angles can be electrically offset in all axes to an accuracy of 0.01° to compensate for angular mounting offset in the position encoders.
Limit Switches	Inputs for antenna movement limit switches in each direction for all three axes plus an interlock (emergency stop) switch. These limit switches should be closed when the antenna is within limits and safe. For 1 and 2 axis systems the limits for the unused axes are internally shorted and do not need any external connections Contacts should be rated for 30V at 100mA.
Back-up	Time is maintained by a battery backed clock. Operating parameters, data and orbital models are held in EEPROM.

Inputs	Limit switch inputs. External Emergency Stop switch input.
Outputs	Antenna Motor drive: 24v or 36v dc up to 4A continuous, 8A intermittent.
Controls	Power switch - rear panel. Manual Control keys - front panel. Enter key - front panel. Menu key - front panel. Emergency Stop switch - front panel.
Indicators	System Alarm LED (red) - front panel.
Displays	Two line LED showing :- — Azimuth angle. — Elevation angle. — Pol angle is displayed when required. — Relative signal strength. — Operating mode, alarm code, menu state.
Dimensions	483mm Wide x 132mm High x 406mm Deep. (19” rack x 2U).
Mounting	Standard 19” rack mount. THE UNIT MUST BE SUPPORTED ALONG ITS SIDES BY 19” RACK GUIDE RAILS OR FIXED BRACKETS**.**
Weight	9kg with IRB-L, 7.75kg without IBR-L.
Operating Temperature	+5°C to +50°C.
Storage Temperature	0°C to +50°C
Relative Humidity	10% - 90% non-condensing.
Power	220V - 240V 50Hz 50W. 110V - 120V 60Hz 50W. A protective earth is required.
Warranty	24 months from date of dispatch.
Country of Origin	United Kingdom.

3. OPERATING THE INTRAC-204

The INTRAC-204 may be operated directly from the front panel or from a remote control terminal.

FRONT PANEL CONTROL

manual control keys — These keys have two functions. In manual control mode they are used to drive the antenna up, down, left or right. In menu mode the left and right keys are used, in conjunction with the Enter key, to move the cursor through the menus. The up and down keys are used to increment or decrement a numeric value which is used in some of the menus.

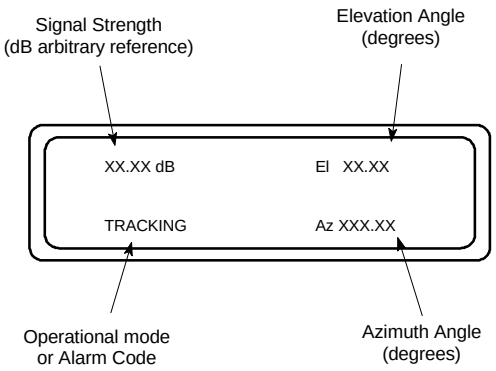
enter key — Used in menu mode to select the menu, or menu option, which is currently next to the cursor and displayed in upper case or to accept a numeric value.

menu key — Used to enter menu mode.

Emergency Stop Switch — Removes all DC power to the motors.

system alarm indicator — Illuminates when a primary alarm is raised.

display



In normal operation mode (i.e., not in menu mode) the display shows the four factors as in the above diagram. In menu mode the options of the currently selected branch of the menu tree are displayed in one or two lines.

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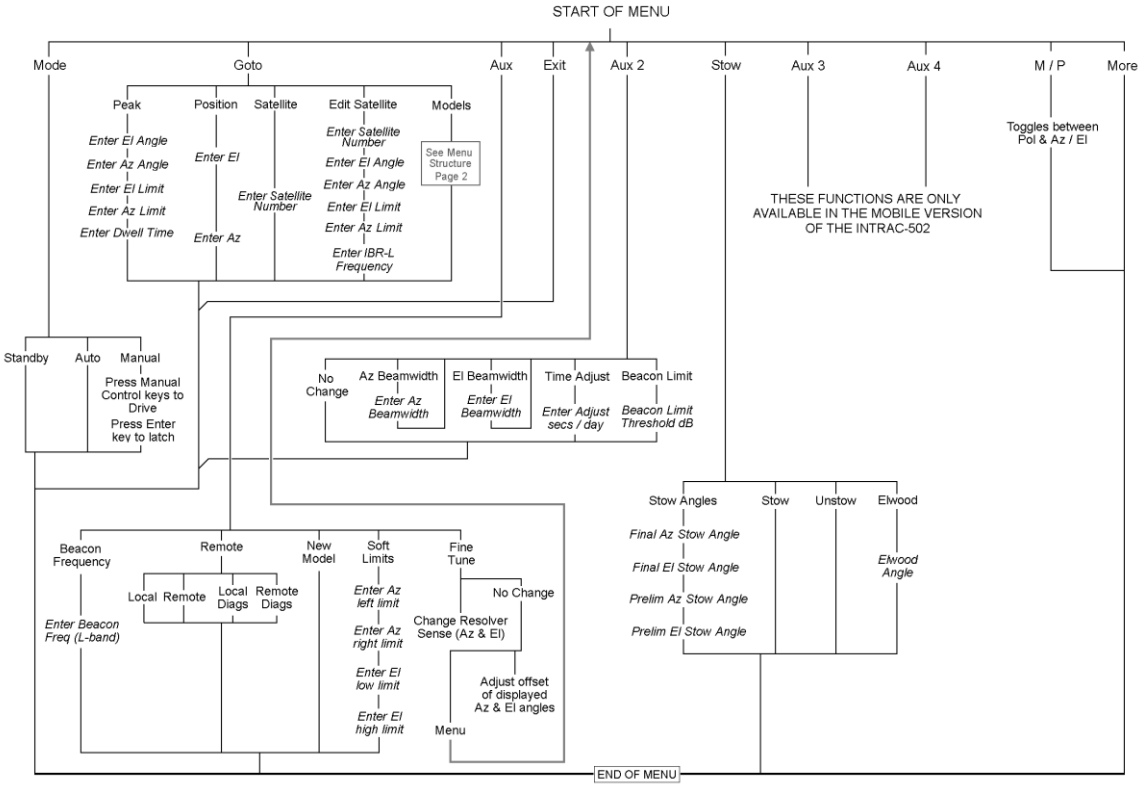
OPERATIONAL MENU

The INTRAC-204 is operated via a menu system which is entered by pressing the Menu key and moved through with the Manual Control left & right keys and the Enter key.

For 1 and 2 axis systems menu functions for non-existant axes will either be not present or have no effect.

The structure of the menu system is shown below :-



In Menu mode the screen changes from its normal display to displaying the menu functions. On pressing the Menu key the ten headings from the top row of the menu are displayed in two lines together with the cursor :-

_MODE	goto	aux	exit	aux2
stow	aux3	aux4	m/p	more

The cursor is moved through the options using the Manual Control left & right keys. The option to the right of the cursor is the one selected and this is indicated by it changing to upper case characters. To step through the menu system press the Enter key when the appropriate option is highlighted. This will cause the display to change to the options of the selected function. e.g., highlight MODE and press Enter :-

_STANDBY	auto	manual

Pressing Enter now will put the INTRAC-204 into Standby.

Some menu functions require numerical data, e.g., for angle values. To edit numeric values position the cursor on the digit to be changed with the left or right manual key and increase or decease the value with the up or down key.

Pressing the menu key again at any time will return to the top level of the menu system where the exit option exists.

DESCRIPTION OF MENU FUNCTIONS

The menu functions will be described working from left to right in the diagram above and dropping down to each sub level as it is reached.

MODE

The mode sub menu allows the INTRAC-204 to be put into Standby, Auto or Manual mode.

Standby

Standby mode is a no movement mode. The antenna is not driven but its position (Az, El & Pol) and the beacon signal level are monitored and displayed. The external inputs are monitored and any fault detected will cause the appropriate alarm(s) to be raised.

As well as being selected from the menu Standby mode is automatically entered when a primary alarm is raised or at the end of a front panel generated goto command.

Auto

Auto is the mode for normal, tracking, operation. There are three sub modes to Auto which are selected by the INTRAC depending on the circumstances. They are not selectable by the user. They are Tracking, Learning and Predicting.

Tracking

This is the normal operating situation, the INTRAC has passed through the learning period, built the orbit model and is tracking the satellite from that model.

Learning

This is a sub-mode used for the first 24 hours of tracking a new satellite. During this time the INTRAC is obtaining data to build the orbit model. Tracking accuracy during this period is very close to full model tracking accuracy. The difference between learning and tracking is not the accuracy but the length of time that the satellite can be tracked after the beacon signal has been lost. (see predicting)

Predicting

This is the mode the INTRAC enters when it does not have a “useful” beacon signal. A useful signal is one that is neither over or under range, varies as expected during antenna movements and has a “beacon receiver in lock” signal. In predicting mode the INTRAC continues to track the satellite by predicting its location from the orbit model. However as the model cannot be updated prediction duration is limited. Once the full model has been built predicting can continue for 72 hours without a tracking

signal. If the signal is lost during learning mode the period of prediction is greatly reduced.

Manual

Manual mode allows the antenna to be driven by the front panel Manual Control keys. Pressing one of the Manual Control keys will cause the antenna to move in the appropriate direction for the time that the key remains pressed. Drive is not latched and will stop as soon as the key is released. Drive may be latched by pressing the Enter key whilst the direction key is also pressed. Pressing Enter again will unlatch the drive.

