

Datex-Ohmeda

S/5™ NeuroMuscular Transmission Module, M-NMT (Rev. 02)

Technical Reference Manual Slot



All specifications are subject to change without notice.

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NeuroMuscular Transmission Module, M-NMT

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INTRODUCTION

This section provides information for the maintenance and service of the NeuroMuscular Transmission Module, M-NMT. The M-NMT module is a single width plug-in module designed for use with the S/5 Anesthesia and Compact Anesthesia Monitors. The module contains peripheral nerve stimulation and response measurement which supports electromyography EMG. The module can also be used as a nerve locator for regional nerve blocking with a regional block cable. However, in this case there is no response measurement.



Figure 1 **NeuroMuscular Transmission Module, M-NMT**

1 SPECIFICATIONS

1.1 General specifications

Module size, W × D × H	37 × 180 × 112 mm / 1.5 × 7.1 × 4.4 in
Module weight	0.37 kg / 0.8 lbs
Power consumption	3.3 W

1.2 Technical specifications

1.2.1 NMT

Stimulation modes	Train of four (TOF) Double burst (3.3) (DBS) Single twitch (ST) 50 Hz tetanus + post tetanic count (PTC)
Measurement intervals for TOF and DBS	Manual; 10 s, 12 s, 15 s, 20 s, 1 min, 5 min, 15 min
Measurement intervals for ST	Manual; 1 s, 10 s, 20 s

1.2.2 Stimulator

Stimulus pulse	Square wave, constant current
Pulse width	100, 200 or 300 µs
Stimulus current range	10...70 mA with 5 mA steps
Stimulus current accuracy	10 % or ±3 mA whichever is the greater
Max. load	3 kΩ
Max. voltage	300 V

1.2.3 Regional block mode

Stimulation modes	Single twitch
Intervals	1 s, 2 s, 3 s
Stimulus pulse	Square wave, constant current
Pulse width	40 µs
Stimulus current range	0...5.0 mA with 0.1 mA steps
Stimulus current accuracy	20 % or 0.3 mA whichever is the greater

2 FUNCTIONAL DESCRIPTION

2.1 Measurement principle

2.1.1 Nerve stimulation

There are three stimulus modes in the NeuroMuscular Transmission Module: Train of Four (TOF), Double Burst 3,3 (DBS) and Single Twitch (ST).

In the Train of Four stimulus mode, four stimulation pulses are generated at 0.5 second intervals. The response is measured after each stimulus and the ratio of the fourth and first response of the TOF sequence is calculated (TOF%).

NOTE: If the first response does not exceed a certain signal level, TOF% is not calculated due to poor accuracy.

Double burst (3,3) stimulation includes two bursts with a 750 ms interval. Both bursts consist of three pulses separated by 20 ms intervals. The responses of both bursts are measured, and the ratio of the second and first response is calculated (DBS%). EMG responses are measured immediately after the first stimulus pulse of both bursts.

In Single Twitch stimulation, one stimulation pulse is generated. The response is measured after the stimulus. In order to prevent decurarization of the stimulated area, the measurement is automatically stopped after 5 minutes stimulation in 1 sec cycle time.

Tetanic/PTC

Tetanic/PTC (Post Tetanic Count) can measure deeper relaxation than TOF. The tetanic stimulation is produced when Start is chosen under Tetanic/PTC. The length of stimulation is 5 seconds. The stimulation generates pulses with a frequency of 50 Hz and with a selected pulse width and current. After tetanic stimulation and a three second delay, Single Twitch stimulation is produced to detect the post tetanic count (PTC). PTC describes the number of responses detected after tetanic stimulation. If there is no response, the measurement will be stopped. If responses will not fade away, a maximum of 20 responses will be calculated. If more can be detected, the PTC value is displayed only as '> 20' and measurement will be stopped. If the TOF, DBS or ST measurement cycle was on when tetanic stimulation started, the cycle will continue after the PTC. After completing the PTC measurement during 1 minute TOF, DBS or another PTC measurement is not possible. This is to avoid erroneous readings due to post tetanic potentiation.

2.1.2 Response

Before each stimulation, the sequence offset, noise and threshold for the response detection is measured. Offset is a baseline of the noise measurement. Noise is calculated by the same algorithm as the response signal itself. The response detection threshold is calculated based on the noise, and if the response is not greater than the threshold then it is interpreted as no response.

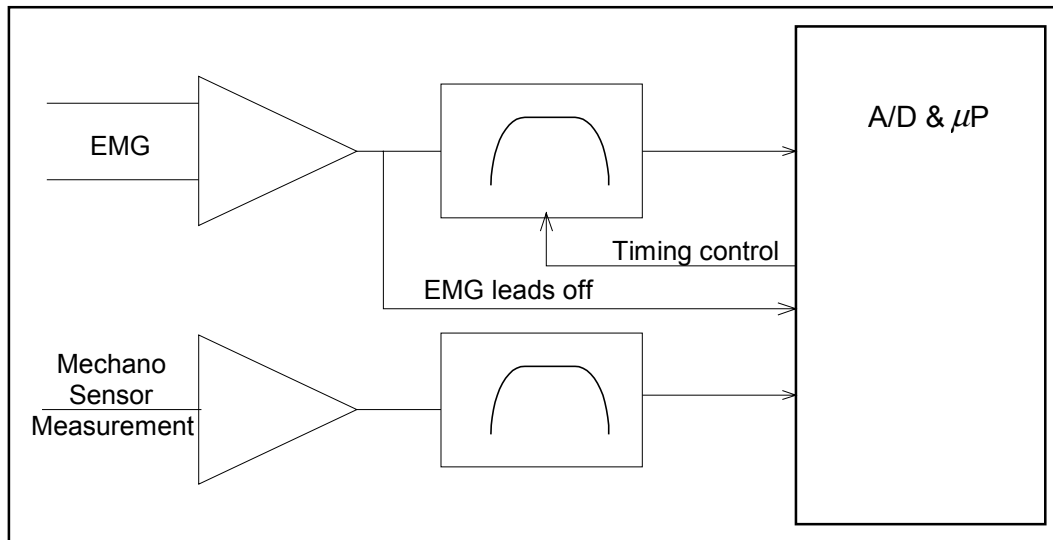


Figure 2 Principle of response measurement

EMG measurement

The EMG response is measured as integrated muscle activity. The EMG measurement starts 3 ms after the stimulation and lasts 15 ms. The 3 ms delay helps to prevent the effect of stimulation artifact.

Mechano sensor measurement

Response is measured as movement of the thumb, which is the area of positive signal.

2.1.3 Regional block

A regional block cable can be used as a nerve locator in local anesthesia. A maximum current of 5.0 mA is given every, every other or every 3rd second. The response measurement is ocular.

2.2 Main components

2.2.1 NMT board

The NMT Circuit Board consists of the following functional sections:

- constant current stimulator
- measuring electronics for the EMG signals

- microprocessor for the stimulation and measuring control, and for counting the measuring results
- serial communication

The serial bus speed is 500 kbps and the bus itself is half duplex, i.e. data can be transferred in both directions but only one way at a time.

Serial communication

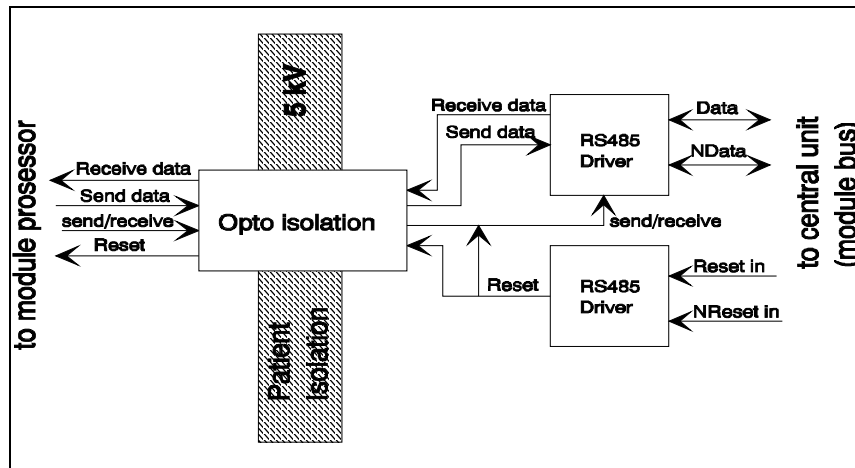


Figure 3 Serial communication and opto isolation

Stimulator

The constant current stimulator generates pulses whose amplitude is independent of the load. The main components of the stimulator are a transformer, a capacitor and a transistor. The transformer produces a high voltage which charges the capacitor and the transistor adjusts the pulse width and amplitude of the current.