GOTO

The Goto menu is used to drive the antenna to specific Az & El co-ordinates and to peak the antenna on a satellite within a specified area of sky. It is also used to input and clear NORAD & IESS-412 data, select the source of the tracking model and to clear the INTRAC model.

Peak

This function searches a defined area of sky for the strongest beacon signal and when the search is complete the antenna is returned to the angle of strongest signal. When Peak is selected it is necessary to enter the nominal Az & El angles for the search plus the range of the search in +/- Az & El Limits. The dwell time is also required.

Note

Dwell time is the time the beacon receiver takes to lock onto the signal. It is the time for which the antenna remains static to allow the beacon receiver to lock to the signal.

Position

This function simply drives the antenna to the entered Az & El co-ordinates. (Also Pol angle if motorised pol is fitted). If any of the entered angles are outside of the Soft Limits that value is not accepted and another must be entered. When all the co-ordinates have been accepted the antenna is driven to them and the INTRAC is then set to Standby.

Satellite

Positional data for up to 40 satellites may be stored within the INTRAC-204. This menu function is used to call one of the stored satellites and cause the antenna to be driven to the co-ordinates. See “Edit Satellite”.

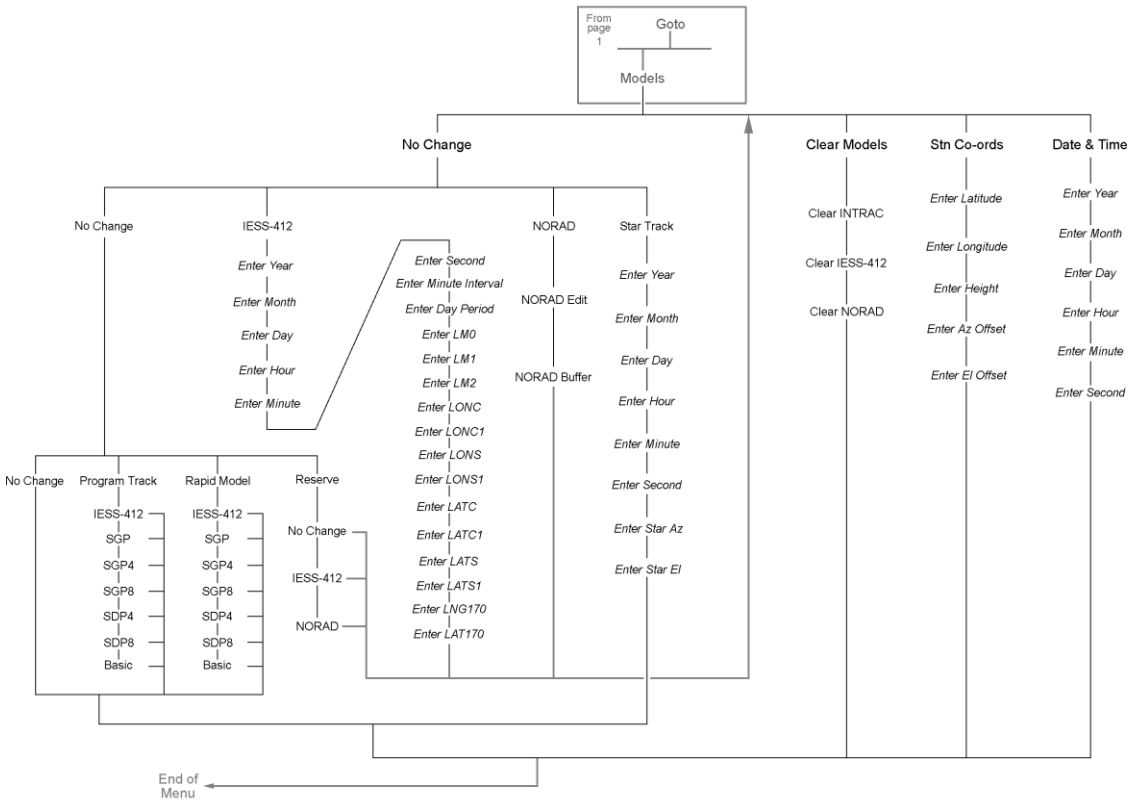
Edit Satellite

The co-ordinates of up to 40 satellites can be entered and stored. Enter the store number, between 1 & 40, and the Az and EL angles (and Pol where fitted) and the IBR-L frequency if an integral beacon receiver is fitted.

Models

The Models function has a number of sub menus one of which, No Change, has more sub menus which include a “No Change”. Note that IESS-412 and NORAD models are not applicable to single axis systems.

No Change Selecting “No Change” drops to the next menu level. Each of the three menu levels has a “No Change” selection. Continuously selecting “No Change” exits from the Menu structure.



First level *Clear Models* This function is used to clear the INTRAC Model, the IESS-412 data and/or the NORAD data.

Stn Co-ords Enter the station latitude, longitude, height and the antenna Az & El offsets.

Date & Time Enter the year, month, day, hour, minute and second.

Second level *IESS-412* Enter the IESS-412 Ephemeris data.

NORAD Enter the NORAD Ephemeris data.

Star Track Enter the Star Track data. (This is a test facility)

Third level *Program Track* Sets the INTRAC to operate in Program Track mode using the IESS-412 data or one of the NORAD (SGP, SDP or Basic) algorithms.

Rapid Model Generates an orbit model using the IESS-412 data or one of the NORAD (SGP, SDP or Basic) algorithms. This by-

	passes the need for the INTRAC to learn the orbit over a 24hr period. The generated model is used and updated in the same manner as an INTRAC learnt model would be.
Reserve	Allows the selection of IESS-412 or NORAD Ephemeris data to be used as the fall-back for Program Tracking in the event that the tracking signal is lost for a greater period than the validity of the tracking model. (Valid IESS-412 or NORAD data must be resident within the INTRAC for this function to operate).
Note	See “Using IESS-412 or NORAD Data” on page 29.
AUX	This sub menu contains various set-up functions and remote / local control selection.
Beacon Frequency	Enter the L-band beacon frequency.
Remote	Select Local (INTRAC front panel) or Remote control of the INTRAC-204. Alternatively select Local Diags (local control but with diagnostic data available at the remote port of the INTRAC) or Remote Diags (allows remote control but commands are not acknowledged and Status Requests are ignored. Diagnostic data is available at the INTRAC remote port).
New Model	Clears the existing orbit model and starts the INTRAC learning a model for the satellite at the current pointing.
Soft Limits	Enter the antenna movement Software Limit values.
Fine Tune	Set the resolver sense to True or Inverse for the Az & El axes. Select “No Change” to enter the Fine Tune Offset menu. Change the displayed angles, if necessary, to equal the known true pointing angles. Select Menu to exit (returns to menu entry level).
EXIT	Selecting “Exit” drops out of the menu structure.
AUX 2	Aux 2 contains more set-up functions.
No Change	By-passes this menu and exits the menu structure.
Az Beamwidth	Enter the antenna Azimuth 3dB beamwidth.
El Beamwidth	Enter the antenna Elevation 3dB beamwidth.
Time Adjust	Enter a correction value for the clock in +/- secs per day.
Beacon Limit	This function only applies when an external tracking receiver is used, i.e., it does nothing when an IBR-L is fitted.

		The beacon level threshold value sets the level at which the INTRAC deems the external receiver to be out of lock. The value is also used during a search to end the dwell period once the signal level rises above it.
STOW		This sub menu is from where the antenna stow angles are set and from where the antenna is “stowed” or “unstowed”.
Stow Angles		Enter the Final and Preliminary Az, El and Pol (where fitted) Stow angles.
	Note	The final Az stow angle is not used.
Stow		Drives the antenna to the stow position. The Pol axis is driven first to its stow position. The elevation axis is then driven to its preliminary stow position followed by the azimuth to its preliminary position. When the antenna is at the preliminary stow position for both axes it is driven to the elevation final stow position. The final azimuth position is not used, i.e., the Az remains at the preliminary position.
Unstow		This command causes the antenna elevation axis to be driven to the preliminary stow position.
Elwood Angle		This is the elevation angle below which no azimuth drive is allowed in any mode. It is used to ensure that the antenna feed horn assembly cannot be damaged by antenna movement when the elevation angle is too low.
AUX 3		This section is not implemented in the INTRAC-204.
AUX 4		This section is not implemented in the INTRAC-204.
M / P		The facility is used to toggle the manual drive control between Az / El and Pol (only operates if motorised Pol is fitted).
MORE		This menu section is for future expansion.

4. ALARMS

The INTRAC-204 control software incorporates a number of continuous integrity checks and system monitoring functions. If any of these fail at any time an alarm will be raised. The most serious alarms are classified as primary alarms and normally cause the INTRAC-204 to enter Standby mode with the front panel System Alarm indicator illuminated and a alarm code displayed in the LCD. Less serious faults generate a secondary alarm. A secondary alarm condition can be detected via the Remote Control port but does not, itself, generate any front panel indication
A full list of alarms, together with the alarm codes they produce, is given on page 23.