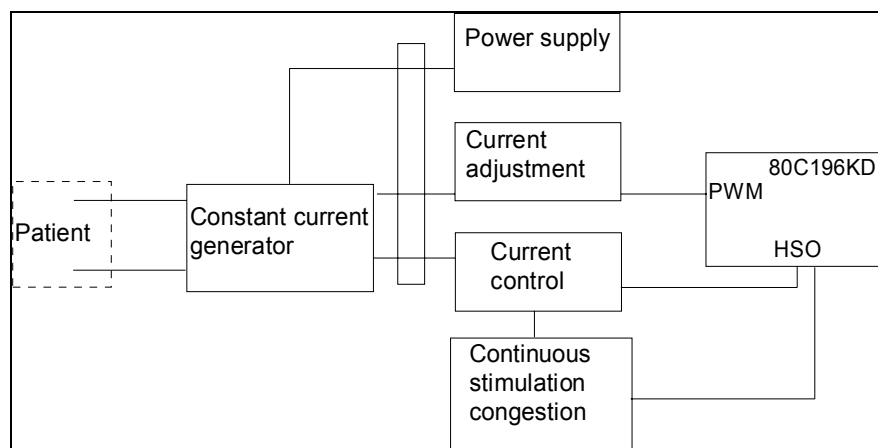


Figure 4 Stimulator block diagram

2.3 Connectors and signals

2.3.1 Module bus connector

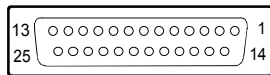
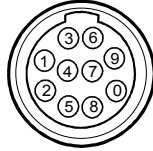


Table 1 **Module bus connector (X1)**

Pin No.	I/O	Signal
1	I	RESET_RS485
2	I	-15 VDC
3	I	+15 VDIRTY
4	I	+15 VDC
5	I/O	-DATA_RS485
6	I/O	DATA_RS485
7	-	Ground & Shield
8	I	-RESET_RS485
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13	-	Ground & Shield
14	I	+32 VDIRTY
15	I	GroundDIRTY
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20	-	ON/STANDBY
21	-	PWM_ECG
22	-	RXDD_RS232
23	-	TXDD_RS232
24	I	+5 VDC
25	I	+5 VDC

2.3.2 Front panel connector

NMT connector (NMT)



Pin No.	Signal
1	EMG Signal +
2	EMG Signal -
3	Not Used
4	Stimulus +
5	Stimulus -
6	Ground
7	Not Connected
8	Sensor Identification
9	+5 V
10	Mechanical Signal

3 SERVICE PROCEDURES

3.1 General service information

Field service of the NeuroMuscular Transmission Module, M-NMT, is limited to replacing faulty circuit boards or mechanical parts. Faulty circuit boards should be returned to Datex-Ohmeda for repair.

Datex-Ohmeda is always available for service advice. Please provide the unit serial number, full type designation, and a detailed description of the fault.

The Datex-Ohmeda NMT Stimulator (order code 871251) is recommended for functional checks.


CAUTION Only trained personnel with appropriate equipment should perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Service check

These instructions include complete procedures for a service check. The service check is recommended to be performed after any service repair. However, the service check procedures can also be used for determining possible failures.

The procedures should be performed in ascending order.

The instructions include a check form (Appendix A) which should be filled in when performing the procedures.

The mark  in the instructions means that the check form should be signed after performing the procedure.

The procedures are designed for monitors with S/5 monitor software of revision 01. However, most of the procedures also apply to monitors, which contain some other monitor software type/revision.

3.2.1 Recommended tools

Tool	Order No.	Notes
NMT simulator	871251	
M-NMT ElectroSensor		
M-NMT MechanoSensor		
M-NMT Sensor Cable		
3 k Ω resistor		
Screwdriver		

- Detach the module box by removing the two screws from the back of the module. Be careful with the loose latch and spring locking pin.

1. Check internal parts:

- screws are tightened properly
- cables are connected properly
- the EMC cover is attached properly
- there are no loose objects inside the module



2. Check external parts:

- the front cover and the front panel sticker are intact
- connectors are intact and are attached properly
- the module box, latch and spring locking pin are intact



- Refit the module box and check that the latch moves properly.

- Turn the monitor on and wait until the normal monitoring screen appears.
- Configure the monitor screen so that information regarding the NMT measurement is shown, for example:

Monitor Setup - Screen 1 Setup - Digit Fields - Field 4 - Nmt

- Preset the NMT measurement settings:

Others - NMT - Stimulus Mode - TOF

Set Cycle Time - 10 sec

NMT Setup - Current - S(70 mA)

Pulse Width - 200 μ S

Stim. Beep Volume - 2

3. Plug in the module. Check that it goes in smoothly and locks up properly



4. Check that the module is recognized, i.e. the NMT header with related information appear in the chosen digit field.



5. Enter the service menu:

Monitor Setup - Install/Service (password 16-4-34) - Service (password 26-23-8)

Take down the information regarding NMT software by selecting SCROLL VERS and turning the ComWheel.



6. Enter the NMT module service menu:

Parameters - NMT

Check that the “Timeouts”, “Bad checksums” and “Bad c-s by mod” values are not increasing faster than by 50 per second. Check that the module’s memories have passed the internal memory test, i.e. “RAM”, “ROM” and “EEPROM” all state OK.



7. Check the front panel START-UP and STOP/CONTINUE membrane keys.
Press each key for at least one second and check that the key being pressed is identified, i.e. the color under the corresponding text on the menu turns blue.



8. Check that the message "Cable off" is shown in the digit field and that "Cable" in the service menu states OFF.

Plug the M-NMT Sensor Cable with the M-NMT ElectroSensor into front panel connector NMT. Check that the message in the digit field changes to "Measurement OFF" and "Cable" on the service menu states EMG and ELECTR. OFF.



9. Perform the stimulus current test.

Connect a 3 k Ω resistor between the ElectroSensor's stimulus electrode leads (brown and white).

Start the test by highlighting START CURR. TEST on the service menu and pressing the ComWheel. Check that the test was successful with all three test currents, i.e. the "Current test (mA):" on the menu states 30 OK, 50 OK and 70 OK.



- Connect the M-NMT ElectroSensor leads to the NMT simulator. Set the switch on the simulator to "Fade off" and turn the knob to "max". Check "Cable" on the service menu now states only EMG.
10. Start NMT measurement (TOF) by pressing the START-UP key on the module.

When the message "Supramax search" changes to "Setting reference" in the digit field, check that the supramaximal current detected is less than 70 mA, i.e. the "Current set" value on the service menu is less than 700.



11. Check that the module gives four successive stimulus pulses with 10 second intervals. A small asterisk (*) should be shown in the digit field during each of the stimulus pulses and simultaneous sound signals should be heard from the loudspeaker.

Check that on the service menu the values for "T1%", "T2%", "T3%", "T4%" and "Ratio%" are all within 950-1059.

Check also that in the digit field the "TOF%" value is within 95-105, "Count" is 4 and "T1%" is within 95-105.



12. Check that the "Noise" value on the service menu stays under 50.



13. Change the stimulus pulse width to 100 μ S through the NMT service menu:

NMT Setup - Pulse Width - 100 μ S

Check that the "TOF%" value is still within 95-105, "Count" is 4 and "T1%" is within 95-105 in the digit field.

Check the same parameters with a stimulus pulse width of 300 μ s.



14. Turn the knob on the NMT simulator to "0".

Check that on the service menu the values for "T1%", "T2%", "T3%", "T4%" turn to 0 and the "Ratio%" states - - -. In the digit field "TOF%" should also state - - -, and "Count" and "T1%" should show 0.

Turn the NMT simulator knob back to "max".



15. Change the stimulus mode to Double Burst Stimulation (DBS) through the service menu:

NMT Setup - Stimulus Mode - DBS

Check that the module now gives only two stimulus pulses with a 10 seconds interval.

Check that on the service menu the values for "T1%", "T2%", and "Ratio%" are still within 950-1059. In the digit field the "DBS%" value should be within 95-105, "Count" is 2 and "T1%" is within 95-105.



16. Change the stimulus mode to Single Twitch Stimulation (ST):

NMT Setup - Stimulus Mode - ST

Check that the module starts to give only one stimulus pulse with a 1 second interval. Note the time when the ST stimulation started.