Primary Alarms

The primary alarms comprise:

- Hardware Alarm
- Drive Fail Alarm
- Synchro Alarm
- Limit / Interlock Alarm

Hardware Alarm

The Hardware Alarm is caused by a processor crash or the failure of an integrity check. The INTRAC will reset the processor and memories, including the model. If the INTRAC was in Auto mode at the time the hardware alarm arose the system will reset the alarm and enter learning mode. If the INTRAC was in any other mode it will enter Standby mode and wait for operator intervention.

Drive Fail Alarm

The Drive Fail Alarm occurs when the INTRAC-204 fails to detect any change in the resolver output after the drive has been activated. The Drive Fail Alarm is also raised if either axis drives in the wrong direction or if an attempt is made to drive within 1.4^{o} of North.

Note

The Drive Fail Alarm is not activated when in Manual mode.

Synchro Alarm

The Synchro Alarm occurs if an apparent change in position greater than 1.4^{o} occurs in a 1/64th of a second interval.

Limit / Interlock

A Limit /Interlock Alarm is raised if any of the limit switch inputs or the interlock input become open circuit.

Secondary Alarms

There are three secondary alarms:

- Unable to Predict
- Beacon Alarm
- Servo Alarm

Unable to predict

The Unable to Predict Alarm is raised by software when confidence in the tracking model is inadequate for prediction. Once the orbit model has been learnt the INTRAC can predict for 72 hours. If the tracking signal is lost during learning the period of predicting is reduced. The Unable to Predict alarm is raised either after 72 hours of no tracking signal or after such other period of predicting as the INTRAC decides, based on the length of the learning period.

Note

When the INTRAC is unable to predict it will either continue to track from the Reserve Model, if a valid IESS-412 or NORAD ephemeris file exists, or enter standby.

Servo Alarm

The Servo Alarm is set if difficulty is encountered performing the cross scans. This normally results from excessive motor drive mechanical over-run in either axis.

These secondary alarm conditions alone do not mean that there is a system fault. The state of these alarms can be interrogated under remote control. However they are not visible from the front panel, unless they are co-existent with a primary alarm.

Recovery from Alarm Conditions

All Primary alarms (except the Hardware alarm when in Auto) cause the INTRAC-204 unit to go into Standby mode.
Recovery from Drive Fail, Synchro and Hardware Alarm conditions is performed by re-selecting the desired operating mode from the menu tree or by sending any remote control mode command (including Standby).
Software limit and hardware limit switch alarms can be cleared only by driving back from the limit condition using Manual mode.
Emergency Stop and Interlock alarms can be cleared only by correcting the cause of the alarm.

Alarm Codes

In the event of a Primary Alarm condition arising, a alarm code is displayed on the INTRAC-204 Front Panel LCD display. The following sections list the codes displayed and explain their significance.

The alarm code is displayed as an octal number with an alphabetic character inserted in the third position from the left.

The alphabetic character indicates the current INTRAC operating mode. The alpha character is coded as follows :

X X Z X X X X X X	Sleep Mode
X X M X X X X X X	Manual Mode
X X S X X X X X X	Standby Mode

NOTE:

There is no alphabetic character to indicate Auto Mode, since alarm codes can never be displayed when in Auto Mode.

The Octal Number surrounds the alphabetic character (which is denoted in the following table by 'x').

Displayed Octal Code	Bits	Alarm
40x100000	21	*Polar Synchro Alarm
20x100000	20	*Polar Drive Fail (i)
10x100000	19	*Polar software CCW limit
04x100000	18	*Polar software CW limit
02x100000	17	*Polar CCW limit
01x100000	16	*Polar CW limit
00x100000	15	*Az/El Drive Fail (i)
00x040000	14	*Az/El Synchro Alarm
00x020000	13	Unable to predict
00x010000	12	*Elevation software limit
00x004000	11	*Azimuth software limit
00x002000	10	*Left Limit
00x001000	9	*Right Limit
00x000400	8	*Down Limit
00x000200	7	*Up Limit
00x000100	6	*Interlock
00x000040	5	*Drive Inhibit
00x000020	4	*Stop Alarm (ii)
00x000010	3	Servo Alarm
00x000004	2	*Hardware Alarm (iii)
00x000002	1	Beacon Alarm (iv)
00x000001	0	Not used

(i) Motor not operating for whatever reason, driving in wrong direction or attempt to drive within 1.4^{o} of North (Az 0^{o}).

(ii) The Stop Alarm is set if any of bits 5 to 12 are active.

(iii) Due to parity error, run-time error, watchdog time-out

(iv)
- Beacon signal >+25 dB (on display).
- Beacon signal Out-of-Lock.
- Beacon signal <-15 dB (on display).
- Beacon signal level not varying during step cycles.

* Primary Alarms which illuminate the System Alarm Indicator.

The displayed octal code is the sum of <u>all</u> the detected alarm codes, so the exact code displayed may well not be contained as a direct entry in the above table. To see what faults have been detected it may first be necessary to break the displayed code into its individual components. Each component will have only one non-zero digit (which will be 1, 2, or 4), and the sum of all the components will be equal to the displayed code.

Examples of alarm codes are shown below

Example 1

Displayed code 00M000070$_8$ (M = Manual mode)

breaks into:-

1st code 00 000040$_8$ Drive Inhibit has been operated.

2nd code 00 000020$_8$ Stop bit set.

3rd code	$00\ 000010_8$	Servo alarm has been raised.

Example 2

Displayed code $00S140126_8$ (S = Standby mode)

breaks into

1st code	$00\ 100000_8$	Az/El Drive has failed.
2nd code	$00\ 040000_8$	Az/El Synchro Alarm raised.
3rd code	$00\ 000100_8$	Interlock circuit opened.
4th code	$00\ 000020_8$	Stop bit set
5th code	$00\ 000004_8$	Hardware Alarm
6th code	$00\ 000002_8$	Beacon signal fault.

In this example the presence of a beacon signal alarm (a secondary alarm) can be seen in the display because of the primary alarm conditions existing at the same time.

5. TECHNICAL DESCRIPTION

Introduction

This section looks at and explains the Operational Modes and Functions of the INTRAC-204 including the Tracking Algorithm.

THE MODES

The INTRAC-204 has six major operational modes :-

- Standby
- Auto - (tracking but includes learning & predicting)
- Manual
- Goto (Peak, Position & Satellite)
- Sleep (alarm induced, not user selectable)
- Remote (transfers control to a remote terminal)

Standby

Standby mode is a “no movement” mode, the antenna is not driven (the brakes where fitted will be applied) but the pointing angles and beacon signal level are monitored and displayed. External inputs to the INTRAC are also monitored and any primary alarms which occur are indicated.

Standby mode is entered in one of three ways :-

- selected by the operator
- a primary alarm occurs
- at the end of a Goto

Auto (normal operating mode)

Auto is the normal operating mode of the INTRAC-204. However Auto is not the mode displayed on the front panel, that is either Tracking, Predicting or Learning.
If Auto is selected when there is a valid model present the INTRAC will enter Tracking mode or, if there is no tracking signal being received, it will enter Predicting mode.

Note. The INTRAC-204 can continue to predict the location of a satellite for up to 72 hours continuous loss of tracking signal.

If Auto is selected with no valid model present the INTRAC will enter Learning mode for a satellite at the present pointing. If no tracking signal is received at this point INTRAC will enter Standby Mode.

Learning

If the antenna is pointing at a satellite from which a tracking signal is being received and no valid model exists Learning Mode is entered when Auto is selected.

The INTRAC performs cross scans whilst monitoring the change in received beacon signal strength. These small

movements enable the INTRAC to estimate the satellite's position and this estimate is used to build the model.. When carrying out a cross scan the antenna describes a small cross (normally +/- 5% of the antenna's 3dB beamwidth) in the sky.

After 24hrs of learning the INTRAC has built the full orbital model. However during the building process the INTRAC maintains a simple orbit model for the satellite which allows INTRAC to track with very nearly the same accuracy as its long term accuracy.

If the tracking signal is lost during Learning Mode the INTRAC will enter Predicting Mode. The time for which INTRAC will be able to predict in this case will depend on the length of the learning period.

Note — The learning period can be by-passed by using Intelsat IESS-412 or NORAD data to establish the initial INTRAC model so that the full prediction ability is available from the start.

Once the model is complete the INTRAC enters Tracking Mode. The model is used to point the antenna and because of the high accuracy of the model the tracking is within 0.05dB RMS of peak signal tracking.

Tracking — In Tracking Mode the INTRAC continuously updates the model by making small perturbations of the antenna and incorporating the resultant data into the model. During periods when the satellite's orbit is changing because of station keeping manoeuvres the INTRAC may increase the frequency of the perturbations.
The system always tracks the satellite from the model. The small movements of antenna pointing are used to maintain and update the model.
If the beacon receiver stops providing a useful signal* the INTRAC will enter "Predicting" sub mode.

Predicting — In this mode the INTRAC will continue to point the antenna according to the model but will not update the model. Once "Tracking Mode" has been achieved "predicting" can continue for 72hrs. If the beacon receiver returns to providing a useful signal* within this period the INTRAC returns to updating the model. If, after 72hrs, the beacon is still not producing a useful signal* the model is deemed to have expired. If this occurs the INTRAC can fall back on the "Reserve Model" which is Program Track using either IESS-412 or NORAD data. (see Reserve Model - page 36)

* useful signal — A useful signal is defined as one that varies sensibly during antenna movements, is neither over or under range and the beacon receiver is in lock.