Check that on the service menu the value for "T1%" is within 950-1059. In the digit field the "Count" value should be 1 and "T1%" within 95-105.

Let the monitor continue to give single twitch stimulation.



17. Check that the NMT measurement stops and the message "Measurement OFF" appears in the digit field for NMT five minutes after the start of the ST stimulation.



18. Replace the M-NMT ElectroSensor with the M-NMT MechanoSensor and check that "Cable" on the service menu states PIEZO.



19. Perform an electrical safety check and a leakage current test.



20. Check that the module functions normally after performing the electrical safety check.



21. Clean the module with suitable detergent.



- Fill in all necessary documents.

3.3 Disassembly and reassembly

Disassemble the NeuroMuscular Transmission Module, M-NMT, in the following way. See the exploded view of the module.

1. Remove the two screws from the back of the module.
2. Pull the module box slowly rearward and detach it from main body. Be careful with the loose latch and spring locking pin.
3. Detach the NMT board by removing the two screws located near the front panel frame, disconnect the cables and pull out the front panel frame.

To reassemble the module, reverse the order of the disassembly steps.

CAUTION When reassembling the module, make sure that the cables are reconnected properly.

4 TROUBLESHOOTING

4.1 Troubleshooting chart

Trouble	Cause	Treatment
Check the stimulus electrodes. EMG electrode off.	Loose electrodes or loose stimulus clip.	Change or attach the electrodes or clip.
Supramax. not found.	Loose electrodes or loose stimulus clip. Stimulus electrodes attached to wrong place. Patient is relaxed.	Change or attach the electrodes or clip. Change the place of the stimulus electrode.
Response too weak.	Loose stimulus electrodes. Measuring electrodes attached to wrong place. Patient is relaxed.	Change or attach the electrodes. Change the place of the meas. electrodes.
Ref. not stable.	Patient is relaxed. Movement artifact.	

4.2 Troubleshooting flowchart

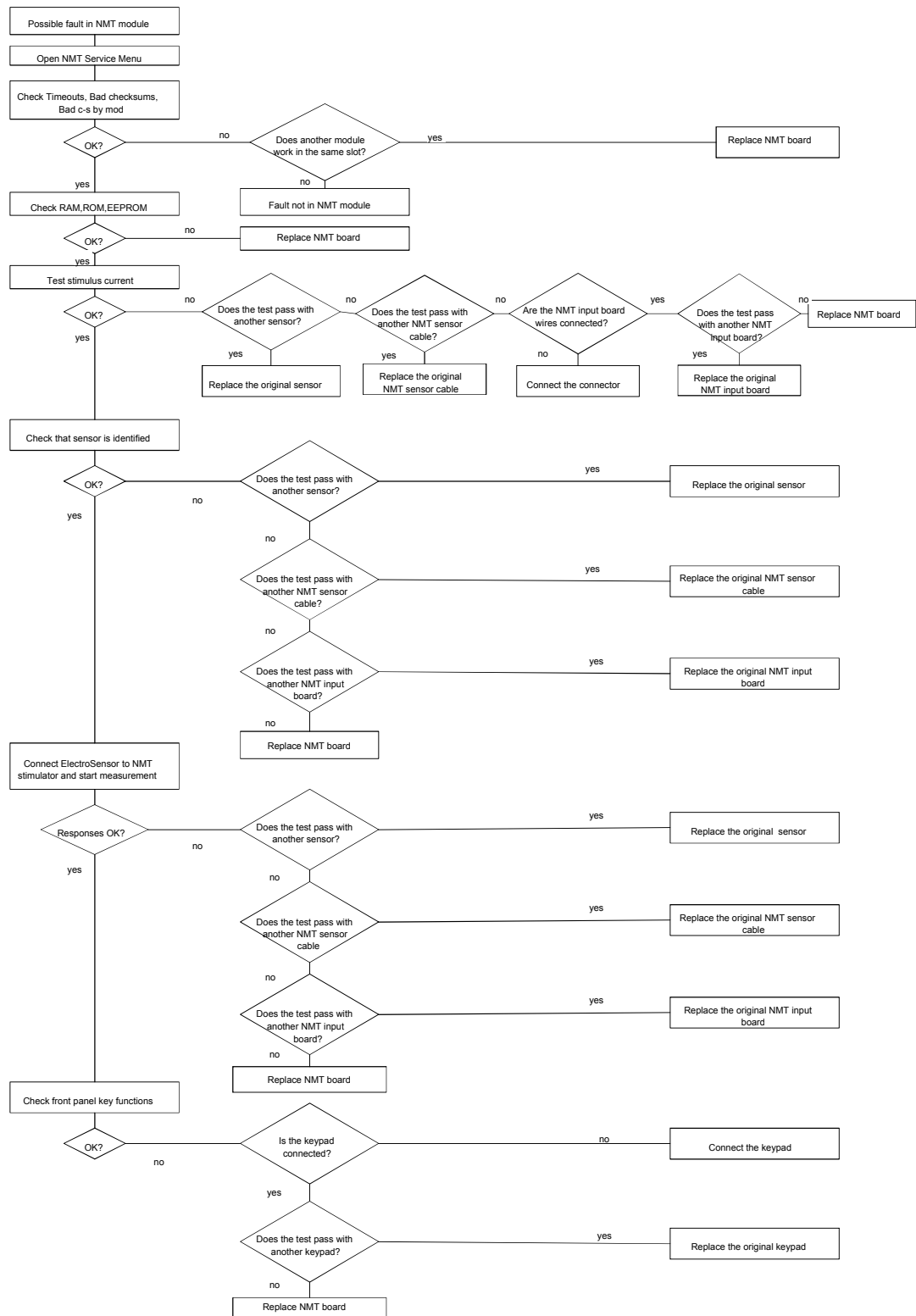
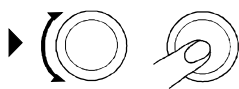
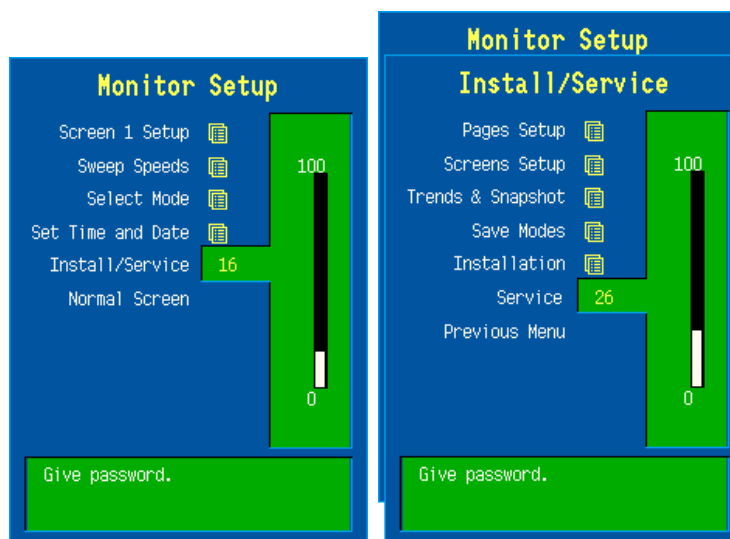


Figure 5 Module troubleshooting flowchart

5 SERVICE MENU



1. Press the **Monitor Setup** key.
2. Select **Install/Service** (password 16-4-34).
3. Select **Service** (password 26-23-8).
4. Select **Parameters**.
5. Select **NMT**.

5.1 NMT menu

NMT		Service Data			
NMT Setup		Cable:	EMG		
Start Curr. test		Cable check value:	1		
T1%/ref	3	Module keys:	Start-up	Stop/Cont.	
Record Data		Stimulus mode:	TOF	Measurement:	OFF
Previous Menu		T1%	1002	Absolute T1	6300
		T2%	684	Absolute T2	4302
		T3%	518	Absolute T3	3256
		T4%	321	Absolute T4	2018
		Ratio%	320	Ref	6282
		Noise	2		
		Offset	2520		
		Curr set	233	Curr meas	234
		Pulses	61		
		Piezo probe:	T1% OFF	Ref.search	ON
		Timeouts	0	RAM	OK
		Bad checksums	0	ROM	OK
		Bad c-s by moc	0	EEPROM	OK

Start Curr. test **Start Curr. test** is a test where the module itself checks the difference between a given current and the measured current. A 3 k Ω resistance should be connected between the stimulus electrodes before starting the test. All the currents checked will be displayed on the service data screen. After the current value, the status of the test is shown. If the test is not passed, send the module back to the factory for calibration.