Manual — Manual Mode allows the operator to drive the antenna using any one of the four Manual Control keys on the INTRAC front panel. Drive is not latched and stops when the key is released. Drive

may be latched by pressing the Enter key whilst also pressing the appropriate direction key. To unlatch drive the Enter key should be pressed again. With a two speed motor drive system fast speed is selected when drive is latched.

Note. The Drive Fail alarm does not operate in Manual Mode.

Goto

There are three "Goto" functions, Position, Peak and Satellite located under menu Goto. Also accessed from the Goto menu is the Models menu, this menu will be discussed later in this section.

Position

For this function El and Az co-ordinates are entered and the antenna is automatically driven to the co-ordinates. When the antenna reaches these co-ordinates the system enters Standby.

Peak

Peak is a search function. Az & El angles for the centre of the search area are entered together with a search area around the centre. The search area will be the centre angles +/- the entred limits. A dwell time, for the beacon receiver to lock on the signal, is also entered. The INTRAC will search the area of sky for the strongest beacon signal on the beacon receiver frequency. At the end of the search pattern the antenna will be returned to the pointing angles of the strongest signal and the INTRAC will enter Standby.

Satellite

Location information, Az angle and El angle plus Pol angle and IBR-L frequency where appropriate, can be stored for up to 40 satellites. This information can then be called up and the antenna driven to the pointing angles and IBR-L tuned to the beacon frequency.

From this function the number under which the required satellite's data has been stored (1 to 40) is entered. When the Enter key is pressed the antenna drives to the angles and the IBR-L is tuned.

The data relating to the satellites to be stored is enter under the "Edit Satellite" function. The store number, between 1 and 40, is entered followed by the Az, El and where appropriate Pol and IBR-L frequency.

Sleep

Sleep Mode is the mode the INTRAC enters when it cannot drive the antenna due to some disabling occurrence external to the INTRAC (such as loss of power at the motor controller). INTRAC continues to monitor the occurrence and when it has cleared antenna drive control continues.

Sleep mode is entered under three conditions.

1. if the antenna is unable to be driven due to a power failure at the Motor Drive Cabinet (which does not affect the INTRAC itself).

2. if the Motor Drive Cabinet is switched into local control.

3. if an interlock switch is operated.

Conditions 2 & 3 are detected by the INTRAC by the Interlock alarm becoming active.

Condition 1 is detected by both direction limit switches of used main axes becoming active. This occurs because relays are normally operated and drop out with no power.

The Primary alarm is activated and a “Z” is displayed in the alarm code.

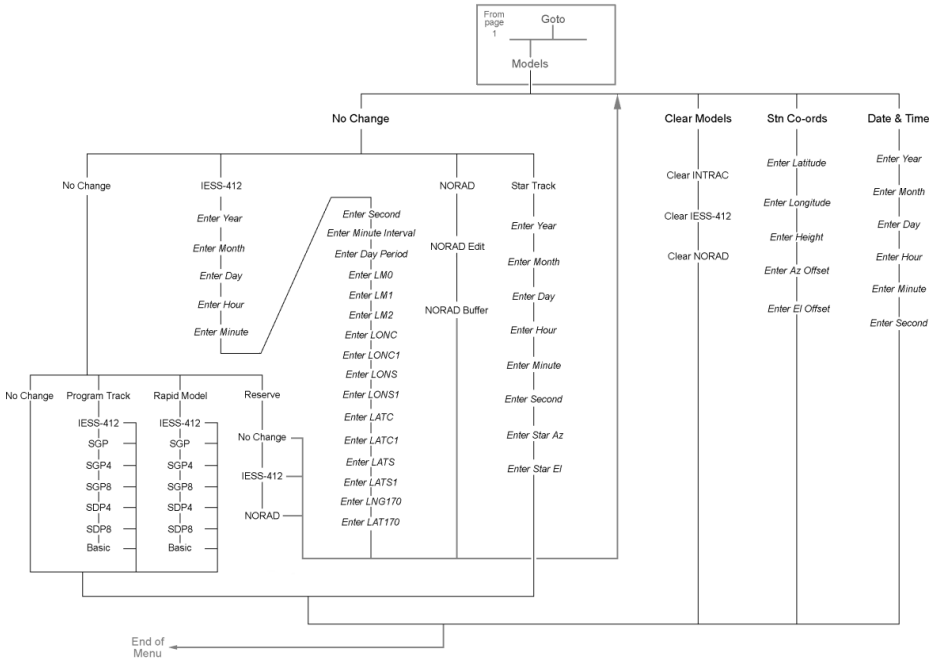
When the condition causing Sleep mode ceases the INTRAC will attempt to return to the mode it was in prior to Sleep mode. If this was Tracking the INTRAC will re-position the antenna according to the model and continue tracking.

Note If the INTRAC is in Remote Mode when Sleep is entered the remote will appear to be in Standby Mode with the Interlock alarm and all four limit switches active.

THE MODELS MENU

The Models menu relates, primarily, to using IESS-412 and NORAD ephemeris data. It is also where the date and time are entered and where the geographical co-ordinates of the antenna are entered, these are required when using the ephemeris data.

Note that functions relating to IESS-412 and NORADare not applicable to single axis systems.



Using IESS-412 or NORAD Data

The INTRAC-204 can make use of Intelsat IESS-412 11-parameter or NORAD ephemeris information in two ways.

1. The information can be used by the INTRAC to generate an “INTRAC model” of the satellite’s orbit. This model is then used by the INTRAC as if it wasa model it had learnt itself. This means that there is no requirement for the 24hr learning period. The model is updated and maintained in the same manner as a learnt INTRAC model.

2. The INTRAC can be commanded to Program Track using positions calculated from the ephemeris data set.

The IESS-412 and NORAD data sets can be entered either manually from the INTRAC front panel or from a PC. A stand alone program is available for loading the data file from a PC.

The IESS-412 data

The IESS-412 data set comprises 21 fields of data :-

IESS Epoch Year	range:	80 to 99 (20th century) 00 to 79 (21st century)
IESS Epoch Month	range:	1 to 12
IESS Epoch Day	range:	1 to 31
IESS Epoch Hour	range:	0 to 32
IESS Epoch Minute	range:	0 to 59
IESS Epoch Second	range:	0 to 59
IESS Minutes Interval	range:	0 to 59
IESS Days Validity	range:	0 to 28
IESS Sat LM0	range:	0 to 360 deg
IESS Sat LM1	range:	-9.99 to 9.99 deg/day
IESS Sat LM2	range:	-9.99 to 9.99 deg/deg/day
IESS Sat LONC	range:	-9.99 to 9.99 deg
IESS Sat LONC1	range:	-9.99 to 9.99 deg/day
IESS Sat LONS	range:	-9.99 to 9.99 deg
IESS Sat LONS1	range:	-9.99 to 9.99 deg/day
IESS Sat LATC	range:	-9.99 to 9.99 deg

IESS Sat LATC1	range:	-9.99 to 9.99 deg/day
IESS Sat LATS	range:	-9.99 to 9.99 deg
IESS Sat LATS1	range:	-9.99 to 9.99 deg/day
IESS Sat LONG170	range:	0 to 360 deg
IESS Sat LAT170	range	-9.99 to 9.99 deg/day

Also required to be set are the Station Co-ordinates and IESS Az & El offsets which are input on the Goto - Models - Station Coordinates menu screen.

The IESS Epoch defines the time instant at the start of the period of the IESS data. The IESS Minutes Interval defines the period in minutes between pointing updates in Program Track mode. The IESS Days Validity (normally 7) defines the period of validity of the data. The INTRAC will accept and use the data two days either side of the validity period.
The parameters IESS Sat (LM0, LM1, LM2, LONC, LONC1, LONS, LONS1, LATC, LATC1, LATS, LATS1) are the IESS-412 11-element ephemeris. The parameters IESS Sat (LONG170, LAT170) are the IESS-412 11-element ephemeris 170hr checksum.

Note The data ranges shown above as +/- 9.99 actually accept more than two places of decimals.

Note The LMO value in the IESS-412 data from Intelsat is given in the range -180° to +180°. The INTRAC-204 cannot accept negative values for this field from the front panel. (It can accept them from a remote M & C terminal). It is therefore necessary to add 360° to the supplied value, if negative, when entering from the front panel. This only applies to the LMO data field negative values can be entered in the other relevant fields.

NORAD data

The NORAD ephemeris data consists of a string of 166 characters. The first 160 characters are split into two “Card Element Sets” of 80 characters each. The next two characters (161 & 162) comprise the Minutes Interval and characters 163 & 164 comprise the Period of Validity of the ephemeris. The final two characters (165 & 166) are the check sum.

There are ten blocks of orbital element parameters contained in the NORAD ephemeris character string :-

Charas.	Data	Description
19 - 32	EPOCH	format - YYDDD.DDDDDDDD
34 - 43	XNDT20	1st rate of change (rev/day/day)
45 - 52	XNDD60	2nd rate of change (rev/day/day/day)
54 - 61	BSTAR	damping factor (er**-1)

89	- 96	XINCL	inclination (deg)
98	- 105	XNODEO	ascending node (deg)
107	- 113	EO	eccentricity
115	- 122	OMEGAO	argument of perigee (deg)
124	- 131	XMO	mean anomaly (deg)
133	- 143	XNO	mean motion (rev/day)

Rapid Model Generation

The INTRAC-204 can use the IESS-412 or NORAD data to build the satellite's orbit model instead of having to learn the orbit over a 24hr period.