T1%/ref **T1% / ref** gives a selection for changing settings related to the M-NMT MechanoSensor. A setting of **3** should always be used for normal monitoring. The settings **1** and **2** are for research purposes only.

Record Data **Record Data** prints out the displayed service data and circuit board information (id., serial number, and software id.) onto the Recorder Module, M-REC.

Service Data **Cable** shows the type of cable being used.

Cable check value shows the bit amount. From the following chart you can check the value for each cable:

EMG	-100...+100
Cable OFF	>1950
Piezo	900...1100
Regional block	600....800

Module Keys checks the function of the module keys. A blue background appears at the back of the text when a key is pressed for more than one second.

Stimulus mode shows the selected stimulus. Stimulus mode can be changed using the NMT Setup menu.

Measurement indicates ON/OFF.

T1%, T2% shows the measured response. A value of 1000 corresponds to 100%.

Absolute T1, T2 shows the voltage measured from the A/D converter.

Noise indicates the interference just before the measurement. A typical value is <10.

Offset is an average of the noise measurement. A typical value is 510.

Curr set is the selected current, a value of 700 corresponds to 70 mA.

Curr meas is the measured current, a value of 700 corresponds to 70 mA.

Pulses indicates pulses the module has produced.

Piezo probe T1% and ref. search shows information related to the MechanoSensor settings.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.

Bad checksums is a cumulative number that indicates how many times communication from the module to the monitor has failed.

Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.

The monitor starts counting these items at power up and resets to zero at power off. The non-zero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure, or module not in place. Also, other modules can cause communication errors that cause these numbers to rise.

RAM indicates the state of the RAM memory.

ROM indicates whether the checksum in the EPROM is in accordance with the software calculated value.

EEPROM indicates if the values stored in the permanent memory are valid.

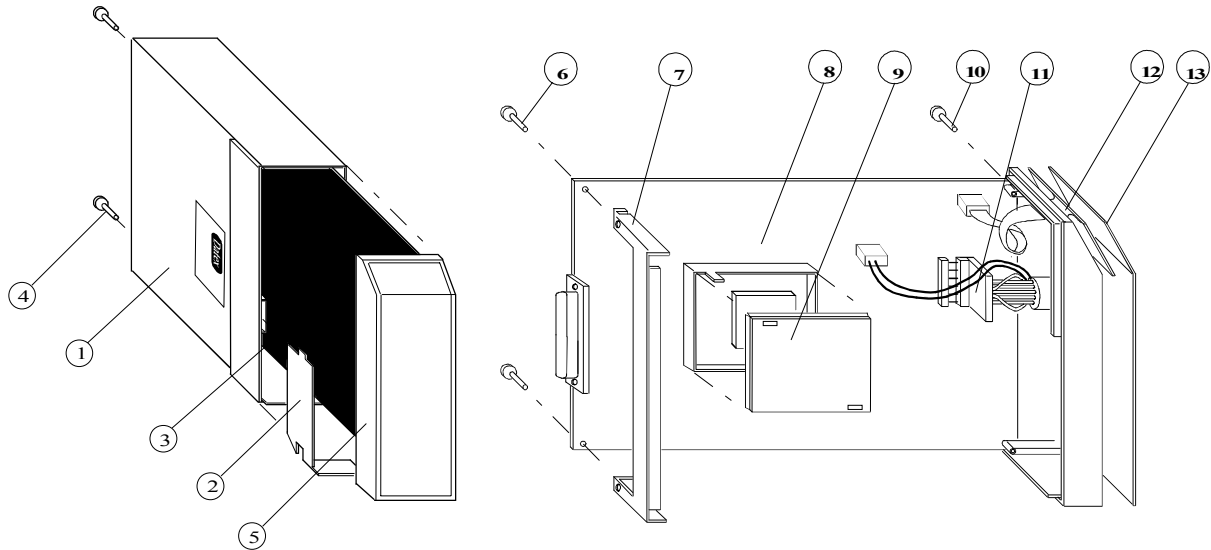
The state is either **OK**, **Fail** or **?** (module not in place or a communication error).

6 SPARE PARTS

6.1 Spare part list

NOTE: Accessories are listed in the *Patient Monitor Supplies and Accessories*.

6.1.1 NMT Module, M-NMT rev. 00



Item	Description	Order No.	Item	Description	Order No.
1	Module box (single width)	886167	8	NMT board, M-NMT (Rev. 00-01)	*887487
2	Latch	879181	9	EMC cover, M-NMT	886320
3	Spring pin	879182	10	Cross cylinder-head screw M3x12	628700
4	Cross recess screw M3x8 black	616215	11	NMT input board	887184
5	Front panel unit, M-NMT	887186	12	Membrane keypad	880101
6	Cross cylinder-head screw M3x6	61721	13	Front panel sticker, see 6.1.3	-
7	Metal frame	879184	-	-	-

The front panel unit includes the connector and input board.

* this part is recommended for stock

6.1.2 NMT Module, M-NMT rev. 01

No new spare parts.

6.1.3 NMT Module, M-NMT rev. 02

No new spare parts.

6.1.4 Front panel stickers for AS/3 modules (square buttons)

Front panel stickers that are related to the Compact Module type and adaptation:

Adaptation codes: DA=Danish, DE=German, EN=English, ES=Spanish, FI=Finnish, FR=French, IT=Italian, JA=Japanese, NL=Dutch, NO=Norwegian, PT=Portuguese, SV=Swedish

Item 13.

Adaptation	M-NMT (rev. 00-01) Order No.
DA	892217
DE	886003
EN	886002
ES	887498
FI	888873
FR	886004
IT	887542
JA	888318
NL	887370
NO	893572
PT	895240
SV	887369

6.1.5 Front panel stickers for S/5 modules (round buttons)

Front panel stickers that are related to the Compact Module type and adaptation:

Adaptation codes: DA=Danish, DE=German, EN=English, ES=Spanish, FI=Finnish, FR=French, IT=Italian, JA=Japanese, NL=Dutch, NO=Norwegian, PT=Portuguese, SV=Swedish

Adaptation	M-NMT (rev. 02) Order No.
DA	898846
DE	898837
EN	898836
ES	898840
FI	898843
FR	898838
IT	898841
JA	8000383
NL	898839
NO	898845
PT	898842
SV	898844

7 EARLIER REVISIONS

This manual also supports earlier module revision 00.

APPENDIX A

SERVICE CHECK FORM

NeuroMuscular Transmission Module, M-NMT

Customer			
Service		Module type	
		S/N	
Service engineer		Date	



OK = Test OK



N.A. = Test not applicable



Fail = Test Failed

	OK	N.A.	Fail		OK	N.A.	Fail
1. Internal parts	<input style="width: 30px; height: 20px; border: 1px solid green;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	2. External parts	<input style="width: 30px; height: 20px; border: 1px solid green;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>
3. Installation	<input style="width: 30px; height: 20px; border: 1px solid green;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	4. Recognition	<input style="width: 30px; height: 20px; border: 1px solid green;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>
5. Module software	NMT						
6. Communication and memories	<input style="width: 30px; height: 20px; border: 1px solid green;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	7. Membrane keys	<input style="width: 30px; height: 20px; border: 1px solid green;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>
8. ElectroSensor recognition	<input style="width: 30px; height: 20px; border: 1px solid green;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	9. Stimulus current test	<input style="width: 30px; height: 20px; border: 1px solid green;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>	<input style="width: 30px; height: 20px; border: 1px solid red;" type="checkbox"/>

10. Supramaximal current		< 70 mA
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11. TOF measurement with NMT simulator

T1%		950-1059
T2%		950-1059
T3%		950-1059
T4%		950-1059
Ratio%		950-1059
TOF%		95-105
Count		4
T1%		95-105
12. Noise		< 50

13. Stimulus pulse width

	100 μ s	300 μ s	Allowed range
TOF%			95-105
Count			4
T1%			95-105
	OK	N.A.	Fail
14. No response	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15. DBS measurement with NMT simulator

T1%		950-1059
T2%		950-1059
Ratio%		950-1059
DBS%		95-105
Count		2
T1%		95-105

16. ST measurement with NMT simulator

T1%		950-1059
Count		1
T1%		95-105

17. Automatic measurement off	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	18. MechanoSensor recognition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Electrical safety check	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	20. Functioning after electrical safety check	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Final cleaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				

Notes

Used Spare Parts

Signature