The IESS-412 data is simply selected in the Goto - Models - No Change - No Change - Rapid Model menu. The orbit model is calculated and the INTRAC enters Tracking Mode.

For the NORAD data there are five choices of NORAD algorithm. These are SGP, SGP4, SGP8, SDP4 & SDP8 and each gives a slightly different Az/El pointing for the same NORAD data.

- SGP — the original NORAD algorithm
- SGP4 — applies to Near Earth Orbits
- SGP8 — applies to Near Earth Orbits
- SDP4 — applies to Deep Space Orbits
- SDP8 — applies to Deep Space Orbits

Orbits are differentiated by their period. Those of less than 225 minutes are Near Earth Orbits and those of more then 225 minutes are Deep Space Orbits. Geostationary satellites are in Deep Space Orbit.
It is assumed that the user know which algorithm applies to the data to be used. However INTRAC will not allow a Near Earth Orbit algorithm to be used with Deep Space Orbit data and vice-versa.
The Basic algorithm available in the Rapid Model Generation table is not of NORAD origin. It has none of the embellishments found in the NORAD routines and is meant for test purposes only.

Once the orbital model has been built using the ephemeris data the INTRAC tracks the satellite from the model and updates and improves it over the following hours and days.

Program Track

The IESS-412 and NORAD data can also be used by INTRAC to calculate the satellite's path which is then used for a simple Program Track operation.
The selections available in Models - Program Track are the same as are available in Rapid Model. On selecting the required algorithm and pressing ENTER the INTRAC enters Program Track mode.

Program Track is an open loop method of tracking and as such is unable to correct for any transducer errors or distortions to the antenna caused by wind.

Reserve Model

Once the orbital model has been built the INTRAC tracks the satellite extremely accurately by continuously monitoring the satellite's position and updating the model. When the beacon signal is not present INTRAC can still track accurately by predicting the satellite's position from the model. However if the beacon signal is lost for more than 72hrs INTRAC deems the model to be no longer valid. In such a situation INTRAC can fall back to a Reserve Model. This is a Program Track model built from either the IESS-412 or the NORAD data. The selection is made in Models - Reserve Model. Assuming the appropriated data has been loaded and is valid INTRAC will automatically fall back to this model when it can no longer predict accurately.

Clear Models

The "Clear Models" menu is used to clear one or more of the INTRAC Model, the IESS-412 Model or the NORAD model. Clearing the INTRAC Model clears the current satellite model. Selecting Auto Continue after this clearing will cause the INTRAC to enter Learning Mode.
Clearing the IESS-412 or NORAD Models simply marks the ephemeris data as being no longer valid. Selecting IESS-412 or NORAD for Rapid Model Generate or Program Track will cause the menu to jump to the Edit IESS or NORAD data menus for new data to be input. Also clearing the data will mean that Reserve Model will not function.

Note

If there is no valid data for IESS-412 or NORAD when they are selected for Rapid Model, Program Track or Reserve the menu jumps to the appropriate data input menu.

ANTENNA MOTION LIMITS

There are two methods of limiting the travel of the antenna; a software method and a hardware method. If either type of limit is reached in any direction in an automatic mode drive is removed, a primary alarm is raised, the System Alarm indicator is illuminated and the relevant alarm code is displayed.

Software Limits

Software Limits are set in the Aux - Soft Limits menu.
If they are reached in any mode other than Manual an alarm is raised and the INTRAC enters Standby mode.
In either Manual (P) or Manual (A) mode the antenna may be driven through the soft limits with no warning.

Hardware Limits

Hardware limits are physical normally closed contact switches mounted on the antenna assembly at the maximum points of travel at each end of all driven axes. When the antenna reaches one of these switches the switch becomes open circuit. This open circuit condition causes drive to be removed from the motors and signals the INTRAC that a limit has been reached. The removal of drive is such that the antenna cannot be driven

any further in the limit direction but can be driven in the opposite direction in manual mode.
When a limit is reached the INTRAC is automatically put into Standby Mode except when in Manual (P) Mode. In this mode the antenna cannot be driven any further in the limited direction but can be driven in the opposite direction.

AXES POSITION

Resolver units are fitted to the driven axes of the antenna. These units supply positional information to the INTRAC's resolver interface circuits.
Fine Tune offsets may be set to equate the resolver outputs to the actual antenna pointing angle.

TRACKING SIGNAL

An L-band Integrated Beacon Receiver (IBR-L) is an option with the INTRAC-204. When fitted this receiver is tuned to the L-band frequency entered under the Aux menu, or in the SatInfo.Dat file, by the INTRAC. If the beacon frequency of the satellite to be tracked is not in the L-band a Block Down Converter will be required to convert the signal to L-band.

If an IBR-L is not fitted the INTRAC requires a dc voltage level which is proportional to the received signal strength from the satellite. Setting the calibration for the external tracking signal is described in section 6 Installation on page

The Tracking Algorithm

During initial acquisition the INTRAC algorithm tracks the satellite using a third order (for each axis) unbiased tracking filter. This algorithm dynamically adjusts the period between the step cycles to match the perceived orbit inclination and received beacon signal level fluctuations and noise level. During this initial period the tracking accuracy is only very slightly lower than the full long term INTRAC tracking accuracy.

The most significant difference during the learning period (first 24hrs) is not the accuracy of tracking but the time for which the system can predict in the event of loss of the beacon signal. The learning period can be by-passed by using Intelsat IESS-412 or NORAD data to establish the initial INTRAC model so that the full prediction ability is available from the start. This model is then modified and optimised by the INTRAC algorithm in the same manner as it would continuously update a model it had "learnt".

The key to deriving a reliable and accurate orbital model is the ability to derive accurate estimates of the many parameters involved in the model. Much specialised noise processing expertise and experience has been applied in the design of the INTRAC algorithm to ensure that INTRAC can build an accurate model and can maintain it even when the beacon signal is subject to severe fluctuations.
The INTRAC tracking filters are designed in such a way as to enable the model to provide the required accurate pointing

prediction at all times. Even when not verified by measurements, as occurs, for example, with loss of beacon, the tracking filters are capable of accurately predicting the satellite orbit for many days. Under INTRAC control, pointing is always controlled from the internal satellite orbit model. When a measurement cycle is performed, it is always done as a perturbation with respect to current pointing. Thus, unlike conventional steptrack, INTRAC is always on track when a measurement cycle is performed. INTRAC never uses the measurement cycle for the purpose of directly bringing the beam on track. INTRAC simply performs one measurement cycle in each axis every 10 minutes in order to up-date the parameters used in the orbital model and for the rest of the time keeps the beam correctly pointed.

6. INSTALLATION

Introduction

The INTRAC-204 unit incorporates the antenna motor drive circuits and, normally, an IBRL integrated L-band beacon receiver. The system also requires the antenna position resolvers to be connected to the INTRAC along with the limit switches from the antenna before the complete system can work correctly.

WARNING

POSSIBLE LETHAL POTENTIALS EXIST WITHIN THIS EQUIPMENT

THE COVERS SHOULD NOT BE REMOVED EXCEPT BY QUALIFIED PERSONNEL.

SWITCH OFF POWER AND ISOLATE SUPPLY BEFORE REMOVING COVERS.

IF IT IS NECESSARY TO OPERATE THE EQUIPMENT WITH THE COVERS REMOVED FOR SERVICING PURPOSES ALL NECESSARY PRECAUTIONS SHOULD BE TAKEN TO PROTECT AGAINST ELECTRIC SHOCKS

Installing the INTRAC-204 sub-system comprises mounting the Controller in a 19" rack, connecting the controller to the drive motors, fitting positional resolvers to the antenna axes and connecting those resolvers to the controller. An L-band RF connection to the IBRL is also normally required.

Note THE INTRAC-204 MUST NOT BE MOUNTED ONLY BY THE FRONT PANEL LUGS.
IT MUST BE SUPPORTED ALONG ITS SIDES

Connections (general)

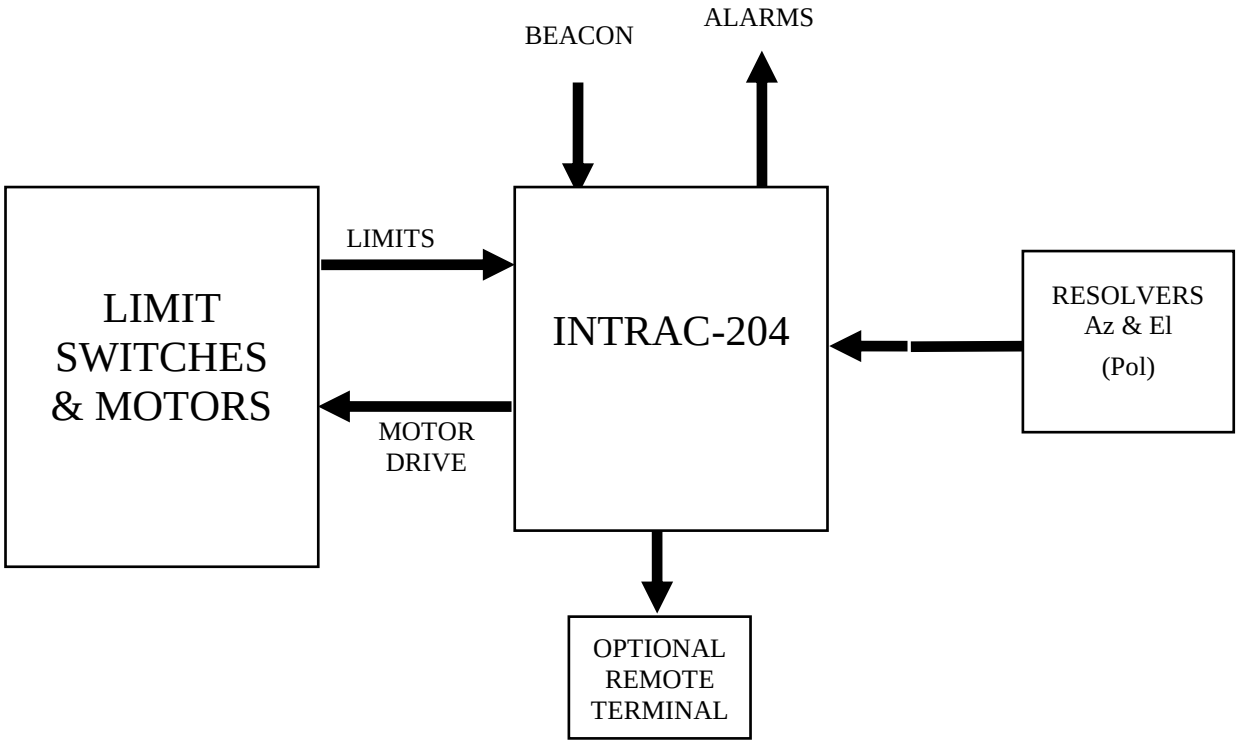
Before making connections to the INTRAC Controller ensure that it is isolated from the power source.

Connect the cables between the drive motors and the INTRAC. The earth connection on the INTRAC motor drive terminals should be used only for connecting the cable screen and not for a motor safety earth. Normally the cable screen is connected at the INTRAC end only.

Emergency Stop Input

The Emergency Stop input terminals are for connection of a normally closed external emergency stop chain. Any number of emergency stop and interlock switches (N.C. contacts) may be connected in series to this input. Opening any of the switches will remove the DC power to the motors. **Note that the external emergency stop circuit is not internally latched** and it is recommended that mechanical latching emergency stop switches are used. If no external emergency stop switches are fitted, then the input terminals should be shorted with a link.

Connections Block Diagram



All connections to the INTRAC-204 are made via its rear panel. The following connectors are available :-

Remote Port (I/O)	9-way D-type	socket
Resolver I/Ps x 2 (or 3)	9-way D-type	sockets
Motor Drive Outputs	Screw Terminal Strips	
Limits/Status (I/O)	15-way D-type	socket
Beacon Signal I/P	N-type (L-band)	socket

Rear Panel Layout

CONNECTOR PIN ALLOCATIONS

Limits

Note Limit and interlock switches should have normally closed contacts. Opening any limit switch will inhibit drive in that direction. Opening any interlock switch will inhibit drive in any direction.

INTRAC™ 204 Limits Connector		Cable Pairing
15 Way D Socket	Signal Name	
1	Interlock	1a
2	AzLeftLimit	2a
3	AzRightLimit	3a
4	ElDownLimit	4a
5	ElUpLimit	5a
6	PolClkLimit	6a
7	PolCClkLimit	7a
8	Ground	
9	Ground	1b
10	Ground	2b
11	Ground	3b
12	Ground	4b
13	Ground	5b
14	Ground	6b
15	Ground	7b

The connector gender in the table is that on the INTRAC. The connecting cable should thus be terminated in the mating gender.

NOTE: On singe or dual axis production units the limit switch inputs associated with unused axes are shorted to ground internally and do not need to be wired externally. On the original prototype unit these limit inputs were not shorted internally and must be (individually) shorted to ground at the connector.

Motor Drive

Motor drive lines from the INTRAC-204 rear panel screw terminal strips connect directly to the drive motors. A screened cable is recommended with the screen connected only at the INTRAC end.

The screw terminal strips are marked +, - and Gnd. Gnd should be used for the cable screen only. If the motor rotates in the wrong direction then swap the wires to the + and – terminals.

Remote Port

The Remote Port is configured for RS232 communication.

INTRAC™ 204 Remote Port Connector		Signal Name	Remote Control PC	
9 way D type Socket	Signal Type		Signal Type	PC Connector
1	N/C		N/C	1
2	output	RCMOUT	input	2
3	input	RCMIN	output	3
4	N/C		N/C	4
5	GND	GND	GND	5
6	N/C		N/C	6
7	N/C		N/C	7
8	N/C		N/C	8
9	N/C		N/C	9

The INTRAC-204 is wired as a DCE unit suitable for direct 1 to 1 connection to the 9-way serial port of a PC AT.

TXD and RXD data flow directions are standard (relative to the DTE). Handshake lines are pulled to the ON condition.

Beacon Signal Connector

The INTRAC-204 is normally fitted with an IBR-L beacon receiver. The beacon signal (at L-band) should be connected to the “N-type” RF connector on the INTRAC rear panel.

Note: It is possible to configure the INTRAC so that 18Vdc (up to 300mA) is connected to the inner conductor of the N-type, in order to power the Block Down Converter. Units are normally delivered with the 18v disabled. The method of enabling and disabling this supply is described below.

Resolvers

Size 11 resolvers (R11W) or RE-01 resolvers may be used with the INTRAC-204 for all axes.
Note that the polarisation only axis can be configured to, alternatively, use potentiometer feedback – see section below.
There are six connections for each of the resolvers. The recommended cable is one with individually screened twisted pairs.
Correctly terminated cables can be supplied by Signal Processors Limited.

9 Way D type Socket INTRAC	Signal Name	RE01 10 way connector	Size 11 Bare Resolver	Size 11 Weather Proof Resolver	Cable Pairing
1	ResSource	A	Red/White	Red	1a
2	Sin	F	Red	White	2a
3	Cos	G	Blue	Black	3a
4	Ground				
5	n/c				
6	ResSourceGnd	B	Yel/White or Blk/White	Black	1b
7	SinGround	D	Black	Black	2b
8	CosGround	E	Yellow	Green	3b
9	Ground			Screens	

Fitting to the Antenna

How the resolvers are fitted to the antenna depends on the antenna concerned.

The shaft of the resolver has to be coupled directly to the Az or El rotational axis and the body of the resolver has to be very firmly fixed to a non moving surface. Alternatively the shaft of the resolver can be fixed to a non moving surface and the body coupled to the rotational axis.

For the coupling between the resolver shaft and the antenna axis we recommend a torsionally stiff flexible “bellows” type coupler which allows for some miss-alignment between the shafts but transmits the rotational movement accurately without introducing any backlash.

It is important the very small movements (<1/40th beamwidth) are coupled accurately, without backlash or windup, to the resolver. It is strongly recommended that the resolver reference points are made by brackets to the fixed and moving parts of the structure and that bearing pins and the like are not used as reference points.

Setting up Put the INTRAC into Manual Mode.

Drive the motors and confirm that the antenna drives in the correct direction. The Up manual button should drive the elevation up and the Right manual button should drive the azimuth in a clockwise direction (viewed from above). If the directions are wrong then swap the motor wires to the + and – terminals.

Setting the direction sense can be done initially by considering which direction of rotation of the resolver shaft (relative to he resolver body) corresponds to an increasing antenna angle (Up and Right, CW), but should always be checked. Alternatively it can be set empirically.

The standard wiring should give a situation where rotating the resolver shaft CCW (looking at the shaft end) should give an increasing displayed angle when the resolver senses are set to True. Under the Aux - Fine Tune - Sense menu the resolver sense can be set to “true” or “inv”. If the antenna moving Up or Right would rotate the corresponding resolver shaft in a CCW direction then set the corresponding sense to True. If the antenna moving Up or Right would rotate the corresponding resolver shaft in a CW direction then set the corresponding sense to Inv. Finally check that these senses are correct by driving the antenna and ensuring that the displayed angle changes correctly.

Alternatively simply drive each axis and note the direction of change of the displayed angle. If this is incorrect then toggle the sense between True and Inv until the displayed direction of change is correct.

Perform this operation for all driven axes.

Zero the Fine Tune - Offsets.

Ensure that the antenna is away from the hardware limit switches. Determine the actual pointing angles of the antenna. The Elevation angle should be between 0° and 90°. The Azimuth angle should be between 90° and 270° (for the Northern Hemisphere). The Polarisation angle should be between -90° and +90°.

Loosen the couplings between the resolver units and their respective antenna shafts. Rotate each resolver shaft slowly until the displayed Az, El and Pol angles are as near as possible to the actual angles of the antenna.

Note If a resolver angle is, or becomes, outside the software limits an alarm will be raised. The software limits may be set wider.

When the displayed angles are as near as possible (at least within 10°) to the actual angles tighten the resolver couplings ensuring that the angles remain as set.

Use the Fine Tune - Offsets facility to change the displayed angles to the actual antenna angles.

Polarisation Potentiometer

The INTRAC-204 can be supplied in a version that accepts potentiometer feedback for the polarisation axis. In this case the unit will be supplied with a dongle that plugs into the standard polarisation resolver socket on the INTRAC. The other end of the dongle is fitted with a 15way D-type socket. The connections are given below.

9 Way D type Socket Polarisation Dongle	**Polarisation Potentiometer** Signal Name	RE01 10 way connector	Cable Pairing
1	Pot Drive Hi	A	1a
2	Pot Wiper	F	2a
3	nc	G	
4	nc		
5	nc		
6	Ground	B	1b
7	Ground	D	2b
8	nc		
9	Ground		Screen

The potentiometer should be connected so that the end corresponding to the high (+90deg) polarisation angle is connected to pin1 and the other end of the potentiometer connected to pin 6. The wiper should be connected to pin 2.

Setting up Potentiometer input

The potentiometer dongle is fitted with two preset resistors, P1 and P2. Initially set the polarisation position to +90 degrees. The potentiometer is supplied with a sine wave ac signal. Adjust P1 so that the signal on the wiper is close to 2V rms (5.6v pk-pk). Then connect wiper to pin 2 of connector.

The setup is performed by connecting a terminal emulator to the remote port of the INTRAC (set to 9600,N,8,1). Set the INTRAC to display polarisation angle. Type LA <CR>(must be in upper case) and adjust P2 until the displayed angle is close to 50 degrees. Type LB <CR>, wait for a + sign to be displayed and then move the feed physically to the 0 deg position. Type LC <CR> and wait for the + sign to be displayed. Finally type LD <CR> and wait for the + sign to be displayed. The display should then change to show the current pol angle (0 degrees) and the system is calibrated. (Note <CR> signifies pressing the carriage return key)

Southern Hemisphere

In the Southern Hemisphere the antenna should be set to point North. With the Fine Tune offsets set to zero, the azimuth resolver should then be rotated until the displayed angles is as close as possible to 180°. The displayed angle should then be changed to 0° using the Fine Tune - Offset facility.

Set the antenna beamwidth

In order for the INTRAC-204 to be able to peturb the antenna by the correct amount when building and maintaining the model the antenna 3dB beamwidth has to be entered. It is entered under menu - Aux2 Az beamwidth and El beamwidth.

TRACKING SIGNAL INPUT

The tracking signal is provided by the integral L-band beacon receiver.

The IBR-L requires a L-band beacon signal at a level within the range -80dBm to -45dBm with a carrier to noise ratio (C/No) of better than 40dBHz. To allow some margin for exceptional propagation conditions we suggest that the normal clear sky level when peaked on the satellite should be in the range -70dBm to -50dBm. Severe signal fades will be handled by the INTRAC algorithm entering Prediction mode for the duration of the fade.

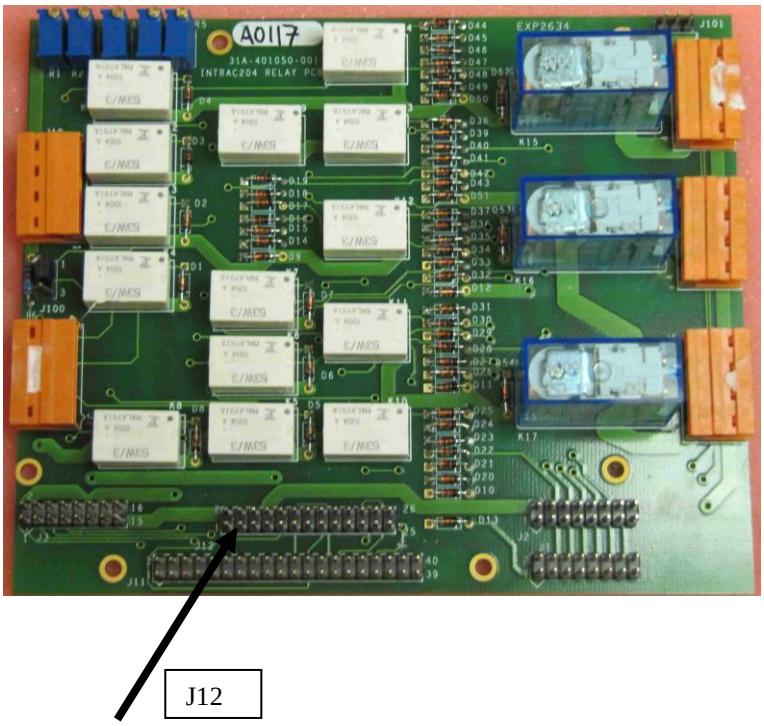
If the signal is greater than -50dBm attenuation must be inserted and if it is lower than -80dBm a higher gain LNA/LNB must be used.
An input level of -45dBm corresponds to a displayed level of +25dB.

Note

In some installations the LNA/LNB power is carried on the L-band signal cable and special arrangements have to be made to ensure continuity for the dc power when attenuation is added in this cable.

18V LNB/BDC supply

The INTRAC can be configured to provide a (nominal) 18V supply (up to 300ma) at the RF input to power the LNB or BDC. This 18V supply is enabled by changing the connection to a ribbon cable inside the unit on the Drive Control (top) card.



The ribbon cable is connected to the connector J12 identified by an arrow in the picture above. The ribbon cable has a connector at the end and one a few centimetres in from the end. If the 18v is not required then connect the ribbon to the card using the end connector. If 18v is required then connect the ribbon to the card using the other connector.

OPERATIONAL CHECKS

Manual Operation

This test checks the operation of the motor drives and limit switches.

Ensure that all limit and interlock switches are in the normal operating condition.

Switch on the INTRAC. If the System Alarm indicator illuminates press the Standby key. If it remains illuminated determine what is causing the alarm from the alarm code(s). Take the necessary action to clear the cause(s) of the alarm.

Select Manual Mode from the Mode menu.

Using the Manual Control keys drive the antenna to the full extent of its travel in each direction. Confirm that the antenna actually moves in the required direction. Check that when a limit switch is reached the motor stops and the System Alarm indicator illuminates.

Note Only one Manual Control key should be pressed at one time and it should be fully released before pressing another control key.

If a Dual Speed Motor Drive Cabinet is used check that the "FAST" key operates correctly. Pressing the "FAST" key when pressing a Manual Control key should latch fast drive in the required direction. Pressing any Manual Key when in latched Fast Drive should have no effect. Pressing the Fast key again should remove drive.

Note The Enter key is the "FAST" key.

Emergency Stop Check

Check the operation of the front panel Inhibit Drive switch by pressing it when one of the motor's is running. Ensure that the motor stops and that the System Alarm indicator illuminates. To re-start the motor, select the appropriate operating mode.

If external emergency stop switches are fitted check their operation in the same way.

It must not be possible to re-start any motor whilst any emergency stop switch is in the operated state.

Auto Operation

Check antenna drive. Select GOTO - Position mode. Enter Az & El angles slightly off the current position. Press Enter and check that the antenna drives to the set angles.

Check tracking. Set the frequency of the L-band Integral Beacon Receiver (IBR-L) to receive the required signal. Drive the antenna to the co-ordinates of the required satellite and check that the INTRAC-204 acquires the beacon signal, i.e., beacon level is displayed on the front panel display.

Select Auto and check that the INTRAC-204 unit performs measurement cycles, acquires the satellite and begins learning the track (Learning displayed on LCD sreen). This should occur if the antenna pointing is accurate enough. Check that after 24 hours of Learning the INTRAC enters Tracking Mode.

Remote Control Port Check

To check the remote control port a PC running a suitable M&C package, e.g., the Advantech RCM-7 is required.

With the INTRAC-204 switched off connect the Remote Control Terminal to the INTRAC-204

Switch on the INTRAC-204 and select Remote mode. Check that the INTRAC-204 communicates with the Remote Control Terminal by driving the antenna and observing that the displayed angle information changes and the antenna moves.

Details of the RCM-7 remote operation package are available from Advantech AMT Ltd. The remote M & C command set and message format are contained in the INTRAC Remote Control & Monitoring Command Set Specification manual.

7. FAULT FINDING

WARNING

POSSIBLE LETHAL POTENTIALS EXIST WITHIN THIS EQUIPMENT

THE COVERS SHOULD NOT BE REMOVED EXCEPT BY QUALIFIED PERSONNEL.

SWITCH OFF POWER AND ISOLATE SUPPLY BEFORE REMOVING COVERS.

IF IT IS NECESSARY TO OPERATE THE EQUIPMENT WITH THE COVERS REMOVED FOR SERVICING PURPOSES ALL NECESSARY PRECAUTIONS SHOULD BE TAKEN TO PROTECT AGAINST ELECTRIC SHOCKS

Introduction

Advantech AMT Limited recommend that users return faulty INTRAC-204 units to Advantech AMT for repair. Advantech AMT have a specially equipped repair facility and are able to repair and return a unit rapidly if required. However if the problem is of an intermittent nature it may be beneficial to allow us to soak test the unit for a longer period.

Repairs carried out by Advantech AMT are warranted for 90 days.

The information given below is intended to help users identify the location of faults. **Note** that we do not recommend that any repairs are carried out by the user without first discussing the intended repair with Advantech AMT customer service personnel.

Note particularly that :-

ADVANTECH AMT LIMITED ACCEPT NO RESPONSIBILITY OR LIABILITY FOR ANY HARM CAUSED TO ANY THIRD PARTY PERSONNEL FROM WORKING INSIDE THE INTRAC-204.

ADVANTECH AMT LIMITED ACCEPT NO RESPONSIBILITY OR LIABILITY FOR ANY DAMAGE CAUSED TO THE INTRAC-204 BY ANY THIRD PARTY PERSONNEL AS A DIRECT OR INDIRECT RESULT OF THIS SECTION OF THIS MANUAL.

ANY THIRD PARTY WORK INSIDE THE INTRAC-204 DURING THE WARRANTY PERIOD WILL INVALIDATE THE WARRANTY

Because the INTRAC-204 forms part of a system, parts of which respond to signals from the INTRAC-204 and parts of which send signals to the INTRAC-204, deciding whether a fault lies with the INTRAC-204 or the external equipment can be difficult.

The simplest method to prove if the fault lies with the INTRAC-204 or some other equipment is to replace the INTRAC with a spare unit. However care must be taken in such a case that any fault with the external equipment does not cause damage to the replacement INTRAC. Also ensure that the replacement unit is correctly set for the installation. This fault finding guide goes no further than trying to identify which of the major assemblies such as power supply, IBR-L or complete printed circuit assemblies may be faulty.

The INTRAC-204 consists of five major assemblies :-

- Board Stack (incorporating interface card, processor card and drive control card)
- DC drive module
- Low voltage power supplies (+41V, +24V,+5V)
- LCD Display panel
- IBRL Beacon receiver

FAULT SYMPTOMS

INTRAC doesn't appear to power up

Check the INTRAC fuse (in the mains input moulding), cable and power source

Pointing Angles Incorrect

The resolvers consist of three coils two of which move with respect to the third. A continuous signal is sent from the INTRAC to the fixed coil and is induced into the other two coils. The amount of induction in each coil is dependant on the respective position of the coils.
The signal sent from the INTRAC is the same for all resolvers.

angles constantly varying

Constantly changing angles are caused by noise on the two return signal lines, a faulty resolver or faulty connections to the resolver. If only one angle (i.e. Az, El or Pol) appears to be changing (when in Standby), then the fault is likely to be with the connections to that resolver or the resolver itself. If all the angles are changing the fault is likely to be on the interface card.

wrong angle displayed

If the wrong angle is displayed, but the angle changes the correct relative amount in response to antenna movement, then either the Fine Tune offsets are wrong or the resolver coupling has slipped. If the displayed angle does not change or appears to change by the wrong amount then there it is probably either a wiring fault or the resolver is faulty. If a similar fault occurs on all axes it is probably the main PCB.

angle doesn't change when antenna is moved

If the displayed angle doesn't change when the antenna is being driven first ensure that the antenna is actually moving in the relevant axis.

Select Manual Mode and drive the antenna in the appropriate direction and either check that the beacon level changes or actually look at the antenna.
If the antenna is moving and the displayed angle is not changing the problem is probably the mechanical coupling between the resolver and the antenna.

No Antenna Drive

When the INTRAC attempts to drive the antenna a DC voltage is placed between the screw terminals marked + and - . This voltage is nominally 36Volts, but depending on the internal settings of the unit may be pulse width modulated to give an apparently lower voltage. If the drive voltage does not appear the most likely cause is that there is an alarm condition or a limits/interlock condition that does not allow drive. The next most likely cause is that the 10A motor drive fuse has blown. If these are all OK then it is possible that the Drive module has failed or the drive PSU (41VDC) has failed.

Tracking Signal (IBR-L)

There is no way of knowing from the INTRAC whether the loss or reduction of tracking signal is due to the satellite, Receive RF chain or the IBR-L itself. Thus when the displayed beacon level falls below normal the user should check with a spectrum analyser on a narrow sweep range so that the actual beacon frequency can be seen and measured before assuming an IBR-L problem.

Although the loss of or reduction in displayed beacon level could be caused by a fault on the Interface PCB the most likely cause is a faulty IBR-L.

Diagnostic data

Diagnostic data can be obtained from the remote port of the INTRAC-204. This data, if collected and sent to Advantech AMT Limited for analysis, can be helpful in fault location. It can indicate whether the unit should be sent back to Advantech AMT for repair or if the cause of the problem is external to the INTRAC-204.

Diagnostic data is obtained from the Remote Port after the INTRAC-204 has been set into diagnostics mode.
Diagnostic mode is entered via Menu - Aux - Remote Enb where the displayed options are :-

local remote local diags remote diags

local diags Selecting local diags causes diagnostic data to be available at the remote port whilst giving control of the INTRAC to the front panel.

remote diags Selecting remote diags causes diagnostic data to be available at the remote port whilst giving control of the INTRAC to the remote control terminal. However in this mode only remote control commands are accepted by the INTRAC, no acknowledgement of the commands is sent to the remote terminal and no status requests are accepted. This mode

cannot be used with the Advantech AMT RCM remote control and monitoring program as this program needs command and status request acknowledgement.

To collect the diagnostic data a PC running a terminal package is required. The terminal should be set for a baud rate of 9600, 8 data bits, 1 stop bit & no parity.

typical data

The diagnostic data that appears on the PC display screen will be similar to that below.

```
PSNUPD 2   31.070   31.056   34.060      0   1303      0   1303 0 -2
STCYCL 2   0.002     31.062   0.019   0.028   31.060 4   0.000 F
STCYCL 2   0.005     31.067  -0.014  -0.048   31.066 3   0.000 F
STCYCL 2   0.003     31.066   0.014   0.035   31.070 3   0.000 F
STPROC 2 -1  60  68  67   1.255  31.064-0.002 0.004  2.0 2.0 2.0 -0.004
STPROC 2 -1  60  68  67   1.254  31.069-0.002 0.004  2.0 2.0 2.0 -0.004
STPROC 2 -1  60  68  67   1.252  31.073 0.003 0.004  2.0 2.0 2.0 -0.004
CHECKD  68  68   0.00   0.00   0.00      0 174000  40002  42104 TT  1 2
CHECKD  7  0      0      0    310 16 0  0  0    8  14   8  14  88 114
```

To send it to SPL-ACT wireless Europe save it as a text file.

8. WARRANTY & REPAIR

WARRANTY

Advantech AMT Limited warrants the INTRAC-204 Antenna Control Unit for a period of 24 months from the date of dispatch.

The liability of Advantech AMT Limited under this warranty shall be limited to repair or replacement of defective units or parts thereof, at Advantech AMT's option, which are returned in accordance with the RMA procedure, carriage and insurance paid, to Advantech AMT Limited, 39 Edison Road, St.Ives, Cambridgeshire PE27 3LF. England. The returned unit(s) must be accompanied by a completed RMA fault report and a document declaring that the equipment is returned for repair under warranty.
Subject to the unit being eligible for warranty repair Advantech AMT Limited will effect the repair and return the unit by pre-paid shipment to the originating location. Subject to the shipment charges being the same as, or less than, that to the original location the unit may be shipped to some other location as the customer may specify.
Under no circumstances shall Advantech AMT Limited be liable for any consequential or incidental costs or damage.

Exclusions

This warranty does not apply to any equipment which has been damaged through abuse, accident (such as lightning strike), negligence or failure to comply with Advantech AMT instructions for storage, installation and use as contained in the equipment manual(s).

Except as specifically provided above, Advantech AMT Limited makes no warranties, expressed or implied, as to the merchantability of the equipment or its fitness for a particular purpose.

REPAIR SERVICE

Advantech AMT Limited will provide a repair service for all equipment manufactured by Advantech AMT Limited for a reasonable period.

Returning equipment for repair

Prior to the return of any equipment for repair, whether under warranty or by payment, Advantech AMT Limited must be contacted to obtain an RMA number and form and also to discuss the problem and confirm that the equipment needs to be returned. During the discussion the parties should also agree the most effective solution to the problem and discuss the method of return in order to avoid unnecessary duties and ensure that the packing is adequate to protect the equipment during shipment.

The cost of returning the equipment to Advantech AMT Limited will be paid by the customer.

Repairs not under warranty

Repairs to equipment not under warranty will be paid for by the customer. On receipt of the defective unit Advantech AMT Limited will investigate the fault, determine the most effective repair technique and issue a repair cost estimate. Repair work will not commence until the cost is authorised by the customer either by a Purchase Order or through a Repair Contract.

In certain circumstances repairs may be carried out on site by prior agreement.

Documentation

On completion of the repair the unit(s) will be returned to the customer together with a Repair Report and a repair contact name at Advantech AMT Limited.

Return shipment

The repaired unit(s) will be returned to the originating location with Advantech AMT Limited bearing the cost of shipment and in transit damage or loss.
The equipment may be returned to some other location at the request of the customer subject to the shipment cost being the same as, or less than, that to the original location.

Warranty of repairs

Advantech AMT Limited will warrant the repaired unit, in respect of the work and material of the repair only, for a period of 12 months from the date of return of the unit to the customer. However where the remaining time of the standard warranty exceeds 12 months the work and material of the repair will be warranted for that remaining period.

NOTE

Advantech AMT Limited reserves the right to charge for rectification of any faults caused as a result of attempts to repair equipment by third parties.